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EXTENDED SURVEILLANCE AS A SUPPORT TO PLIM

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The safe exploitation of the reactor pressure vessel was and is always a major concern in nuclear power plant life management. At present, issues like Plant Life Extension, where utilities look into the possibility of license renewal after 40 years of operation, are becoming relevant in the USA. In other countries PLIM beyond the design life of the NPP could also be desirable from the economic viewpoint. The limiting factor could, however, be the integrity of the reactor pressure vessel.

The reactor pressure vessel surveillance procedures as defined by regulatory legislation is limited and can be supplemented with valuable information that can be extracted in parallel to conventional surveillance testing or through additional testing on surveillance material. This is justified for several reasons:

1. The current methodology is semi-empirical, contains flaws and is in a number of cases overconservatif. Without giving in on safety, we need to try and understand the material behavior more fundamentally;
2. Some reactor surveillance materials demonstrate inconsistent behavior with respect to the overall trend. These materials are called 'outlier' materials. But are they really outliers or is this connected to the indexing methodology used?
3. Additional data, for example the results of instrumented Charpy-V impact tests, have been obtained on many surveillance test specimens and are not adequately exploited in the actual surveillance methodology;
4. Scientific research provides substantial information and understanding of degradation mechanisms in reactor pressure vessel steels. Although we will not concentrate on this topic, the development of powerful microscopic investigation techniques, like FEGSTEM, APFIM, SANS, positron annihilation, internal friction, led to an intensified development of radiation damage modelling and are an input to micro-mechanical modelling. Moreover, due to the ever increasing computer power, additional multi-scale (time and space) calculus tools trying to predict macroscopic radiation damage behaviour of materials are under accelerated development. For latter research area, realistic application to reactor pressure vessel materials will need its time, but these efforts should be encouraged and supported by dedicated experiments;
5. New methodologies, like the master curve approach to directly assess the initiation fracture toughness of the material, have been very successful; they mostly support the actual regulatory surveillance methodologies, shed light on some of the deficiencies of the actual regulation and allow to make an independent 'absolute' assessment of fracture toughness;
6. Reconstitution technology is an indispensable tool to prepare additional specimens. The technique is mature for use on irradiated samples and is an integral part of enhanced surveillance.

These tools that involve the interpretation of instrumented impact testing, reconstitution of test specimens and three-point bend quasi-static fracture toughness testing on small geometry specimens have triggered a different approach towards so-called enhanced surveillance strategies for reactor pressure vessel life time management. Moreover, consistent analysis and understanding of information is a powerful asset to detect irregularities in the surveillance approach or in the vessel surveillance material.