# The risk of APR1000 in Czech

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KHNP received EU certification for APR1000 early last year. Many design changes are expected to accommodate the EUR Requirements in detail design process, but KHNP and related organizations does not have big design change experience. I think that's a big problem and prime risk point. I wonder how KHNP will be able to carry out these new big design changes within fixed construction period and limited cost promised by themselves in the Bid. The reason of low cost of Korean nuclear construction is mainly because copy design and repeated construction minimizing project cost impact for several decades.

Korean nuclear development policy has been focused on technical localization in design, production and construction of nuclear technologies transferred proven design licensed from Combustion Engineering. Now KHNP wants to export NPP because no more construction is possible in Korea already saturated construction supply. Korean OPR 1000 design is based on CE SYS 80 (1300MW) technical transferred by technical transfer (TT) contract. And then, 12 units constructed in Korea repeatedly. APR 1400 design is based on ABB-CE SYS 80+(1400MW) to the EPRI URD and the APR 1400 design work is done by TA (Technical Assistance) contract between KHNP and ABB-CE. APR1000 is to be installed first to incorporate EU safety requirements. So, it should be recognized that there is no verified and proved design of APR1000 exist up to now. The Korean nuclear industry has been organized for the purpose of self-reliance of technology divided into each functions of the group companies.

Nuclear construction work is normally done by EPC led by Engineering company such as Westinghouse, AREVA… but KHNP is an utility company and the role is project management without any basis of Engineering background. Engineering documents repeatedly produced by KEPCO E&C never been reviewed by third party. Doosan orders to subcontractors and supplies all NSSS equipment including TBN & Generator using design document produced by KEPCO E&C. So, KHNP' s project management is bureaucratic procedures with less accountability rather than responsible technical judgment. Absolutely, No efficient for big design changes. KEPCO E&C also has many problems in integrating all the technical interfaces of in-between NSSS - A/E - BOP - Equipment supply - Field Construction even though it is repeated construction because all the managing done by KHNP. All final decision should be made by KHNP. The role of engineering is sometimes just a

reference in the final decision. KHNP controls budget, schedule and quality of Equipment supply and construction with technical support from KEPCO E&C. Technical matter will not be a major concern in decision making process in many times.

KHNP intervenes in all fields and steps in Nuclear Power Plant Supply. KHNP's hegemony together with corrupted politicians is a big source of corruption in 2013 Korean nuclear scandal. KHNP's annual R&D investment of 350M$ by which controls high level of nuclear elite group secured. It builds strong nuclear business cartel (Academy, Research, Engineering). Korean nuclear scandal in 2013 has not been stopped yet because the system of corruption has been unchanged! KHNP staffs still re-employed at subcontractors after retirement. All of these can affect the safety and quality of nuclear power plants.

Some examples caused by KHNP's purchasing problems.

KHNP purchased and installed PAR (Passive Autocatalytic Recombiner) at all NPPs in 2013. But it was pointed out the quality document forged. So, KHNP had to do PAR performance test again but the test was interrupted at 8000 seconds during the test because flame arise. However, the performance test was accepted no problem by KHNP & NSSC (Nuclear Safety and Security Commission). So many citizens raised complaints and issues. But they dismissed the complaints and the PAR continuously installed at all nuclear power plants in Korea. After 11 years, when anonymous informant raised problems, finally, KINS reported survey result that current PARs does not have sufficient H2 removal performance but the flames are still acceptable. Unbelievable!!! The Flame can be minimized simply by changing catalyst manufacturing method. So, many people does not understand KHNP and NSSC's action for the safety.

KHNP purchased CFVS (Containment Filtered Vent System) and installed first at Wolsong NPP # 1 in 2012. During installation, the piles to support the equipment penetrated water leak protection sheet underground, but they didn't't recognize it for many years until radioactive water leakage raised by unknown informant in 2020. So, many citizens and social organizations asked government to organize joint investigation team. However, KHNP dug out the damaged underground leak protection sheets in advance, removed the evidence of leaking and finally no punishment. However, it was also found that contaminated water was overflowing from another resin storage tank and flowing over into the sea, but no measures were still undertaken. How BNPP was successful in UAE? The answer is that FANR hired ex-US NRC staffs and regulates all design and construction process without KINS assistance. High skilled and experienced review and inspections are indispensable for KHNP construction work.

MMIS system developed for localization in 2010 and Installed first at APR1400 Shinhanul #1, #2.

Construction delay at least 5 years due to technical problems and finally start operation in 2022, 2024 at least 5 years of delay. However. Shinhanul #1 shutdown for MMIS problem in a year after start operation. SHinhanul #2 start operation in April 2024 but shutdown in June for unknown problems and shutdown again right after restart 1 week after shutdown.

KEPCO E&C accepted SEBIM, CCI valves after technical bid evaluation for the BNPP's POSRV (Pilot Operated Safety Relief Valve) supply. But KHNP wanted SEMPELL to be in the vendor list. SEMPELL finally won the bid and installed both in Shinhanul #1, #2 and BNPP project. All installed POSRV leaked during test, so ENEC requested to replace them all in Barakah. But KHNP wanted to use them as is by repair. It delayed commercial operation by about 4 years. ENEC may not understand KHNP's response.

Concrete cavities were found inside the reactor building wall in all Korean Nuclear Power Plants. The largest cavity size was found to be 157cm depth in the 167cm wall thickness in Hanbit NPP #3, #4 which are Korean reactors licensed from US and first constructed in Korea. The concrete was not sufficiently compacted during construction. This might be driven by KHNP to comply with construction deadline. The cavities or voids were also found in the Barakah NPPs as well.

New big design changes will be challenging to KHNP in Czech Nuclear Construction.

KHNP does not have design of large cooling towers, so no experience in design, construction and operation. Therefore, it is expected a lot of try and error during engineering and construction process of APR1000.

When designing a double containment wall, the spatial arrangement must be updated based on existing reference plant – huge design change must be involved. Thousands of penetrations, passing pipes, and attachments on reactor building wall. It makes a lot of design interfaces among lots of related organizations. Many try and errors are expected during project undergoing.

Korea does not have completed design and construction experience for core catcher. Additionally, third-party review system to minimize errors does not exist in Korea. The performance of PECS (Passive Ex-vessel corium retaining and cooling system) must be verified by precise experiments on an appropriate scale before construction, and should be inspected and confirmed its performance independently. APR1000 reactor vessel supported by long column mounted on the concrete near bottom head of Reactor Vessel. It should be verified RV support column when very hot Corium could cause oxide the concrete at the bottom of the columns which may lose the integrity of column structures and support function.

These are just examples. There are a lot more examples of problems.

Westinghouse and EDF has already been experienced difficulties in the design incorporating new advanced engineering safety features but KHNP group didn't have those experience. Korean strong points are price and schedule. But APR1000 design is not verified because of incorporating new big designs to the EU safety requirements. Finally, Korea always performed design with technical assistance from Westinghouse. But it may be different situation in Czech. Westinghouse sued KEPCO/KHNP over intellectual property issues.

On October 2022, Westinghouse filed a lawsuit against KEPCO/KHNP in the U.S. District Court of Columbia for violation of U.S. Federal Law 810, which prohibits the transfer of nuclear technology to third countries without U.S. permission. In the mutual technical support agreement signed in around 2010 between Westinghouse and KEPCO/KHNP to obtain APR1400 design certification from U.S. NRC. Korea specified in the written agreement that Korean Reactor design is based on Westinghouse owned license. Since it was dismissed in the court on the judgment that it is not for company to file lawsuits but for US government DOE. It is understood that arbitration is currently undergoing, but the specific details are not opened yet.

US 10CFR Part 810 describes all transfer of US nuclear technology shall be approved by US government. It defines details of technology to be ruled under the law Part 810 such as reactor vessel and the attachment composing pressure boundary, and the apparatus to control of reactivity etc. If US permits KHNP export APR1000 to Czech, then Czech may not be able to export its nuclear technology transferred from KHNP to EU without permission by US Government as well. All permission requests shall be in written form to US Government and shall be made by Westinghouse only.

CEO of KHNP Mr. Hwang and Minister of MOTIE Mr. Ahn visited the United States before KHNP submitted the bid to the Czech Republic and they also visited to Czech right after submit the bid to Czech Republic. It is believed that a fairly close agreement may be undergoing among related parties for the upcoming nuclear projects in Czech.

It is too big, too long and too much risky project and Low Possibility of successful construction because of many project uncertainties ahead. Korea may use Czech project for the opportunity of APR1000 design upgrade for uncertain EU projects upcoming. Is it sustainable business?

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