

# Ambition to Reach Zero Level Failure in VVER 1000 with Russian Fuel

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## Summary

In addition to presentation “The Zero Failure Level Project: Organization, Status, Tasks” by A.V. Ugryumov other aspects of the project and associated topics are discussed.

## 1. Introduction

Regardless of meeting conditions for fuel assembly design, testing, manufacturing, transportation, handling and operation, fuel assemblies, from time to time do not behave exactly to the expectation. All around the world international projects focused on the improvement of the fuel performance were conducted by different fuel vendors and different utilities. “The Zero Failure Level Project” was initiated by TVEL, the fuel supply company, in 2013, originally in the format of 2 party agreements between TVEL and different power generation companies. Since 2014 in the current Project participate along with TVEL, 4 utilities: NAEK “Energoatom”, ČEZ a.s., NPP Kozloduj and Rosenergoatom. Subject of the project are fuel assemblies supplied by TVEL for VVER 1000 operated in reactors of the above utilities.

The purpose of “The Zero Failure Level Project” is to bring to real operation of VVER 1000 units the dream of all utilities such as problem free and cost effective operation. This essentially turns into requirement on failure free fuel operation. At the same time the general requirements such as safety, cost effectiveness, operational flexibility, fuel cycle and fuel flexibility need to be satisfied. During routine inspections practically no violation of established requirements are typically revealed. Fuel assembly is designed properly, manufactured and operated according to design requirements. At the same time, utilities and suppliers spend time and resources to address appropriately different issues connected with fuel behavior, which cannot be treated as negligible. This is the reason, why within “The Zero Failure Level Project” it is considered as failure any deviation from design expected

fuel behavior. This project is unique by addressing fuel related issues of one fuel vendor with fuel assembly designs of 2 different fuel design bureau operated in one plant type of VVER 1000 NPPs operated however at different operating conditions.

## 2. Aspects of Zero Failure Level Project

This project actually raised several questions on what does it mean “standard” or, in other words: why “the same” fuel behaves in “the same” reactor type in different way. Typical examples are: standard fuel assembly design, standard reload core design practices along with tools and core monitoring systems, standard fuel assembly handling practices and standard core with lead test assemblies, lead use assemblies, lead assemblies and mixed cores. In practice “standard” core and/or fuel assembly operational conditions specified by supplier reflect among others utility requirements which, in its turn, reflect electricity grid requirements and in some case may, while in other may not reflect as built NPP data. During fuel assembly licensing process, in 4 different countries, may be imposed in addition to supplier’s design condition different licensing conditions. During operation, so called real operating conditions satisfy conditions imposed by operational procedures which may or may not be more restrictive than licensing and supplier’s conditions. On the other hand, based on the operational experience feedback, conclusions can be drawn only if compared are parameters at “comparable” conditions.

In order to avoid misleading conclusions, several specific tasks were performed and many of them are still in process. Specific failure tree was developed in a format, which allows step by step failure tree improvement. Fuel types and its modifications, taking into account manufacturing conditions, were specified. In parallel with fuel types classification, real operational conditions were evaluated based on approximately 280 parameters by fuel assembly design features, operational procedures and practices and about 250 reactor unit parameters. In ad-

dition to this, VVER 1000 Foreign Material Exclusion practices were compared among utilities and space for improvement identified.

As a result of this stage, groups of units with similar fuel operational conditions should be revealed and experience sharing database created. Regardless of VVER 1000 concept with spent fuel pool inside the containment, special attention shall be paid to the pool side fuel assembly inspections in future without negative impact on the units outage schedule. In order to create conditions for Operational Experience Feedback and, by the same,

to improve conditions for root cause investigation and prevention of potential defect reoccurrence. It is also recognized a need for consistent methods of operational data and data from pool side fuel assembly inspection. In the area of Foreign Material Exclusion activities closer cooperation between utility and supplier should be established including foreign material classification and improvement in root cause investigation. Such investigation should include search of eventually unrevealed foreign materials during maintenance activities in previous outages.

