FIELD REPORT #5

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Interview with...

AREVA

LEADERSHIP INTERVIEW

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Luc Oursel on the Nuclear Industry Outlook

On March 11, Japan was struck by a magnitude 8.9 earthquake followed by devastating tsunami that had terrible consequences on the Fukushima Daiichi power plant? What was AREVA reaction to the events?

AREVA immediate concern after the events was for the thousands of victims of the earthquake and tsunami and their families. As early as March 14, we provided an emergency aid in the form of a donation of one million euros to the Japanese Red Cross to help support its 85 medical teams and nearly 735 workers deployed in the impacted area in response to the humanitarian disaster resulting from the tsunami.
Then, more specifically on the nuclear side, AREVA provided several tons of special equipment to Japan, including protective masks, hazmat suits, self-contained breathing apparatus, and radioactivity measurement equipment, as well as boric acid made available by EDF.

At TEPCO's request, 20 AREVA experts were sent to Japan to provide assistance to manage the situation and analyze the aid that could be provided to TEPCO. They are experts in radioactive effluent treatment, in transportation and management of used and damaged fuel, in dosimetry and in boiling water reactors. Backed by large teams in France, Germany and the United States, more than a hundred people are now involved in the process. Anne Lauvergeon, AREVA's CEO, also went to Tokyo twice since the events to meet Japanese officials to assess the situation and examining with them the solutions proposed by AREVA.

These are very practical actions, the first result of which was that mid-April, TEPCO accepted AREVA's solution to treat the contaminated water from the damaged Fukushima nuclear power plant. The method will use a unique technology, based on a co-precipitation concept, which was developed by the group and is already used in our Marcoule and La Hague facilities in France. The decontamination of the water is imperative to enable the rehabilitation of the power plant's power supply and cooling systems.

Luc Oursel - AREVA
Chief Operating Officer in charge of International, Marketing and Projects.

These events must have sparked a lot of questions from your customers. What supporting measures has AREVA been taking in response?

AREVA immediately mobilized to pulse and support its customers all around the world. The group is in a unique situation as it has business with 95% of the utilities that operate nuclear power plants, and has worldwide deployment of engineering services, in France, Germany, Europe, the U.S. and Asia. So, right after the beginning of the crisis, we set-up a certain number of technical groups to share with customers our first understanding of the situation and help them respond to their stakeholders interrogations and requests.
In Germany for instance, as early as March 12, AREVA Gmbh set up a technical committee gathering AREVA experts in BWR (Boiling Water Reactor) designs, severe accident analysis, and radiation protection. Regular phone conferences have been held with utilities' management, providing answers to a range of customer technical questions.
In the U.S., a communication center was set up and now follows up with utilities on NRC initial publications and on INPO requests.

In France, AREVA met with its customers at a seminar, held in Paris between April 12 and 14, where we have been able to share a first understanding of the events that occurred at the Fukushima power plant and discuss the utilities' needs for short-term support in their response to these events.
These are just some examples of the actions we take daily

to engage with our customers. Creating spaces for exchange and dialogue is at the heart of the group's policy of openness and transparency in its pursuit of continuous improvement, safety being our top priority.
AREVA's teams are now supporting utilities in the preparation for the safety checks that will be performed in the coming months by the regulators of each country. Thanks to our knowledge and expertise, we are able to provide support to the reactors we built, as well as, all the other technologies in operation today: all types of PWR (heavy or light water reactors) and BWR.

What consequences for the industry after Fukushima can we anticipate?

It is far too early to say what impacts this accident will have on the nuclear industry.
However, as the growing demand for electricity around the world and the need to reduce CO_2 generation are still a reality, nuclear energy remains an essential component of the energy mix to provide low-carbon, affordable electricity. Many countries such as China, UK, South-Africa and Czech Republic have already announced their plans to move forward with their nuclear program.
Nevertheless, the nuclear industry will need to reinforce public confidence in nuclear safety to emerge as even more robust as the results of Fukushima.
It is imperative that safety remains a fundamental value of the nuclear industry. We must seek to achieve continuous improvements, be transparent, be humble and reflect that citizens and stakeholders alike around the world have been and remain shaken by these events.
"Safety-First" has always been an integral part of AREVA's DNA. This is why we always chose to design reactors with a higher safety level. Less expensive because less safe was never an option; the Japanese events confirm that this is the right strategy for long-term public acceptance.

Following these events, a lot of questions were raised about the new generation of reactors currently under construction or planned. Can you tell us more about the EPR safety systems and how the reactor would cope in case of total loss of electrical power such as in Fukushima?

To make it simple, we consider that the EPR reactor would have resisted to the events that occurred in Fukushima and that power would not have been lost as the reactor has several layers of back-ups.
The EPR reactor has four separate and redundant safeguard divisions that provide a quadruple redundancy in the safety systems. Each division has its own cooling system, with water reserves and injection mechanisms, each capable of cooling the reactor by itself and each being powered by a dedicated power source.
In case of loss of external power from the main as well as from the auxiliary electrical grids, the EPR reactor has still 3 levels of power back-ups. First, four dedicated emergency diesel generators, housed in two separate buildings, which have their own protected fuel supply and can power the safeguard divisions for 72 hours. All buildings are antiseismic, and specifically laid out to provide protection against floods and tsunamis (adaptations being made according to site-specific requirements). Then, these are backed up with two additional and redundant station blackout diesel generators which have also their own protected diesel supply and can last 24 hours. Finally, should all the above fail to start, there are batteries that would supply power for 12 hours to all critical equipment. All these back-ups would give staff valuable additional time to re-establish a stable situation.

Finally, as the events in Japan have shown, once again, that even very unlikely events can occur, AREVA reactors are all designed to cope with the worse case scenario, such as the core meltdown, thanks to unique safety features. The EPR reactor, for instance, is equipped with a core-catcher. This is the ultimate passive safety feature of the EPR reactor and is based on the so-called "deterministic approach". This means that our reactors are designed to keep a core melt under control, however low the probability of that event might be – indeed, ultimately, safety of the population is not negotiable. The core catcher housed within the double-wall concrete shell building would provide valuable additional time for the plant to be reconnected to the grid or powered by mobile means, preventing any significant radiological release to the environment.

The EPR reactor therefore offers in-depth protection against both internal and external accidents (e.g.: commercial airplane crash). We sometimes simplify the safety concept of the EPR reactor by saying: 'if something happens outside, nothing happens inside; if something happens inside, nothing happens outside.' Of all new reactor designs, the EPR reactor has the unique advantage to have been developed from the early stages with the strong participation of the French and the German safety authorities and combines proven safety systems inherited from its highly efficient "parent" reactors, the French N4 and the German Konvoi, as well as innovative safety features stemming from unrelenting continuous improvement and return on experience.
The EPR reactor therefore meets the highest safety requirements in effect to date, including in terms of seismic resistance. It is the most robust design to date.

What level of seismic activity is the EPR reactor designed to withstand? And how does it compare to the earthquake experienced in Japan March 11?

Regarding seismic resistance, it is important to understand that the key parameter to evaluate the risk of possible plant damage, is the ground motion experienced by the plant on a given site. We call it the ground acceleration. Expressed in g (g being the acceleration communicated to an object by gravity), this ground motion or acceleration depends on a number of factors such as the magnitude of the earthquake (the Richter Scale value), but also the distance from the epicenter and the type of soil upon which the building is sited (e.g., hard rock like granite or soft soil like compacted limestone) which, for a same magnitude, will weaken, more or less, the motion

experienced on site.
All EPR reactors are therefore designed to meet the site-specific regulatory seismic requirements of each site.
For example: In Olkiluoto, Finland, the plant has to be able to withstand a peak ground acceleration of 0.10g.
On some U.S. sites, as well as the Koeberg site in South Africa, the plant has to withstand acceleration up to 0.30g.
For Flamanville, France; Taishan, China; and the UK, the peak ground acceleration is rated at 0.25g. So, to answer your second question, yes, if we were to build an EPR reactor in a very high seismic zone such as the one in Fukushima, the EPR reactor would be designed to withstand the required level of ground acceleration. And, yes, the EPR reactor would have withstood the Fukushima earthquake where the ground acceleration experienced is reported to have been about 0.30g to 0.50g.
Actually, and given the level of margin available, the EPR reactor can withstand an earthquake with a peak ground acceleration of 0.60g without damage that would impair the operability of its safety systems.

Can the EPR reactor resist tsunamis?

Yes, as here again the EPR reactor is designed to meet the site-specific regulatory requirements.
Consequently, the elevation of the platform level, as this is how protection against tsunami is achieved, is adjusted according the geography of the site.
Sometimes, additional protections are implemented such as dikes, wave breakers, etc. (example the Blayais plant in France). In addition, as for the EPR design specifically, should the water level exceed the platform level, the reactor building, the safeguard buildings, the fuel building, and the diesel buildings are designed to resist floods and severe impact loads, including tsunamis.

Why not just have a solely passive design such as some of your direct competitors?

Active or passive safety systems are not the real issue; the bottom line is the level of safety achieved.
All nuclear incidents and accidents have resulted from an unexpectedly complex sequence of events that demand an equally diverse range of response. This is why all of AREVA's reactor designs leverage both active and passive technologies to provide complementary, diverse and redundant safety systems. The global safety level of the plants is thus maximized and the process control over their operation is optimized.
Passive has advantages and drawbacks which complement very well the advantages and drawbacks of active systems. This is why AREVA deliberately chose to integrate the best of both safety approaches to maximize the overall safety of the plant.
Passive isn't perfect. Because of the complexity of the processes sometimes involved, passive systems can be difficult to model and test. Thus, designs relying solely on passive safety systems may not adapt and react to unexpected and complex sequence of events, such as that in Fukushima. Claiming the contrary is, at minimum, presumptuous.
They give very little flexibility and provide only one response to abnormal events regardless of their specificity or severity.
Most of the passive systems can only be used once. Once they have been activated, they are no longer available. Active systems are therefore required to transition from an immediate response to a sustainable condition.
Finally, passive systems can also fail. As they usually require sophisticated structures and design to function in an optimal way, they are more sensitive to small or external disturbances such as debris, clogging, unexpected steam production, etc.
Therefore, while a certain number of passive safety systems are clearly necessary to ensure a good level of independence in the case of reactor system failure, to depend fully on them is to adopt a strictly probabilistic approach to risk management and take the risk for the plant to not being able to cope with unexpected sequences of events. Yet, the events in Japan have shown that even very unlikely events, with dramatic consequences can occur.
Safety is not simple. It is AREVA's position that relying on one kind of safety system is simply not enough.

Following the Fukushima events, does AREVA anticipate the impact they will have on the EPR design, if lessons were to be learned and safety requirements modified accordingly?

Again, because of the characteristics of its design and the involvement of the safety authorities in its development from the early stages, the EPR reactor is already the most robust design to date. We are therefore confident that, if we were asked by safety authorities to make some adaptations, these wouldn't be major changes and we are well positioned to comply.
The EPR reactor is indeed in a unique situation. Under construction in 3 countries – Finland, France and China – and under certification in two others – the UK and the U.S., we have the opportunity to address these issues with well established and experienced safety authorities. This is a real asset for the EPR reactor.
However, as of today, none of our customers have requested any changes.

The new generation of reactors is one thing, but what about the current nuclear fleet? Safety checks have been announced all around the world. Should we be worried about the safety of the power plants currently in operation?

This question is more for the utilities who operate the current fleet. However, AREVA will provide support to its customers throughout this period as we have in our portfolio a range of products and services in areas such as safety analysis, plant design upgrade and post-accident management procedures that can be of immediate value to utilities. Other products and services will be developed to address new utilities' needs and new regulatory requirements.
That being said, it is important to understand that the safety principles of the new generation designs which provide complementary, diverse and redundant safety systems are

rooted in previous reactor designs.

The current nuclear plants have thus a series of safety features and back-up systems that provide utilities with a diverse range of responses to address unexpected events.

In addition, as with the new plants, all current nuclear power plants were designed and built according to site-specific regulatory requirements making the plants able to resist the worst possible conditions that can occur on site i.e.: earthquakes, floods, tsunamis, etc.

Finally, there are no "old" plants. The current fleet of NPPs has been modernized and upgraded over the years to always maintain the highest level of safety and meet the latest regulatory requirements in effect.

However, the nuclear industry being a particularly conscientious and responsible industry, safety checks will be performed to reassess the safety margins of NPPs in the light of the Fukushima events and determine if there is a need for additional safety provisions (being technical or organizational). AREVA is committed to supporting its clients and the regulators during this process so that the highest degree of safety is guaranteed throughout the current and future nuclear fleet.

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