MODIFIED FUEL IMPLEMENTATION EXPERIENCE AT UNIT 3 OF SUNPP

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Until 1991 Ukraine was part of the USSR. Upon its dissolution Ukraine gained independence. October 1996 witnessed establishment of a state company "National Nuclear Energy Generating Company (NNEGC) ENERGOATOM" encompassing five Ukraine's nuclear power plants. Ukraine's NPPs currently operate 15 units, of which 13 are WWER-1000 and 2 – WWER-440. The NPPs were constructed to Russian designs and utilize only Russian-made nuclear fuel. At about the same time there evolved an idea of diversification (expansion, increasing the number) of nuclear fuel suppliers for Ukraine's NPPs. The diversification is expected to enhance Ukraine's energy (and national) security. To that end the Ukraine Nuclear Fuel Qualification Project (UNFQP) was started in 1998. The Project is implemented pursuant to the Implementing agreement between the Government of Ukraine and the Government of the USA. The objective of the Project is to provide technical assistance to Ukraine in the area of operational safety enhancement and diversification of nuclear fuel deliveries for WWER-1000 reactors.

INTRODUCTION

The main tasks of the UNFQP are to qualify alternative fuel types for Ukraine's NPPs which produce over 50% of the country's electricity and to set up a design organization to support NPP operation.

Center for Reactor Core Design (CRCD) hosted by Kharkiv Institute of Physics and Technology (KIPT) was established in 1999 to fulfill this mission. Westinghouse Electric Company was selected to design alternative fuel types and transfer methodology to CRCD. South Ukraine NPP (SUNPP) Unit 3 with the WWER-1000 (V-320) reactor was chosen as the project implementing utility. SUNPP is located on the banks of the Bug river in the Nikolayev region in the south of Ukraine, hence its name South Ukraine NPP.

The project has two stages. During the first stage, six Westinghouse-manufactured Lead Test Assemblies (LTAs) were loaded into the core for four cycles of operation together with the Russian fuel assemblies. Currently, the LTAs are in their last cycle of operation. During the second stage a reload batch consisting of 42 Westinghouse fuel assemblies is expected to be loaded into the reactor core late in 2009. The design, manufacturing and safety substantiation of Westinghouse LTAs is based on Westinghouse methodology approved by the State Nuclear Regulatory Committee of Ukraine (SNRCU).

WESTINGHOUSE LTA RECEIVING INSPECTION

In June 2005 railroad platforms with shipping casks were delivered to the SUNPP site. The shipping casks with Westinghouse LTAs were removed from the platform by crane and placed in one row in the fresh fuel area.

Prior to opening in presence of Westinghouse representatives, each shipping cask was checked for integrity of seals and compliance with the shipping documents, subjected to surface radiation checks and visual inspection for possible damages. The shipping casks were opened and the Westinghouse LTAs were removed by the SUNPP personnel with the involvement and under supervision of Westinghouse staff. Upon removal of the shipping cask lid, Westinghouse LTAs were checked for compliance of their serial numbers with the numbers indicated in the shipping documents, the cask internals were visually inspected, and the accelerometers were checked for tripping. No further comments were made on this stage of activities.

The radiation control inside the cask showed the radiation background to be within the normal range.

The next stage of Westinghouse LTA receiving activities was done pursuant to a dedicated program.

WESTINGHOUSE LTA OPERATION

Westinghouse LTAs were installed into the core of each cycle (17-20) by a refueling machine using a standard shipping-and-handling procedure:

- Fuel assembly removal from the fresh fuel cask (only for Cycle 17).
- Fuel assembly removal from the storage pool (Cycle 18-20). At this stage Westinghouse LTA drag force against the storage pool cell walls was done to make sure that the technical specification limit was not violated.
- Carrying fuel assembly over the storage pool and the reactor.
- Fuel assembly loading into the core according to the Loading Pattern. At this stage Westinghouse LTA drag force against the adjacent Russian fuel assemblies was done.
After loading into the reactor, the fuel assemblies were checked for their top nozzle axial positions in the core to confirm meeting the allowable limits.

During cycle operation power distribution in each fuel assembly in the core is monitored to ensure fulfillment of the limiting values.

Westinghouse LTAs were unloaded from the reactor core using a refueling machine and a standard shipping-and-handling procedure:

- Fuel assembly removal from the core. At this stage Westinghouse LTA drag force against the adjacent Russian fuel assemblies was done.
- Carrying fuel assembly over the reactor and the storage pool.
- Fuel assembly placing into the storage pool. At this stage Westinghouse LTA drag force against the storage pool cell walls was done.

A visual inspection is performed for each Westinghouse LTA on all six faces in the storage pool using a resident underwater television for visible defects and damages, identification of which may lead to rejection of Westinghouse LTAs. No evidence of fuel rod damage or damage to other fuel assembly components was obtained during Westinghouse LTA visual inspection.

A leakage test was done to monitor fuel rod clad integrity. The leakage test after each operation cycle showed that there were no leaking Lead Test Assemblies.

Also, a rod cluster control assembly (RCCA) drag force test in the Westinghouse LTA guide tubes is done in the storage pool:

- Installation and locking of the RCCA cask on the fuel assembly top nozzle;
- RCCA insertion into the fuel assembly guide tubes until fully rodded position;
- Removal of the RCCA from the fuel assembly guide tubes.
Fig. 1. Cycle 17 Loading Pattern

(Westinghouse LTAs are installed in "D1" locations.
The core is composed of two fuel assembly types – Westinghouse LTAs and Russian TVS-Ms)
Fig. 2. Cycle 18 Loading Pattern
(Westinghouse LTAs are installed in "D2" locations.
The core is composed of two fuel assembly types – Westinghouse LTAs and Russian TVS-Ms)
Fig. 3. Cycle 19 Loading Pattern

(Westinghouse LTAs are installed in "D3" locations.
The core is composed of two fuel assembly types – Westinghouse LTAs and Russian TVS-Ms)
Fig. 4. Cycle 20 Loading Pattern

(Westinghouse LTAs are installed in "D4" locations.
The core is composed of THREE fuel assembly types – Westinghouse LTAs, Russian TVS-Ms and Russian TVSAs)

As of today, Center for Reactor Core Design, supported by Westinghouse, has completed an immense scope of work to substantiate the operation of such a mixed fuel cycle containing fuel assemblies of various designs and various pressure drops.
CONCLUSIONS
Completion of Cycle 20 is expected to confirm positive results of Westinghouse LTAs operation. It will allow a transition to the second UNFQP stage – installation into the SUNPP Unit 3 core of a reload batch consisting of 42 Westinghouse fuel assemblies. If the reload batch operation proves reliability and safety of these fuel assemblies, it will be a further step towards transition of Ukraine's NPPs to commercial operation of another vendor's fuel.