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CONTROLLING OPERATIONAL RISKS IN NUCLEAR POWER PLANTS

KONTROLA RYZYKA OPERACYJNEGO W ELEKTROWNIACH JĄDROWYCH

Abstract Nuclear power plants (NPPs) contain within their fuel a significant amount of radioactive isotopes that if released to the atmosphere could result in major land contamination and severe health hazards to exposed populations. Beyond the immediate and acute damage from a severe nuclear accident there exist the potential additional longer-term major health hazards due population evacuations, contaminated food and water supplies chronic radiation related diseases and inadequate medical attention. Further long-term psychological damage to evacuated populations and to nearby communities are more difficult to quantify but nevertheless real. To all these health related effects we must add the very significant economic damage to the plant itself, the operating utility, uninhabitable property, loss of industrial production and commercial activities, and the economic costs of caring for the affected populations. In short, should a major catastrophic accident occur in an operating NPP the consequences could become significant on national and international levels, as we saw recently in Japan following the Fukushima Accident. It is thus clear that controlling the risk of failure in operating nuclear power plants is the most important aspect of NPP operations and utility supervision, far more important than short-term maximizing generation and profit.

Streszczenie Elektrownie jądrowe posiadają w swoim systemie poważne ilości radioaktywnych izotopów, uwolnieniu których do atmosfery może spowodować poważne zagrożenie dla zdrowia, środowiska, psychologiczne efekty społeczne, zaś dla właścicieli elektrowni wielkie straty ekonomiczne. Stąd też kontrola ryzyka katastrofy w elektrowni jądrowej jest najistotniejszym elementem zadań operacyjnych elektrowni. Lata doświadczenia wskazują, że właściwie prowadzona kontrola ryzyka operacyjnego zapewnia również dobre wyniki ekonomiczne elektrowni mimo poważnych kosztów z tym związanych. Referat przedstawia podstawowe elementy niezbędne dla efektywnej kontroli ryzyka operacyjnego.

In fact, most utilities now recognize that good operational safety and failure risk control translate directly into good economics, despite the costs entailed. The issue of how good safety and risk control equate with good economics is the main themes of this presentation. I will first describe here the multiple level processes required to ensure good operating NPP safety and failure risk control, and then elaborate on how these can result in good economics that benefit the NPP, the owner utility and the electricity consumers.

Operational risk control is not just a function of the plant design features – important enough aspects that are addressed in this conference. In fact additional various factors combine to assure good plant safety and it is the combination of all these factors put together that will ultimately result in good safety records. Among the factors that play a role in assuring plant safety I should mention:

– Stable, strong and independent regulatory regime;
– Mandatory participation in inter-utility national or international safety organization;
– Utility commitment to providing adequate resources for maintaining plant safety;

– Choice of nuclear plant design with multiple, redundant, modern safety systems and structures;
– Strict operators training, qualifying and re-qualifications;
– Strict adherence to following well-tested operating procedures and processes;
– Operating plant management system which pushes responsibility down to the operators subject to ongoing management review;

It should be stressed again that it is the combination of implementing all the above factors at the NPP, utility, utility organizations and national level that is responsible to mitigating plant risks and preventing catastrophic failures, rather reliance on safety features designed into the NPP technology itself. Even a good plant design and a well-meaning utility will not suffice to ensure good operational safety without implementation of the other factors mentioned above and discussed in this presentation.

I should stress that the combined safety measures discussed above does not come cost free. In fact, nuclear plant operating and maintenance (O&M) costs are quite high, compared with the operating costs of other technologies for electricity generation, and will remain uniformly high throughout the very long operating life of the NPP. This is consistent with the significant amount of radioactive fission product contained in the reactor's core which will remain there and must be protected against throughout the plant life. Unlike older fossil fired plants it is impossible to relax nuclear operational standards towards the later part of the plant life and consign the NPP to partial load following duty only. An NPP by its nature will always be assigned to base-load generation and it has to maintain full operational safety discipline during every year of the sixty to eighty (or more) years of the expected plant operating life.

This brings me to my final point that the very long lifetime planned for the new NPP designs now being commercialized – sixty years of nominal life, most likely extended to eighty or a hundred years change the way we understand nuclear economics. It is quite likely that the lifetime of a new NPP project from the date of contract signing to final shutdown will exceed the lifetime of most babies born in the year of contract signing. The initial plant investment is very high in part to account for the design features required to assure long operating life. O&M costs are high so as to maintain the NPP in near pristine operating condition throughout its life. Given these high initial and recurring costs long operating lives are essential to allow cost recovery and profit accumulation. In fact, it is not just the long lifetime but also the achievement of high annual availability and capacity factors that are essential for NPP profitability. High annual capacity factors could only be achieved by maintaining good safety record and controlling operational risks so that the plant will not have to be shut down for repairs and for implementation of new safety features and procedures.

This introduces the nexus between failure risks control and maintenance of good safety records and assuring NPP profitability. At some time before the mid-life point of an NPP, once the initial investment has been fully returned, the plant could turn into a license to print money. But this could only be achieved if all the failure risk control measures outlined ion this presentation are consistently implemented throughout the NPP's operating lifetime. Failure to maintain adequate safety levels is not an option for an NPP and the owner utility that wants to survive and thrive.