

MDEP Design-Specific Common Position TR-EPRWG-05

TECHNICAL REPORT ON FIRST-PLANT-ONLY- TESTS (FPOT) CONSIDERED FOR EPR

Participation

Regulators involved in the MDEP working group discussions:	NNSA (China), STUK (Finland), ASN (France), SSM (Sweden), ONR (UK)
Regulators which support the present common position:	NNSA (China), STUK (Finland), ASN (France), SSM (Sweden), ONR (UK)
Regulators with no objection:	AERB (India)
Regulators which disagree:	-

Introduction

Multinational Design Evaluation Programme's (MDEP) EPR design specific working group (EPRWG) started discussions on commissioning related issues when some of the member countries were entering the commissioning phase of the plant projects. The first practical action in this area was an EPRWG/EPR Operators Owners Group (EPR OOG) commissioning workshop held in China on 3rd-4th June 2013.

During the workshop, the member countries of the EPRWG explained their regulatory requirements and practices for commissioning. The EPR OOG, which is a joined group of Framatome (previously AREVA), licensees and power companies interested in constructing EPR plants, explained their plans and processes for the commissioning phase. The workshop was considered a good introduction for discussions on the subject – the EPRWG concluded that processes proposed by the industry were broadly harmonised between the projects.

In the above mentioned workshop, the EPR OOG introduced the concept of First Plant Only Tests (FPOTs)¹. The following reasons were given for performing a test only on the first commissioned EPR unit:

- Test is complex to implement (requires e.g. specific instrumentation);
- Test causes severe loads to the plant structures/equipment;
- Test is time consuming (e.g. includes testing in various configurations).

According to the presentation, the test results are considered valid on all other EPRs if the test conclusions are not affected by design differences between the units, practice differences between the plants or regulatory differences between countries.

The EPRWG met with the EPR OOG again in Paris on 7th November 2013. In the meeting, EPR OOG explained in greater detail their plans for FPOT tests and requested whether the EPRWG would be able to provide a common position on the subject.

MDEP Common Position Paper

The MDEP EPRWG drafted a common position paper to provide guidance for licensees intending to take credit for the results from a FPOT conducted during commissioning of the first EPR unit to characterise the performance or behaviour of a system or component. In order to come up with this common position, the EPRWG conducted a survey among its members on the preconditions which would be necessary for crediting FPOTs. The individual regulators responses are available within the MDEP internal database known as the MDEP Library.

The EPR OOG met with the EPRWG again on 4th November 2015 to discuss the draft common position and provide feedback which was addressed in a further draft of the paper as appropriate.

Early 2016, the EPRWG draft common position paper addressing FPOTs on the EPR design was considered ready to be issued. However, at this time the other MDEP design specific working groups recognised the content of the EPR common position paper to be applicable to their own designs. As a consequence, the draft EPR common position paper on FPOTs was amended and published as a generic paper at the STC level in May 2016.

The MDEP generic common position paper, CP-STC-01 *Common Position addressing First-Plant-Only-Tests*, provides high-level guidance to applicants and licensees that wish to take credit for a FPOT

¹ Definitions are provided in CP-STC-01 Common Position addressing First-Plant-Only-Tests (FPOT)

performed during the commissioning of the first unit of a similar type. It is important to note that national regulators retain authority for all licensing and regulatory decisions in their respective countries irrespective of the common position paper. As such the paper recommends that applicants and licensees seek early discussions with their regulator to reach a common understanding as to what will be acceptable on a case-by-case basis.

EPR First Plant Only Tests

During the meeting with the EPRWG on 7th November 2013 Areva (now Framatome) identified the following possible EPR FPOTs:

- Special vibration measurements on the Reactor Pressure Vessel Internals (RPVI),
- Pressuriser normal spray efficiency with different reactor coolant pump configurations,
- Loss of one reactor coolant pump at 40% nominal power and pump restart,
- Enhanced monitoring of Low Head Safety Injection (LHSI) in Residual Heat Removal (RHR) mode during establishment of a vacuum in the primary circuit.

Below is a short description of each test (objective, differences between units, applicability of results to all units) from the Areva presentation in the November 2013 meeting.

Special Vibration Measurements on the RPVIs

The test objective is to perform the vibration measurement programme in compliance with the U.S. Reg. Guide 1.20 and detect signs of unexpected vibrations if any.

The tests are performed with various reactor coolant pump configurations and during four different plant states (ranging from cold shutdown to hot shutdown) with the core unloaded.

According to Areva, the main factors impacting the test results are geometry, component characteristics and flow rate characteristics. Although in the UK-EPR the cross-over leg upstream of the reactor coolant pumps is longer than in other units, Areva's view is that the impact is insignificant. The test results are therefore considered valid for all units.

The test was identified as a potential FPOT because it requires temporary instrumentation to be fitted to (and subsequently removed from) the internals which is both time consuming and introduces the potential to damage the internals.

Pressuriser normal spray efficiency with different primary coolant pump configurations

The objective of the test is to evaluate the influence of the different reactor coolant pump configurations on normal spray efficiency and to provide data, e.g. for preparing plant operating procedures. The FPOT would include more pump configurations than the standard EPR test programme and thus provides additional information.

The spray line geometry and the spray valve characteristic are not identical in all units. However, according to Areva, these differences can be taken into account when applying the results and there are no other differences (primary circuit geometry, reactor coolant pump characteristics, thermal hydraulic conditions) that would affect the results.

The test was identified as a potential FPOT because it is time consuming due to the requirement for testing in numerous configurations.

Loss of 1 reactor coolant pump at 40% nominal power and pump restart

The test is a pre-test before performance of a pump trip at 100% nominal power, with the objective of checking that controls (e.g. steam generator level control, average coolant temperature control and pressuriser pressure and level controls) can maintain the physical parameters within their normal operating region.

The steam generator level control was understood to be different in Olkiluoto 3 (OL3) compared with Flamanville 3 (FA3) and Taishan (TSN). According to Areva, the results of a FPOT could be applied to all units, but a complementary evaluation of the steam generator level behaviour would be needed.

The test was identified as a potential FPOT because it is an additional test to that required by the standard EPR testing programme and it would cause an additional loading condition (pump restart).

Enhanced monitoring of LHSI in RHR-mode during establishment of a vacuum in the primary circuit

The objective of the test is to check that there is no cavitation or vortex effect on LHSI/RHR pump in mid-loop operation while the level is above the threshold of automatic LHSI/RHR pump trip. The test is performed by decreasing slowly the water level in the primary circuit down to the threshold and observing the pump operation (vibration, noise, variation of pressure and pump parameters).

According to Areva, the main parameters affecting the test results (LHSI pump characteristic and installation) are identical in all units. The results can therefore be directly used for all units.

The test was identified as a potential FPOT because of the schedule impact, potential for damage to pump integrity and the requirement for numerous checks on hydraulic/vibratory behaviour in several locations.

Special Vibration Measurements on the EPR RPVIs

The RPVI special vibration test was identified as the first, and most significant, of the candidate FPOTs to be performed and therefore provided the opportunity to implement for the first time the MDEP common position paper. Originally the FPOT was to be performed at OL3 and as such preparations were undertaken to perform the vibration tests (i.e. temporary instrumentation was installed). However, due to project delays TSN unit 1 (TSN1) became the lead EPR and therefore had to perform the tests. Since OL3 had already installed the instrumentation and there was uncertainty as to whether the results from TSN1 would be available in time to support the OL3 schedule the decision was taken to repeat the tests at OL3.

The MDEP EPR Commissioning Activities Technical Expert Sub-Group (CATESG) organised a joint observation of the TSN1 RPVI FPOT in March 2017, to gain confidence in the manner in which the test was undertaken and to observe the quality assurance and quality control arrangements. The objective was not to review the technical adequacy of the tests nor the resulting data. In this aim, the Chinese regulatory authority, NNSA, shared with its counterparts, in a very open manner, its inspection process and results.

One of the preconditions set by MDEP for crediting a FPOT is for regulators and licensees to be provided with the opportunity to observe the test. The attendees at the FPOT included ONR, ASN and STUK representatives supported by NEA. In addition, the Taishan Nuclear Power Joint Venture Co., Ltd welcomed representatives from EDF (France) and NNB GenCo (UK) to observe the FPOT alongside the regulators. Whilst planning to repeat the test at OL3, representatives from TVO (Finland) also attended.

At the end of the visit the EPR CATESG concluded that there was evidence of adequate quality control arrangements for preparation and performance of the TSN1 RPVI FPOT, no fundamental reasons were identified for not crediting the TSN1 FPOT results at follow on EPR units subject to the licensees submitting an adequate justification to their respective regulator. Furthermore, all stakeholders acknowledged that observation of the FPOT was a positive example of MDEP supporting regulators to work together to benefit the EPR family.

Framatome (previously Areva) issued a preliminary report of the testing performed on TSN1 in October 2017 to support fuel loading and concluded that the vibration amplitudes and vibratory strains measured in hot shutdown conditions validated the RPVI vibratory behaviour. The only deviation of significance was for the Control Rod Guide Assembly (CRGA) for which measured vibrations exceeded the acceptance criterion.

After further analysis and comparison with full scale mock-up results Framatome concluded that the TSN1 CRGA measurements were not representative because of the temporary instrumentation mass. The non-instrumented CRGA vibration amplitudes are considered to be of the same order of magnitude as past experience from similar reactor designs. As such, Framatome considers the TSN1 reactor internals to be a valid prototype and that the results can be transposed to other EPRs.

Subsequent to the TSN1 FPOT, TVO conducted the special RPVI vibration measurement tests at OL3 for which the Framatome report is awaited, however it is understood that the results are acceptable.

It is understood that EDF and NNB GenCo will be formally applying to their respective regulators to credit the TSN1 RPVI tests at FA3 and Hinkley Pont C (HPC). However, EDF has made the decision to perform the vibration tests on the CRGA and the necessary temporary instrumentation has been installed in advance of hot functional testing.

Lessons Learned

The EPR CATESG observation of the RPVI FPOT identified a number of learning points associated with the practical arrangements that should be considered when preparing to observe any future FPOTs. The learning points have been reflected in a revision to the MDEP generic common position paper (CP-STC-01, revision 1) published in April 2018 and are summarised below.

Host licensee/regulator

- If necessary, confidentiality “agreements” for inspectors shall be agreed within the MDEP framework rather than between individual regulatory organisations;
- If necessary, confidentiality “agreements” should only be written in English;
- OECD staff are exempt from individually signing confidentiality “agreements”;
- Documentation should be provided in advance of the visit to allow an initial review by relevant subject matter experts and to facilitate a more effective engagement;
- Translator(s) should be available as appropriate.

Observing regulators

- Arrangements are handled by the MDEP Secretariat;
- The visit should focus on the implementation of the FPOT, quality arrangements, etc. rather than the technical adequacy of the tests and the resulting data.

Observing licensees

- The MDEP Secretariat informs the OOG of the dates and planning for the FPOT observation
- The host licensee is responsible for ensuring the necessary arrangements are in place (e.g. site access, confidentiality “agreements”, etc.) for the observing licensees to observe the FPOT.