

RESEARCH REACTOR BUSINESS AT AREVA TA: STATUS AND PERSPECTIVES

B. VIDAL[†]
AREVA TA,
Marketing & Sales Direction/Business Development Department,
Aix-en-Provence,
France

Abstract

Research reactors offer essential support for a country's nuclear power generation industry. They have for many years now provided this support in countless ways: They have made it possible to test new developments, to act as the forerunners for pressurised water reactor operations, for qualifying components, training operators as well as allowing the production of radioactive elements for medical or industrial purposes and they have also been used to perform tests on materials. In a word, they have definitively made a difference in our everyday life. For some forty years now, through its various iterations¹, AREVA TA has taken part in, or led the design and production of more than twenty research reactors and today, within AREVA, has the leading role in energies that generate lower CO₂ emissions and in the range of engineering specialties and services offered by the group in this field, alongside CERCA, the world leader in the supply of fuel for research reactors. All of this, in a competitive worldwide market that is more than ever dominated by the need to meet the expectations of the general public.

1. INTRODUCTION

For a company like AREVA, the research reactor market offers a number of dynamic trends worth examining. This presentation starts by setting out the major market segmentation aspects, dictated by the expectations of public authorities and public opinion in each sovereign nation. It then goes on to state how a nuclear power plant manufacturer and integrator can, at every step in the maturation of a project, provide the basic building blocks that can today ensure modularity, progressivity in investment spending along with operational efficiency. It is in this part that some examples will serve to prove what a nuclear power plant manufacturer and integrator, backed up by all of the expertise of a group like AREVA, can bring nation states, scientific communities and operators when it comes to developing a complete nuclear programme.

This introduction also offers the opportunity to thank the entire scientific and research community, for without their clairvoyance and tenacity, the expertise of a nuclear power plant manufacturer and integrator would be but a hollow and meaningless shell.

2. MARKET SEGMENTATION

2.1. The tools needed today, to train tomorrow's researchers

Training reactors remain essential in supporting the teaching of reactor physics, in maintaining skills, running experiments and in undertaking practical applications, as well as in enhancing the acceptance of a civilian nuclear power industry in any given country. A

[†] Technicatome, now known as AREVA TA was founded on 1 July 1972 by combining two departments belonging to France's Atomic Energy Commissariat. One was dedicated to naval nuclear power projects while the other built atomic "piles", forerunners of today's reactors.

B. Vidal

research reactor is a kind of first and essential stepping stone along the way to learning electro-nuclear techniques.

A research reactor dedicated to training makes it possible to undertake uses that cannot possibly be envisaged on a power reactor: allowing students/trainees to go “hands-on” with the controls while retaining the necessary safety conditions. Letting them learn physics phenomena “full-scale” or repeat an action a number of times until they are fully aware of every step, etc. This kind of work on real-life installations can also be completed by work on simulators so as to achieve all of the goals of quality training: observing, seeing, touching, understanding, testing.

2.2. The tools needed to expand the production of radio-isotopes for medical use

A research reactor is one of the most widespread technological solutions applied for producing the artificial radioactive elements used in medical applications. The main medical applications involved are radiation therapy, diagnostic medical imagery, palliative care and the sterilisation of medical materials. Amongst the fifty or so radio-isotopes that can be produced thanks to research reactors, the most often used are: molybdenum 99, cobalt 60 (together, these two represent 70% of the world market for radio-isotopes), palladium 103, iodine 131, etc. Once they are produced in the research reactors, the radiopharmaceutical products are made by vendors prior to purchase and use by nuclear medicine centres, hospitals, diagnostic imaging centres and so on.

The supply situation is a critical one for a number of reasons: the very short shelf life of radio-isotopes (e.g. 66 hours for molybdenum 99), with no storage being possible (therefore assuming that production takes place close to the place of final use), isolated producers whose maintenance shutdowns especially are not coordinated (there have been two recent supply crises, one in November 2007 [when the Canadian NRU shutdown] and one in August 2008 [when the Dutch HFR shutdown]) and lastly the world’s ageing production capacity.

2.3. Multi-purpose reactors, tools that are sized to simultaneously meet multiple needs

Designed to support multiple applications, multi-purpose reactors are especially affected by the issue of an aging worldwide installed base. These reactors bring their host countries a true nuclear industrial dimension and have their own place in an overall nuclear programme. In Europe especially, they have a place in supporting the nuclear power generation industry by enabling advanced research into the materials of today and tomorrow, and on their behaviour over time. They enable refined studies and experiments into the behaviour of fuels under irradiation conditions, they allow studies into the transmutation of long life fission products and into minor actinides. They also bring solutions for advance electronics industry applications (e.g. doping silicone). When they are called multi-purpose, they are considered to be “do all machines”, making it possible to perform a number of services, training operators and validating their training, while undertaking research oriented experiments.

More widely, any research reactor fits into a larger programme, supported by a nationwide teaching or research project or has a more industrial and commercial vocation. The infrastructures surrounding any reactor, the labs, cells and test platforms required for optimum use of the reactor itself must also be taken into account.

3. WHAT A MANUFACTURER AND INTEGRATOR CAN BRING NUCLEAR RESEARCH CENTRES

3.1. Precisely assessing the needs of operators and researchers: an example, the CNESTEN Maâmora Nuclear Research Centre

B. Vidal

This project undertaken by AREVA TA on behalf of CNESTEN, in partnership with SPIE-Batignolles, involved designing, building and bringing into service a nuclear research centre in 40 months so that once operational it could host a TRIGA Mark II reactor. Prior exchanges with the client made it possible to properly understand their needs, to integrate their operating and maintenance requirements into the project. To do this, AREVA TA teams applied their experience as technical and operational operators of support and research installations so as to anticipate operating situations and make allowance from the start of the project for organisational and human factors in the very layout of the buildings, cells and labs, and lastly to train future operators in running the Centre's installations. This approach also made it possible to guarantee the necessary flexibility for legitimate evolutions to the installation so as to respond to future needs.

CNESTEN also entrusted their industrial partner AREVA TA with an operational assistance assignment and with taking charge of site maintenance.

This assignment essentially comprised providing assistance in structuring the operating documentation from every aspect and in managing operations. This work was completed by training courses held at the AREVA TA Training Centre, whether on-site or in France, on full scale and partial training installations. This assignment was one of the essential elements brought by AREVA TA as a manufacturer and integrator for CNESTEN in their own work to support the development of nuclear and nuclear generation projects in Morocco.

3.2. Deploying suitable design engineering expertise: for example, simulating the behaviour of a reactor in operation thanks to the SARIE® software workshop

Teams from AREVA TA have designed and perfected a simulation workshop used to predict the way an operational reactor will work. This software workshop, called SARIE® has been used for many years now to simulate the behaviour of naval nuclear propulsion reactors designed by AREVA TA. It makes it possible to adapt the design to true needs in terms of the safety and availability of the installations to be designed as well as optimising engineering costs, reducing the need for tests prior to service introduction to just what is needed. The SARIE® platform, designed around the ALICES® software core developed by CORYS, the world leader in nuclear simulator systems also allows modelling and validating the options applied for future reactor control, to prepare suitable man-machine interfaces and finely adjust control and command actions. SARIE® can be used both during the design phases as well as during the building and operating phases.

Using this platform, teams from CORYS, an AREVA TA subsidiary company apply their excellent knowledge and expertise in managing nuclear installation operating situations and they can also bring the scientific community, through the simulators that they design, a relevant and pre-figurative vision of operational reality. CORYS is also very present in the field of simulators used for training and teaching the skills required in nuclear installation control situations.

The expertise especially built up by AREVA TA teams in the naval nuclear propulsion field has further been put to use thanks to a reference database that is shared by the various project teams.

3.3. Implementing operational control and command systems: an example, digital control and command systems for running an experimental pile

Teams from AREVA TA designed, developed and in 2002, brought into service, the digital control and command systems for running the AZUR installation, an experimental nuclear pile designed for qualifying fuels and naval nuclear propulsion cores as well as for training operators. This control and command system works through lines used to acquire

B. Vidal

physical measurement values, processing and validating data as well as triggering the regulation automation systems and installation safety mechanisms. These measures are mainly triggered by neutron flow measurement systems. Furthermore, fulltime radioactivity hazard monitoring is ensured using atmospheric sensors as well as by monitoring releases of gasses and dust from the chimney.

For almost twenty years now, digital control and command systems designed and installed by AREVA TA have been chosen to equip installations like the naval propulsion test reactor, RES, the JHR (Jules Horowitz Reactor) research reactor. These systems were the forerunners to the AREVA TA Pegasus NR™ range used to build standard architecture systems.

3.4. Ensuring fuel management: an example, fuel for CERCA research reactors

CERCA, an integral part of the AREVA Group is the world's leading supplier of fuel for research reactors. For more than fifty years now, CERCA has supplied its clients with dedicated fuel for research reactors. Whatever the plate geometry, the size of the elements or sections, and all to international Low-Enriched Uranium (LEU) standards, the fuels made by CERCA now equip almost 40 research reactors in 25 countries. CERCA also manages the supply of targets for producing ⁹⁹Mo and other isotopes necessary to medicine around the world.

3.5. Integrating operator requirements right from the design stage: an example, the Jules Horowitz Reactor

AREVA TA provides the industrial process management for the only multi-function research reactor currently under construction in Europe. This reactor will allow a number of experiments to be conducted and will bring the scientific community the experimental tools needed along with the degree of performance called for since initial design work started. Taking performance demands into account right from the reactor design stage is one of the priorities expressed by the industrial project owner. The manufacturer and integrator must be able to commit to achieving performance levels in line with the demands made by the scientific community. To do this, AREVA TA calls on the best specialists available within the AREVA Group, right from the earliest design phases, covering specialties such as neutronics, fuel physics, safety, control and command systems, simulation aspects and ergonomics. This way, the design can progressively integrate client needs, performance related expectations, national and international regulations, while doing everything possible to plan for, right from the design stage, the operating procedures that will optimise research reactor servicing and maintenance costs over the long term, etc. The proximity of French Atomic Energy Commission (CEA) researchers also allows the manufacturer and integrator that we are to properly measure the expectations that scientists have of a programme facing exceptionally challenging demands, while always working within a tight budgetary context.

The Jules Horowitz Reactor (JHR) is leading the way in the rebirth of research reactors in Europe and prefigures full international cooperation during the operating stages. In performance and safety terms, its targets are ambitious ones while its context sets out size constraints. All of this has led the teams from AREVA TA, working alongside CEA teams, to implement an overall approach that brings the programme its true dimension: testing of materials, codes, calculation approaches, experiments, qualifying a new fuel, etc. JHR also opens the way forward to a new approach in all of these areas.

3.6. Supporting the project owner and/or the operator to guarantee compliance with safety regulations

B. Vidal

Thanks to teams from its subsidiary company AREVA Risk Management Consulting, present in France and in Great Britain, close to nuclear facility and power plant operators, AREVA TA is able to support its clients at all times in ensuring compliance with national and international installation safety regulations. During the project phases, our main assignments are to support the project owners and future operators in securing the necessary administrative approvals (putting together and supporting the examination of applications for permission to create the facilities, waste management, etc.). During the operating phases, our own teams and the ones from AREVA Risk Management Consulting support and advise nuclear facility operators to guarantee the requisite safety level for their installation over its entire life cycle (renewed safety examinations, regulatory compliance audits, studying modifications, updating reference databases, zoning, dismantling, etc.). At all times, we make the most of the operational feedback we have gained from more than twenty licensing jobs undertaken with some ten different national safety authorities.

4. CONCLUSION

Research reactors retain a highly characteristic place in the civilian nuclear power international panorama: they support existing nuclear electricity generation programmes by allowing experiments on materials, thereby moving collective knowledge forward. They are the first step for a state when developing a national mechanism that requires learning, teaching and training. They also support the production of radio-isotopes suited to new demands in the field and growth in this market.

All of the aforementioned goals require that industrial partners like the AREVA Group be able to put forward responses that may be unique or replicated ones, based on expertise, skills and past achievements that have proven themselves in terms of performance achieved, compliance with safety fundamentals as well as being able to adapt to a client's true needs. By mobilising the Group's positives, CERCA for fuel, CORYS for simulators, RMC for risk management and its knowledge of national and international regulations, and last but not least, AREVA TA for its experience as a designer-manufacturer-technical operator of naval propulsion or research reactors, the AREVA Group can now offer responses worthy of its client's needs as future operators of nuclear design and research centres.