Human and Organisational Factors in Perspective

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ABSTRACT

The paper gives a description of three recently initiated activities to look at human factors (HF) and organisational factors (OF) in perspective. The first activity is concerned with HF and nuclear power that will result in a book published by Elsevier. The second activity refers to a conference held 1986 in Knoxville, Tennessee as a point of departure to assess impacts of the Chernobyl accident on HF/OF activities in the nuclear power industry. The third activity takes LearnSafe, which was an EU-project running from 2001 to 2004, as a baseline to consider what has changed in the HF/OF field during the last fifteen years. The activities bring development of the HF/OF area in perspective to elucidate development needs for ensuring a continued safety of our NPPs.

1 INTRODUCTION

A common observation after large accidents is that there have been precursors that were not reflected properly in attempts to enhance safety. One may as an example take the TMI accident in 1978, which identified training, operating procedures and deficiencies in applying lessons learned from previous accidents [1]. This document refers in more than sixty places to deficiencies in the control room as contributing causes to the accident. Considering presentations on the NATO conference in Brechtesgaden, Germany in 1976 [2], a fair conclusion is that several papers pointed to problems that afterwards were described in the Kemeny report.

From the Kemeny report one may pick the following citation "To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures, and practices -- and above all -- in the attitudes of the Nuclear Regulatory Commission and, to the extent that the institutions we investigated are typical, of the nuclear industry". Investigations also revealed problems with "system" that manufactures, operates, and regulates nuclear power. Findings included structural problems in organisations, deficiencies in processes, and a lack of communication among key individuals and groups. A question today is whether or not these fundamental changes have been accomplished. This sets goals and targets for HF/ OF activities in nuclear power plant (NPP) design, operation and regulatory control.

The impact of the TMI accident was large in the whole Western world. In the United States the accident started work in modifying control rooms, existing requirements and guidance. The document NUREG-0737 gives an appreciation of the tasks the industry in the United States was confronted with [3]. The list includes HF/OF issues, such as for example needs to do control room assessments, to update operational instructions and to establish positions of shift technical advisors to support control room operators. The development efforts to improve existing control rooms resulted in several standalone operator support systems that were marketed by major reactor vendors.

The development in the Western countries followed closely what was happening in the United States and national regulatory systems were updated together with necessary changes in facilities and organisations. In the Soviet Union however, the TMI-accident was mostly seen as evidence of the supremacy of the communistic system.

In this article we describe three activities we are involved in, which give perspectives on HF/OF activities in Finland. The first has to do with a project initiated by one of us (AMT), which aims at writing a book on HF in the nuclear industry [4]. The second has to do with an assessment of papers presented at a conference of the American Nuclear Society in 1986 [5]. The third activity is an activity where two of us (BW, RG) are involved, which aims at assessing how the results of the LearnSafe project [6] have been used. The activities give us a possibility to assess how HF/OF activities after the accidents of TMI, Chernobyl and Fukushima have been applied.

2 HF IN A CONTEXT OF NPPs

Two of us (BW, AMT) participate in the preparation of the book on HF and nuclear power [4]. In one of its introductory chapters the history of HF in Finland is briefly described. Credit is given to engineers in Imatran Voima Oy (IVO, presently Fortum) and ASEA Atom for the control room design in the Loviisa and Olkiluoto NPPs. The NPPs also gained largely by Finnish companies in the manufacturing industries, such as Ahlström, Nokia, Strömberg, Tampella and Wärtsilä.

The TMI-accident had in Finland relatively minor impacts. It was clear that the four reactors would be finished and taken into operation. Regulatory practices were influenced and several studies were carried out to assess possible problems, but already a cursory assessment made it clear that the control rooms in Loviisa and Olkiluoto NPPs were far better than the worst control rooms in the United States.

The Technical Research Centre of Finland (VTT) was already in 1970 involved in simulation studies, which aimed at ensuring a high technical operability of the Loviisa NPP. This work was extended to the planning for, acquirement of and model development to the Loviisa full scope training simulator.

That background fitted well into the Nordic Nuclear Safety Research (NKS) research programmes that in the KRU-project in 1977-1981 took a close look on control room design, human reliability and operator training. Based on these early efforts in cooperation with Denmark, Norway and Sweden a strong HF/OF knowledge centre at VTT was established. Working contacts have later over the years been unfolding with other institutions such as Aalto University and the Finnish Institute of Occupational Health (TTL).

Today a working platform for HF/OF research activities has been created within the Finnish SAFIR-programme [7], with which nuclear power companies (Fortum, TVO, Fennovoima) and the Finnish nuclear authority (Radiation and Nuclear Safety Authority, STUK) have good connections. The funding for SAFIR-programme in the period 2015-2018 was nearly 30M€ of which the largest share (60%) came from the Finnish Nuclear State Waste Fund (VYR) . A new SAFIR research period was started this year (cf. http://safir2022.vtt.fi/).

3 AFTER CHERNOBYL

We take the conference of American Nuclear Society in Knoxville, Tennessee 1986 [5] as an anchoring point of the state of HF/OF in the nuclear field before the Chernobyl accident. The conference attracted some three hundred people from the United States, Canada, Europe and Japan. More than seventy papers were presented in twelve sessions, of which the HF/OF-area was targeted in all sessions, with topics such as human modelling, intelligent systems, organisational issues, innovative applications and training systems. The concept of safety culture was conspicuous by its absence.

The Chernobyl had a large impact on the whole world. IAEA convened a post-accident review meeting on the Chernobyl Accident in Vienna from 25 to 29 August 1986. This meeting resulted in a report INSAG-1, which was published in September 1986. It included a detailed account of the accident and its causes. Due to the openness of the delegation from the Soviet Union it gave a basis for an accurate physical understanding of the accident. The report was later updated in 1992 [8]. The understanding of design weaknesses helped in backfitting the fleet of RBMK reactors. Presently several RBMK reactors have been shut down and all new builds have been cancelled. Russia however intends to operate some of its RBMK reactors towards 2030 and beyond.

Reading an account of the social impacts of the accident, a horrible story is opening [9]. Apparently the plant had not made preparations for emergencies. The control room operators had deficient understanding of reactor dynamics. The experiment was conducted in spite of indications that it should not be continued. Emergency teams called in to fight the fire had no information on the radiation they were exposed to. Evacuations were delayed several days because none had the authority to make the necessary decision. Two conflicting parties in Moscow were formed on the need to inform the international community on details of the accident. Communist hardliners argued for a complete secrecy and Legasov with supporters for a complete openness. Fortunately for the success of the IAEA meeting in August his opinion won, but caused his total disgrace in the Soviet Union. Some political historians have argued that the Chernobyl accident was the final nail in the coffin of the Soviet Union.

International cooperation resulted in the INSAG-3 published in 1988, which has been updated in the INSAG-12 document [10]. The largest impact on HF/OF activities of the Chernobyl accident was the introduction of safety culture. The concept was described by IAEA in the report [11] and it got an immediate acceptance all over the world. A response of the academic world can be seen for instance in a search of the journal Safety Science, which starting from 1995 gives more than a thousand hits. A recent article [12] gives an account of different aspects of safety culture and their relations in the academic discussions since 1986 to the present.

A consequence in Finland was that a nearly ready application for a Decision in Principle (DiP) of a fifth plant was shelved. Discussions were opened up again in 1993, but the political scene was still not ready. However in 2002 the Finnish Parliament accepted the application of a DiP by TVO to build a new plant in Olkiluoto.

The Chernobyl accident had a large influence on the third NKS-programme (1985-89) both regarding reactor safety and radiation protection. The HF/OF-activities were directed to systems of emergency management in the INF-project [12], which investigated improved performance in emergency management by the use of modern information technology.

4 LEARNSAFE REVISITED

Two of us (BW, RG) have started a small project that aims at considering changes in the HF/OF-area that have happened in the nuclear field since 2004. The project has a background in the EU-project "Learning organisations for nuclear safety", which during the years 2001 until 2004 was operated by a consortium consisting of five research organisations and nine associated contractors from the nuclear industry [9]. The reporting from the project was partly closed for the project participants only, but in the beginning of 2018 project results were placed in the open domain (http://dy.fi/4wo). Project results from 2004 can be seen as a snapshot of NPP views, challenges and practices at that time.

The Fukushima-accident is by far the event with the largest impact on the nuclear field since 2004. On the political scene it nearly killed all aspirations on a renaissance for nuclear power. In Germany it caused the so called Energiewende, which implies that the fleet of nuclear reactors in Germany will be phased out by 2022. It caused major investigations and assessments of nuclear safety in all plants over the world, which in Europe took the form of stress tests that were carried out and reported to licensing bodies. The stress tests did however not say much about HF/OF issues.

Considering international activities since 2004, it is fair to say that the safety standards of IAEA, which at that time were mostly a structure with some documents, is now almost complete. This has been a commendable effort. National authorities have followed up with updates of national regulatory systems. STUK in Finland for example completed a major revision of their YVL-requirements in 2013. These activities have resulted in a burden on all NPPs in the world to reflect new requirements on their management systems, which in turn set requirements on HF/OF activities.

In a broader context one may say that the results of the LearnSafe project were applied systematically only in Sweden. Efforts to initiate a follow up research project within the Euratom framework were turned down in project evaluations. Vattenfall explored possibilities for a cooperation between power companies in Finland and Sweden, but also this initiative was unsuccessful. Vattenfall then decided that follow up activities could be funded internally and a Safety Management Institute (SMI) was established. It supported education and training of managers at all levels in Forsmark and Ringhals and it was also engaged in supporting Vattenfall's hydro power facilities.

In 2010, i.e. before the Fukushima accident, nuclear power was once more discussed in the Finnish Parliament. This time three applications for new plants were brought to the table. Fortum applied for a DiP for a third reactor at the Loviisa site, TVO for a fourth reactor at the Olkiluoto site and a newcomer Fennovoima Oy for a plant on a new site. Of these only TVO's and Fennovoima's applications were approved. This implies that nuclear power will supply electricity to the Finnish grid until late 2080s, a considerable time period to be planned for.

In Sweden additional reactors have been and are to be shut down, two in Oskarshamn at 2015 and 2017 and two in Ringhals at 2019 and 2020. Finland and Sweden have taken divergent routes concerning nuclear power.

5 CONCLUSIONS

In a perspective one can conclude that it has been difficult for the nuclear industry to incorporate HF/OF activities in design, operation, regulation and as established parts of organisational development. Looking at the situation in Finland today we think that problems have been bridged, which can be seen in a willingness of NPPs to apply HF tools for safety assessments [14]. However, there are still many challenges remaining for HF/OF activities, such as lack of structured conception of HF/OF itself, leading to inadequate use of existing knowledge and tools as a part of safety management, e.g. in risk assessments, reporting, analysis and learning from operational events.

We believe that shortcomings in identifying and correcting problems when only indications for their seriousness exist, are related to difficulties in assessing likelihood and costs of associated plant excursions. The accidents discussed above can in retrospect be seen as system defects waiting for their discovery in an incident or accident.

A cynical view on activities of the nuclear industry is that whatever happens, the argument is that accidents are impossible. We believe that this is not true anymore and that the industry is willing to admit that accidents are possible. One may reflect this discussion on the academic discourse of theories of "normal accidents" and "high reliability organisations". In our understanding available HF/OF theories and models present sound arguments and should not be seen as conflicting. Instead applying theories, models, methods and tools in practice, can ensure that NPPs with knowledge and experience that already is available, can be made reasonable safe and economically feasible [15].

We think that the three accidents considered above, clearly show that an accident anywhere is an accident everywhere. The common reason for the accidents were that HF/OF related issues were not sufficiently taken into account. In addition complacency and production pressures had their own shares in the forces that brought the facilities from being a valuable asset to a large liability in just a few catastrophic hours.

It has been argued that sociotechnical system present so called wicked problems for decision makers [16]. A question is whether or not system thinking together with proper HF/OF considerations can provide theories, models, methods and tools to help in combating some of the wickedness in the problems NPPs are forced to address. One thing is however for sure, the HF/OF area will for its continued development rely on an open and candid communication between engineers, behavioural scientists and managers.

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