4. Fukushima Accident. A View from Russia

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I got first news about the accident form the BBC world news channel shortly after the first explosion on 12 March 2011. I had been hearing from the news that there were some problems at a couple of Japanese NPPs but the scale of recent tsunami and the destruction and loss of life it had caused totally eclipsed for me the importance of these problems. The now famous video with the fist massive explosion at Unit 1 actually stunned me as I think it stunned every Russian who has some relation to the nuclear industry. We do not have a video of the explosion at Chernobyl NPP but the scale of explosion and subsequent damage to the reactor building seemed comparable and associations with that tragic event in now distant 1986 instantly came to my mind.

The first comments of invited experts on both the BBC and local Russian TV channels were strangely optimistic, it seemed that they were discussing a minor event that would not have any consequences in terms of radioactive contamination and loss of life. The best of experts' explanations went to the following. "There had been some loss of water circulation due to a failure of the emergency diesel generator and there had been water vapor reacting with zirconium rods of the fuel assemblies for some time yielding hydrogen. The pressure of hydrogen inside the reactor vessel had been building up and leaked to upper part of reactor building when it exploded. Thus, the explosion was very strong but all of the invited experts repeatedly said that the containment was intact there was no danger of radioactive leaks into the environment." I personally was not impressed by these explanations and remained fully convicted that something very serious had happened. At that time all experts, TEPCO and the IAEA insisted that the accident was a relatively insignificant one incomparable to the Chernobyl or even to the Three Mile Island accident.

I found some technical information about BWR containment Mark I and read it and it seemed to me that there was no relieve valve from the containment (more properly dry and wet wells) to the structure on the top of the reactor building where the explosion took place. Moreover I personally would have expected to see a hydrogen explosion in the stack near the building if there was a dedicated relief valve designed to provide a way for bleeding untreated and potentially radioactive gases directly into the environment in case of a serious accident. The idea, if it is a design feature, to allow such gases to bleed from the containment into the top part of the reactor building was too queer for me to believe at that point.

The second massive explosion on March 14, 2011 was another surprise for me. Watching the video of the explosion on YouTube I noticed that the color of

smoke during explosion was darker and there was some yellow flame at the moment of explosion. As I had seen many small explosions of hydrogen I know that pure hydrogen normally explodes without any smoke and color just like it was during the explosion at Unit 1. Consequently, I thought that something was actively burning inside the building before the explosion, perhaps cables or even the polyether foam lining of the containment wall. The last supposition was an especially dire one as it meant that reactor core might have been molten then melted through the bottom of the reactor vessel and finally fell on the floor below the reactor vessel.

After the second explosion it became evident that the fact that spent fuels in these reactors was stored in a pool inside the top superstructures destroyed by the explosions also had very serious consequences if these fuel assemblies became exposed to the environment and it seemed that coolant circulation and make-up for these pools stopped.

During all these events it was regularly reported that diesel generators were damaged in the tsunami and their failure was the onset of all the subsequent events. This gives rise to two principal questions. If a strong tsunami after an earth quake was considered as a probable option in the safety analysis (and it seems absolutely improbable that it was not), why all the generators were installed in places where they can be damaged. We can see several small hills near the plant and it is difficult to see why the generators were not installed on one of these hills in a relative safety. Another question arises from the fact that for many days emergency services were unable to deliver new generators and connect them. In such an industrialized country with numerous ports and floating cranes it seems strange.

Later I found that a number of researches on the behavior of Mark I had been made before the accident. The most recent one was accomplished in 2010, just before the tragedy. All these researches predicted that at some point during an accident involving the loss of coolant circulation there would be bleeding of explosive gases from the containment into the building, specifically into the top structure. It seems that some panels of that structure even were designed to provide ventilation in case of an accident so it seems that the events that lead to the explosions had been considered as a probable scenario. There are proven methods to oxidize hydrogen containing gases without explosions but no such systems seem to be provided to function in the design of the Fukushima NPP. Moreover it seems that the vent lines did not function well for bleeding excessive gases from the containment to the stack.

Thus, there are many questions concerning the original design and, especially, the fact that all subsequent reviews and licensing procedures failed to address these issues and move the diesel generators to a right place preventing the total loss of power in the first place and then to provide a system preventing massive hydrogen explosions that destructed the buildings and exposed spent nuclear fuel pool to the environment. The measures that should have been taken would not have been prohibitively expensive for the plant's operator but they seemingly were not considered at all.

I am no expert in nuclear reactor design but, at the same time, I'm not a stranger to the problems of the nuclear power. After the Chernobyl disaster the safety review and licensing procedures became more rigorous, perhaps even too rigorous. Tons of papers have been compiled and thousand of man-years spent on safety analysis and related

simulations but when the day of reckoning came it became evident that any amount of paper work cannot be a substitute to real safety systems and good design decisions. As a result, the trust of the public to all the safety reviews and licensing procedures adopted by the modern nuclear industry has been deeply undermined and it is not clear what action should the industry take now to win back the public opinion. It is evident that we cannot make the licensing procedures even more complex as they are prohibitively complex already. Yet, we see that an absolutely predictable and quite probable event - a strong earthquake with a subsequent tsunami on the Eastern shore of Japan - in real life led to the second most serious accident in the history of civil nuclear power. Perhaps for many years the industry has been more concentrated on the consideration of improbable events like the Deluge in New Mexico or a 9.0 magnitude earthquake in Northern Russia and other negligible events instead of a hands-on approach to realistic accident scenarios?

The questions about the Fukushima accident posed in this essay might have been asked by any of the leaders of the anti-nuclear movement in any country of the world and the world nuclear industry as a whole must provide objective, detailed and independently reviewed answers to these questions if it wants to make a lesson of the accident and find a place for one of the greatest technological achievements of XXth century - the nuclear power - in the post-Fukushima world.

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