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OECD Boulogne building.

Abu Dhabi towers.
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Director-General William D. Magwood, IV

Speech at the International Ministerial Conference on Nuclear Power in the 21st Century[1]

Mr William D. Magwood, IV, NEA Director-General delivering his opening remarks at the International Ministerial Conference on Nuclear Power in the 21st Century. St Regis Saadiyat Island Resort, Abu Dhabi, United Arab Emirates, 30 October 2017.

As we gather here today, we begin several days of discussion about the role of nuclear energy in this still very new century. In contrast to past discussions about this subject, the outlook for the future of nuclear power must be made in technical, policy and economic environments that are extraordinarily unclear.

The world came together in Paris at the end of 2015 to set itself on a path towards a low-carbon future, but two years later, the path remains uncertain. Many countries have made broad political decisions to reduce carbon emissions, but few have made substantive steps towards realising this vision. Despite ambitious words, some have made steps in the opposite direction, presenting an easy political message rather than a substantive strategy to implement a true low-carbon economy.

This is not new. Energy has always been a political matter. The history of the region in which we convene today has been shaped, in part, by energy politics since before the turn of the previous century.

In OECD economies, a powerful and resilient system of electricity generation and distribution has been constructed that has successfully fostered industrial expansion and an enhanced quality of life and health. This system serves as the framework on which future plans may be crafted and it gives us the ability to experiment, to test new approaches and even to make mistakes.

But this framework is, today, under vastly increased pressure. It is being asked to do what it is ill-equipped to do and it is suffering from a lack of investment in needed infrastructure. The electricity markets themselves are in a state in which zero or negative pricing is commonplace, and the companies that built the successful systems upon which everyday life depends face financial unviability.

Baseload plants, which today supply nearly all of our electricity, are being shut down. In some places, even hydroelectric plants, which are second only to nuclear power as the source of zero-carbon energy in OECD countries, are operating at a loss. In many markets, the only electric supply that can be built is that which is subsidised by governments. Some consider this to be an energy transition. Others worry that we are witnessing the erosion of an infrastructure that powered economic development for many decades and, perhaps, an opening of a door to economic decline.

1. Mr Magwood's remarks followed those of Mr Yukiya Amano, Director General of the International Atomic Energy Agency (IAEA).

Whichever side of this debate is correct, the reality today is that many electricity markets are dysfunctional, emissions are not falling rapidly enough to meet global targets and uncertainty about the future of energy is higher than it has ever been.

Whatever picture emerges for the future energy portfolio for the world, it will need to adapt to what may be a vast new wave of electrification, with electricity poised to displace petroleum in many transportation applications.

The future energy portfolio must also reflect the aspirations of the 1.2 billion people in the world today who are currently without access to electricity and the 2.7 billion people who lack clean cooking facilities. It will also need to respond to 6.5 million premature deaths that today occur each year due to air pollution.

These challenges are likely to grow – not shrink – as the global population grows from 7.5 billion today to about 10 billion by 2050.

So what will the energy framework look like in the future? There are many projections and scenarios, many plans and intentions. But the reality is no one knows.

There is no reason to believe that the analysts and prognosticators of today have any better foresight than those of the last ten, twenty or thirty years. And their records are dismal.

I am often asked about the future of nuclear energy in the world. On the one hand, the answer is quite clear. New nuclear plants are, today, being built all around the world. Roughly 60 nuclear reactors are under construction around the world as we speak – including four units, 300 kilometres west of this hall. Dozens more are in the planning stages. If these projects and plans proceed, all of those reactors are likely to be in operation in 2050, alongside the many plants already producing electricity today.

It is true, however, that the regional distribution of nuclear power plants may become very uneven. To some degree, that simply reflects the particular preferences of individual countries, with their individual circumstances taken into account.

But the fact that nuclear plants are being built in some parts of the world and shut down in others also reflects market dysfunction and policies that heavily subsidise renewables and suppress nuclear energy. And it reflects the failure of many traditional suppliers to deliver on their promises to build a new generation of plants on schedule and within set budgets.

Nevertheless, whatever the reasons, each country should be free to take its own energy path.

For some countries, the emphasis today is on renewable energy. This is a reasonable and rational path, particularly as the cost of wind and solar energy drop. We should use these resources and in some circumstances – such as in developing countries that lack extensive infrastructure – renewables should be the energy resource of choice.

The question that must be answered, particularly by OECD countries with their vast, well-functioning electric supply frameworks, is to what degree variable renewable energy resources can practically be applied. Many authoritative studies and projections exist and the conclusions vary; some, such as a 2015 analysis assembled by France's EDF, indicate that 40% variable renewables is an optimum target. Others, such as the International Energy Agency, think 75% could be achievable.

The outcome will rely on advancements in transmission and distribution, energy storage and other technologies. But it is clear that the higher the proportion of variable sources, the greater the grid stability challenge. For a country with 75% variable renewables, a capacity equivalent to about 25% of demand must be able to be ramped up and down within an hour to maintain a stable supply.

To the degree that natural gas thermal plants remain, as they are today, as the backup supply to enable increased use of variable resources, the objective stated by many countries to reduce carbon emissions by 80% or more by 2050 will be elusive.

Professor James Hansen was the scientist who first raised broad awareness of climate change when he testified before the US Congress in 1988. Originally highly regarded as an expert studying the atmosphere of Venus, he became aware of parallels between that hot planet and trends on the Earth. Dr Hansen concluded that carbon in our atmosphere was impacting weather and warming the planet. He remains one of the leading voices in the world advocating aggressive action to reduce carbon emissions.

Dr Hansen has said, starkly, that "renewables plus natural gas equals planetary doom."

I imagine there are many people who will listen intently to Dr Hansen when he speaks of the threat of climate change, but fall suddenly deaf when he highlights the folly of an electricity system that is fronted by wind turbines but backed by constantly spinning gas turbines and quietly restarted coal plants.

This is particularly true where nuclear is substituted by a mix of renewables and natural gas – experience demonstrates consistently that carbon emissions rise.

The need to plan for and implement an advanced energy system that will support our future needs, desires and realities is too important to continue listening selectively. We must have our ears and our eyes open and our efforts set to give future generations the greatest benefit previous generations bestowed to us: choices.

With so much uncertainty about the future, the world will need as many tools as possible at its disposal. Nuclear energy is one of the options in the global toolbox to address climate change, air pollution and energy security.

Whether renewables ultimately comprise 40% of our future electric supply or 75%, something else will need to provide the other 25% to 60%; and that something else must be fully dispatchable – available when renewables are not; available when the winters are long and cold; available when the summers are unbearably hot and the wind is still.

Far from being a conflicting choice with renewables, nuclear generation could be an enabler for large scale renewable deployment. The complementarity between the two technologies may mitigate risks related to renewable intermittence, contributing to a decarbonised and more secure electricity system.

If we are truly to reach this advanced energy system of the future, three things will be needed.

First, we must address the dysfunction in our electricity markets. Requirements for utilities to use subsidised renewables, which have zero marginal cost but enjoy guaranteed remuneration, have dramatically depressed wholesale prices and drained electric utilities of the resources that will be needed to build the systems of the future in many OECD countries.

Abu Dhabi was host to the International Ministerial Conference on Nuclear Power in the 21st Century (October 2017).

Shutterstock, Leonid Andronov

In today's power markets, no technology, not a single one – renewables included – is able to finance itself on the basis of market prices. This is simply not sustainable, unless governments plan to essentially nationalise their electric systems and use taxpayer resources indefinitely to support these policies, irrespective of cost.

NEA analysis demonstrates that a better path would be to redesign markets to incentivise the use of low-carbon energy technologies and to allocate system costs – such as transmission access – fairly to those technologies that create them. We should also create pricing systems that reflect the realities of high-fixed cost, low-carbon technologies, which concerns both nuclear and renewables. In order to ensure sufficient investment, we must create long-term financing mechanisms that ensure stable returns over the lifetime of the wind farm, nuclear plant or other installation. Finally, we should remunerate dispatchable capacity for the service that it provides to the system by being ready to satisfy demand at any time.

Second, we need to reinvigorate research and innovation on a broad front. We benefit today from the broad and forward-looking research programmes of the past. By not continuing to plant seeds that can grow over the long-term, we risk starving the generations that will follow us.

For nuclear energy to play a larger role in our future energy system, we should explore innovations to make nuclear plants more flexible and cost-efficient while achieving high levels of nuclear safety. We should explore Generation IV technologies and advanced, proliferation-resistant fuel cycles. We should undertake a major new global initiative to develop the materials of the 22nd century today.

Because we truly do not know what energy resources and technologies will be needed or available over the coming decades, we owe it to the future to maintain a broad front of research, development and innovation. Given the long-term nature of energy research and infrastructure development, the choices we make today will weigh heavily on the ability of the next generation to respond to the challenges of 2050.

Finally, we need to bring our policies in line with our desires. In 2015, the OECD, the Nuclear Energy Agency, the International Energy Agency and the International Transport Forum reported to an OECD Ministerial Council Meeting regarding how to better align policies across different areas for a successful economic transition of all countries to sustainable low-carbon economies. The report, *Aligning Policies for a Low-carbon Economy,* found that across a broad range of policies covering everything from agriculture to energy, despite the positive words from most governments about reducing carbon emissions, their policies were moving in the wrong direction.

If we are serious about reducing carbon emissions, we must make that our priority, not the promotion of the technologies that provide nice photo opportunities but lead to higher emissions.

We at the NEA work with our member countries and others around the world to provide the analysis needed to chart our next steps. Programmes and initiatives such as Nuclear Innovation 2050, which can bring regulators into the discussion about future innovations, and the forward-looking Generation IV International Forum, bring countries together to explore the technologies of the future. We will do these things and more.

But in the end, the governments of the world must rise to real challenges of the future and follow the example of our forbearers who looked beyond the easy answers of today and addressed the hard tasks of tomorrow. The forbearers who built the great electric systems that brought light to the darkness in the 20th century. The forbearers who harnessed the atom and took humankind's first steps into space. And the forbearers who built a great global city in the Arabian desert.

Thank you.

William D. Magwood, IV,
NEA Director-General

The Cabri Reactor: Equipped for NEA Cabri International Project tests

by F. Barré, C. Manenc and M. Kissane

Mr François Barré (francois.barre@irsn.fr) is Safety Research Deputy Director, IRSN, Ms Christelle Manenc (christelle.manenc@irsn.fr) is Project Leader of the Cabri Experimental Programme, IRSN, and Dr Martin Kissane (martin.kissane@oecd.org) is Nuclear Safety Analyst in the NEA Division of Nuclear Safety Technology and Regulation.

Introduction

The objective of the Cabri International Project (CIP) is to study the behaviour of nuclear fuel rods and their cladding during a reactivity injection accident (RIA) in a pressurised water reactor (PWR). The project was launched in the year 2000 by the French Institute for Radiation Protection and Nuclear Safety (IRSN) and includes refurbishment of the Cabri reactor, upgrading work vis-à-vis regulations, implementation of a water loop, development of experimental devices and the carrying out of twelve RIA tests.

The Cabri reactor has been undergoing a major refurbishment over the past ten years, and is now equipped with a new configuration that will enable CIP to study the behaviour of advanced fuels in more fully representative PWR accident conditions.

The Cabri reactor

The Cabri experimental reactor is located in the south of France in Cadarache, and is owned and operated by the French Alternative Energies and Atomic Energy Commission (CEA). The IRSN has been given priority to use the reactor by government decree for its research programme on fuel safety. It is therefore funding the Cabri refurbishment, the reactor operation and all the experimental work in order to complete the CIP tests.

The Cabri facility is a pool-type research reactor dedicated to studying reactor-initiated accidents or RIAs on a section of highly irradiated fuel in a water-cooled reactor. The possibility of such an accident under real circumstances would depend largely on the reactor technology, but an accident could also arise after the ejection of a control rod, and would result in a rapid, sudden and local increase in the neutron flux, which would induce an increase in nuclear power as a result of fission. The Cabri facility reproduces these representative conditions of accident scenarios. Power transients are obtained by depressurising the neutron absorbing element, helium-3 (^3He) in the core. The nominal power of the reactor is 10 MW – designed to carry out power transients with a pulse width between 10 and 100 ms, a maximum power of more than 20 GW and an injected energy of up to 200 MJ.

Going critical for the very first time in 1964, the Cabri reactor was originally intended for tests to study reactivity accidents that had been taken into account in the safety analysis of certain research reactors. In 1977-1978, the reactor was reconverted, meaning that the core was changed and the facility equipped with a loop reproducing the operating conditions of a sodium-cooled fast reactor. From 1978 to 2001, safety tests for the Phénix and Superphénix fast reactors were performed, followed by sodium loop studies of reactivity accidents in PWRs (i.e. the PWR-Na programme, from 1993 to 2000).

Following changes in the conditions for using fuel in reactors, and to supplement the previous PWR-Na programme, in 2000 the IRSN launched the Cabri International Project under the auspices of the Nuclear Energy Agency. The project consists of tests that study the behaviour of PWR fuel rods in the Cabri facility during a reactivity accident when such fuel rods are in conditions identical to those of reactor conditions (i.e. temperature, pressure and water flow).

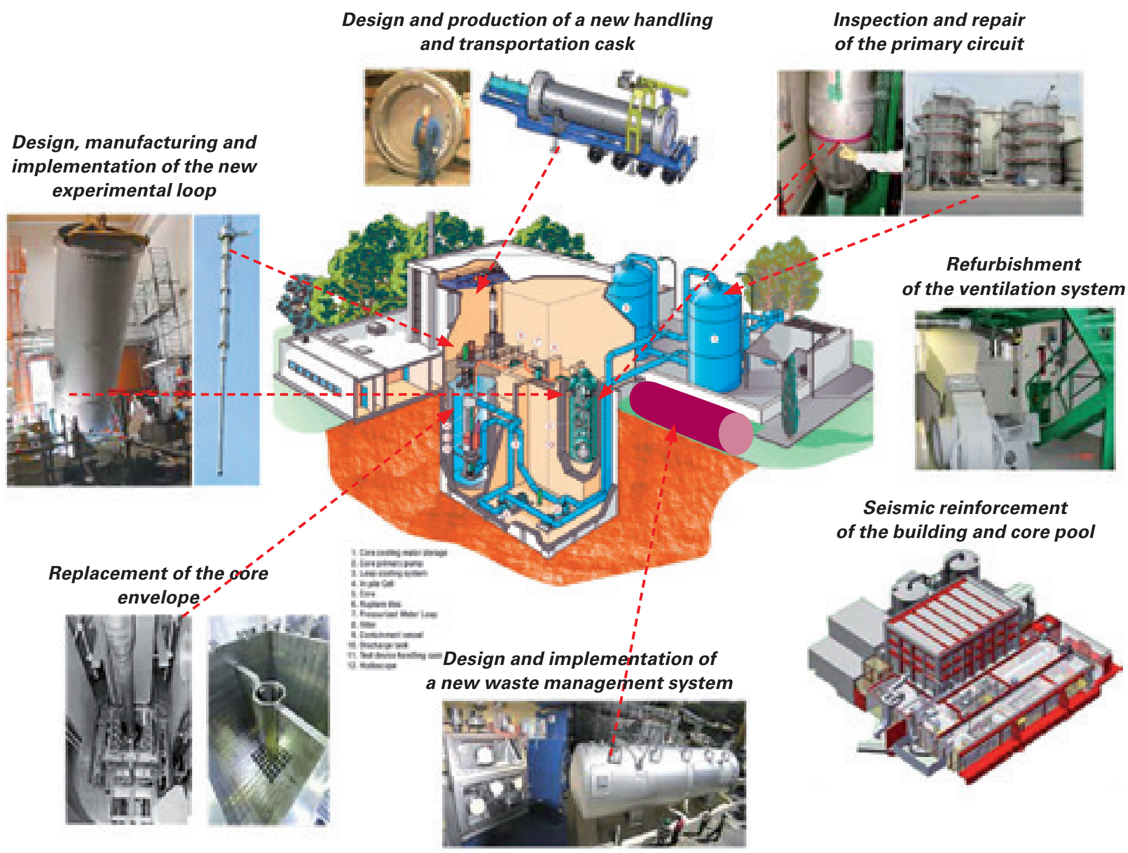
Before being able to perform the CIP tests, however, it was necessary to refurbish the Cabri reactor and to adapt it to PWR conditions. This refurbishment – whereby a water loop was implemented in the place of the sodium loop – was completed in 2015.

Refurbishment and upgrading work

The refurbishment of the reactor was performed by the CEA during the 2003-2015 period, and it included a large number of delicate tasks, such as:

- seismic reinforcement of the building and core pool (see Figure 1: the red colours show the reinforced part of the reactor);
- replacement of the core envelope;
- refurbishment of the ventilation system;
- design and implementation of a new waste management system;
- renovation of the glove boxes of the primary circuit;
- design, manufacturing and implementation of the new experimental water loop to replace the sodium loop.

Figure 1: **Overview of the refurbishment tasks**



The refurbishment of the reactor has led to a fully renewed experimental reactor. With authorisation from the French Safety Authority (ASN) in 2015, the first criticality of the Cabri reactor occurred in the new, post-renovation configuration on 20 October 2015.

The commissioning tests

Qualification tests for the pressurised water loop were performed to assess operation at nominal PWR conditions (155 bar, 280°C, 1.5 M^3h^{-1}). The ^3He transient rod system was qualified to assess the depressurisation kinetics and the time control system.

Performed between October 2015 and June 2016, low core power tests (<100 kW) were used for neutron characterisation of the reactor core, in particular the integral efficiency of the six control rods, the transient rod reactivity worth, the kinetic parameters (delayed-neutron fraction and prompt-neutron lifetime) and the reactivity effects (experimental cell configuration, core stacking effect and isothermal temperature coefficient).

High power tests (see Figure 2) were performed at the end of 2016, primarily for the calibration of experimental neutronic chambers by thermal balance on the core's water circuit.

In the first half of 2017, 66 transient power tests were performed under conditions similar to those of future experimental tests. The main objectives of these tests were to qualify the whole facility (transient rods, primary circuit, water loop, experimental measurements and data acquisition), to check the absence of impacts of the water

Figure 2: **Photos looking down into the reactor pool showing the Cherenkov radiation characteristic of the different core powers**

100 kW | 2 MW | 7 MW | 14 MW | 23 MW

Figure 3: **Example of a power transient**

Start up: simple depressurisation – 3He pressure: 11.5 bar maximum characteristics obtained

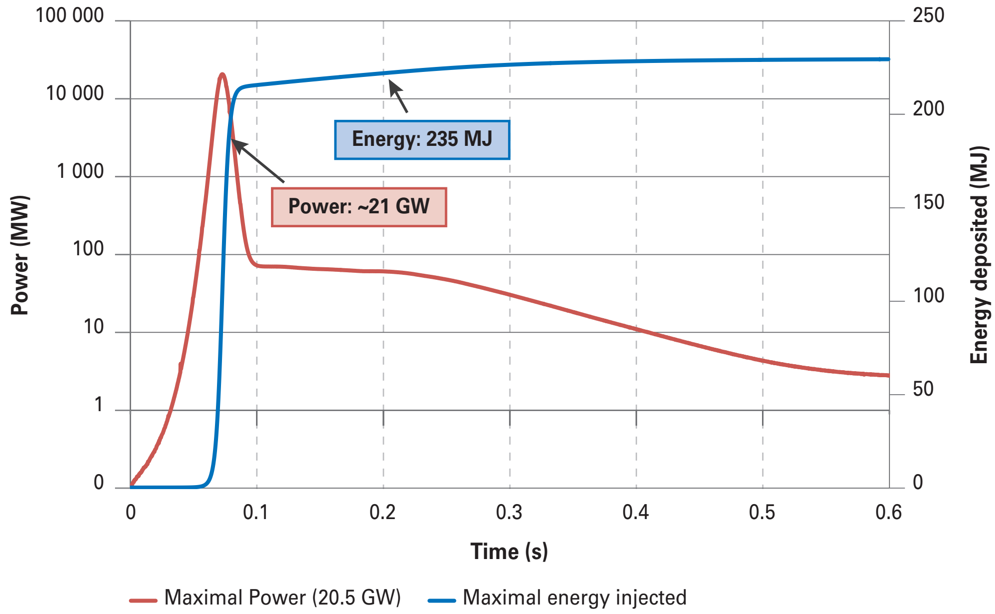


Figure 4: **The Cabri hodoscope**

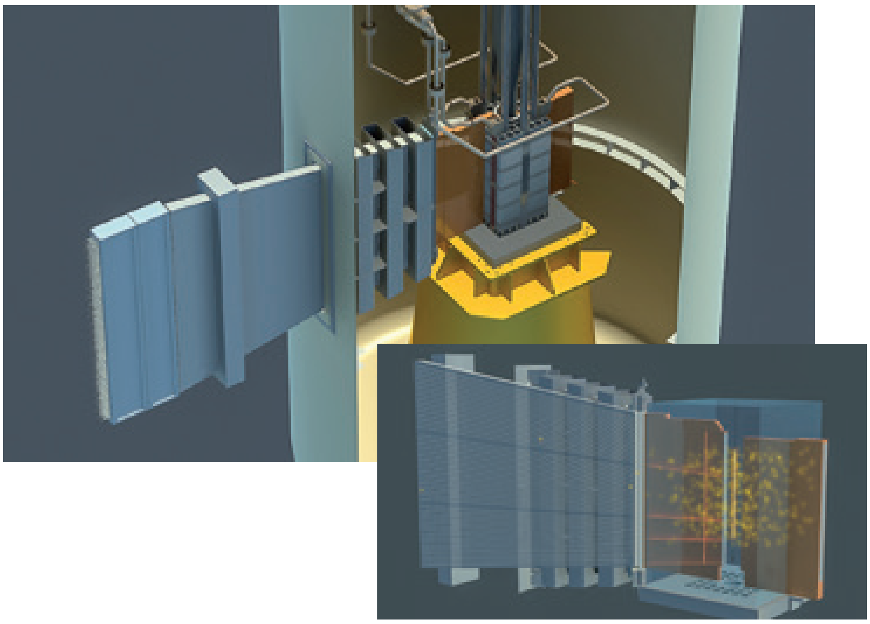
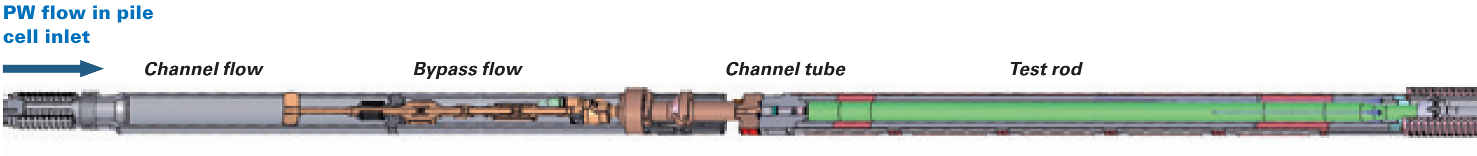


Figure 5: **Test device**

Start up: simple depressurisation – 3He pressure: 11.5 bar maximum characteristics obtained



loop conditions on the transient and to assess the reactivity injection system (reproducibility, settings and ^3He purity). The maximum test powers were between 203 MW and 21 GW, with an injected energy between 21 MJ and 235 MJ.

By mid-2017, all commissioning tests were performed, and the CEA submitted its application to the French Nuclear Safety Authority (ASN) with the goal of launching the CIP experimental phase.

The CIP

The experimental project is directed by the IRSN, which also develops and makes use of its own experimental devices and instrumentation. It consists of exposing sections of irradiated fuel rods under the thermos-hydraulic and neutronic power conditions encountered during an RIA. Power transients are simulated through the depressurisation of ^3He within the Cabri reactor core. The rod being tested is positioned inside the centre of the Cabri reactor core's test device (see Figure 5).

The test device containing the fuel rod is equipped with a considerable range of instrumentation, making it possible to measure the main experimental parameters: flows, pressures, temperatures, axial displacement of the cladding, etc. The water loop is equipped with a gamma spectrometry unit, used to characterise fission-product release in case of cladding failure. The reactor is fitted with a specific device called a hodoscope (see Figure 4), which is designed to measure fuel movement during the power transient. The Cabri facility is equipped with non-destructive testing capacities, namely gamma scanning and X-ray tomography.

Placed under the aegis of the NEA, the project is co-ordinated and co-funded by the IRSN, with multiple French and international partners supporting the project from twelve different countries – the Czech Republic, Finland, France, Germany, Japan, Korea, the Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Among the twelve tests to be carried out in total, the first two reactivity injection tests on irradiated rods were carried out in 2001 and 2002 in the Cabri reactor equipped with the sodium loop (i.e. before the refurbishment phase and the implementation of the water loop). These two tests made it possible to study phenomena that do not depend on the nature of the coolant. In order to study conditions representative of an accident in a PWR, the sodium loop nonetheless had to be replaced by a pressurised water loop. The ten remaining tests in the water loop are now being planned to start in 2018. Table 1 provides the text matrix, which was prepared by the project's International Technical Advisory Group and validated by the International Steering Committee.

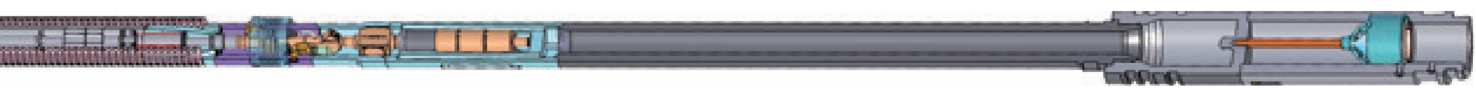
With the first test in the water loop imminent, the IRSN would like to acknowledge all CIP partners for their continued support during this major refurbishment of the Cabri facility.

Table 1: The current test matrix for the ten remaining CIP tests

N°	TEST	TEST ROD			OBJECTIVE			In Na loop
		Fuel	Burn-up (GWd/t)	Cladding	Boiling crisis	Post failure event	More	
1	CIPQ	MOX	47	Zy-4	X		Loop qualification	X (Rep Na 6)
2	CIP1-2	UO_2	77	M5	X			X (CIP02)
3	CIP3-1R	UO_2	75	Zirlo		X		X (CIP01)
4	CIP4-1P	MOX-P	65	M5	X		μ structure influence of MOX fuel effect of filling pressure 90b vs 50B in others tests	
5	CIP4-1P-HP	MOX-P	65	M5	X			
6	CIP4-2	MOX-SBR	65	Zy-4		X		
7	CIP3-3	UO_2	> 55	Optimised Zirlo	X		New cladding material	
8	CIPX	UO_2		M-MDA				
9	CIPY	To be defined						
10	CIPZ	To be defined						

Note

1. Reactivity injection accidents, often called reactivity accidents or reactivity-initiated accidents (RIAs), are generally taken into account in the reactor design. For PWRs, they result from the failure of a mechanism controlling a control rod assembly, which helps to regulate the nuclear reaction. Reactivity accidents lead to a rapid, violent generation of energy in the fuel.



TREAT: A new element in the international nuclear science infrastructure

by J. Dyrda

Dr James Dyrda (james.dyrda@oecd.org) is Nuclear Scientist in the NEA Division of Nuclear Science.

TREAT subpile room, Idaho, United States.

The restart of another key element in the national and international nuclear science infrastructure was completed at the end of 2017. After an extended shutdown lasting more than 23 years, the Transient Reactor Test Facility (TREAT) in Idaho, United States, successfully achieved its first criticality on 14 November 2017. The US Department of Energy (DOE) has been working on this restart programme since 2013 in order to add a key element to the ongoing project to develop, test and qualify accident tolerant fuels (ATFs). These innovative ATFs can enhance the safety resilience of the nuclear power reactor fleet worldwide once deployed in an industrial setting.

TREAT is a graphite-moderated, air-cooled, thermal-spectrum test facility designed to evaluate reactor fuels and structural materials under simulated nuclear excursions and transient power/cooling mismatch situations. Highly enriched uranium fuel is homogeneously interspersed within the zircaloy-clad fuel elements, which are arranged within the core as a 19x19 lattice with interstitial cooling channels and with a thick radial reflector. The agile design of the control system and the graphite heat sink has made TREAT a flexible tool because it can operate at specifically adapted transient pulse shapes in accordance with the experiment in question. Its steady-state power is 120 kW, and in pulse mode the peak can reach up to 19 GW.

Initial commissioning activities are now underway to prepare the facility for the start of experimental campaigns. These preparatory activities will include operator qualifications, instrument testing, radiological characterisation and detailed calibration of the core's operational characteristics – including heat balance, reactivity control and rod worth measurements, as well as trial transients. To complement these campaigns, experimental vehicles that contain the test sample and its specific instrumentation, while providing bespoke environmental conditions, are under design and engineering at the Idaho National Laboratory (INL). The first experimental results from TREAT are expected before the start of 2019.

From an international perspective, TREAT is a fundamental asset that will be a strong complement to other facilities, including the Cabri facility discussed in the article on page 6, with both facilities offering different ranges in terms of the experimental design. Multi-national partnerships with research, development and regulatory bodies, for example between the Idaho National Laboratory, the French Alternative Energies and Atomic Energy Commission (CEA) and the French Institute for Radiation Protection and Nuclear Safety (IRSN), are already in place to enable collaboration. TREAT will be used as an instrument to validate novel computational codes – these multi-purpose simulation tools are under development among American national laboratories and academic partners. As such, the intended benefits offered by the TREAT restart include positive impacts to basic science, nuclear safety and the economic viability of the wider power industry.

An article outlining TREAT and Cabri experimental capabilities that address nuclear fuel behaviour under reactivity-initiated accidents (RIAs) will be included in a later edition of *NEA News*.

The NEA inspiring female leaders in science and engineering

by Y. Hah and T. Saito

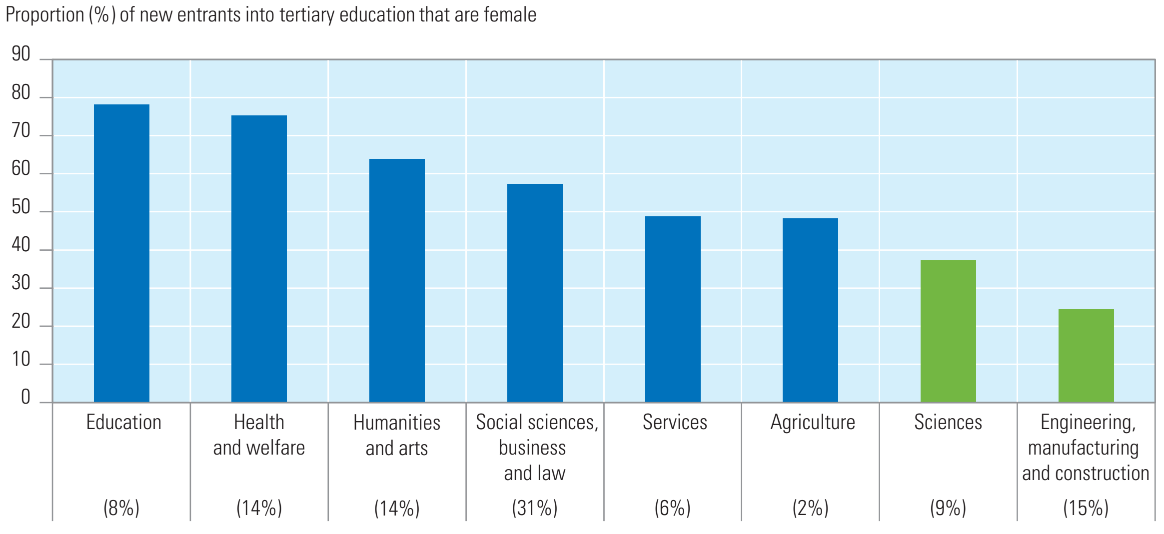
Ms Yeonhee Hah (yeonhee.hah@oecd.org) is Head of Division and Mr Tomoyuki Saito (tomoyuki.saito@oecd.org) is Nuclear Safety Specialist in the NEA Division of Radiological Protection and Human Aspects of Nuclear Safety.

Despite progress over the past decades, women remain under-represented in executive positions in science, technology, engineering and mathematics (STEM) fields. Female students tend to do very well in math and science early in their academic careers but often take other career paths. At the university level, in 2014, only 37% of new entrants into tertiary-level science programmes (OECD average) were women (see Figure 1). This percentage is even lower for engineering, manufacturing and construction programmes (24%), and less than 20% (OECD average) of women enter into computer science programmes.

A similar trend can be seen in the workforce. In OECD countries, men are almost four times as likely as women to be employed in engineering and computing, with women also remaining under-represented in leadership positions in these fields. Women have a far less chance of becoming CEOs, sitting on boards of private companies or of holding public leadership positions (see Figure 2). Several factors can explain why women do not pursue careers in STEM fields, including the "leaky pipeline" phenomenon, which translates into fewer opportunities for women to reach top-level positions. Women often interrupt their careers to care for family, work part-time to balance professional and personal demands, or face some form of discrimination in the workplace.

Many countries are working to close the gender gap by developing policies to reverse this trend, and some progress has been made, with most OECD countries tackling workplace harassment and discrimination through stronger laws and regulations. Additionally, several countries, including Australia, Germany, Italy, Japan, Mexico and the United Kingdom, have introduced measures to encourage young girls to study in STEM fields.[1] Nonetheless, gender gaps persist in all areas of social and economic life across countries, and the size of these gaps has seen little change in recent years, making it evident that more work still needs to be done.

Figure 1: Women are under-represented among new entrants in STEM fields in higher education
Proportion (%) of new students entering tertiary education who are female, by field of education (OECD average, 2014)



Note: The figures in parentheses under the x-axis labels indicate the share (%) of all new entrants in each field of education.

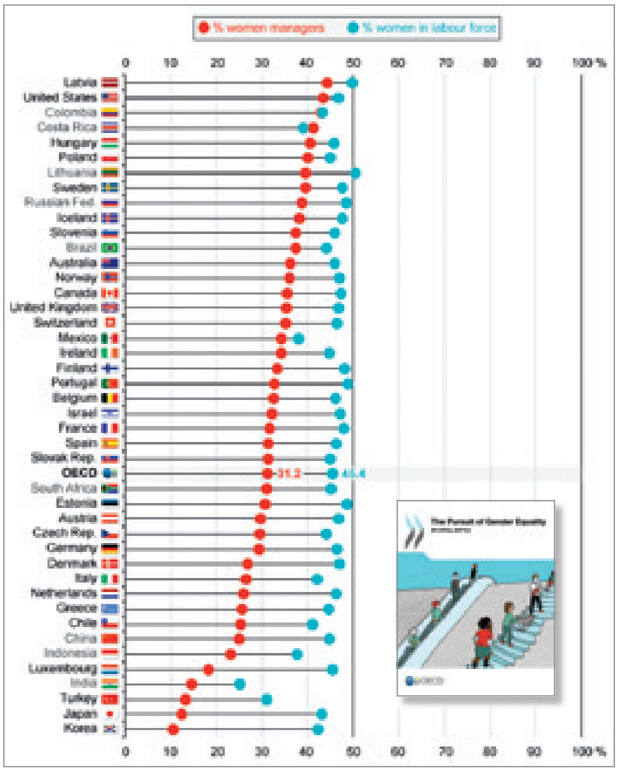
Source: OECD (2017), *The Pursuit of Gender Equality: An Uphill Battle*.

1. See OECD (2017), *The Pursuit of Gender Equality: An Uphill Battle*, OECD Publishing, Paris

Figure 2: Women are under-represented in management positions

Female share of management employment and female share of labour force, all ages, 2015 or latest available year

Note: OECD partner countries and accession candidates are indicated in grey.



The looming shortfall of youth studying in STEM fields has been a challenge for NEA countries as well and has real implications for the future. As part of its overall strategy and mission, the NEA supports its members in their efforts to secure qualified human resources, build nuclear skills capability and develop a new generation of nuclear experts. To do so, it is essential to ensure that all young people, including young women, have the opportunity to explore careers in science and technology. The NEA thus encourages its members to explore ways of attracting, recruiting and retaining youth, in particular girls, in science and technology, as well as enhancing the conditions and prospects for women and girls at every stage of their careers and education.

Source: OECD (2017), *The Pursuit of Gender Equality: An Uphill Battle.*

It is in this spirit that the NEA partnered with Japan's National Institutes for Quantum and Radiological Science and Technology (QST) to hold a mentoring workshop on 25-26 July 2017 in Chiba, Japan. The "Joshikai for Future Scientists: International Mentoring Workshop in Science and Engineering" was held in conjunction with the QST's first International Symposium on Quantum Life Science. This two-day workshop opened during a joint session between the QST symposium and the mentoring workshop, with remarks by Toshiei Mizuochi, State Minister of Education, Culture, Sports, Science and Technology (MEXT); Toshio Hirano, QST President; and Aiko Shimajiri, Special Advisor to the Minister, Cabinet Office, Government of Japan. A keynote lecture on quantum biology was given by Professor Johnjoe McFadden of the University of Surrey, United Kingdom. The joint opening session also featured an inspirational video address by Hélène Langevin-Joliot, distinguished nuclear physicist and granddaughter of Marie Skłodowska-Curie (See extracts from the transcript on page 14).

General view of the working groups.

QST, Japan

Workshop Leadership

(From left) Sachiko Yano, Asako J. Nakamura, Noriko Hosoya, William D. Magwood, IV, Shizuko Kakinuma, Aiko Shimajiri, Claudie Haigneré, Rumina Velshi, Cynthia Pederson, Tatiana Ivanova, Yeonhee Hah and Aditi Verma.

The co-chairs of the mentoring workshop, Claudie Haigneré, Senior Advisor to the Director-General, European Space Agency (ESA) and former astronaut, as well as Shizuko Kakinuma, Director of the Department of Radiation Effects Research (NIRS, QST) and the Unit Leader of the QST Diversity Management Unit, delivered closing remarks during a joint session with the QST symposium and reported on the outcomes of the workshop discussions. Over the two-day event, 55 female students from high schools around Japan, accompanied by 16 teachers, had the unique experience of exchanging with 7 highly accomplished women role models from Canada, France, Japan, Russia and the United States. These mentors shared their real-life experiences and provided valuable advice and insight to the students attending the workshop. Discussions addressed the difficulties faced by women professionals in many parts of the world and the steps that can be taken to support young women who aspire to become science and technology professionals. This workshop clearly highlighted the strong desire of young women to meet with role models who are pursuing successful careers in science and engineering.

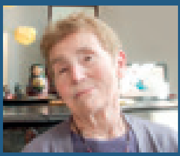
Consideration is therefore being given to organising more of such events that allow young students – both male and female – to see and exchange with those who are already accomplished in STEM fields. Science and engineering leaders – especially women leaders – should be vocal about why careers in science and technology are worthwhile and should be active in both social and traditional media in order to serve as solid role models. Today's students need to be made aware of tomorrow's wide array of STEM career options. Policy makers also need to be involved to better understand and consider future generations' needs and concerns.

The NEA would like to support more mentoring events in other countries and provide students with formative experiences to converse with leaders from nuclear sciences and technology areas. Mentors are clearly needed to inspire youth, offer real-life advice and help address questions such as: What challenges do women face in STEM fields? How can women ascend to leadership roles in these areas? How did mentors build successful STEM careers while pursuing full lives outside of work?

Women are, in many countries, an underused asset that could help to provide the skills and capabilities that all countries need to respond to an ever-changing, ever more complex world. Female students would like to be a part of the solution to the world's challenges, and the NEA International Mentoring Workshops can help reinforce young women's confidence to continue in the pursuit of their dreams.

See the video at: https://youtu.be/KQw19bwWVeM

Extracts from the interview with Dr Hélène Langevin-Joliot



Dr Langevin-Joliot is a distinguished scientist and the granddaughter of Marie Skłodowska-Curie. She was interviewed on film by NEA staff members and the resulting video was shown at the opening of the International Mentoring Workshop in Japan in July 2017.

Her early interest in sciences

I would say that the idea of doing science came to me quite naturally.

My brother and I grew up in a family in which both parents were scientists.

I saw them going off to the laboratory; they used to talk about what they did and they seemed very happy to be doing it. I didn't understand much of their scientific conversations, but I heard it often. It was part of my universe.

My mother, rather than my father, who at that time had other preoccupations, encouraged me to carry out what you might call small experiments.

At the time, it was really easy to buy substances like alums or sulphates to make beautiful coloured crystals; you didn't have to tell the chemist shop why you wanted to buy them. It wasn't at all difficult to get bits of chemistry equipment – nothing very complicated but good enough for having fun. So, with lots of patience, I was able to grow some very pretty crystals.

A childhood memory

I was a secondary school student at the start of the German Occupation. We had moral training as part of the new programmes, which were heavily influenced by the conception of the role of women in Nazi Germany, with the three K's: Kirche (church), Kuche (kitchen) and Kinder (children). This was moral training for young girls of 12, 13 or 14 being told, "See, that's your future!" I raised my hand in the class, stood up and explained that no, certainly not, that wasn't the way things had to be done. Of course a woman should have a career; like the boys, there was no reason why not. It meant that women would be free, and so on and so forth – I added lots of explanations, given my age at the time.

I can still remember telling my mom what I had done. She approved, of course, and then suddenly she stopped and asked, "Do you think that every woman has a job as interesting as mine?" And I realised at that moment that for me, having a profession meant just that, or something equivalent. Well, that really made me think, and she went on to say that a woman should have the right to have a job and choose a career.

Having self-confidence

I also think that women should work on acquiring more confidence so that they can make their presence felt, which is something that doesn't come naturally to them. But women also have one trait that sometimes makes them pass up a promotion or an opportunity. They usually – much more so than men – ask themselves the question, "Do I have the ability to take on this responsibility?" I think that women should still keep this in mind, but not, however, to the point of being too timid.

It would also be a good idea for women to express themselves even when they are not directly involved, so they come to mind when people are looking for someone to take over a particular function important for the future of the laboratory or project, etc. They could offer an opinion, suggest how something should be done. Every woman should consider her own capabilities and the possibilities in a particular area.

On Toshiko Yuasa – a renowned Japanese nuclear physicist who worked in France under Frédéric Joliot-Curie at the Collège de France

I think that given the cultural differences in Japan, it can be very important to tell young Japanese women about global opportunities, to encourage them and to give them the possibility of going abroad.

Ah! Toshiko Yuasa ... she was quite someone!

An unforgettable personality...

I saw her for the first time here in the garden when she was young, and I'll never forget it ...

When you think of her career, it's nevertheless extraordinary. Because remember that, at the time, she couldn't finish secondary education without special permission. All sorts of things, such as entering a laboratory, were harder for her than for Marie Curie. She always said that the book *Madame Curie: A Biography*, written by my aunt [Eve Curie], had in a way made Marie her mentor, urging her to like science, to want to do science and to not hesitate to leave her country to go where she could to do science under the best conditions. She had started in Japan and realised very quickly that she wouldn't get very far, so she left her home country to do her thesis in distant Paris.

Society's role regarding women

You know, people have wonderful theories, saying it'll work if we appoint women, etc. But they've created conditions in the society that are extremely discouraging for women who wish to have a career.

I think we need to be sure that the conditions allow compromises. Surely there are some young Japanese women who say, "I have no family responsibilities; I'm as free as a bird; I do what I want". That's all very well. But it seems to me that for a greater number, it's important that the family aspects are sorted out.

I'm convinced that handling these aspects is the key to having more women working in all areas of research, including technological research in industry, because if we take away their freedom to have families, which may form a real part of their lives, well, it doesn't work.

At the end of the 1930s, my mother, as Secretary of State for scientific research, was asked, "What do you wish for young women?" My mother's response was not very feminist. She replied, "I wish all young women to have what I have myself: a beloved husband, children and a job that fascinates them." If you view life like that, it's easier to pursue science.

My advice to young women

So the first thing is a career, and if you want to be a scientist, you'll go into science.

When I give talks on Marie Curie, I tell people what she said herself: "I haven't sacrificed my life to science; I've spent a lot of time on science because I wanted to". But she also wanted to spend time with her daughters. That's right!

I believe that the issue is generalised and simplified down to a problem for women, and for women only. I believe much more in talking about things, airing the problems that exist and confronting them.

I think that it is the real crux of the matter, and it doesn't please everyone because it requires some effort on the part of men. And it requires support from society to make it possible. That's all.

See the interview at: https://youtu.be/_AOQ8os3Pr0

Metadata for radioactive waste management

by M. Ciambrella

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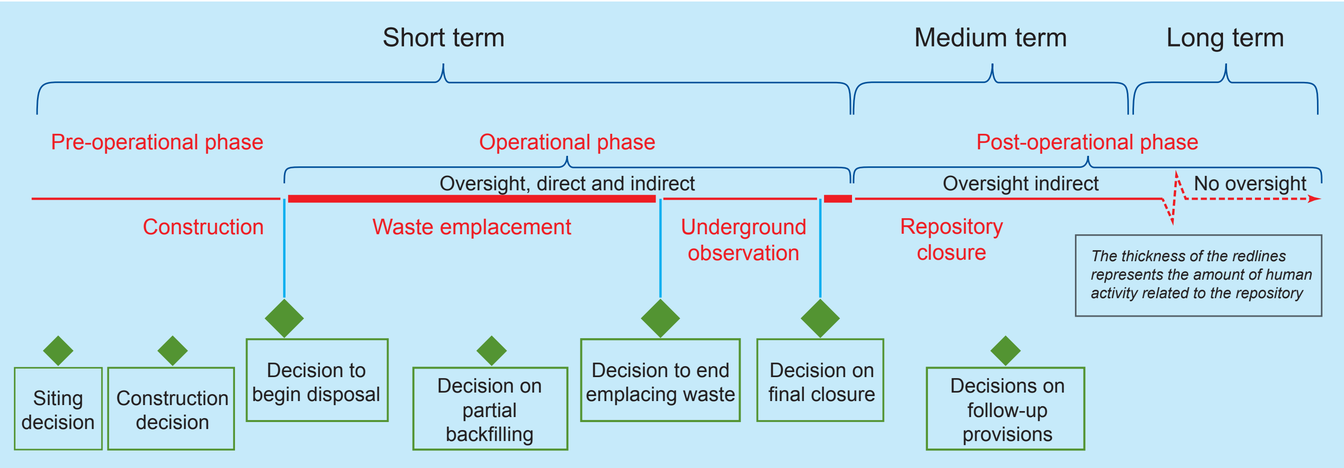
Figure 1: Repository life phases and examples of major decision points



Many countries have implemented national programmes for the safe, ethical and economically sustainable management of radioactive waste – including spent nuclear fuel considered as waste – from the generation of such waste to its disposal (i.e. "from cradle to grave"). One of the challenges that the radioactive waste management process must tackle is the long-term management of data and information that are collected during each step of the process, and that have to be available in the subsequent steps as the programme proceeds towards repository development. From a general point of view, the realisation of a radioactive waste repository requires very large amounts of data across multiple and disparate disciplines of science and technology such as nuclear science, waste management, geoscience and engineering. National programmes tend to run over a period of many decades, with evolving changes in relation to boundary conditions (e.g. legal and regulatory framework), generations of workers succeeding and determining data and information loss risks, and the site characterisation evolving and having an impact on the choices for the disposal design system as well as the safety case. The development of a robust safety case, for example, for the post-closure of a deep geological repository requires the availability of huge volumes of data on the waste to be disposed of, the engineered barrier systems and the rock environment. These data should be collected from the very beginning of the programmes, without concern that time will erode the quality of data. As long as the data are managed and maintained in a well-organised manner, safety analysts can be confident about using the data for performance assessments, scenario formulations and safety evidence elaborations.

Data, information and metadata

Data and information are two different concepts, and it is not a trivial endeavour to find suitable definitions for the two terms. The Latin origins of the words help to demonstrate the difference in meaning: data comes from *datum* meaning something given, whereas information comes from *informatio* meaning idea, notion and also explanation. If data are considered as facts in the form they are originally collected (e.g. numbers, functions, tables, strings, texts, pictures, videos), then information could be considered as organised and structured data presenting an idea or a concept.

The main challenge of long-term data and information management is to ensure that future users will not only have access to the data collected, but that they will also have confidence in these data and be able to understand the information they provide. The basic tenet of long-term data and information management is that *data are being collected and managed for others to use them.* Individual R&D teams and scientists who are currently involved in national programmes for radioactive waste management have to be aware that they are collecting data not only for themselves but also for future users, including future generations of their own colleagues.

The challenges emanating from the long-term management of large volumes of data and information are certainly not limited to radioactive waste management, but involve modern society at a global level. We are living in an era of *big data* where extremely large collections of data are produced by all societal sectors every second of the day for multiple and extensive purposes, from industry to social media, and from digital marketing to geographic information systems. Experts involved have been developing specific and powerful tools and techniques to address these modern challenges, and for the most part these tools and techniques are included under the heading of "metadata".

Metadata are usually defined as "data about data". They are additional data that structure and organise data, providing them context and allowing the user to understand the information that they contain. For example, they:

- provide provenance to the data: who, what, when, where, why and how (i.e. the famous *Six W's*);
- provide context to facilitate the accurate interpretation, and use or reuse of data;
- describe and maintain the original data quality;
- add additional information about the data in a structured and detailed way;
- help users to quickly find the data that they are looking for and support the search for information.

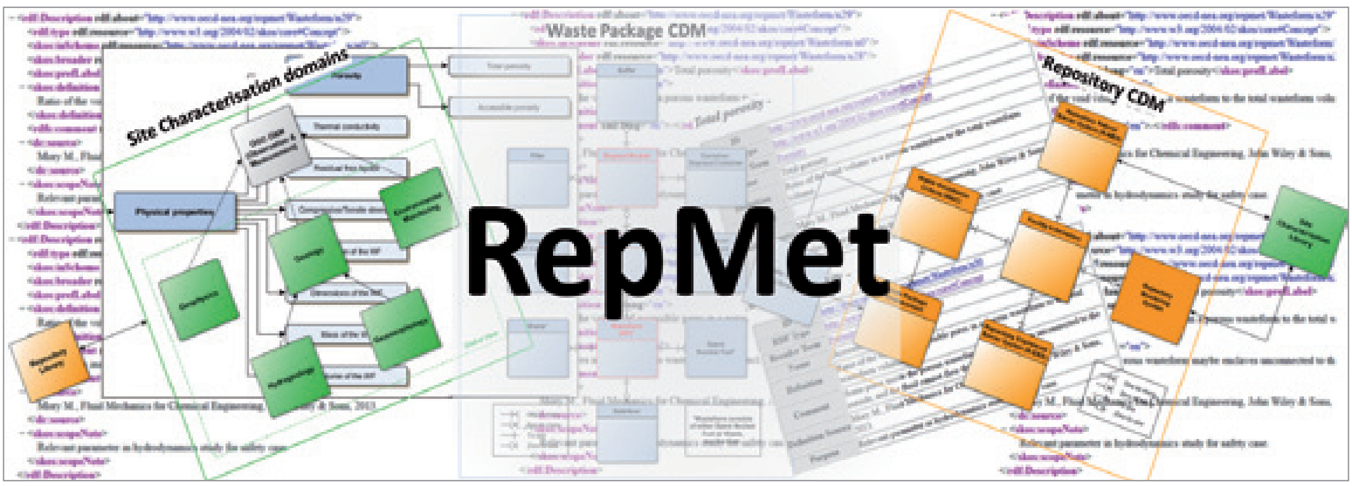
Metadata in radioactive waste management: RepMet

The NEA Integration Group for the Safety Case (IGSC), under the auspices of the Radioactive Waste Management Committee (RWMC), launched a four-year initiative in 2014 called Radioactive Waste Repository Metadata Management (RepMet). The goal of this initiative is to bring about a better understanding of metadata and its implementation in the radioactive waste management field in support of national programmes. To highlight the significance of the subject, several radioactive waste management organisations (RWMOs) and research laboratories from NEA countries were involved in launching RepMet, including: ANDRA (France), ENRESA (Spain), JAEA (Japan), NAGRA (Switzerland), RWM (United Kingdom), NWMO (Canada), ONDRAF/NIRAS (Belgium), Posiva Oy (Finland), PURAM (Hungary), Sandia National Laboratories (United States), SKB (Sweden) and SURAO (Czech Republic).[1]

RepMet experts have elaborated some overall recommendations for RWMOs concerning metadata implementation, illustrating the benefits and underlining the risks arising from their neglect. Members of the RepMet initiative analysed the phases of metadata implementation, focusing on the need for a robust *metadata culture* in RWMOs and a solid commitment at all organisational levels to the definition of policies and consequent procedures for the capture and long-term maintenance of metadata. All of these considerations have been collected in a high-level report targeting RWMO decision makers and managers. This report will be released in 2018.

From a more technical point of view, the RepMet group worked on the conceptual design of databases[2] – the so-called *RepMet Libraries* – so as to address topics relevant to national radioactive waste management programmes, making use of the metadata sets that members selected. For the development of the libraries, RepMet examined and adopted several concepts of the data modelling theory (i.e. Entity-Relationship Diagrams [ERDs]) and selected metadata-based tools such as consolidated metadata standards or relevant directives (i.e. the ISO[3] 19156 *Geographic Information – Observations and Measurements [O&M] Standard,* the *Minnesota Recordkeeping Metadata Standard [MRMS]* and the European Union *INSPIRE*[4] *Directive)*, as well as controlled dictionaries and formal languages for their representation (i.e. the World Web Consortium [W3C] *Resource Description Framework [RDF]* and the W3C *Simple Knowledge Organization System [SKOS])*. The RepMet Libraries pertain to the main technical disciplines involved in the realisation of a radioactive waste repository, which are geoscience, waste management and engineering, and entail, respectively, the:

- *Site Characterisation Library* – on the geological and geophysical characterisation of the repository site;
- *Waste Package Library* – on the packaged waste and spent nuclear fuel ready for disposal at the repository;
- *Repository Library* – on the repository requirements and structures at closure.



The elaboration of the scope of these three RepMet Libraries was twofold, first to identify the core information about the library topic representing the minimum and essential information that an RWMO should collect and maintain for multiple purposes (e.g. safety case development); and second, to give example applications of how the assembly of metadata-based tools and techniques can provide an original methodology to promote and support the long-term management and use of core information that the group had identified in relation to each library topic.

The RepMet Libraries are presented in detail in three technical reports, supported by an additional document illustrating and explaining the concepts and the tools of the modern data and information management adopted for their elaboration. To increase their visibility and to demonstrate the applications of some web-based tools, the group developed a web version of the three libraries called "RepMet web-products".

All RepMet final deliverables, including the reports and web-products, will be available on the RepMet website[5] in the coming months.

View of a vitrified waste product store.

Next steps

Over the past four years, RepMet has been working towards the implementation of all the above activities. RepMet members have recognised the importance of continuing and increasing joint efforts in this field as the initiative nears the end of its mandate. Experts have thus identified several working areas of interest for the future, including the development of new libraries using the methodology that RepMet assembled, which involves different topics to increase the coverage of the radioactive waste management life cycle (e.g. transport, interim storage and waste treatment). The current libraries can also be extended, increasing their level of detail and integrating them with other IGSC projects, such as the *NEA International Features, Events and Processes (FEP) Database*. Metadata sets that RepMet has identified can also be used for modelling, not only the properties of objects such as waste packages, but also the safety assessment process chains tailor-made for the needs of the radioactive waste industry.

Conclusions

Metadata play a crucial role in modern data and information management and have a fundamental function in the most innovative sectors of society. Radioactive waste management can take extensive advantage of metadata implementation since poor data quality and unclear information are considerable risks for the consistent and appropriate evolution of national programmes for radioactive waste management.

RepMet is the first international study at the NEA level on metadata application in the field of radioactive waste management, and it is intended to support national programmes in managing their data and information in a way that is both suitable for long-term management and use, and harmonised internationally. The RepMet focus on modern tools for metadata, emerging from a constantly evolving field, represents a further example of the continuous and significant engagement of the NEA in spreading innovation through co-operation among international experts, and in this way contributing to the sustainable use of nuclear energy.

Notes

1. ANDRA – French National Agency for Radioactive Waste Management; ENRESA – Spanish National Company for Radioactive Waste Management; JAEA – Japan Atomic Energy Agency; NAGRA – Swiss National Cooperative for the Disposal of Radioactive Waste; RWM – Radioactive Waste Management, NWMO – Canadian Nuclear Waste Management Organisation, ONDRAF/NIRAS – Belgian Agency for Radioactive Waste and Enriched Fissile; PURAM – Hungarian Public Limited Company for Radioactive Waste Management; SKB – Swedish Nuclear Fuel and Waste Management Company; SURAO – Czech Radioactive Waste Repository Authority.
2. A "data model" is the organisational and structural model of a database as related to a specific business domain such as radioactive waste management. A "conceptual data model" (CDM) is a type of data model: it describes the organisation and the structure of a database in terms of objects of interest, together with their descriptive properties and logical associations. CDMs are not related to the software and hardware technology used for the database realisation. They allow RepMet members to represent data in a way that is independent from the IT systems.
3. ISO – International Organisation for Standardisation.
4. INSPIRE – Infrastructure for Spatial Information in Europe.
5. www.oecd-nea.org/rwm/igsc/repmet.

References

Atzeni, P. et al. (2014), *Basi di dati,* 4th Edition, McGraw-Hill Education.

NEA (2017), "Summary Record of the 7th RepMet Meeting", NEA/RWM/IGSC(2017)3.

NEA (2016), "NEA Radioactive Waste Management Committee Statement", NEA/RWM(2016)7.

NEA (2014), "Vision Document for the Radioactive Waste Repository Metadata Management (RepMet) Project", NEA/RWM(2014)2.

Castiglioni, L. et al. (1966), *IL Vocabolario della Lingua Latina,* 1st Edition, Loescher Editore.

A strategic partnership between the NEA and China

by G. Piccarreta

Ms Giovanna Piccarreta (giovanna.piccarreta@oecd.org) is Counsel for International Affairs.

The NEA Director-General William D. Magwood, IV recently met with the Chairman of the China Atomic Energy Authority (CAEA), Mr Tang Dengjie.

With 37 operational nuclear power reactors that are among the world's most advanced, 19 units under construction – and 18 additional reactors currently in preparation (i.e. site approved or under review) – as well as 25 years of operating experience, China has the largest nuclear power programme worldwide today and is developing vast technological capabilities.

The NEA mission is to bring together the world's most advanced countries to maintain and further develop the scientific, technological and legal bases required for a safe, environmentally sound and economical use of low-carbon nuclear energy for peaceful purposes. China has become increasingly active in NEA activities over the past few years. For instance, China participates in the Committee on Nuclear Regulatory Activities (CNRA), the Committee on the Safety of Nuclear Installations (CSNI) and the Nuclear Law Committee (NLC), as well as in selected NEA working groups under different Standing Technical Committees. The country is also a full participant in the Generation IV International Forum (GIF), the Multinational Design Evaluation Programme (MDEP) and the International Framework for Nuclear Energy Cooperation (three NEA-serviced bodies) and is involved in a number of NEA joint projects.

NEA Director-General William D. Magwood, IV and NEA staff have intensified meetings and visits to China so as to further develop this strategic partnership. The Director-General recently met with the Chairman of the China Atomic Energy Authority (CAEA), Mr Tang Dengjie, who underlined CAEA willingness to enhance engagement with the NEA.

In the context of this progressively increasing collaboration, several agreements have been signed between the Nuclear Energy Agency (NEA) and China in recent years, including in 2013 when the Joint Declaration on Co-operation with the CAEA was signed; in 2014, with the Memorandum of Understanding with the National Nuclear Safety Administration (NNSA); and in April 2017 with the signing of the Memorandum of Understanding between the NEA and the National Energy Administration (C/NEA).

NEA countries consider this collaboration with China as a major strategic axis in the current period, with significant expected cross benefits. China can draw greatly from the experience of 33 NEA member countries, notably as pertains to nuclear regulatory activities and inspection practices, radiological protection and emergency management, as well as stakeholder involvement, public communication and radioactive waste management. Regarding the evolution of nuclear technology, the cross-fertilisation of NEA country experiences with the Chinese dynamic in the field could facilitate and streamline the development of the innovations required for nuclear energy to be part of the solution to enable a low-carbon energy mix.

International Nuclear Law Essentials in Singapore

by K. Nick

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Shutterstock, De Burachet

The next session of INLE will be held in Singapore from 26 February to 2 March 2018.

One of the missions of the NEA is to help create the sound national and international legal regimes required for the peaceful uses of nuclear energy and to serve as a leading centre for nuclear law information and education. Training future and practising lawyers in the public and private sectors is essential to ensure appropriate and applicable legal frameworks. In this context, the NEA International School of Nuclear Law (ISNL), a two-week summer course in the south of France, was created in 2001 and has been held in co-operation with the University of Montpellier for the past seventeen years. To date, more than 950 participants from all continents have attended this course.

A second NEA programme, International Nuclear Law Essentials (INLE), was created in 2011 as a one-week course for professionals. This five-day programme is designed to provide participants with a practical and comprehensive understanding of the various inter-related legal issues associated with the safe and peaceful use of nuclear energy. The INLE is an intensive course in international nuclear law that addresses the needs and interests of lawyers working in either the public or the private sector. It is also of interest to scientists, engineers, policy makers, managers and other professionals working in the nuclear field.

In recent years, the NEA has witnessed a shift in the nationality of applicants to its legal educational programmes, with greater numbers originating from the Asian region. As more nuclear power reactors come online in Asia, the need for nuclear law education and training in the region has been growing.

The decision was therefore made to hold the next session of the INLE in Singapore, in co-operation with the **National University of Singapore (NUS)**. The 2018 INLE will take place on the NUS Bukit Timah Campus, home to the **NUS Faculty of Law** and the **Centre for International Law (CIL)**. The NUS is consistently ranked among the world's best as a leading global university. Holding the INLE at NUS should allow the INLE to attract experts from all over the region and beyond.

The 2018 INLE programme will remain very similar to previous programmes. It will again be conducted under the leadership of Paul Bowden, Partner at Freshfields Bruckhaus and Deringer LLP, London, United Kingdom, and comprehensive lectures will be delivered by renowned specialists in nuclear law from international organisations, governments and private industry. The traditional subjects will be covered during the five-day programme, including:

- international radiological protection standards;
- nuclear safety, regulation and licensing;
- environmental law and nuclear activities;
- management of spent fuel and radioactive waste;
- transport of nuclear materials and fuel;
- nuclear security: physical protection, illicit trafficking and terrorism;
- non-proliferation and international safeguards for nuclear materials;
- liability, compensation and insurance for nuclear damage;
- international trade in nuclear materials and equipment.

New lecturers from the region will also be part of the programme and will focus on nuclear energy in Asia.

The 2018 INLE will provide a unique opportunity to learn nuclear law in a new setting and to network with individuals in the field that participants might not normally have a chance to meet. Participation is open to anyone who has at least one year of relevant professional experience and who has a basic understanding of law as it relates to nuclear energy.

The 2018 programme includes admission for the participant to the general lecture and discussion sessions. More information, including the draft programme and the application form, can be found at: www.oecd-nea.org/law/inle.

The NEA thanks outgoing NRA Chairman Dr Shunichi Tanaka

by T. Niioka

Mr Terumasa Niioka (terumasa.niioka@oecd.org) is Nuclear Safety Specialist in the NEA Division of Nuclear Safety Technology and Regulation.

The framed letter presented by Mr Magwood to Dr Tanaka in July 2017.

Among the hard lessons identified through the analysis of the 2011 Fukushima Daiichi nuclear power plant accident in Japan was that the regulator at the time of the accident was far too much a part of the "nuclear village". It was thus not institutionally equipped to provide effective safety oversight to Japan's nuclear industry, and a loss of public confidence in the regulator resulted – a condition that is, even under normal circumstances, difficult to remediate.

Following the accident, the government of Japan moved quickly and effectively to establish a new regulator, drawing from successful models in other countries. The Nuclear and Industrial Safety Agency had previously been responsible for the regulation of nuclear safety under the Ministry of Economy, Trade and Industry (METI), which itself was responsible for the use of nuclear power. To ensure a transparent separation of these two sectors, nuclear safety regulation was decoupled from METI, and a new Nuclear Regulation Authority (NRA) was established in September 2012 as an external organisation of the Ministry of the Environment with a high degree of independence.

Creating the NRA would be only the start of a long journey. The hardest work would be to rebuild public trust in the national nuclear regulator; to establish new safety standards that would be applied to Japanese nuclear facilities before they could restart operations; and to build an organisation and staff capable of fulfilling the nuclear safety mission.

Under Dr Shunichi Tanaka's leadership – the first NRA Chairman for a period of five years beginning in September 2012 – the NRA took steps to address such challenges and to establish a robust foundation for the new regulatory organisation. The roles and responsibilities of nuclear safety and security regulations for nuclear facilities and radioactive materials, which had been shared among several governmental organisations, all came under the auspices of the NRA. Responsibility for nuclear non-proliferation safeguards, previously the onus of the Ministry of Education, Culture, Sports, Science and Technology, was also integrated into the NRA.

From 2012, the NRA has been disseminating nuclear regulation and other activities via several proactive and prompt channels, including the NRA website, which excludes for confidentiality reasons information on nuclear security and related issues. NRA meetings are generally open to the public for the transparent dissemination of information.

Taking into account lessons learnt from Fukushima Daiichi NPP accident, and the current state of the art in science and technology, the NRA has also been enhancing nuclear regulations, for example, by developing countermeasures against severe accidents, introducing back-fit systems, as well as 40-year operational time limits for nuclear reactor facilities. In addition, the Nuclear Emergency Preparedness Commission was established under the Japanese Cabinet Office to enhance the nuclear emergency preparedness and response system.

The progress made over the last five years by the NRA in all the above areas has been extraordinary and heartening. Dr Tanaka has led NRA efforts across uncharted and often contentious waters of the post-Fukushima environment, all with care and wisdom. He has employed a sound approach to regulatory decision making based on an independent and competent assessment of the most current scientific and technological information, free from external pressure or bias.

The NEA programme of work in nuclear safety technology and regulation has benefited greatly from the technical contributions and support of the NRA during Dr Tanaka's tenure as NRA Chairman, and thus the NEA would like to thank Dr Tanaka for his long-standing and continuing support and wish him every success and fulfilment in the future.

The NEA Director-General William D. Magwood, IV presented Dr Tanaka with a letter of recognition during his visit to Japan on the occasion of the "Joshikai for Future Scientists: International Mentoring Workshop in Science and Engineering" (see article on page 11) in July 2017. When meeting Dr Tanaka, Mr Magwood presented him with the framed letter that he had signed alongside the Chair of the Steering Committee for Nuclear Energy, as well as the Chairs of the NEA Committee on Nuclear Regulatory Activities (CNRA) and the NEA Committee on the Safety of Nuclear Installations (CSNI). The letter highlights the unique and historic role that Dr Tanaka played in confronting challenges that arose during the years following the Fukushima Daiichi accident.

Many of these challenges will require years and even decades of hard work to resolve and so the NEA takes this opportunity to wish Dr Tanaka's successor, Toyoshi Fuketa, the best in facing continuing challenges and applauds his inauguration promise to "uncompromisingly pursue safety".

Update on NEA Joint Projects

Nuclear safety, nuclear science, radioactive waste management, radiological protection

NEA joint projects and information exchange programmes enable interested countries, on a cost-sharing basis, to pursue research or the sharing of data with respect to particular areas or issues in the nuclear energy field. The projects are carried out under the auspices, and with the support, of the NEA.

At present, 17 joint projects are being conducted or completed in relation to nuclear safety, 2 in the area of nuclear science (advanced fuels, and characterisation of fuel debris and fission products), 2 in support of radioactive waste management and 1 in the field of radiological protection. These projects complement the NEA programme of work and contribute to achieving excellence in each area of research.

Advanced Thermal-hydraulic Test Loop for Accident Simulation (ATLAS) Project

Contact: nils.sandberg@oecd.org

Current mandate: October 2017-September 2020

Budget: EUR 3 million

Participants: Belgium, China, Czech Republic, France, Germany, Korea, Spain, Switzerland, United Arab Emirates and United States.

- provide experimental data for resolving key light water reactor (LWR) thermal-hydraulics safety issues related to long-term coolability with partial core blockage, passive core makeup during station blackout, intermediate size loss-of-coolant accidents and design extension condition scenarios such as multiple steam generator tube ruptures;
- provide an integral-effect experimental database, which will be used to validate code predictive capability and accuracy of models.

Behaviour of Iodine Project (BIP)

Contact: martin.kissane@oecd.org

Current mandate: January 2016-December 2018

Budget: EUR 1 million

Participants: Belgium, Canada, Finland, France, Germany, Japan, Korea, Sweden, Switzerland, Sweden, United Kingdom and United States.

- obtain a more detailed and mechanistic understanding of iodine adsorption/desorption on containment surfaces by means of new experiments with well-characterised containment paints and paint constituents, and novel instrumentation (spectroscopic methods);
- obtain a more detailed and mechanistic understanding of organic iodide formation by means of new experiments with well-characterised containment paints and paint constituents, and novel instrumentation (chromatographic methods);
- develop a common understanding of how to extrapolate with confidence from small-scale studies to reactor-scale conditions.

The ATLAS facility.

KAERI, Korea

The Cherenkov blue light of the Cabri reactor became visible on 12 October 2016 in Cadarache, France.

IRSN/CEA, France

Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Plant (BSAF)

Contact: kentaro.funaki@oecd.org

Current mandate: April 2015-June 2018

Budget: EUR 270 K

Participants: Canada, China, Finland, France, Germany, Japan, Korea, Russia, Spain, Switzerland and United States.

- provide information and analyse results on severe accident (SA) progression, fission product (FP) behaviour, source-term estimation and comparison with measured plant data within the first three weeks of the Fukushima Daiichi accident at units 1 to 3, respectively, to support the safe and timely decommissioning of Fukushima Daiichi NPP;
- contribute to understanding of SA phenomena that took place during the accident, through comparisons with participants' analysis results and with measured plant data;
- share the above results with the objective of improving methods and models of the SA codes applied in each participating organisation, in order to reduce uncertainties in the SA analysis and validate the SA analysis codes using data obtained through the decommissioning process.

Cable Ageing Data and Knowledge (CADAK) Project

Contact: ollivilhelm.nevander@oecd.org

Current mandate: January 2015-December 2017*

Budget: EUR 50 K/year

Participants: Canada, Germany, Slovak Republic, Switzerland and United States.

- establish the technical basis for assessing the qualified life of electrical cables in light of the uncertainties identified following initial (early) qualification testing;
- enter, for a number of member countries, cable data and information in the system, e.g. technical standards being applied in the qualification of cables and inspection methods being used regularly;
- estimate the remaining qualified lifetime of cables used in NPPs.

* This project has been discontinued and a final report will be issued in 2018.

Cabri International Project (CIP)

Contact: martin.kissane@oecd.org

Current mandate: March 2015-March 2018

Budget: ≈ EUR 74 million

Participants: Czech Republic, Finland, France, Germany, Japan, Korea, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom and United States.

- extend the database for high burn-up fuel performance in reactivity-induced accident (RIA) conditions;
- perform relevant tests under coolant conditions representative of pressurised water reactors (PWRs);
- extend the database to include tests done in the Nuclear Safety Research Reactor (Japan) on boiling water reactor (BWR) and PWR fuel.

Component Operational Experience, Degradation and Ageing Programme (CODAP)

Contact: ollivilhelm.nevander@oecd.org

Current mandate: January 2018-December 2020

Budget: EUR 75 K/year

Participants: Canada, Chinese Taipei, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Slovak Republic, Spain, Switzerland and United States.

- collect information on passive metallic component degradation and failures of the primary system, reactor pressure vessel (RPV) internals, main process and standby safety systems, and support systems (i.e. ASME Code Class 1, 2 and 3 or equivalent), as well as non-safety-related (non-code) components with significant operational impact;
- establish a knowledge base for general information on component and degradation mechanisms such as applicable regulations, codes and standards, bibliography and references, R&D programmes and proactive actions, information on key parameters, models, thresholds and kinetics, fitness for service criteria, and information on mitigation, monitoring, surveillance, diagnostics, repair and replacement;
- develop topical reports on degradation mechanisms in close co-ordination with the CSNI Working Group on Integrity and Ageing of Components and Structures (WGIAGE).

Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD)

Contact: jihtong.lin@oecd.org

Current mandate: January 2014-December 2018

Budget: ≈EUR 80 K/year

Participants: Belgium, Canada, Chinese Taipei, Denmark, European Commission, France, Germany, Italy, Japan, Korea, Russia, Slovak Republic, Spain, Sweden, United Kingdom and United States.

- exchange scientific and technical information among nuclear facility decommissioning projects, based on biannual meetings of the Technical Advisory Group, to ensure that the safest, most environmentally sound and economical options for decommissioning are employed.

Fire Incidents Records Exchange (FIRE) Project

Contact: markus.beilmann@oecd.org

Current mandate: January 2016-December 2019

Budget: EUR 70 K/year

Participants: Belgium, Canada, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Spain, Sweden, Switzerland, United Kingdom and United States.

- collect fire event experience (via international exchange) in the appropriate format and in a quality-assured and consistent database;
- collect and analyse fire events data over the long term so as to better understand such events, their causes and their prevention;
- generate qualitative insights into the root causes of fire events in order to derive approaches or mechanisms for their prevention and to mitigate their consequences;
- establish a mechanism for the efficient feedback of experience gained in connection with fire, including the development of defences against their occurrence, such as indicators for risk-informed and performance-based inspections;
- record the characteristics of fire events in order to facilitate fire risk analysis, including quantification of fire frequencies.

Fire Propagation in Elementary, Multi-room Scenarios (PRISME) Project

Contact: andrew.white@oecd.org

Current mandate: January 2017-December 2021

Budget: EUR 7 million

Participants: Belgium, Canada, Finland, France, Germany, Japan, Spain, Sweden and United Kingdom.

- answer questions concerning smoke, fire and heat propagation inside a plant by means of experiments tailored for code validation purposes for fire modelling computer codes;
- undertake experiments related to smoke and hot gas propagation, through a horizontal opening between two superimposed compartments;
- provide information on heat transfer to cables and on cable damage;
- provide information on the effectiveness of fire extinguishing systems.

Halden Reactor Project

Contact: markus.beilmann@oecd.org

Current mandate: January 2018-December 2020

Budget: NOK 444 million

Participants: Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Japan, Korea, Norway, Russia, Slovak Republic, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States and European Commission.

Generate key information for safety and licensing assessments with the aim of providing:

- extended fuel utilisation-basic data on how the fuel performs, both under normal operation and transient conditions, with emphasis on extended fuel utilisation in commercial reactors;
- degradation of core materials-knowledge of plant materials behaviour under the combined deteriorating effects of water chemistry and nuclear environment, also relevant for plant lifetime assessments;
- man-machine systems-advances in computerised surveillance systems, virtual reality, digital information, human factors and man-machine interaction in support of control room upgradings.

Halden reactor hall showing the rotating floor plate above the cavity containing the reactor vessel, Norway.

Thor Energy, Norway

High Energy Arcing Fault Events (HEAF) Project

Contact: markus.beilmann@oecd.org

Previous mandate: July 2012-December 2016
New mandate under discussion

Costs covered by the US NRC and in-kind contributions

Participants: Canada, Finland, France, Germany, Japan, Korea, Spain and United States.

Perform experiments to obtain scientific fire data on high energy arcing fault phenomena known to occur in nuclear power plants through carefully designed experiments:

- use data from the experiments and past events to develop a mechanistic model to account for the failure modes and consequence portions of HEAFs;
- improve the state of knowledge and provide better characterisation of HEAFs in fire probabilistic risk assessment (PRA) and US National Fire Protection Association (NFPA) 805 license amendment request applications;
- examine the initial impact of the arc to primary equipment and the subsequent damage created by the initiation of an arc (e.g. secondary fires);
- use international collaboration to expand on the pool of available test data and acquire authorship involvement in the development of a new US NUREG that consequently has international standing and applicability.

Hydrogen Mitigation Experiments for Reactor Safety (HYMERES) Project

Contact: markus.beilmann@oecd.org

Current mandate: July 2017-June 2021

Budget: EUR 5 million

Participants: China, Czech Republic, Finland, Germany, Japan, Korea, Russia, Spain, Switzerland and United States.

Improve the understanding of hydrogen risk phenomenology in containment in order to enhance modelling in support of safety assessments that will be performed for current and new NPPs. With respect to previous projects related to hydrogen risk, HYMERES introduces three new elements:

- tests addressing the interaction of safety components;
- realistic flow conditions;
- reviews of system behaviour for selected cases.

Information System on Occupational Exposure (ISOE)

Contact: olvido.guzman@oecd.org

Current mandate: January 2016-December 2019

Budget: EUR 396 100

Participants: Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Czech Republic, Finland, France, Germany, Hungary, Italy, Japan, Korea, Lithuania, Mexico, Netherlands, Pakistan, Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Ukraine, United Arab Emirates, United Kingdom and United States.

- collect, analyse and exchange occupational exposure data and occupational exposure management experience at NPPs;
- provide broad and regularly updated information on methods to improve the protection of workers and on occupational exposure in NPPs;
- provide a mechanism for dissemination of information on these issues, including evaluation and analysis of the data assembled and experience exchanged, as a contribution to the optimisation of radiological protection.

The PANDA reactor pressure vessel.

Paul Scherrer Institute, Switzerland

The EPICUR apparatus used for experiments on irradiating iodine species for the STEM project.

IRSN, France

International Common-cause Failure Data Exchange (ICDE) Project

Contact: olli.nevander@oecd.org

Current mandate: January 2015-December 2018

Budget: EUR 120 K/year

Participants: Canada, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Spain, Sweden, Switzerland and United States.

- provide a framework for multinational co-operation;
- collect and analyse common-cause failure (CCF) events over the long term so as to better understand such events, their causes and their prevention;
- generate qualitative insights into the root causes of CCF events, which can then be used to derive approaches or mechanisms for their prevention or mitigation of their consequences;
- establish a mechanism for the efficient feedback of experience gained in connection with CCF phenomena, including the development of defences against their occurrence, such as indicators for risk-based inspections;
- generate quantitative insights and record event attributes to facilitate the quantification of CCF frequencies in member countries;
- use the ICDE data to estimate CCF parameters.

Loss of Forced Coolant (LOFC) Project

Contact: nils.sandberg@oecd.org

Current mandate: March 2011-March 2019

Budget: EUR 3 million

Participants: Czech Republic, France, Germany, Hungary, Japan, Korea and United States.

Perform integral tests in the high-temperature engineering test reactor (HTTR) in order to:

- provide experimental data to clarify the anticipated transient without scram (ATWS) in the case of an LOFC with occurrence of reactor re-criticality;
- provide experimental data to validate the key assumptions in computer codes predicting the behaviour of reactor kinetics, core physics and thermal-hydraulics related to protective measures for safety;
- provide experimental data to verify the capabilities of these codes regarding the simulation of phenomena coupled between reactor core physics and thermal-hydraulics.

Primary Coolant Loop Test Facility (PKL) Project

Contact: nils.sandberg@oecd.org

Current mandate: July 2016-June 2020

Budget: EUR 4.78 million

Participants: Belgium, China, Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Spain, Sweden, Switzerland, and United States.

- investigate safety issues relevant for current PWR plants as well as for new PWR design concepts;
- focus on complex heat transfer mechanisms in the steam generators and boron precipitation processes under postulated accident situations.

Source Term Evaluation and Mitigation (STEM) Project

Contact: martin.kissane@oecd.org

Current mandate: January 2016-December 2019

Budget: EUR 2.5 million

Participants: Canada, Finland, France, Germany, Japan, Korea, Sweden, United Kingdom and United States.

Improve the general evaluation of the source term, and in particular:

- perform experiments to study the stability of aerosol particles under radiation and the long-term gas/deposits equilibrium in a containment;
- conduct a literature survey on the effect of paint ageing;
- perform experiments to study ruthenium transport in pipes.

Studsvik Cladding Integrity Project (SCIP)

Contact: markus.beilmann@oecd.org

Current mandate: July 2014-June 2019

Budget: SEK 130 million

Participants: Czech Republic, China, Finland, France, Germany, Hungary, Japan, Korea, Norway, Russia, Spain, Sweden, Switzerland and United States.

- generate high-quality experimental data to improve the understanding of the dominant failure mechanisms for water reactor fuels and devise means for reducing fuel failures;
- achieve results of general applicability (i.e. not restricted to a particular fuel design, fabrication specification or operating condition);
- achieve experimental efficiency through the judicious use of a combination of experimental and theoretical techniques and approaches.

Thermal-hydraulics, Hydrogen, Aerosols, Iodine (THAI) Project

Contact: martin.kissane@oecd.org

Current mandate: February 2016-July 2019

Budget: ≈ EUR 4.7million

Participants: Belgium, China, Czech Republic, Finland, France, Germany, India, Hungary, Japan, Korea, Luxembourg, Slovak Republic, Sweden, Switzerland and United Kingdom.

Address remaining questions and examine experimental data relevant to nuclear reactor containments under severe accident conditions concerning:

- the release of fission products from a water pool;
- the resuspension of fission products;
- hydrogen combustion;
- passive autocatalytic recombiner (PAR) operation in counter-current flow conditions.

THAI test facility: top view into the open PAD vessel during instrumentation work.

Becker Technologies, Germany

Thermochemical Database (TDB) Project

Contact: maria-eleni.ragoussi@oecd.org

Current mandate: April 2014-March 2018

Budget: EUR 1.5 million

Participants: Belgium, Canada, Czech Republic, Finland, France, Germany, Japan, Spain, Sweden, Switzerland, United Kingdom and United States.

Produce a database that:

- contains data for elements of interest in radioactive waste disposal systems;
- documents why and how the data were selected;
- gives recommendations based on original experimental data, rather than on compilations and estimates;
- documents the sources of experimental data used;
- is internally consistent;
- addresses all solids and aqueous species of the elements of interest for nuclear waste storage performance assessment calculations.

Thermodynamics of Advanced Fuels – International Database (TAF-ID) Project

Contact: davide.costa@oecd.org

Project agreement: January 2013-December 2017

Budget: ≈ EUR 470 K

Participants: Canada, France, Japan, Korea, Netherlands, United Kingdom and United States.

Make available a comprehensive, internationally recognised thermodynamic database and associated phase diagrams on nuclear fuel materials for the existing and future generation of nuclear reactors. Specific technical objectives this project intends to achieve are:

- predict the solid, liquid and/or gas phases formed during fuel/cladding chemical interaction under normal and accident conditions;
- improve the control of experimental conditions during the fabrication of fuel materials at high temperature;
- predict the evolution of the chemical composition of fuel under irradiation versus temperature and burn-up.

Thermodynamic Characterisation of Fuel Debris and Fission Products Based on Scenario Analysis of Severe Accident Progression at Fukushima-Daiichi Nuclear Power Station (TCOFF)

Contact: davide.costa@oecd.org

Project agreement: June 2017-December 2019

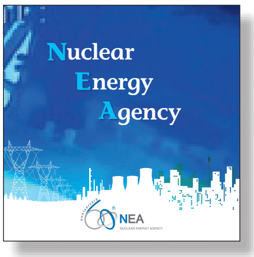
Budget: ≈ EUR 620 K

Participants: Czech Republic, European Commission, France, Germany, Japan, Korea, Netherlands, Russia, Sweden and Switzerland.

The TCOFF project will provide a framework for the exchange of technical information on topics related to thermodynamic databases available for modelling the fuel/core degradation process, which include thermodynamic functions/models, experimental data, calculation tools, calculation methods for quasi-equilibrium systems, and prioritisation of items for improvement/enlargement, with reference to the accidental scenario at the Fukushima Daiichi nuclear power station (NPS). The project aims to:

- improve the quality and/or inventory of thermodynamic databases, which are used for severe accident analyses with a reference to the severe accident progression at different units of the Fukushima Daiichi NPS;
- conduct joint thermodynamic evaluations of the severe accident progression at in-vessel and ex-vessel phases at units 1, 2 and 3 of the Fukushima Daiichi NPS, aiming at characterising fuel melting; molten core relocation; fission product behaviour; the chemical and phase composition of fuel debris; and the thermodynamic evaluation of the formation of materials, which may potentially be detected at the Fukushima Daiichi NPS.

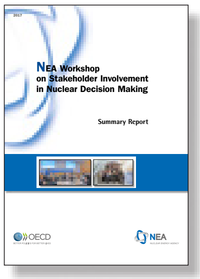
General Interest



The Nuclear Energy Agency brochure

NEA No. 7398. 28 pages.

Available online at: http://oe.cd/neabrochure



NEA Workshop on Stakeholder Involvement in Nuclear Decision Making

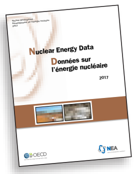
Summary Report

NEA No. 7302. 83 pages.

Available online at: http://oe.cd/2aJ

See the video at: https://youtu.be/h4pb471IO6U

Nuclear development and the fuel cycle



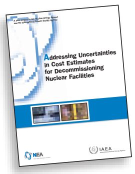
Nuclear Energy Data 2017/ *Données sur l'énergie nucléaire 2017*

NEA No. 7365. 100 pages.

Available online at: http://oe.cd/2aK

Nuclear Energy Data is the Nuclear Energy Agency's annual compilation of statistics and country reports documenting nuclear power status in NEA member countries and in the OECD area. Information provided by governments includes statistics on total electricity produced by all sources and by nuclear power, fuel cycle capacities and requirements, and projections to 2035, where available. Country reports summarise energy policies, updates of the status in nuclear energy programmes and fuel cycle developments. In 2016, nuclear power continued to supply significant amounts of low-carbon baseload electricity, despite strong competition from low-cost fossil fuels and subsidised renewable energy sources. Three new units were connected to the grid in 2016, in Korea, Russia and the United States. In Japan, an additional three reactors returned to operation in 2016, bringing the total to five under the new regulatory regime. Three reactors were officially shut down in 2016 – one in Japan, one in Russia and one in the United States. Governments committed to having nuclear power in the energy mix advanced plans for developing or increasing nuclear generating capacity, with the preparation of new build projects making progress in Finland, Hungary, Turkey and the United Kingdom. Further details on these and other developments are provided in the publication's numerous tables, graphs and country reports.

Radioactive waste management



Addressing Uncertainties in Cost Estimates for Decommissioning Nuclear Facilities

NEA No. 7344. 64 pages.

Available online at: http://oe.cd/2aL

The cost estimation process of decommissioning nuclear facilities has continued to evolve in recent years, with a general trend towards demonstrating greater levels of detail in the estimate and more explicit consideration of uncertainties, the latter of which may have an impact on decommissioning project costs. The 2012 report on the *International Structure for Decommissioning Costing (ISDC) of Nuclear Installations,* a joint recommendation by the Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA) and the European Commission, proposes a standardised structure of cost items for decommissioning projects that can be used either directly for the production of cost estimates or for mapping of cost items for benchmarking purposes. The ISDC, however, provides only limited guidance on the treatment of uncertainty when preparing cost estimates. *Addressing Uncertainties in Cost Estimates for Decommissioning Nuclear Facilities,* prepared jointly by the NEA and IAEA, is intended to complement the ISDC, assisting cost estimators and reviewers in systematically addressing uncertainties in decommissioning cost estimates. Based on experiences gained in participating countries and projects, the report describes how uncertainty and risks can be analysed and incorporated in decommissioning cost estimates, while presenting the outcomes in a transparent manner.

National Inventories and Management Strategies for Spent Nuclear Fuel and Radioactive Waste

Extended Methodology for the Common Presentation of Data

NEA No. 7371. 70 pages.

Available online at: http://oe.cd/2aM

Radioactive waste inventory data are an important element in the development of a national radioactive waste management programme since these data affect the design and selection of the ultimate disposal methods. Inventory data are generally presented as an amount of radioactive waste under various waste classes, according to the waste classification scheme developed and adopted by the country or national programme in question. Various waste classification schemes have evolved in most countries, and these schemes classify radioactive waste according to its origin, to criteria related to the protection of workers or to the physical, chemical and radiological properties of the waste and the planned disposal method(s).

The diversity in classification schemes across countries has restricted the possibility of comparing waste inventories and led to difficulties in interpreting waste management practices, both nationally and internationally. To help improve this situation, the Nuclear Energy Agency developed a methodology that ensures consistency of national radioactive waste and spent fuel inventory data when presenting them in a common scheme in direct connection with accepted management strategy and disposal routes. This report is a follow-up to the 2016 report that introduced the methodology and presenting scheme for spent fuel, and it now extends this methodology and presenting scheme to all types of radioactive waste and corresponding management strategies.

Radiological Characterisation from a Waste and Materials End-State Perspective

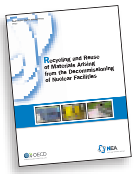
Practices and Experience

NEA No. 7373. 96 pages.

Available online at: http://oe.cd/2aN

Radiological characterisation is a key enabling activity for the planning and implementation of nuclear facility decommissioning. Effective characterisation allows the extent, location and nature of contamination to be determined and provides crucial information for facility dismantling, the management of material and waste arisings, the protection of workers, the public and the environment, and associated cost estimations.

This report will be useful for characterisation practitioners who carry out tactical planning, preparation, optimisation and implementation of characterisation to support the decommissioning of nuclear facilities and the management of associated materials and waste. It compiles recent experience from NEA member countries in radiological characterisation, including from international experts, international case studies, an international conference, and international standards and guidance. Using this comprehensive evidence base, the report identifies relevant good practice and provides practical advice covering all stages of the characterisation process.



Recycling and Reuse of Materials Arising from the Decommissioning of Nuclear Facilities

NEA No. 7310. 68 pages.

Available online at: http://oe.cd/2aO

Large quantities of materials arising from the decommissioning of nuclear facilities are non-radioactive per se. An additional, significant share of materials is of very low-level or low-level radioactivity and can, after having undergone treatment and a clearance process, be recycled and reused in a restricted or unrestricted way. Recycle and reuse options today provide valuable solutions to minimise radioactive waste from decommissioning and at the same time maximise the recovery of valuable materials. The NEA Co-operative Programme on Decommissioning (CPD) prepared this overview on the various approaches being undertaken by international and national organisations for the management of slightly contaminated material resulting from activities in the nuclear sector.

The report draws on CPD member organisations' experiences and practices related to recycling and reuse, which were gathered through an international survey. It provides information on improvements and changes in technologies, methodologies and regulations since the 1996 report on this subject, with the conclusions and recommendations taking into account 20 years of additional experience that will be useful for current and future practitioners. Case studies are provided to illustrate significant points of interest, for example in relation to scrap metals, concrete and soil.

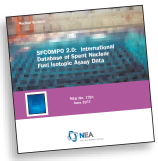
Sourcebook of International Activities Related to the Development of Safety Cases for Deep Geological Repositories

NEA No. 7341. 64 pages.

Available online at: http://oe.cd/2aP

All national radioactive waste management authorities recognise today that a robust safety case is essential in developing disposal facilities for radioactive waste. To improve the robustness of the safety case for the development of a deep geological repository, a wide variety of activities have been carried out by national programmes and international organisations over the past years. The Nuclear Energy Agency, since first introducing the modern concept of the "safety case", has continued to monitor major developments in safety case activities at the international level. This Sourcebook summarises the activities being undertaken by the Nuclear Energy Agency, the European Commission and the International Atomic Energy Agency concerning the safety case for the operational and post-closure phases of geological repositories for radioactive waste that ranges from low-level to high-level waste and for spent fuel. In doing so, it highlights important differences in focus among the three organisations.

Nuclear science and the Data Bank



SFCOMPO 2.0: International Database of Spent Nuclear Fuel Isotopic Assay Data

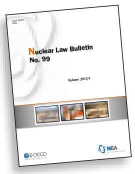
NEA No. 7391. DVD.

SFCOMPO 2.0 is the NEA database of experimental assay measurements. Measurements are isotopic concentrations from destructive radiochemical analyses of spent nuclear fuel (SNF) samples, supplemented with design information for the fuel rod and fuel assembly from which each sample was taken, as well as with relevant information on operating conditions and design characteristics of the host reactors. SFCOMPO 2.0 contains data from 750 SNF samples coming from 44 reactors representing 8 different international reactor designs. SFCOMPO 2.0 was released online in June 2017.

SFCOMPO 2.0 has been developed by the NEA in close collaboration with Oak Ridge National Laboratory (ORNL). The data in SFCOMPO 2.0 has undergone an independent and iterative review process by the Expert Group on Assay Data of Spent Nuclear Fuel (EGADSNF), under the NEA Working Party on Nuclear Criticality Safety (WPNCS). The data have been reviewed for consistency with the experimental reports but have not been formally evaluated. Assay data evaluations are a multidisciplinary effort involving reactor specialists, modelling and simulation experts, and radiochemistry experts. Any errors in measurements, omissions or inconsistencies in the original reported data may be reproduced in the database. Therefore, it is important that any user of the data for code validation consider and assess the potential data deficiencies. The evaluation of assay data will provide a more complete assessment and may result in the development of benchmark specifications and measurement data in cases of high quality experiments.

SFCOMPO 2.0 contains only openly accessible, published experimental assay data. An online Java application of SFCOMPO 2.0 is available at: www.oecd-nea.org/sfcompo.

Nuclear law



Nuclear Law Bulletin, Volume No. 99

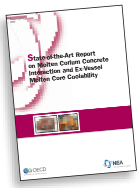
NEA No. 7366. 120 pages.

Available online at: http://oe.cd/2aQ

The *Nuclear Law Bulletin* is a unique international publication for both professionals and academics in the field of nuclear law. It provides readers with authoritative and comprehensive information on nuclear law developments. Published free online twice a year in both English and French, it features topical articles written by renowned legal experts, covers legislative developments worldwide and reports on relevant case law, bilateral and international agreements as well as regulatory activities of international organisations.

Feature articles in this issue include: "Reformed and reforming: Adapting the licensing process to meet new challenges"; "Reflections on the development of international nuclear law"; and "Facing the challenge of nuclear mass tort processing".

Nuclear safety and regulation



State-of-the-Art Report on Molten Corium Concrete Interaction and Ex-Vessel Molten Core Coolability

NEA No. 7392. 365 pages.

Available online at: http://oe.cd/2aR

Activities carried out over the last three decades in relation to core-concrete interactions and melt coolability, as well as related containment failure modes, have significantly increased the level of understanding in this area. In a severe accident with little or no cooling of the reactor core, the residual decay heat in the fuel can cause the core materials to melt. One of the challenges in such cases is to determine the consequences of molten core materials causing a failure of the reactor pressure vessel. Molten corium will interact, for example, with structural concrete below the vessel. The reaction between corium and concrete, commonly referred to as MCCI (molten core concrete interaction), can be extensive and can release combustible gases. The cooling behaviour of ex-vessel melts through sprays or flooding is also complex. This report summarises the current state of the art on MCCI and melt coolability, and thus should be useful to specialists seeking to predict the consequences of severe accidents, to model developers for severe-accident computer codes and to designers of mitigation measures.

Publication of NEA-serviced bodies

Multinational Design Evaluation Programme (MDEP) Annual Report: April 2016-April 2017

MDEP report. 58 pages.

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The Nuclear Energy Agency (NEA) is an intergovernmental agency established in 1958.
Its primary objective is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally sound and economical use of nuclear energy for peaceful purposes. It is a non-partisan, unbiased source of information, data and analyses, drawing on one of the best international networks of technical experts.

The NEA has 33 member countries: Argentina, Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The NEA co-operates with a range of multilateral organisations including the European Commission and the International Atomic Energy Agency.

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