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RELY ON EXCELLENCE

Safety based on material expertise and quality

EagleBurgmann produces radiation-resistant expansion joints for ventilation systems in nuclear power plants

Applications within the field of nuclear technology place special demands on the components used. Not only do they have to work reliably under normal operating conditions, they also have to withstand the loads which can occur in the event of a serious incident. When developing expansion joints for the nuclear power plant in Doel, Belgium, the material engineers at EagleBurgmann faced a particular challenge: they had to come up with a material which would tolerate a rigorous exposure test in a radioactive environment. But the search for the right material was only the starting point for a complex process of extensively documented tests and production according to strictly defined parameters.

Sometimes conventional materials can serve unconventional purposes. The material experts at EagleBurgmann suggested testing EPDM 400G for its radiation resistance. The synthetic rubber had previously only been used in non-radioactive applications. And indeed: the material withstood the radioactivity even significantly longer than required.

Radiation-resistant components are required in every reactor

The Doel nuclear power plant near the Belgian city of Antwerp has a total output of 2,923 mW which covers a quarter of Belgium's electricity needs. Furthermore, the plant, which consists of four pressurized water reactors, lies in a densely populated area. 9 million people live within a radius of 75 km, and the city center of Antwerp is only 15 km southeast of the facility. These circumstances make Doel the power plant where the most people are at risk of exposure to radiation in case of a serious incident in the whole of Europe. Both Doel and Tihange, Belgium's second nuclear power plant, are operated by the Belgian power company Electrabel.

In 2018, Electrabel commissioned the companies Tractebel and Laborelec to test all components installed in the Doel facility for their resistance to radiation. This included the expansion joints used for the ventilation systems of the reactor buildings. They were made of the synthetic polymer Polytetrafluoroethylene (PTFE), which did not withstand the radiation exposure optimally. Thus, Electrabel tasked EagleBurgmann to find an alternative solution.

Quick solution due to high competence in nuclear technology

EagleBurgmann provides solutions for demanding applications in various industries. Nuclear technology has been part of the application spectrum for many years. Customers from the industry include Engie, Electrabel's parent company, for which EagleBurgmann supplies proven components such as mechanical seals, packings and gaskets. Based on the material competence built up over many different projects, the technicians and engineers quickly found a promising approach as to which material could meet the requirements of Electrabel. The synthetic rubber EPDM 400G was previously used by EagleBurgmann as a standard material, for example in expansion joints for ventilation systems. Even the material manufacturer was surprised by the fact that it was also radiation-resistant.

Advantages

- **Material exceeds application requirements**
- **Production according to customer-defined processes**
- **Comprehensive documentation for each delivered unit**
- **Easy installation by power plant employees**

The synthetic rubber EPDM 400G had to withstand a radiation exposure of 65 rad for half an hour – and significantly exceeded this requirement.

The expansion joints were tested on special test rigs according to customer specifications.

Material exceeds customer requirements for radiation resistance

Analyses performed in Tractebel's test laboratory confirmed the assumption of the EagleBurgmann experts: "The material actually withstood a radiation exposure of 65 rad for half an hour. It is therefore approved for usage in the reactor building", says Tony Foncke, who supervised the project in Technical Sales Support at EagleBurgmann. "The robustness of the material even exceeded customer requirements by far. After three months in a radioactive environment, the material was still in acceptable condition and showed only some contamination with the radiation medium", he explains. Due to the test results, Electrabel decided to replace all expansion joints in the ventilation systems of the reactor buildings with expansion joints made of EPDM 400G.

Designed for emergencies

In Doel, twelve large ventilation systems are installed. They cool the reactor area and are essential for the safe operation of a nuclear power plant. Like in most ventilation systems, vibrations occur here, too, which have to be absorbed by expansion joints. Additionally, the expansion joints compensate for any possible axial and radial misalignments of the ducts. The number of expansion joints needed depends on the size of the reactor. For the Doel facility, EagleBurgmann supplied approximately 50 units in two designs: round expansion joints with a nominal diameter of DN 1,200 and rectangular ones with DN 1,200 x 900.

The design of the expansion joints factors in the loads which might occur in the event of a malfunction and must withstand the emitted radiation for at least half an hour, for example in the event of a radioactive leak. Under normal operating conditions, non-radioactive air flows through the expansion joints at low temperatures and pressures. The reliable tightness over a long service life influences the overall economy of the entire power plant. "The expansion joints can only be replaced when the reactor is shut down for maintenance purposes", explains Foncke. "Those are a few, narrow time windows each year. In the meantime, absolutely nothing is allowed to happen."

Customized quality processes

Due to safety reasons, quality control of components for applications in the field of nuclear technology is essential and significantly more complex than in less critical industries. Therefore, EagleBurgmann set up a close-knit process for the production of the expansion joints in association with the customer. It includes each production step from quality control of the raw material to the documentation of each individual processing step.

In addition, representatives from Electrabel, Tractebel and EagleBurgmann visited the EPDM 400G production facility and convinced themselves that the manufacturing processes met the high quality and safety requirements. Production batches which have been checked at Tractebel are given the additional designation NCL for "nuclear". Only this EPDM 400 NCL may be installed in the expansion joints for Electrabel.

Precise definition of individual process steps and comprehensive documentation

In collaboration with the quality department at EagleBurgmann, the people in charge at Electrabel developed precise workflows for the manufacturing of the expansion joints. From the raw materials used to the duration of the vulcanization process, every work step was precisely defined on the basis of customer specifications. The customer checked that the specified work processes were carefully observed during two audits at the EagleBurgmann production plant. "It was very important for us to create transparency. The customer should be able to check the implementation of the standards at any time during production", says Tony Foncke. Each produced batch is accepted in person by employees from EagleBurgmann as well as the quality manager from Electrabel during a visit to the production plant.

Every single expansion joint is delivered with a comprehensive quality report, a certificate of compliance and numerous other documents which confirm the quality of the product as well as the strict obedience to the stipulated workflows. The person responsible for production guarantees by signature that all specified production processes and parameters are precisely adhered to. The production has recently been relocated from Denmark to Turkey without any drawbacks for the customer.

Application-oriented tests and safety for the power plant personnel

EagleBurgmann performs tests for the expansion joints on special steel devices according to customer specifications. Test procedures such as pressure and bubble tests are used to determine if the components can withstand a given pressure for half an hour. These performance tests are also supervised by employees from Electrabel and Tractebel. Only after they have accepted the test results, the expansion joints are delivered to the power plant.

The high quality demands and detailed documentation requirements are reflected in the time required for the individual steps.

While the production itself is completed after two weeks, documentation and quality assurance take up four to six weeks. The product design has also been optimized to facilitate installation. Power plant employees can install the expansion joints on site in the reactor building in the shortest possible time and without any special training. This also reduces the number of people who need access to the nuclear power plant.

Second Belgian nuclear power plant will also be equipped with EPDM expansion joints

By now, Electrabel uses expansion joints made of EPDM 400 NCL in all four reactors of the Doel nuclear power plant. Tony Foncke sees the quality of the delivered products confirmed. "The customer is very satisfied with the expansion joints. The first were installed in 2018, which was two years ago. None of them had to be replaced so far." The customer has a few spare copies in stock for each type of the expansion joints used and can replace them independently if necessary. Meanwhile, Electrabel is considering the retrofit of the second Belgian nuclear power plant in Tihange, where radiation-resistant expansion joints from EagleBurgmann might also be installed in the near future.

Operating conditions

- Temperature: up to approx. 80 °C
- Pressure: in the millibar range
- Flow medium: air
- Special requirements: radiation resistant for 30 min at 65 rad

Even more safety through heavy-duty components for nuclear technology

EagleBurgmann is a competent partner for the nuclear energy sector not only in the area of expansion joints, but also for mechanical seals. The operating conditions which have to be covered within this industry sometimes go far beyond what usually occurs when using these kinds of components. For example, the engineers designed a mechanical seal for an emergency cooling system which must also work safely when water evaporates between the sliding surfaces at a temperature of 150 °C. Cement dust, steel particles and components of thermal insulation material which are conveyed to the seals in the event of an explosion should also not lead to seal failure. A seal design which refrains completely from the usage of O-rings as well as the innovative DiamondFace® technology were used to cover these requirements. In more than 1,400 hours on the test bench, the seals also had to prove that they were able to last for at least one or two years of continuous operation.

EagleBurgmann – at the leading edge of industrial sealing technology

Our products are used wherever safety and reliability count: in the industries of oil & gas, refineries, petrochemicals, chemicals, pharmaceuticals, food, power, water and many more. About 6,000 employees contribute their ideas, solutions and dedication every day to ensure that customers around the globe can rely on our seals. With our modular TotalSealCare Service, we emphasize our strong customer orientation and offer custom-tailored services for every need. **Rely on excellence.**

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