

Learning Lessons from TMI to Fukushima and Other Industrial Accidents: Keys for Assessing Safety Management Practices

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The main objective of the paper is to discuss and to argue about transfer, from an industrial sector to another industrial sector, of lessons learnt from accidents. It will be achieved through the discussion of some theoretical foundations and through the illustration of examples of application cases in assessment of safety management practices in Nuclear Power Plant (NPP).

The nuclear energy production industry has faced three big ones in 30 years (TMI, Chernobyl, Fukushima) involving three different reactor technologies operated in three quite different cultural, organizational and regulatory contexts. Each of those accident has been the origin of questions, but also generator of lessons, some changing the worldview (see Wilpert and Fahlbruch, 1998) of what does cause an accident in addition to the engineering view about the importance of technical failures (human error, safety culture, sociotechnical interactions). Some of their main lessons were implemented such as improvements of human-machine interfaces ergonomics, recast of some emergency operating procedures, severe accident mitigation strategies and crisis management. Some lessons did not really provide deep changes. It is the case for organizational lessons such as, organizational complexity, management of production pressures, regulatory capture, and failure to learn, etc.

Other high risk industries have had their major accident cases too in the last decades: e.g., aviation accidents such as Tenerife airport planes crash (1977) and loss of Rio-Paris flight (2009); space shuttles losses with Challenger (1986) and Columbia (2003); train accidents, e.g., Paddington trains collision (1999); process industries with Flixborough (1974), Seveso (1976), Bhopal (1984), Toulouse (2001), Texas City (2005), Buncefield (2005), or offshore with Piper Alpha (1988), Deepwater Horizon (2010), etc. Similar lessons can be learned from those accidents.

Nevertheless, in-depth learning remains difficult as exemplified by some institutions which repeated similar accidents (e.g., NASA and BP) or difficulties to learn from previous accidents (e.g., with Fukushima) or from previous incidents (TMI, Columbia, Texas City). Several question could or should arise:

- How to go beyond the implementation of lessons case by case?
- Is it possible to use the knowledge of the main case studies of industrial accidents?
- Could this knowledge change our mindset and practices of accident prevention?
- How to use knowledge of the past accidents to apply it to organizational diagnosis of safety in normal and future operations, especially in the nuclear sector?

Remarkably, the systematic study of industrial accidents since the mid-70's by few researchers has shown some recurring patterns in the incubation of accidents (Turner, 1978),

latent errors (Reason, 1990), and their systemic and organizational root causes (Bignell and Fortune, 1984; Reason, 1997) and this whatever the accidents and their different occurrence contexts (industrial sector, country regulation, culture, history). Beyond the retrospective bias, this empirical observation, has open the possibility of capitalising generic lessons of accidents such as accident patterns, but also about the causes with the concept of pathogenic organizational factors (Dien *et al.*, 2004). Later, the concepts of new Knowledge and Culture of accidents were proposed (Dechy *et al.*, 2010) to distinguish the issues of knowledge construction, its transfer and use according the actions targeted (during assessment or daily management of safety).

In parallel, major methodological outbreaks were observed in accident investigations of Paddington trains accident (1999), Columbia space shuttle loss (2003) and Texas City refinery explosion (2005) and provided valuable lessons, especially on their organizational aspects. It validated the possibility of the capitalisation of a methodology strongly linked with pathogenic organizational factors, the organizational analysis and diagnosis approach (Dien *et al.*, 2004, 2012; Rousseau and Largier, 2008), both for accident investigation and normal operation assessment.

After this literature review and theoretical developments synthesised in the first part of the paper, efforts have been made, for more than ten years, to translate those lessons into new framework of analysis (e.g., production pressures, see Montmayeul, 2006, organizational learning, see Dechy *et al.*, 2009) and into practices for nuclear safety assessment. Two examples of assessment conducted by IRSN relying on organizational diagnosis in several NPP are presented: safety management in normal operation and organizational issues during outages for maintenance.

The second part of the paper will give therefore some examples of the use of the knowledge of accidents during organizational diagnosis, but will also show more recent developments in the learning from incidents.

To conclude, rationale for using lessons from accidents is stressed (“gift of failure” (Wilpert, 2011), “royal road” (Llory, 1996)). Some perspectives to these developments and transfers are then discussed with also some limits and barriers in theory and practice.