Safety culture in the construction phase – lessons learned from Olkiluoto 3

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- Section 28, Safety culture

“When designing, constructing, operating and decommissioning a nuclear power plant, a good safety culture shall be maintained. The decisions and activities of the management of all organisations participating in the above mentioned activities shall reflect its commitment to safety-promoting operating methods and solutions. Personnel shall be motivated to perform responsible work and an open working atmosphere shall be promoted in the working community to encourage the identification, reporting and elimination of factors endangering safety. Personnel shall be given the opportunity to contribute to the continuous enhancement of safety.”
Olkiluoto 3 nuclear power plant project in a nutshell (1)

- **December 2003**: Turn-key contract signed between TVO and Consortium Framatome NP (current name Areva NP) - Siemens
- **February 2005**: Government granted the construction permit, the construction started soon after
- **2009**: Original schedule for fuel loading
- **2012**:
  - At the present time installations and testing are on-going
  - Declared delay at least 5 years
  - Extra costs ? Billion euros
  - Arbitration in progress

Photo: TVO
Olkiluoto 3 nuclear power plant project in a nutshell (2)

Some figures from 2010:

- around 2000 subcontractor companies from almost 20 countries involved
- long supply chains, eg 4-tier contracts
- 15 000 individuals have participated to the induction training to work at the construction site
- some 20 different languages spoken on site…
My (biased) view of the OL3 project:
The regulator initiated activities to study the safety culture and human factors issues in the OL3 project

- **2006: Investigation** of the management of the safety requirements in subcontracting. (compliance with the procedures of selecting and supervising subcontractors, attitudes of the management towards the non-conformances and inspections, training of subcontractors on safety culture)

- **2007: a research project** on how subcontractors understand the safety significance of their work (challenges in the welding of the containment steel liner)

- **2008: a special inspection** on the safety culture at the construction site (former Areva supervisor went public with his safety concerns because he felt they were swept under the carpet)

- **2009: a follow up inspection** on the safety culture measures taken by the licensee (A year before the licensee was required to develop a systematic way of following the safety culture on site)

- **2010: a follow up inspection** at the construction site
An example of possible safety culture issue at OL3: Concreting the reactor building base slab 2005

- Multiple organizations participated in specifying and testing the concrete mixture, as well as in the preparation and conducting the concreting of the reactor base slab during 2005. The regulator followed the process carefully.

- However, the concrete composition was changed during the pouring (to prevent repeated pump jams and to prevent drying of the concrete during the work).

- Information about the change in the concrete mixture was conveyed to the licensee and to the regulator months later (when the results from the quality of the final concrete arrived).

- Vivid discussion and argumentation on whether the quality requirements were adequately followed, and if all parties understand the principles of nuclear safety.
Some lessons learned from OL3 project

- The Olkiluoto 3 project in Finland revealed that in the beginning of the project the licensee, the vendor, as well as the regulator, had difficulties in establishing a shared view of the concept of safety culture in pre-operational stages.
  - The IAEA definition of safety culture had been somewhat challenging even for the operating units to operationalize. The organisations were in the process of making sense of what do all the characteristics of a good safety culture mean in practice.
  - In a new build project the nuclear hazards are distant and intangible, especially for the construction stage. The nuclear material is not on the site – do the nuclear safety culture principles still apply? Is a NPP construction project any different from e.g. building a shopping mall?
  - A new build project is a network activity. Whose safety culture should be followed? Who is responsible for creating it?
  - What level of safety culture can be expected from small subcontractor companies that work mainly for other industries?

The issue of developing a good safety culture is tightly coupled with the question of how to manage complex projects in general.
Researchers’ viewpoints on safety culture challenges at OL3 construction stage (1)

- **The complexity and the size of the network** was underestimated by all parties, thus there was insufficient attention paid for developing shared cultural characteristics and practices at the beginning of the project.
- The need to **know the local requirements and practices** as well as understanding of the impact of national culture differences was not emphasized strongly enough since the beginning.
- **The quality management approach** was applied but due to the complexity of the project it soon became reactive. The traditional quality management process did not work well enough in ensuring the expected performance in the network.
  - Soon after the start of the construction work there were hundreds of non-conformances in the quality management data system. Not enough resources to form an overview of the problems, one-by-one approach was ineffective.
  - Mixed findings from different audits and QC inspections. Vendor’s findings did not always correspond with licensee’s and regulators findings.
  - TVO (the power company) has a mediated contact with the subcontractors and the construction site (turn key contract), long communication chain slows down tackling of the problems.
Researchers’ viewpoints on safety culture challenges at OL3 construction stage (2)

- The licensee, vendor and regulator seemed to share a set of cultural assumptions, which were fairly mechanistic (typical for nuclear industry?) and did not capture well the social aspects of the network:

  - An assumption that management systems (the written documents) and work specifications describe the reality of different organizations and activities
    
    “Everybody speaks English because it’s the official language of the project”

  - An assumption that everybody knows what nuclear safety is
    
    “When they come here and see the two running reactors they know nuclear safety is important”

  - An assumption that construction workers don’t have to make ad hoc interpretations and local judgments in their work
    
    “Workers are not here to evaluate the design and procedures, they are here to do good welds”

  - An assumption that safety and economic issues can be tackled separately
    
    “Contracts (commercial agreements) do not affect the contractors working practices, thus the regulator doesn’t need to have access to the contracts”
Towards establishing a good safety culture

- VTT’s research group saw the need to specify the criteria for good safety culture more clearly and to add some missing characteristics into the existing safety culture models.

- According to the VTT’s DISC model, an organization has good potential for safety (safety culture) when the following 6 criteria are fulfilled:
  1. Safety is a genuine value in the organization and is reflected in decision making and daily activities;
  2. Safety is understood as a complex and systemic phenomenon;
  3. Hazards and core task requirements are understood thoroughly;
  4. The organization is mindful in its practices;
  5. Responsibility is taken for the safe functioning of the entire system;
  6. Activities are organized in a manageable way.
The three cornerstones of safety culture
(Reiman and Oedewald, 2009)

Safety culture is not only about the safety conscious mindset or good systems and structures which create preconditions for high quality work. Safety culture is largely dependent on the organisational and individual knowledge and understanding of the hazards and safety consequences of the work.

Mindset which shows that safety is valued and responsibility for it is taken

Understanding and knowledge of the hazards and one’s contribution to safety

Systems and structures which create good preconditions for daily work

Safe activities
Conclusions (1): Safety culture in new builds - the question of appropriate safety culture model

- All the six safety culture criteria specified in the DISC model apply in the design stage as well as the construction stage. Also IAEA has drafted a publication “Safety Culture in pre-operational stages”.

- When starting a safety culture program or development initiative, pay attention to the following:
  - Traditional safety culture *improvement approaches* emphasize the mindset part of safety culture.
  - Safety management approaches emphasize the structures and systems to create good preconditions for safety.
  - Both of these practical approaches tend to take the *understanding part* as self evident.

- In the new builds there are organisations with limited experience of nuclear power industry, limited knowledge on nuclear safety hazards, accident scenarios and related safety principles and no prior knowledge of country specific circumstances.

Without understanding and knowledge organisations may not work optimally with safety issues even though they might have positive safety mindset and good technical and organisational prerequisites.

All the three cornerstones of safety culture are needed!
Conclusion (2):
Safety culture in new builds – the question of national culture

Could safety culture be the same in different national contexts?

- We state that the **basic principles should be universal** (e.g. the five IAEA characteristics or the six safety culture criteria in the DISC model) **but the roadmap to achieve those is likely dependent on the characteristics of the national culture**
  - Mindfulness, alertness to possible new risks, openness to questioning behavior is one of the universal basic principles of safety culture. In the Nordic countries communication style is rather straightforward and it is culturally acceptable for a worker to openly question management decisions. In eastern cultures the norms of respecting seniors and protecting co-workers from losing face hinders such behavior. Other means for discussing and reporting concerns need to be established in the organizations.

- The manifestations of a good safety culture may differ slightly form country to another
  - In some countries information technology e.g. e-mail, sms, data base is emphasized as an efficient way to share information and one can trust that the coworkers will receive the information that way. In other cultures information technology can be viewed secondary or bureaucratic way sharing information and poor communication
Conclusion (3)
Safety culture in new builds – the question of shared vs. company specific safety culture

- Inter-organizational boundaries often coincide with differences in understanding and doing, which might pose challenges for safety, especially when multi-actor and culturally diverse networks are considered (Carlile, 2002).

- The real context for building safety is networked and involve diverse actors beyond the boundaries of the organization.

- The nuclear projects need to develop a shared, inter-organisational safety culture. This requires efforts put on inter-organisational relations, common infrastructure, and appreciation of local responsibilities and autonomy. Even though nuclear safety responsibility lies within the licensee, the network safety culture may require polycentric control.
Additional reading


Thank you for your attention!