Equipment qualification:

a major factor both for new builds and maintenance programmes in the nuclear industry

Equipment qualification is a major factor for the nuclear industry, both in terms of new builds and maintenance and refurbishment programmes for existing facilities, such as EDF's "Grand Carénage" project. An excellent command of the qualification process is essential to ensure that equipment can be effectively qualified while optimising lead times and costs.

Franck Laroudie

Expert in equipment qualification

Franck holds a doctorate in materials science and engineering and has 20 years' experience in equipment qualification for nuclear power plants.

Patrice Sauze

Commercial Engineering Director

An engineer by training, Patrice has over 20 years' experience in the nuclear industry. Having worked for 15 years on the operations side, he created and leads Assystem's Qualification offering in France.

In any operating nuclear power plant, some equipment is classified as "Important to Safety" (ITS). As this classification suggests, such equipment absolutely has to work effectively in all of the different types of operating and environmental conditions where it is needed. Consequently, ITS equipment has to be qualified (through tests, analyses, calculations etc.) before being installed in order to guarantee that it will work properly throughout its lifespan.

The operators of nuclear power plants are responsible for this qualification process, which can either be carried out by the operator itself or subcontracted to equipment suppliers or external service providers such as Assystem. It all depends on what sort of contracts the operator decides to use.

The two main types of qualification

The first type of equipment qualification is initial qualification, which primarily concerns new-build nuclear facilities such as the Flamanville EPR, the Hinkley Point EPR in the United Kingdom, and the ITER project in Cadarache in France.

The second type is ongoing qualification, which is used when a nuclear power plant's lifespan is extended beyond its fourth 10-year inspection (i.e. beyond approximately 40 years), such as in the Grand Carénage project in France. *"How can you prove that ITS equipment which is already installed – often since the plant's units were first commissioned – is still qualified? Or does the equipment need replacing? Safety is obviously the priority here, but there are also financial aspects because replacing all the equipment would be extremely expensive".*

Ongoing qualification enables certain equipment to be kept beyond 40 years.

Any failure to properly manage the process and/or a problem with a test could significantly affect the timing of new builds or financially impact the Grand Carénage maintenance and refurbishment programme.

Lessons learnt from the FA3 new build mega project

The Flamanville 3 (FA3) EPR – which EDF is currently building in the Manche region of France – perfectly illustrates the importance of the qualification business and its impact on a major industrial project. Because FA3 is an unprecedented new-build mega project, with no similar cases to refer to, the main difficulties with the qualification process from the outset were:

- the volume and duration of the qualification work (some 400 items of equipment)
- the lack of experience of some of the suppliers carrying out the process

As a result, a number of qualifications fell behind schedule or were incomplete, which meant they had to be reworked. This can delay a qualification by at least a year, especially if new tests need to be carried out – it's clear what impact that can have on a project's lead times.

As one of our experts states, "It is clear that it is vital for all the suppliers to have a perfect command of the qualification process, or otherwise to receive expert guidance throughout that process".

Each to their own job: a win-win approach

In the project Assystem worked on for EDF/DIPDE, the selected approach was to group together all of the professions involved in developing and qualifying a new item of equipment. Thus, in 2018, EDF/DIPDE launched an invitation to tender for the research, design, qualification, supply and turnkey installation of an inverter for the power supply of the sprinkler pump for a 900 MW unit.

Having extensive experience in this type of equipment – particularly thanks to its high-quality R&D department – the company AMC ETEC, based in Saint-Raphaël, France, put forward a bid for the project in association with SPIE. To round out its offer, AMC ETEC asked Assystem to contribute its nuclear expertise for the equipment qualification part of the project.

And thanks to this multi-profession approach and the key skill sets offered, AMC ETEC won the bid.

Assystem's mission was to work on the qualification and feasibility studies for the inverter and look for the right instrumentation and control systems equipment and suppliers, while providing cross-profession support.

The aim of the first phase was to limit any risk of the qualification test campaign failing. To that end, earthquake resistance tests were performed, which were successful and therefore led to validation of the equipment's design. The next phase will be the full qualification test campaign, which will be used as the basis of the Equipment Qualification Summary Report.

The overall objective is to have, by end-2021, a prototype that has successfully passed all of the tests required for equipment to operate in the highly restrictive environment of a nuclear power plant.

This project aptly illustrates the benefits that a Qualification "excellence centre" can provide to an industrial player which is an expert in its own specific technical domain but has no nuclear experience, when developing equipment for a nuclear power operator.

Another example of a successful qualification process is that used for an industrial mixer for the French Alternative Energies and Atomic Energy Commission (CEA).

For its STEMA project, the CEA wanted to replace the bituminisation process deployed for immobilising the radioactive sludge generated from the liquid effluent treatment plant at the Marcoule nuclear site by a process that embeds the waste in a cement matrix. The CEA had selected EIRICH as its supplier, which was specialised in industrial mixers but had no experience of the nuclear sector. They therefore asked Assystem to help EIRICH ensure that the STEMA mixer was suitable for nuclear materials and that it complied with the requirements of ANDRA – France's national radioactive waste management agency. Assystem's work started with defining the design requirements for the mixer, which covered a range of issues including safety compliance (earthquake resistance, forced ventilation of the mixer, elimination of fire risks related to the mixer's motor), protection of the mixer's components against radiation, prevention of leakage from the waste container barrels by using an airtight mechanical seal, and the feasibility of carrying out maintenance work on the mixer.

> **"An industrial player with no nuclear experience was able to develop and successfully qualify equipment."**

Assystem then deployed several additional qualification methods, including calculations for static/dynamic sizing, earthquake resistance and the fire extinction system; specifications for the supply/manufacture/assembly/testing of the mixer's components; and on-site tests.

Thanks to Assystem's engineering expertise, an industrial player with no nuclear experience was able to develop and successfully qualify equipment that met the CEA's specific needs.

Equipment qualification – a profession in its own right

Once the qualification requirements have been determined and the equipment to be qualified has been selected, the first stage of the process involves setting the qualification strategy, which can be implemented either through analyses or tests or a combination of both.

The chosen strategy is described and substantiated in a Qualification Strategy Report (drafted by the supplier if the supplier is responsible for the qualification process), which the operator must approve. *"Having a strong command of the process is vital to ensure that no time is wasted at this stage, bearing in mind that any time lost during the quality strategy definition phase cannot be made up later on, particularly when it comes to testing*", stresses our expert. He also recommends that priority must be given from the outset to equipment with the highest risk of failing at the test stage. This is because any major non-compliance issues identified during the final testing stage could require changing the design of the equipment concerned and performing a full new test campaign. Such a scenario would significantly increase equipment qualification times as it generally takes about a year to carry out a full test campaign.

After the tests have been successfully completed and the test reports validated, the supplier (or operator) draws up the Equipment Qualification Summary Report, stating that the

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equipment has been qualified, and then the “Qualification Preservation Sheet”, which sets out what has to be done to ensure the equipment concerned remains qualified during the assembly and operational phases. This means that it is usually only once all the stages of the process have been completed that the on-site assembly of the equipment should begin.

In light of these factors, Assystem considers that qualification is a profession in its own right. When the process is carried out by a design office, it encourages synergies between the various engineers involved and the different issues involved in a project, and therefore generates efficiency gains. *“It enables the process to be optimised holistically, which is the real benefit of using qualification specialists. These specialist engineers can meet the specific needs of either the nuclear operator – which may not have the necessary people to oversee qualifications or perform them if they are done in-house – or the equipment supplier. But of course they never work for both the operator and the supplier on the same project for the same piece of equipment.”*

The FA3 project clearly demonstrates the advantages of having a qualification excellence centre. *“Assystem wants to be able to offer clients the kind of organisation it provided to EDF on this project, which is why it has set up a qualification excellence centre in order to improve on what has been done up until now.”*

Digital solutions to boost effectiveness: moving towards augmented qualification

Each phase of the qualification process requires in-depth cross-profession knowledge, coupled with the ability to handle a large volume of heterogeneous data and organise very complicated activities involving multiple players and interfaces.

The complexity relating to all three of these factors is taken into account in the new organisational methods described above, used alongside systems modelling techniques and a document-based approach, which will help improve qualification processes and reduce performance timeframes and the related impacts on project delivery.

Assystem thinks it will be possible for Qualification Summary Reports and test reports to be processed automatically, therefore identifying the conditions necessary for qualifying given pieces of equipment and helping nuclear operators to compile databases of qualified equipment. *“This documentary database would include all qualified equipment along with its qualification conditions. Ideally, it would comprise a high degree of detail, such as the type of seal used in a particular model of equipment”.*

A search engine with key words could then be used to easily look for replacement equipment (for example, when existing equipment has become obsolete), or to find similar items of equipment, particularly when qualifications are performed via analysis.

It may even be possible to model the whole equipment qualification process for a new build, drawing on the methods utilised in the space industry. *“In that case, digital would offer a new way of managing a project in terms of costs and lead times by identifying any blocking points in the qualification process and enabling them to be anticipated”*, concludes our expert. ■