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EDITORIAL

While much of the work of the NEA is focused on enabling a clear energy future, it is also a priority that the nuclear sector deal with its legacies. As nuclear technologies were explored and developed over many decades, research and development activities left old facilities, waste and surplus materials in their wake. In some cases, these legacies were not left in a condition that provides for easy remediation, and in all too many examples clear information about what was left behind is either incomplete or has been lost over time. This has led to expensive efforts in many NEA member countries to clean up these legacy sites.

Over the last year, the NEA’s first new committee in a quarter of a century, the Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM), began its work and is formulating a programme of work to address these and other vital issues. This new committee’s efforts will provide important opportunities to share lessons learnt and identify common challenges that can be addressed on a multilateral basis. We are very excited to see where the CDLM will lead us.

As countries go about addressing these legacies, it is clear that stakeholders will have a vital role in the decisions that are made. One of the important lessons that have been absorbed over the years has been that projects that proceed without stakeholder support court future disruption and instability.

In past decades, nuclear projects of many types were conducted with minimal public input. Eventually, environmental assessments and public consultations with affected groups and communities, as part of a broad and participatory decision-making process, became the norm. The second NEA Workshop on Stakeholder Involvement, about which we report in this volume, highlighted the difficult challenge of drawing the public into technically complex decisions where considerations of risk are involved. Outcomes of this workshop, which included the viewpoint of public stakeholders – including two citizens from Fukushima Prefecture, Japan – will be carried forward by the NEA standing technical committees.

An area of stakeholder involvement we highlight in this edition of NEA News that has an often-troubled history of legacy activities is uranium mining. The legacy waste associated with uranium mining raises concerns in some communities that believe they were impacted by past activities. Today, most reviews of the impact of uranium mining now include some consideration of its social and economic impact on the local population. In contrast to the past, many NEA member countries today provide special attention to indigenous and aboriginal peoples who are often the people living closest to uranium ores. As this edition reports, this is a very important development in both addressing past concerns and ensuring that new legacy issues are not created.

As the most important legacy issue facing the nuclear sector is the management and disposal of radioactive waste, we are pleased to have a guest editorial in this edition of NEA News by Jean-Paul Minon, former Chair of the NEA Radioactive Waste Management Committee. He looks at the issue holistically and addresses fundamental questions related to geological disposal. The long-term management of radioactive waste is, as Minon argues, an issue with multiple dimensions: both technical and scientific, but also societal and financial. The NEA strives to address all of these questions in its ongoing work.

Finally, we note that not all decades-old facilities are legacies to be remediated – but are assets that can be preserved and utilised safely to great benefit. Almost 70% of the world’s operating reactors are now over 30 years of age and countries around the world are considering the operation of reactors to continue not just past the 40-year mark but for as long as 80 years. Deliberations on the refurbishment and long-term operation of existing plants are an essential topic. As highlighted by our sister agency, the International Energy Agency, the world’s effort to address carbon emissions will be greatly hobbled if nuclear power plants retire after only 40 years of operation. Legal Frameworks for Long-Term Operation of Nuclear Power Reactors, the subject of the lead article in this volume, is the latest NEA contribution to the policy debates on the subject of long-term operation.

Our members recognise that looking forward does not mean ignoring the past. We at the NEA reflect this in our work across all elements of the nuclear sector.

William D. Magwood, IV,
NEA Director-General
Legal Frameworks for Long-Term Operation of Nuclear Power Reactors: A new NEA report

by K.S. Nick

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In July 2019, the world’s oldest operating nuclear power reactor marked 50 years since it was first connected to the electricity grid. Four other nuclear power reactors will have also passed this milestone before the end of 2019. With almost 70% of the world’s operating reactors over 30 years of age, countries around the world are assessing whether to allow reactor operation to continue past 50-60 years and potentially up to 80 years. Unlike the situation over thirty years ago when specific national plans and programmes for nuclear power plant ageing began to develop, the international community now has decades of knowledge and experience ensuring the safe operation of nuclear power reactors during long-term operation (LTO).

Decisions to pursue LTO, however, do not simply involve technical matters. Instead, these are complex, national decisions that concern long-term energy policy, economics and social licence. As such, legal systems are playing an increasingly vital role in adjudicating public policy and regulatory questions – particularly in countries with long-established nuclear power programmes.

Ensuring that a proper legal framework for LTO is in place is a key component of a decision to authorise LTO. While there are numerous reports that address LTO from a technical standpoint, and some of these also incorporate a review of regulatory frameworks for LTO, there was no single source that comprehensively addressed the legal and policy aspects.

1. Terminology is a particular challenge in this subject area as countries use different words to describe the same or similar concepts. The differences in the terminology used may be attributed to the specific licensing approach undertaken in each country, whereas other differences in terminology can simply be attributed to translations from the original language into English. Chapters 1 and 2 of Legal Frameworks for Long-Term Operation of Nuclear Power Reactors (NEA, 2019) uses the term LTO generally (“Operation beyond an established time frame defined by the licence term, the original plant design, relevant standards or national regulations” [IAEA, 2018]) without direct reference to the specific meaning that this term may have in any given, national context. To the extent possible, a generic approach is taken in Chapter 3 of the report, as well as with the country reports, although if a word has a specific national meaning, that word is used. If a country does not refer to “long-term operation”, for example, but instead to “extended operation”, this terminology is used for that country.
aspects involved in a decision to allow or authorise LTO. It was with the objective of providing insight into the various laws, regulations and policies that contribute to different countries’ approaches to LTO around the world that the NEA recently released *Legal Frameworks for Long-Term Operation of Nuclear Power Reactors* (NEA, 2019).

**Method**

The information contained in the above report was gathered via an extensive, 55-question survey entitled “Long-Term/Extended/Continued Operation of Nuclear Power and Research Reactors” sent to all NEA member countries. The survey was originally prepared by the NEA, but was revised and supplemented with additional questions following multiple rounds of consultation with members of the NEA Working Party on the Legal Aspects of Nuclear Safety (WPLANS).²

The scope of the survey was broad and applied to both nuclear power and research reactors. The report, however, applies only to nuclear power reactors. In many if not most instances, the laws and regulations related to research reactors differ from those related to nuclear power reactors. It was thus determined that a report with a narrower focus on nuclear power reactors would provide more useful, targeted and insightful information.

With this narrower scope, the report has been able to comprehensively address multiple, important themes. These include all of the significant legal and policy aspects relating to a country’s legal and regulatory framework for LTO. Specific areas of focus include:

- the primary legal documents detailing the legal framework;
- the scope of the safety and environmental assessment for LTO, with a comparison to initial licensing reviews;
- the ability to impose new safety and environmental requirements;
- the degree of public access to information on safety and environmental issues;
- the extent of public participation in safety and environmental issues;
- legal challenges to safety and environmental issues.

Official information was provided by 25 countries, 24 of which are NEA member countries and by an additional country that participates in certain NEA activities.³ In total, the report covers 359 (80%) of the world’s operating nuclear power reactors. Keeping in mind that laws and regulations may change, this report nonetheless provides a snapshot in time, with all information current as of 30 June 2019.

The report is structured into two main sections. The first main section provides the international context, with an overall review of the different approaches to LTO. Countries around the world approach LTO differently. Even among countries with similar approaches, small distinctions can ultimately amount to major differences. This section analyses information related to:

- licensing framework, including term type for initial nuclear power reactor operation and whether there is a specific regulatory decision at the time of LTO, leading to a specific authorisation for LTO;

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² The WPLANS was created by the NEA Nuclear Law Committee (NLC) in 2016 to strengthen NLC work at the intersection of nuclear law and nuclear safety. Although the NLC had for many years been expanding the scope of its work to include areas outside its traditional focus of nuclear third party liability, the creation of the WPLANS was the first concerted effort to systematically address this important area of nuclear law. Members of the WPLANS include senior legal experts from national regulatory bodies, ministries and government-owned nuclear companies, all of whom have first-hand experience in addressing the legal aspects of nuclear safety-related issues.

³ Not all reporting countries operate nuclear power reactors, and not all countries that operate nuclear power reactors are pursuing LTO.
• responsible governmental entities for the review and authorisation or approval of LTO;
• regulatory approaches to authorising or approving LTO;
• environmental reviews and transboundary notification;
• new safety requirements;
• provision of information;
• public participation; and
• legal challenges.

The second section of the report provides a detailed review of national policies on LTO. Because non-nuclear power countries responded to the survey, an entry is included regardless of whether the country has an operating nuclear power reactor. In many ways, the country reports are the central part of Legal Frameworks for Long-Term Operation of Nuclear Power Reactors. Each country report is drafted so that it can be read and understood separately from the report as a whole. When applicable, each country report provides key data regarding the status of nuclear power reactor operation, important details about the designed and authorised periods, terminology, main laws/regulations/documents for initial operation and LTO, responsible government bodies, application and review timing, scope of review (both safety and environmental), new safety and transboundary notification requirements. Each country report concludes, as far as applicable, with a review of the available avenues for access to information and public participation during the LTO-approval process in the individual reporting country, as well as the opportunities and procedures to initiate legal challenges.

Convergences and divergences in national approaches to LTO

With information collected from countries that have both experience in and plans for LTO, the report highlights some of the commonalities that emerge and the possible reasons for some of the variations. A comprehensive analysis of the information provided by reporting countries draws the following main conclusions:

• Differences in the initial licensing frameworks for nuclear power reactor operation have a substantial impact on the legal frameworks for LTO. Initial authorisations for nuclear power reactor operation may be granted either for a specific, time-limited term or for an indefinite duration. This variation most often, but not systematically, determines whether a specific decision is taken to authorise the LTO of a nuclear power reactor.
• All reporting countries require a review of nuclear safety related aspects of LTO by their national regulatory bodies, although authorisation or approval for LTO is in some instances granted by a ministry or by the government, rather than the regulatory body.
• Regulatory approaches to LTO are often described as either a periodic safety review (PSR) or a licence renewal. For reporting countries, however, the usual PSR and/or licence renewal dichotomy was not the most suitable distinction. Instead, the safety review in reporting countries is performed by either carrying out a PSR, an LTO-specific review or a combination of the two. It should be noted that such reviews do not necessarily lead to a formal licensing decision to authorise LTO.
• Of the reporting countries that require a specific authorisation for LTO, approaches vary in terms of the requirements for a new licence, a renewed licence, an amended or updated licence and/or a ministerial order.
• A legal requirement exists in the majority of reporting countries to perform a review of the environmental impacts prior to LTO, although the nature and extent of such reviews vary.
• In all reporting countries, new safety requirements related to LTO can be imposed through the LTO-review process. However, the ability to impose new safety requirements is not always specifically linked to an LTO-approval process; in many reporting countries, new safety requirements may be imposed as part of the PSR process or in some cases at any time during reactor operation.
• Most reporting countries’ legal frameworks provide rights to the public to access LTO-related information held either by public authorities or, in some reporting countries...

Figure 2: Regulatory approaches to LTO

Countries that use a LTO-specific process to authorise or approve LTO
Countries that use a combined PSR and LTO-specific review process to authorise or approve LTO
Countries that use a solely PSR-based process to authorise or approve LTO

Source: NEA (2019).
LTO = long-term operation; PSR = periodic safety review.
countries, by licensees. Typically, these rights are provided under the general environmental or national nuclear laws and therefore are not specific to LTO.

- The legal frameworks for LTO-related public participation vary among reporting countries. While not all reporting countries provide for public participation, in those that do such requirements typically rest with the nuclear regulatory body or another decision-making authority (e.g. the public authority in charge of environmental protection or a local authority). Such public participation may entail public hearings, written comments and/or the dissemination of draft decisions for public consultation, as well as requirements for the decision-making authority to take into account comments received when reaching its final decision.

- Nearly all reporting countries allow legal challenges to the LTO process. These legal challenges often concern the authorisation, approval or other type of decision made in the context of the LTO-review process. In most instances, the procedures for such challenges are determined by civil or administrative procedures that are not unique to the nuclear energy sector.

NEA Director-General William D. Magwood, IV summarised the importance of this report by saying:

“Legal Frameworks for Long-Term Operation of Nuclear Power Reactors adds a new dimension to national and international discussions about long-term operation. This first-of-a-kind report, addressing the legal and regulatory aspects of decisions to authorise or approve the long-term operation of nuclear power reactors in countries around the world, will serve as a key resource for not only lawyers, but also for policymakers, engineers and academics. While the choice to proceed with long-term operation is a matter of national policy, Legal Frameworks for Long-Term Operation of Nuclear Power Reactors demonstrates that enhancing knowledge in this important area is critical.”

References


Uranium royalties and taxation – Reflecting social and economic benefits in decision making

by K. Cunningham and L. Grancea

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Background

Mining plays a major role in the world economy, occupying a primary position at the start of the global supply chain and providing resources to enable the shift to a low-carbon future. The benefits of mining can be seen in multiple areas in many countries, including gross domestic product (GDP), foreign direct investment, exports earnings and mineral rents that are paid to host governments. Like other extractive industries, uranium mining has the potential to generate significant social and economic benefits. These can be seen directly through increased employment, training, salaries and wages, and government revenues (royalties and taxes). It can also provide economic stimulus to the local and broader economy through secondary industries such as retail and service sectors that supply the mine and the mine’s employees.

The decisions on taxation levels and methodology and the disposition of those benefits are made by a host government and are based on the desired economic result. Policy decisions must balance the promotion of mine development with the potential benefits for and impacts on the host communities. Stakeholder consultation is an important factor since, after all, it is at the local level that the impacts of mining will be greatest (NEA, 2014).

Mining is an important factor to consider in the economic forecasting and evaluation of a uranium project during the process of making a development decision. This consideration is inclusive of the entire life cycle of a mine, and industry will consider jurisdictional comparisons as early as the assignment of exploration funding. A country or region that desires to promote and foster uranium development must consider national and international jurisdictional comparisons of royalties and taxes as these are factors considered by companies that operate globally. Royalty/tax systems are either profit based, revenue based or a hybrid combination of the two. The systems may be both specific to the jurisdiction and to the commodity.

Secondly, in the discussion on mineral royalties and taxation, considerations on the disposition of revenues from...
those taxes is very important from a social and economic perspective. It is the host government which receives these revenues that decides on the method and recipients of the revenues. Both economic and social licence policies are factors taken into account in the decisions. As a result, a decision is often subject to significant comment in public and political venues on the potential positive and negative impacts. The method and distribution of the revenue is specific to the jurisdiction and may be direct (revenue sharing to impacted stakeholders) or indirect (through public expenditure from general revenue).

The total marginal tax rate for uranium development will include multiple taxes, such as corporate income taxes, capital taxes, sales taxes or payroll taxes, which may be administered by a federal, state or municipal jurisdiction, as well as mineral royalties or taxes, which may be applied by these jurisdictions. For the purposes of this discussion, it will be specific to uranium royalty/taxation, which has a direct impact on the uranium development decision.

The Extractive Industries Transparency Initiative (EITI), which originated in 2003, resulted from growing international concern around the issue of transparency in the management of revenue streams. The EITI initiated a process by which countries and companies voluntarily agreed to disclose the revenues paid by extractive industry companies and those received by governments (see Box 1).

Mineral royalty and tax decisions that are established to provide a jurisdiction with a specific economic result must consider that uranium prices, and thus revenues, are based on uranium supply and demand scenarios, and may be impacted by decisions and events in the global nuclear market. An example is the Fukushima Daiichi incident that took place in Japan in 2011, which has continued to impact uranium prices to the current day (NEA/IAEA, 2018).

A case study comparing two leading uranium jurisdictions – namely Saskatchewan, Canada and the Northern Territory, Australia – is presented here to provide specific information on different royalty systems, as well as methodologies and results.

Saskatchewan, Canada – Royalty system

Canada is the world’s second largest uranium producer, with Saskatchewan the only producing jurisdiction. In 1930, under the Natural Resources Transfer Agreement, the federal government of Canada transferred jurisdiction of mineral ownership to western provinces, including Saskatchewan. This transfer granted Saskatchewan the right to lease, manage and impose royalties and taxes on Crown minerals within the province. While uranium (as pitchblende) was first discovered in Saskatchewan in 1935, uranium was not produced in the province until 1953.

Box 1: The Extractive Industries Transparency Initiative (EITI)

In 2003, a diverse group of countries, companies and civil society organisations attended the Lancaster House Conference in London, hosted by the United Kingdom government. Participants agreed to a “Statement of Principles” to increase transparency over payments and revenues in the extractives sector. These principles became the cornerstone of the Extractive Industries Transparency Initiative (EITI). According to these principles, the wealth from a country’s natural resources should benefit all its citizens, and this requires high standards of transparency and accountability to all aspects of natural resource management, including tax transparency, commodity trading and licensing.
Prior to 1976, uranium royalties were regulated as a metallic mineral royalty under *The Mineral Disposition Regulations, 1961*. The royalty was levied at a maximum of 12.5% of “income derived from mining operations”.

The first uranium specific royalty system was implemented in 1976 in an era of rising uranium prices and government policy of allowing resource companies to earn a fair rate of return, but taxing away any excess return. The policy objectives of the system were to:

- ensure that a fair share of the economic rent from hard-rock minerals is captured by the province as owner of the resource;
- provide producers with an adequate rate of return on investment bearing in mind that mineral exploration is a relatively risky proposition and that market fluctuations have been substantial;
- leave marginal production decisions as unaffected as possible;
- provide an incentive for exploration in Saskatchewan that is as great for potential producers as it is for existing producers; guarantee a minimum payment to the province in return for its resources so that resources are not simply given away to maintain production.

The royalty system had a two component structure where the total royalty was a combination of a basic revenue based royalty (3%) and a graduated profit based royalty (rates increased from 0% to 50% as profits increased).

In 1980, amendments were made to clarify fair market value reporting requirements and royalty/taxation revisions that recognised certain expenditures. In 1988, the basic royalty rate was amended (from 3% to 5% of gross sales) and both a corporate capital tax and resource credit were implemented. A capital tax surcharge of 2% coupled with a 1% Saskatchewan Resource Credit (SRC) was also added.

In 1990, the system was replaced to allocate the royalty burden more fairly among the producers. It continued to ensure a fair financial return to the province and security for the industry by extracting higher royalties during years of high profitability and lower royalties in years of low profitability. It maintained long-term revenue neutrality for the industry as a whole relative to the 1976 system but generated more revenues in the short term.

In 2001, a new system was implemented that was entirely revenue-based. With new operating regimes no longer following the one mine/one mill design, companies could also report royalties on a consolidated corporate basis. The royalty system had three components: a base royalty (5% of gross sales), a tiered royalty (rates increased from 6% to 15% as sales price increased) and the retained SRC (1% gross sales).

In 2013, a new profit-based system was implemented to recognise the costs incurred by industry. The return to a profit-based system that recognises actual capital costs is more sensitive to industry profitability and will promote new investment. The royalty system has three components: a basic royalty (5% of gross sales), a profit royalty (increases from 10% to 15% as profit increases) and a revised SRC (0.75% gross sales).

In the last few years (2012-2016), the uranium mining industry has paid more than CAD 600 million in taxes and royalties (not including income taxes).

### Saskatchewan royalty revenue disposition

Following the 1930 Natural Resources Transfer Agreement, Saskatchewan had the right to lease, manage and impose royalties and taxes on Crown minerals within the province. While certain commodities in southern Saskatchewan have freehold ownership, all uranium mine operations are located in northern Saskatchewan and sole ownership lies with the Crown, with no Aboriginal rights existing on the uranium mine lands.

With sole ownership, all uranium royalties are paid to Saskatchewan, and the disposition of the revenues is the decision of the government. From the very beginning of uranium production until the current date, all royalty monies are deposited into Saskatchewan’s General Revenue Fund (GRF). The acting government decides on the disposition of GRF funds as a whole, without a specific decision on the disposition of uranium royalty revenues.
All uranium production in Saskatchewan is located in the northern part of the province. The region is home to 48 First Nation, Métis and municipal communities that are very sparsely located. Of the approximately 38,000 residents, 80% of the region’s people self-identify as Indigenous.

Northern residents have consistently raised the issue of revenue sharing since the first public inquiries of the 1970s, and they continued to do so at the federal-provincial panels of the 1990s.

The 1977 Bayda (Cluff Lake) Inquiry recognised the issue and recommended: “The provincial government should institute a royalty sharing scheme under which the government would pay a share to certain northern governing bodies and in return those northern governing bodies would undertake to perform certain governmental functions.”

The issue of revenue sharing was again identified in the Joint Federal-Provincial Panel on Uranium Mining Developments in Saskatchewan hearings held from 1991 to 1997. The position of the Government of Saskatchewan with respect to uranium mine development in the province was stated as follows: “The Government of Saskatchewan supports the responsible development of its uranium resources provided that individual projects:

- adequately protect the environment;
- provide for the health and safety of workers; and
- provide an appropriate distribution of socioeconomic benefits.”

The province stated that for every CAD 1.00 the province receives in revenue (primarily uranium royalties as all other revenues are of very low value), it would spend CAD 1.60 in the north in support of health care, education and training, social services, justice, community and economic development, and environmental protection.

To address the socio-economic benefits and revenue sharing issue, Saskatchewan requires uranium operations to provide socio-economic benefits through regulation, and more specifically through the Mine Surface Lease Agreement and the Human Resource Development Agreement (HRDA). These agreements focus on maximising northern employment, training and business opportunities and increasing communication. Programmes and regulatory instruments developed in co-operation with industry, Aboriginal communities and representative agencies to deliver direction and economic benefit derived from royalty revenues include: the Northern Labour Market Committee and Northern Career Quest (Multi-Party Training Plan [MPTP] or Environmental Quality Committees [EQC]).

While revenue sharing and royalty revenue disposition in northern Saskatchewan and issues of a low income population continue to co-exist, support for the uranium industry remains strong with 73% of northern respondents supporting the industry. The Government of Saskatchewan and the uranium mining companies have maintained a high level of public acceptance for operations through the continued evolution of development policies, and a supportive and proactive industry.

Northern Territory, Australia – Royalty system

As a territory, the Northern Territory (NT) did not have ownership of the mineral rights that were under the responsibility of the Commonwealth government. The Aboriginal Land Rights (Northern Territory) Act 1976 was a Commonwealth initiative that pre-dated self-government in the Northern Territory. While the Commonwealth retained property rights to minerals, the main features of the original Act was that property rights to minerals would be retained by the Crown but title to land would be vested in Land Trusts on behalf of traditional Aboriginal owners.

Uranium (as tobernite) was first discovered in the Northern Territory in 1869; however, uranium was not produced until 1954 at Rum Jungle. The Commonwealth government, through the Australian Atomic Energy Commission, was responsible for the mine located at this site.
In 1977, the amount of royalties for uranium production was determined by the Northern Territory Mining Ordinance. This was set at 1.25% of the gross proceeds of sales of uranium, less transport. The rate with respect to land in Aboriginal Reserves was 2%.

When it granted self-government to the NT in 1978, the Commonwealth government retained ownership of uranium and the power to approve the development of uranium mines.

In 1980, royalties for uranium mining operations in the NT were determined on a case-by-case basis, taking into account a range of relevant considerations. These considerations included the world market for uranium, any payments negotiated with traditional owners, the loss or damage likely to be suffered by any indigenous communities affected by such mining operations and the royalty rates set for other mines. Ad valorem royalties were set at 5.5% for Ranger mine, 3.75% for Nabarlek and 5.25% for Jabiluka. The Ranger mine is the only uranium mine presently operating in the NT, with Energy Resources Australia (ERA) as the operator.

Under the current Ranger arrangements, ERA pays an ad valorem royalty of 5.5% that is collected by the Australian government, and it is then shared between the Aboriginal Benefits Account (4.25%) and the Northern Territory (1.25%).

According to the Fox Report (Ranger Uranium Environmental Inquiry), the direct payment of royalties to traditional Aboriginal owners with limited support, education or oversight has generated some negative social impacts. The 1977 report stated: “Aborigines in the Region are in a state of transition between a system of imposed wardship and an assertion of independence, one encouraged by Government. But the current civic culture is one in which disunity, neurosis, a sense of struggle, drinking, stress, hostility, of being drowned by new laws, agencies, and agendas are major manifestations. Their defeat on initial opposition to mining, negotiations leading to Ranger and Nabarlek, the fresh negotiations on Jabiluka and Koongarra, new sources of money, the influx of vehicles, together have led... to an unhappy verdict.”

A 1985 Aborigines and uranium report found that many of the concerns mentioned in the Fox Report had not ended, that the living standards of Aborigines had not improved and that Aboriginal society could be described as a “society in crisis”.

A 1997 report entitled Impact of Uranium Mining on Aboriginal Communities in the Northern Territory also indicated that the direct payment of royalties to traditional owners had negative social impacts.

Not all outcomes from royalty payments are negative, however, and in some cases uranium royalty payments have provided significant benefits. In the 1980s and 1990s, Northern Territory royalty revenue disposition

While one of the main features of the original Act allowed the Commonwealth to retain property rights to minerals, title to land was nevertheless vested in Land Trusts on behalf of traditional Aboriginal owners. Under the current Ranger mine arrangements, ERA pays an ad valorem royalty of 5.5% that is collected by the Commonwealth government, and it is then shared between the Aboriginal Benefits Account (4.25%) and the Northern Territory (1.25%).

In 2013, the Gundjeihmi Aboriginal Corporation, the Northern Land Council, ERA and the Commonwealth government finalised a suite of agreements governing operations at the Ranger Project Area, including a new mining agreement. These agreements entitle the traditional owners, the Mirarr people, to greater participation in the benefits from mining on their land, including an increased share of royalties. They also established a regional socio-economic trust and a Relationship Committee with ERA to promote information sharing and collaboration. Total royalty rates have remained unchanged at 5.5%.

Kakadu national park, Northern Territory, Australia, where the Ranger mine is located.
Creative Commons, Thomas Schoch CC-BY-SA
the Gagudju Association, which received royalties from the Ranger uranium mine, used them to develop successful tourism ventures, build trust funds for children, assist their members and supplement personal incomes and health and education services to Gagudju outstations.

Lessons learnt

Royalty systems and methodologies vary between jurisdictions and are designed to meet governmental objectives, whether these be revenue generation or the promotion of economic development. Such systems are nonetheless subject to external factors such as market fluctuations, which can impair a system’s ability to achieve the desired objective and necessitate revisions to meet objectives. In both the Saskatchewan and Northern Territory examples, it has been demonstrated that using revenue-based, profit-based or hybrid methodologies can successfully achieve economic objectives.

Methodologies for the disposition of uranium royalty revenues are similarly designed to meet governmental legislative or policy objectives, which are primarily to ensure that impacted local populations benefit from uranium development. In the Saskatchewan example, while direct revenue sharing continues to be a concern for local stakeholders, the methodology for the delivery of socio-economic benefit through other government programming has provided monies that may exceed royalty revenues and with significant positive impacts. In the Northern Territory example, direct revenue sharing has resulted in both positive and negative impacts, but without education or support to manage the revenues, the negative social outcomes have been significant.

When designing a tax system, policymakers must keep in mind the important effects that taxes can have on mine economics and on potential levels of future investment. The overall tax system should be equitable for both the country and the region, as well as for local communities and the investor. Though it is not possible to outline one, ideal approach to royalty taxation, policymakers should carefully weigh the long-term benefits to be gained from a sustainable uranium mining industry that will contribute to long-term development, infrastructure and economic diversification.

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Deep geological disposal in NEA member countries

by J.P. Minon

Mr. Jean-Paul MINON, Former General Manager, Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS), and Former Chair of the NEA Radioactive Waste Management Committee (RWMC).

At the end of the last International Conference on Geological Repositories in 2016, it was clear that a transition phase had begun with some countries moving from R&D in underground research laboratories to the implementation of deep geological repositories (DGRs). One issue frequently raised over the last decade in relation to DGRs has been that of safety, not just during operation but also post-closure safety.

For regulatory bodies, the challenge will be to ensure safety throughout the lifetime of a DGR, one that has to be applied to the specificities of disposal facilities. The development of geological disposal is a complex issue that has technical, scientific, societal and financial dimensions. Funds are required to construct and operate the facility since surveillance or control of the installation is necessary even after the closure of the repository. The timescales involved are long, and there are also multiple regulations – nuclear, mining and conventional safety regulations – with many actors involved. Each country is developing its own decision-making process, taking into account the local cultural context. For the implementation and for the entire life cycle of the facility, it is crucial to have social support from the local and general public in the country.

There is an extensive amount of knowledge available and R&D performed on this issue worldwide. As a result, the scientific basis for geological disposal is solid. International collaboration functions well in this area, at the level of the Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA), European Union (EU) member countries, and the International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM). Finland, France and Sweden, amongst others, have made considerable progress in developing geological disposal facilities; the first such facility is expected to be operational within the next decade.

Work is also being carried out with the International Commission on Radiological Protection (ICRP), taking into account the values and ethical principles presented in ICRP publications. The general public is increasingly concerned about the ethics of radioactive waste management. Poor engagement on the part of the general public can translate to the policy level. In many countries, there is a lack of policy, and waste management agencies have to “push the file” to get a decision made. Because of past focus on the need for interim storage, and not on a final disposal solution, the result has been that no final destinations have even been selected in many cases. Today, efforts are being made to correct this
situation, and permanent disposal facilities should help to solve the problem. Historical (or “legacy”) waste is another important issue, and the temptation is strong to turn to long-term storage again as a solution, because it seems easier to wait than to act. Another problem is the disappearance of knowledge from the first generation of nuclear specialists, although many among us are attempting to stay active and transmit some of our tacit knowledge.

The NEA report *The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables* and the Nuclear Innovation 2050 (NI2050) initiative have underlined that climate change can impact public opinion regarding energy production. Nuclear energy should be understood not in opposition to renewables, but as part of a more balanced and reliable mix of energy production, which avoids producing high amounts of CO\(_2\). Some directives of European law oblige member states to define such frameworks and policies.

The price of DGR facilities remains uncertain as well. However, it is important to carefully consider financing because such funds will also be essential to future generations. The licensing procedure is difficult, as it is a first-of-its-kind decision that needs to be taken by safety authorities. Authorities may not understand the necessity of a particular solution and the impact of a decision-making process that is slow or delayed, but it is important to move together through dialogue, while also respecting the independence of the safety authorities. Another problem is the “wait and see” attitude, reflected in the false hopes associated with overly promoting new technologies or waiting for international solutions. The long timescales involved are also a source of apprehension because views are changing with each new generation.

Today, underground research laboratories exist in Europe and Japan, with more planned in China and Russia, but at the same time laboratories are closing. In the last decade, more and more underground research facilities have begun operation. In many other countries, there are different, ongoing projects, with a defined end-goal to begin operations. This goal is within sight for Finland, France, Sweden and Switzerland. In other countries, there is no clear view of a timeline for beginning operations at the present time. There are operating underground facilities, with many countries having clear views on what has to be done, and others restarting or reconsidering the process.

The process of finding a long-term solution for radioactive waste management is long and complicated. There is an absolute need for a regulatory framework, policy, continuity and public support at national and local levels during a project’s entire life cycle. The stability of standards is problematic as a result of the large time frames, as is the means of preserving a vast amount of knowledge and data. In addition, there is the question of securing funding, and ensuring that international co-operation continues to be promoted. Countries should act quickly because spent fuel is accumulating worldwide at a rate that, according to recent projections, will double the existing total by 2040.

Dry storage containers made of reinforced high-density concrete.

**The five barriers work together to safely contain and isolate the used nuclear fuel from people and the environment.**

Nuclear Waste Management Organization, Canada

Nuclear Waste Management Organization, Canada
A new licensing scheme for the codes distributed by the NEA Data Bank Computer Program Services

by A. Dufresne

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Since the creation of the Computer Program Library at Ispra (Italy) in 1964 – later renamed the Computer Program Services (CPS) at the NEA Data Bank initiation in 1978 – the NEA has played an active role in collecting, testing, preserving and distributing codes developed among its member countries. Recent changes to the NEA Data Bank licensing framework for code distribution reflect the evolution of both the way work is carried out today and the controls that countries and code owners are willing to keep on their codes’ distribution. It is also an opportunity to review and streamline the CPS code distribution process. This new framework was approved by the Management Board for the Development, Application and Validation of Nuclear Data and Codes (MBDAV) in June 2019 and will be implemented during 2020: all codes distributed by the CPS will have a “single-user” licence and end users will be able to download the requested code once the CPS validates their requests.

Background

Unlike today, computers were a rare resource in the early stages of CPS existence, and CPS procedures and restrictions still reflect this initial configuration. An establishment, for example, is defined by both its affiliation and its geographic location. An establishment can access the CPS code collection under two conditions: the corresponding country representative approves its nomination and the establishment designates a liaison officer who becomes the privileged interlocutor with the CPS. As outlined in Figure 1, each liaison officer is in charge of validating all requests from his or her establishment. He or she also makes the requested codes available to staff members of the establishment. Codes distributed by CPS are referred to as “single-site”: meaning that once the code is distributed to the establishment, it can be shared within the entire establishment.
Call for evolution

For the past 15 years, an increasing number of code authors have been asking the CPS to distribute their codes with a “single-user licence”, i.e. the licence grants the right to use the code only to the requester, as long as that person keeps working for the same establishment and the use matches the intended use provided at the time of the request. Codes originating from the United States and Canada, received thanks to an arrangement between the NEA Data Bank and the Radiation Safety Information Computational Center, are already distributed under single-user terms. This has led to a dual licensing system – “single-site” vs. “single-user” – which often creates confusion for CPS beneficiaries. It is therefore important to provide clear instructions on how to use the codes received from the CPS, facilitating compliance with all restrictions on their use. It was thus decided to establish a single-user licensing framework. In addition to simplifying the rules, this would harmonise the system and also be an asset for code authors willing to contact users of their codes and for the creation of code-user communities. Last, but not least, end users will be able to download their codes once the CPS approves their requests, thereby making access to computer programs faster and more convenient.

The new code-licensing framework

The new procedure, set out in Figure 2, stipulates that licence terms depend on both the code and the code authors (the licence signed by the end user in the request is the one to refer to for completeness). The main features of this single-user licence are:

- A user can request a code while working at a nominated establishment, with the approval of the liaison officer.
- After the screening of the request by the CPS, the end user is sent a copy of the code.
- The licence for the code’s use is valid while the user is working at the given establishment, following the provided intended use.
- The user cannot keep the code when leaving the establishment and must uninstall and destroy the copy.
- The package cannot be redistributed or shared by any means with anyone else.
- If a user works for multiple establishments, he or she needs to request a copy for each of these establishments (more than one affiliation and/or more than one site).
Conclusion

The NEA Data Bank Computer Program Services is working towards introducing the single-user licence to improve the services provided to the end users and to take account of modern ways of working. This is one of the most important challenges of the Data Bank since its creation 50 years ago.

With this new licensing framework, the goals are to:

- **homogenise** the terms and conditions of use for all codes distributed by the CPS, even if code owners keep the possibility to tailor their code licence based on their needs.

- **facilitate** the development of user networks thanks to the provision of end-user information at the time of the request.

- **streamline** NEA Data Bank services for the end users: by default, users will receive a secured download link; and the physical dispatch on CD/DVD will be reduced.

With this new licensing system, the CPS wishes to offer a better service to its end users in order to attract new codes and adapt to the needs of the community it serves. For a complete catalogue of currently available codes at the CPS, see [www.oecd-nea.org/tools/abstract/list](http://www.oecd-nea.org/tools/abstract/list).

Reference

The 2nd NEA Workshop on Stakeholder Involvement: Risk Communication

by P. Bourassa

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Trust: An Essential Element for Effective Risk Communication

Stakeholder involvement is key to achieving decisions that are accepted and sustainable for the use of nuclear energy and technologies. To this end, and as a follow-up to the 2017 Workshop on Stakeholder Involvement in Nuclear Decision Making, the NEA held the Workshop on Stakeholder Involvement: Risk Communication on 24-26 September 2019. This workshop helped to shed light on the complex challenges and best practices of communicating issues related to radiological risk. Panel discussions and interactive sessions served to support 145 officials from 30 countries and states in identifying and developing the tools and approaches needed to foster dialogue and shared understanding of radiological risks between officials, experts and stakeholders.

The event brought together nuclear regulators, government agencies, elected officials, operators and representatives of civil society, including ordinary citizens and non-governmental organisations (NGOs). The workshop programme provided an opportunity to hear from high-level public officials presenting as keynote speakers, as well as from experts during panel sessions and armchair discussions. The second day’s focus was on case studies of risk communication activities held in various prevailing circumstances, followed by breakout sessions in mixed-interest groups. By design, the programme allowed for interactions with the presenters and among the participants, regardless of their backgrounds. Hearing stakeholders’ concerns and viewpoints was a key highlight of the workshop, with a special session featuring a school administrator and high school students from Fukushima Prefecture, who shared their candid views about radiological risk communication in the context of the Fukushima Daiichi crisis and its aftermath. Many discussions highlighted that building trust is essential for effective risk communication through local and long-term engagement.

To help support the workshop discussions, the NEA held an open survey on the topic of risk and risk communication, the results of which NEA Director-General, William D. Magwood, IV shared during his opening remarks on the first day of the workshop. The survey – launched on 3 September 2019 and receiving 208 responses from 33 countries and regions – revealed that clear facts and trustworthiness of the communicating organisation were the two most important considerations when people listen to or read about risks in their daily lives. The respondents...
to the survey also indicated that their top two sources of information when searching for information about risks are the internet and national government experts.

Of the outcomes from workshop discussions, it was shown that delivering an understandable message is not an easy task, especially in scientific and technical areas where topics are usually complex and not easily accessible to the public. Depending on whom the message is for, expectations may differ and various and subjective factors may impact how the message is delivered and received. Participants learnt that being able to adapt the communication to meet the audience’s needs and address its real concerns is a key factor to having a meaningful and successful dialogue with stakeholders.

Various initiatives exist worldwide to provide the public with opportunities to contribute to important societal debates, in particular when those are risk-related, such as may exist in the nuclear sector. Such initiatives must be supported by dedicated communication actions and stakeholder involvement processes, but it is the manner in which the concerns and interests of the public are dealt with that will determine whether the efforts will be successful. When stakeholders can see how their interactions and feedback are taken into account in the decision-making process, there will be more confidence in the organisations and, consequently, the initiatives will be more trusted and valuable.

Workshop participants discussed different tools and strategies that can be implemented to increase the communication activities’ efficiency and effectiveness. For example, the development of simplified radiological exposure scales to support communication on complex issues may help deliver a message easily understood by the public. In addition, taking into account human behaviour and societal considerations when communicating can help deliver impactful and understandable messages. Indeed, communication is a living domain, where processes and tools evolve, in the same way that societal and public expectations evolve.

The workshop highlighted the need to increase the use of social media when communicating on nuclear matters, as it has become an important source of information for the general public. Organisations must also make concerted efforts to encourage youth participation in decision-making processes and to build a relationship of trust with the media. Finally, hearing from representatives of civil society and of NGOs at the workshop, participants recognised that these stakeholders have specific, local knowledge and understanding, which is important input in to decision making.

Chairs and representatives of NEA Standing Technical Committees closed the workshop by stating that their committees and subsidiary bodies would discuss possible follow-up actions identified during the workshop, including using simplified scales to support communication about complex issues. They will aim to develop programmes of work to address identified gaps and improvement opportunities, in areas such as training and development, stakeholder engagement and social media, and building trust.
Understanding and managing the risks from exposure to low-dose ionising radiation

by E. Lazo and J. Garnier-Laplace

While it is generally well understood in the radiological protection community that in concept, optimisation of protection is not minimisation of exposure, conservative choices tend to be the norm in practice. This is partly driven by the uncertainty in the effects of low levels of radiation exposure. Epidemiological science and data suggest that any level of exposure can cause risk, and that the dose/risk relationship can be represented as a straight line from zero dose upwards through the linear non-threshold (LNT) model. However, existing human and animal dose effects data cannot statistically determine if adverse effects do or do not occur at low doses. The exposures that do lead to statistically significant adverse health effects are above the doses typically received by most radiation workers, and are well above the doses experienced by the public. Biological studies of the effects of radiation exposure provide some evidence that low doses may not lead to adverse effects in certain circumstances, but at the same time they have not yet fully explained the complex cellular repair and damage mechanisms, and cannot yet resolve the issue of what level of exposure can cause damage. Not knowing whether or not low doses can cause a risk of cancer or leukaemia, these uncertainties thus invoke consideration of the precautionary principle, which often leads to conservative protection decisions.

To address these issues, the NEA has initiated two projects. First, a high-level group has been formed under the NEA Committee on Radiological Protection and Public Health (CRPPH) to create a network of low-dose effect research funding and implementation organisations in order to facilitate global co-ordination of the many, ongoing research projects around the world. This work is aimed at improving the efficiency of research programmes, encouraging co-operation, reducing unnecessary duplication and increasing cost effectiveness. Reducing uncertainty in low-dose effects should help to better structure and size radiological protection decisions.

Second, although radiological protection decisions are informed by science, they are taken based on judgements. As mentioned above, uncertainty tends to push decisions to be conservative. For example, a clean-up activity could:
1) leave no or very little contamination, causing significant environmental disruption, and resulting in virtually no public radiation exposure; rather than 2) leave somewhat higher levels of contamination with little environmental disruption, and result in a very small dose with an unmeasurable effect on public health. To better understand where choices of actions may tend towards being objectively and significantly conservative, and to share experience of avoiding extremes, the CRPPH organised a workshop entitled: Optimisation: Rethinking the Art of Reasonable. This workshop took place from 13-15 January 2020 in Lisbon, Portugal, and allowed participants from around the world the opportunity to discuss the issues evoked here in greater depth.
The Fourth International Workshop on the Indemnification of Damage in the Event of a Nuclear Accident

by X. Vásquez-Maignan

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With regard to the determination of nuclear damage, the aim was to discuss in different sessions the meaning of each of the following heads (or types) of damage that have been included in the post-Chernobyl versions of the nuclear liability conventions:

- loss of life or personal injury;
- loss of or damage to property;
- economic loss (arising from damage 1 and 2, loss of income deriving from an economic interest in any use or enjoyment of the environment, loss caused by preventive measures, and any other economic loss);
- costs of measures of reinstatement of impaired environment;
- costs of preventive measures.

The meaning to be given to each head of damage may in practice depend on the circumstances of the accident, the international convention(s) applicable (if any), the national legislation and case law, and the interpretation that the competent court may have. The purpose of the workshop was to identify:
The workshop also addressed the administrative challenges of handling nuclear damage compensation claims. It did so to highlight the complexity of such a process, which would require, among many other things, national and international co-ordination between several governmental authorities and private actors, the establishment of an adequate claims handling procedure in case the countries concerned (i.e. the state where the installation is located and the affected states) do not have treaty relations, and a common understanding of the applicable legal framework between the countries concerned. The workshop clearly demonstrated the need to be prepared beforehand by, for example, setting up whatever is possible in advance (e.g. IT system, website, co-ordination between fund providers), clarifying the responsibilities between all the actors involved (which may change from one country to another or from one operator to another) and carrying out international nuclear claims handling exercises.

A group of experts from different fields and backgrounds (e.g. legal, economics, radiological protection, insurance) was constituted for each head of damage and for the claims handling. Such a variety of experts ensured a holistic analysis of each topic. There were in total 42 experts from 16 member and non-member countries involved in the groups. They prepared notes and relevant supporting documents for each topic, which were then made available to the participants before the workshop. This approach ensured an active and collaborative discussion between the panel of experts and the participants who came to the workshop well prepared for the discussions.

A total of 140 participants attended the workshop from 24 NEA member countries, 5 non-member countries, the European Commission and the International Atomic Energy Agency. They represented governments, regulatory authorities, technical support organisations, academia, judicaries, operators, suppliers and law firms, as well as nuclear insurance pools. The NEA is now preparing a report that should help countries to be prepared with regard to the determination of nuclear damage and claims handling in the case that a nuclear accident with transboundary damage were to occur.
The second NEA International Radiological Protection School (IRPS-2) took place from 19-23 August 2019 at Stockholm University in Sweden, and like IRPS-1 was strongly supported by the Swedish Radiation Safety Authority (SSM). This five-day course aimed at providing mid-career radiological protection experts with an understanding of the “spirit” of the radiological protection system. International experts presented the nuances, history and between-the-lines meanings of international guidance and working experience, which will allow tomorrow’s radiological protection leaders to appropriately apply the radiological protection system to address current and future radiological circumstances. A total of 33 participants from 15 countries took part in the course. Despite it being only the second time that this course has been held, a significant amount of evolution has nonetheless occurred in comparison with the 2018 IRPS-1 course. In order to allow more time for discussion, the number of topics presented was reduced. In addition, significant emphasis was placed on presenting and discussing specific case studies to illustrate specific nuances of the radiological protection system and to allow lecturers to more directly engage with participants. The 2020 edition of the IRPS will once again take place at Stockholm University with support from the SSM, from 17-21 August. For more information on IRPS-2, see: oe.cd/nea-irps.
The eleventh meeting of the NEA Expert Group on Multi-physics Experimental Data, Benchmarks and Validation (EGMPEBV) was held on 12-13 September 2019. The EGMPEBV brings together experts on multi-physics experiments and simulation to review the state of the art in multi-physics validation, and provide guidance on best practices. The expert group has started collecting experimental data for validation purposes with the aim of underlining the value of the significant investments that NEA member countries have made in code development. As part of the next phase of the EGMPEBV activities, first-of-a-kind multi-physics benchmarks are being developed to test the novel modelling and simulation systems that are the subject of multiple code development projects in member countries. Following an agreement with the Russian State Nuclear Energy Corporation, Rosatom, a unique benchmark using data from the Rostov Unit 2 VVER-1000 reactor has been specified and will now be distributed to expert benchmark participants as the first power plant multi-physics benchmark exercise of the expert group. This benchmark will be run in parallel to two others using data from the Studsvik R2 research reactor in Sweden and the Tennessee Valley Authority (TVA) Watts Bar 1 reactor in the United States, which was established as part of the Consortium for Advanced Simulation of Light Water Reactors (CASL) project.

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First NEA International Mentoring Workshop in Science and Engineering held in Russia

by Y. Hah and O. Saraev

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On 2 October 2019, a session of the NEA International Mentoring Workshop in Science and Engineering series took place at the National Research Nuclear University in Moscow, Russia. In collaboration with the Russian State Nuclear Energy Corporation, Rosatom, female university students engaged in direct conversations with successful women who are national and international leaders in their fields to discuss their career paths and experiences. With the motivation of improving the gender balance in technical fields, this series of workshops focuses on encouraging and retaining young women on track towards technical careers while also highlighting the importance of consolidating their technical and leadership skills. The Russia workshop featured opening remarks and a presentation on the NEA-led initiative by Ms Yeonhee Hah, NEA Head of the Division of Radiological Protection and Human Aspects of Nuclear Safety, who encouraged the participants to consider careers as “STEMinists”* working in science and engineering. Ms Laurie Swami, President of the Canada Nuclear Waste Management Organization (NWMO) and Ms Tatiana Ivanova, Head of the NEA Nuclear Science Division, participated in the workshop as mentors, together with several accomplished female scientists and engineers from Rosatom.

* STEM = Science, technology, engineering and mathematics.
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 2 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-nea.org

Current mandate: October 2017-September 2020

Budget: EUR 3 million

- 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;
- carry out analytical activities to improve the technical competence among OECD/NEA member countries in the area of thermal-hydraulics for nuclear reactor safety analysis.

**Behaviour of Iodine Project (BIP)**

Contact: andrew.white@oecd-nea.org

Current mandate: January 2016-March 2019

Budget: EUR 1 million

- 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.

View of the ATLAS integral thermal hydraulic test facility located in Daejeon, Korea.

KAERI, Korea
Cabri International Project (CIP)
Contact: andrew.white@oecd-nea.org
Current mandate: March 2018-March 2021
Budget: Initial cost of 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 project 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: diego.escrigforano@oecd-nea.org
Current mandate: January 2018-December 2020
Budget: EUR 65 K/year

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

- collect and analyse information on passive metallic and high density polyethylene (HDPE) component degradation and failures to promote a better understanding of underlying causes, impact on operations and safety, and prevention. Detailed objectives and schedules for data submissions will be defined for each calendar year of project operation;
- analyse the information collected in the event database to develop topical reports on degradation mechanisms. Objectives and schedules for the topical reports will be developed for each calendar year of project operation. CODAP will actively seek technical input from the NEA CSNI Working Group on Integrity and Ageing of Components and Structures (WGIAGE). In addition, the Management Board will communicate and co-ordinate as needed with WGIAGE concerning technical matters of mutual interest;
- develop and implement an enhanced web-based event database that supports the creation of standard and custom reports on certain aspects of the database contents. Building on the experience with the existing web-based event database, the new development will address user-friendliness, improved database structure, and analysis tools that enable advanced statistical analyses of the database contents;
- provide ageing management programme support that addresses current operability determination practices, performance of new materials in the field (e.g. dual-certification stainless steels, super-austenitic stainless steels, Alloy 690, Alloy 52/152), and commendable practices of licence renewal and long-term operation;
- facilitate the exchange of existing and future information among the participating organisations as a way to improve the quality of decisions made about components material degradation, ageing management and operability determination. The CODAP database, along with other relevant information collected, will be used for applications of service experience data with an emphasis on observed trends and patterns, past and current degradation mechanism mitigation practices, and risk characterisation of passive component failure events.

Co-operative Programme for the Exchange of Scientific and Technical Information on Nuclear Installation Decommissioning Projects (CPD)
Contact: wei-whua.loa@oecd-nea.org
Current mandate: January 2019-December 2023
Budget: ≈ EUR 75 K/year

Participants: Belgium, Canada, Chinese Taipei, Denmark, European Commission, France, Germany, Italy, Lithuania, Japan, Korea, Russia, Slovak Republic, Spain, Sweden, Switzerland, 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-nea.org
Current mandate: January 2016-December 2019
New mandate under discussion
Budget: EUR 75 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-nea.org
Current mandate: January 2017-December 2021
Budget: EUR 4.26 million
Participants: Belgium, Finland, France, Germany, Japan, Korea, United Kingdom and United States.

- 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-nea.org
Current mandate: January 2018-December 2020
Budget: NOK 370 million
Participants: Belgium, China, Czech Republic, Denmark, Finland, France, Germany, Hungary, Japan, Korea, Netherlands, Norway, Russia, Slovak Republic, Spain, Sweden, United Arab Emirates, United Kingdom, United States and European Commission.

Generate key information for safety and licensing assessments and aim at providing data from post-irradiation examination (PIE), hot-cell experiments and man-technology-organisation studies:
- on how fuel performs, both under normal operation and transient conditions, with emphasis on extended fuel utilisation in commercial reactors;
- on 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;
- on man-machine systems-advances in computerised surveillance systems, virtual reality, digital information, human factors and man-machine interaction in support of control room upgradings.

High Energy Arcing Fault Events (HEAF) Project
Contact: markus.beilmann@oecd-nea.org
Current mandate: February 2019-December 2021
Budget: EUR 2.38 million
Participants: Belgium, Canada, France, Germany, Japan, Korea, Netherlands, 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);
- 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).

View of the Halden reactor hall.
IFE, Norway
Hydrogen Mitigation Experiments for Reactor Safety (HYMERES) Project
Contact: markus.beilmann@oecd-nea.org
Current mandate: July 2017-June 2021
Budget: EUR 4.84 million
Participants: China, Czech Republic, Finland, Germany, Japan, Korea, Russia, Spain, Sweden, 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 (ISODE) Project
Contact: oleg.saraev@oecd-nea.org
Current mandate: January 2020-December 2023
Budget: EUR 379 100
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.

International Common-cause Failure Data Exchange (ICDE) Project
Contact: diego.escrigforano@oecd-nea.org
Current mandate: January 2019-December 2022
Budget: EUR 140 K/year
Participants: Canada, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Sweden, Switzerland and United States.

• 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 for 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 ICDE data to estimate CCF parameters.

The PANDA reactor pressure vessel.
Paul Scherrer Institute, Switzerland
Loss of Forced Coolant (LOFC) Project
Contact: andrew.white@oecd-nea.org
Current mandate: March 2011-March 2022
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.

Preparatory Study on Analysis of Fuel Debris (PreADES) Project
Contact: yuji.kumagai@oecd-nea.org
Current mandate: July 2017-July 2020
Budget: EUR 275 K
Participants: Canada, European Commission, France, Japan, Korea, Sweden, Switzerland and United States.

• collect information for improving knowledge and methodologies for fuel debris characterisation that will support future fuel debris sampling at Fukushima Daiichi units 1-3;
• identify the needs for fuel debris analysis that will contribute to the decommissioning of the Fukushima Daiichi plant and expand the knowledge base of severe accidents;
• prepare a future international R&D framework on fuel debris analysis.

Primary Coolant Loop Test Facility (PKL) Project
Contact: nils.sandberg@oecd-nea.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.

The objective is to perform integral tests in the PKL-facility to:
• 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;
• provide data for verifying computer codes used in safety analyses;
• provide data for further developing these codes for complex scenarios and flow-regimes.

Rod Bundle Heat transfer (RBHT) Project
Contact: didier.jacquemain@oecd-nea.org
Current mandate: October 2019-September 2022
Budget: EUR 1.44 million
Participants: Belgium, Czech Republic, Finland, France, Germany, Italy, Japan, Korea, Spain, Sweden, Switzerland, and United States.

The objective is to conduct experiments in the RBHT facility in the United States in order to:
• simulate reflood scenarios in a prototypical PWR rod bundle section;
• investigate the effect of complex (e.g. oscillatory), inlet flows;
• obtain high-quality data on flow rates, temperature distributions, heat-fluxes and droplet size distributions;
• organise a benchmark exercise to further develop and assess system thermal-hydraulics and sub-channel codes.

The PKL integral thermal hydraulic test facility located in Erlangen, Germany.
Framatome, Germany
Reduction of Severe Accident Uncertainties (ROSAU) Project

Contact: didier.jacquemain@oecd-nea.org
Current mandate: June 2019-June 2024
Budget: EUR 8.64 million
Participants: Belgium, Canada, Czech Republic, France, Japan, Korea, Sweden and United States.

The objective is to reduce knowledge gaps and uncertainties associated with severe accident progression by performing large-scale tests investigating:

- spreading of melt in a cavity and the effect of metal content in melt on molten core-concrete interaction;
- in-core and ex-core debris coolability.

In addition to the experiments, a parallel analytical activity will be carried out to refine and validate models and codes for each test category to form the technical basis for extrapolating the findings from the experiments to plant conditions.

Source Term Evaluation and Mitigation (STEM) Project

Contact: andrew.white@oecd-nea.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-nea.org
Current mandate: July 2019-June 2024
Budget: SEK 145 million
Participants: China, Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Norway, Russia, Spain, Sweden, Switzerland, Ukraine, United Kingdom 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 and Iodine (THAI) Project

Contact: andrew.white@oecd-nea.org
Current mandate: February 2016-July 2019
Budget: ≈ EUR 4.8 million
Participants: Belgium, Canada, China, Czech Republic, Finland, France, Germany, Hungary, India, Japan, Korea, Luxembourg, Slovak Republic, Sweden, Switzerland and United Kingdom.

The project aims to 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-nea.org
Current mandate: February 2019-January 2023
Budget: EUR 1.5 million

Participants (TDB-6): Belgium, Canada, Czech Republic, Finland, France, Germany, Japan, Netherlands, Sweden, Switzerland, United Kingdom and United States.

Produce a database that:
• contains internally consistent thermodynamic data of solid and aqueous species 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.

Thermodynamics of Advanced Fuels – International Database (TAF-ID)
Contact: davide.costa@oecd-nea.org
Project agreement: November 2018-November 2021
Budget: ≈ EUR 460 K

Participants: Canada, France, Japan, Korea, Netherlands, United Kingdom, United States and European Commission – Joint Research Centre.

The objective of the TAF-ID project is to 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. The TAF-ID database makes it possible to:
• 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.

Specific technical objectives the TAF-ID Phase II intends to achieve are:
• test the validity of the TAF-ID database by performing measurements on complex fuel compositions and comparing the experimental results to calculations;
• continue the development of the database;
• organise training sessions for users of the TAF-ID database.

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-nea.org
Project agreement: June 2017-July 2020
New mandate under discussion
Budget: ≈ EUR 760 K

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

The TCOFF project provides 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.
Legal Frameworks for Long-Term Operation of Nuclear Power Reactors
NEA No. 7B04. 176 pages.
Available online at: http://oe.cd/nea-lto-npp

Radioactive waste management
Cost Benchmarking for Nuclear Power Plant Decommissioning
NEA No. 7460. 60 pages.
Available online at: https://oe.cd/2KQ

The nuclear sector has in recent years been placing increasing attention on the need to better understand variations between cost estimates for the decommissioning of nuclear power plants, as well as the relationship between estimated and actual costs, and the apparent escalation of these costs. Building on previous work by the Nuclear Energy Agency, Cost Benchmarking for Nuclear Power Plant Decommissioning examines approaches and methods for the benchmarking of nuclear power plant decommissioning costs. Particular focus is given to identifying key factors, drivers and constraints to implementing cost benchmarking. These factors are addressed from a broad range of perspectives in order to develop a roadmap for implementation that will garner sufficiently broad support from a wide base of interested stakeholders. The report also identifies a number of perceived barriers that may impede the implementation of benchmarking for decommissioning. Co-ordinated efforts and further analysis will be needed to help remove these barriers.

NEA No. 7421. 180 pages.
Available online at: https://oe.cd/2Ph
Radioactive waste repositories are designed to isolate waste from the living environment without human intervention over extended periods of time. Nevertheless, the intention of building together, among truly interested parties, pipelines for testing, validation and qualification of technologies before these technologies become industrial products, ensuring that all stakeholders, in particular regulators, are involved from an early stage of the process. These pipelines have to be set up and themselves validated using a sample of the technology, selected together by all stakeholders. Once a pipeline is operational for a technology, industry may then use it for qualifying industry products, in a much more effective way than having to redo the full qualification process from scratch for each new product and for each separate country or market.

Nuclear Energy Data 2019/Données sur l’énergie nucléaire 2019
NEA No. 7474. 102 pages.
Available online at: http://oe.cd/nuclear-data-2019

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 2040, where available. Country reports summarise energy policies, updates of the status in nuclear energy programmes and fuel cycle developments. In 2018, 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. 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.

Nuclear Innovation 2050
An NEA initiative to accelerate R&D and market deployment of innovative nuclear fission technologies to contribute to a sustainable energy future
NEA No. 7472. 12 pages.
Available online at: https://oe.cd/2Qr

The central concept of N2050, beyond technology development aspects, consists...
is not to abandon the repositories, but to provide the oversight that is necessary to ensure that they are not forgotten by society. In response to this challenge, the Nuclear Energy Agency launched the international initiative “Preservation of Records, Knowledge and Memory (RK&M) Across Generations”. As a result, an in-depth understanding of this issue was developed, as well as a specific methodology to address it. The RK&M preservation toolbox, for example, offers a menu with 35 different preservation mechanisms and guidelines on how to combine and implement them.

This report may be used as a general guide to the RK&M preservation topic. It presents a historical review, addresses ethical considerations, analyses the fundamentals of RK&M preservation, outlines various mechanisms and indicates how to develop these mechanisms into a systemic RK&M preservation strategy. The report aims to inspire and assist a variety of actors so that they can discuss and develop national and repository-specific RK&M preservation strategies.

Preservation of Records, Knowledge and Memory (RK&M) Across Generations: Compiling a Set of Essential Records for a Radioactive Waste Repository
NEA No. 7423. 92 pages.
Available online at: https://oe.cd/2KP
Radioactive waste repositories are designed to be intrinsically safe in that they are not dependent on the presence or intervention of humans. In response to this challenge, the Nuclear Energy Agency initiated the Preservation of Records, Knowledge and Memory (RK&M) Across Generations Initiative, calling on the international community to help create an in-depth understanding of this issue was developed, as well as a specific methodology to address it. The RK&M preservation toolbox, for example, offers a menu with 35 different preservation mechanisms and guidelines on how to combine and implement them.

This report proposes and describes the concept of a Set of Essential Records (SER) as an important component of a RK&M preservation strategy. The SER is designed to be a compilation of actual records, selected because they would be required for future generations to understand the repository system and its performance, and to assist them in making informed decisions. The guidance set forward in this document is complemented by appendices, illustrating an example procedure for the selection of records to form part of the SER.

Radiological Protection and Human Aspects of Nuclear Safety
Challenges in Nuclear and Radiological Legacy Site Management
Towards a Common Regulatory Framework
NEA No. 7419. 156 pages.
Available online at: https://oe.cd/2Oq
Many countries are dealing with challenges stemming from nuclear and radiological sites. In particular, managing these sites in an open and transparent fashion while taking into account the views of all relevant stakeholders and building confidence in the solutions adopted is an ongoing challenge. This report provides information on the challenges and lessons learnt in legacy management and regulation based on practical experience documented in 13 case studies and site visits conducted by the OECD Nuclear Energy Agency. A preliminary framework for a stepwise process to help reach an accepted and sustainable end-state is proposed based on this experience. The complex challenges and interactions among stakeholders in progressing in a harmonised, step-by-step manner are also examined in depth. The report concludes with recommendations for future international collaborative work to improve and test the preliminary framework, and to examine and address the complexity of the relevant interactions.

Insights from Leaders in Nuclear Energy: Leadership for Safety
20 pages.
Available online at: https://oe.cd/2KR
Insights from Leaders in Nuclear Energy: Leadership for Safety
NEA No. 7424. 20 pages.
Available online at: https://oe.cd/2Qo
A mature and well-guided multi-stage approach to the validation of nuclear power plant control room designs has the potential to reduce the risks involved in the design process. Such an approach can also increase the effectiveness of, and efficiencies in, the validation process, as well as overall confidence in the results.

Challenges and lessons learnt in legacy management and regulation based on practical experience documented in 13 case studies and site visits conducted by the OECD Nuclear Energy Agency. A preliminary framework for a stepwise process to help reach an accepted and sustainable end-state is proposed based on this experience. The complex challenges and interactions among stakeholders in progressing in a harmonised, step-by-step manner are also examined in depth. The report concludes with recommendations for future international collaborative work to improve and test the preliminary framework, and to examine and address the complexity of the relevant interactions.

Nuclear science and the Data Bank
International Co-operation in Nuclear Data Evaluation
An Extended Summary of the Collaborative International Evaluated Nuclear Data Library Organisation (CIELO) Pilot Project
NEA No. 7498. 36 pages.
Available online at: https://oe.cd/nea-cielo
Current knowledge of the nuclear physics of fuels and materials provides an understanding and simulation of the operations of nuclear reactors and other systems, both under ordinary and exceptional circumstances. As part of a broad spectrum of collaborative activities underpinning research in basic nuclear...
sciences, the Nuclear Energy Agency is supporting collaboration between experimentalists, theoreticians and modelling experts to advance the state of the art in nuclear data.

This report offers an overview of collective results from 31 institutions in 15 NEA member countries, along with results from technical experts in the People’s Republic of China, in the context of the NEA Collaborative International Evaluated Library Organisation (CIELO) Pilot Project. It reviews recent developments resulting from new measurements and semi-empirical models, as well as the validation of the CIELO nuclear data evaluations against suites of systems representing a wide range of current and future nuclear facilities. The CIELO project has delivered new, evaluated data for the isotopes of uranium, plutonium, iron, oxygen and hydrogen, which have been adopted in all nuclear data libraries released since the CIELO project was completed.

The Criticality Safety Benchmark Evaluation Project (CSBEP) was initiated in 1992 by the United States Department of Energy. The project quickly became an international effort as scientists from other interested countries became involved. The International Criticality Safety Benchmark Evaluation Project (ICSBEP) became an official activity of the Nuclear Energy Agency (NEA) in 1995. This handbook contains criticality safety benchmark specifications that have been derived from experiments performed at critical facilities around the world. The benchmark specifications are intended for use by criticality safety engineers to validate calculation techniques used to establish minimum subcritical margins for operations with fissile material and to determine criticality alarm requirements and placement. Many of the specifications are also useful for nuclear data testing. Example calculations are presented; however, these do not constitute a validation of the codes or cross-section data. The evaluated criticality safety benchmark data in the 2019 edition are presented in nine volumes. These volumes span over 70,000 pages and contain 574 evaluations with benchmark specifications for 4,973 critical, near-critical or subcritical configurations, 45 criticality alarm placement/shielding configurations with multiple dose points for each, and 237 configurations which have been categorised as fundamental physics measurements that are relevant to criticality safety applications. New to the handbook are subcritical experiments with the Inherently Safe Subcritical Assembly (ISSA), carried out in the ISSA laboratory at Lawrence Livermore National Laboratory (LLNL) in the United States. A photograph of the core tank exterior is shown on the handbook cover. The 2019 edition is available online at: https://doi.org/10.1787/110ba6fc-en.

The 2019 edition of the International Handbook of Evaluated Reactor Physics Benchmark Experiments contains data from 166 experimental series that were performed at 56 nuclear facilities. A total of 162 of the 166 evaluations are published as approved benchmarks. The remaining four evaluations are published as draft documents only.

The cover of the handbook shows the graphite structural material from the Molten-Salt Reactor Experiment (MSRE) performed at Oak Ridge National Laboratory (ORNL), United States. Newly evaluated measurements from MSRE have been added to this edition of the handbook. The 2019 edition is available online at: https://doi.org/10.1787/8df549c0f-en.

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Commercial Nuclear Power Plants

Nuclear News has produced three updated wall maps that together show the location of every commercial power reactor around the world that is operable, under construction, or ordered. Each map includes a table that lists the generating capacity, design type, date of commercial operation (actual or expected), and reactor supplier of the reactors on that map.

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Actual map dimensions: 99.7 X 67.9cm. Map data valid as of 3/31/19. Note that U.S. nuclear power plants are shown on the U.S. map only, not on either of the worldwide maps.

*The Americas include Canada, Mexico, and South America, but not the United States.