Cooperation in Nuclear Power

(Updated January 2019)

- **The nuclear power industry is subject to various arrangements for cooperation among utilities, and internationally, among government and United Nations nuclear agencies.**
- **Since the Chernobyl accident the amount of technical assistance from the West for Eastern Bloc nuclear power operators has increased vastly.**
- **The World Association of Nuclear Operators is a particularly valuable means of international assistance.**

The principal flow of information in the nuclear power industry is among the staff of the about 450 power reactors operating in 31 countries. This is at a number of levels. Internationally, the World Association of Nuclear Operators (WANO) is the lead player, but among governments the UN's International Atomic Energy Agency (IAEA) is also vital. WANO was based on the US INPO model, though due to INPO operating in a single national regulatory, legal and economic environment, it has tighter sanctions than WANO.

National Cooperation

In the USA the **Institute of Nuclear Power Operations** (INPO), Atlanta, was established in 1979 soon after the Three Mile Island accident and has as its members all US utilities with nuclear power plants in operation or under construction. Its aim is self regulation and safety enhancement through plant evaluation by peer review, and it provided the model for development of WANO internationally. It is funded by the utilities. Among its activities are:

- Analysis of reported events and dissemination of the lessons learned.
- Promoting the exchange of information and good practices among all nuclear utilities.
- Benchmarking against international best practice.
- With industry, developing and monitoring a set of 10 performance indicators.
- Maintaining evaluation and peer review programs.

For instance, in relation to international benchmarking, in 1995 INPO took a team of 13 experts from US utilities to look at operational aspects of managing boiling water reactors in Finland and Spain, then generally considered the world's best performers. Partly as a result of INPO, the composite Performance Indicator Index for US nuclear power reactors rose steadily from 76% in 1998 to 92% in 2003 and has stayed at that level.

In testimony before the BP Deepwater Horizon Oil Spill and Offshore Drilling Commission in August 2010 the CEO of INPO said "that industry self-regulation has been one driving factor toward improved industry performance. In the early 1980s, the typical nuclear power plant had a capacity factor of 63 percent, experienced seven automatic shutdowns per year, and had collective radiation exposure levels that could be significantly reduced. Today, the typical plant has a 91 percent capacity factor with zero automatic shutdowns per year and an occupational radiation exposure about six times lower than in the 1980s."

INPO has a higher capacity for self-regulation than is possible internationally, as it deals with a single national regulator in one legal context and also draws upon the excellent nuclear safety culture long nurtured in the US Navy. Anything identified by peer review which is not acted upon in timely fashion is referred to the INPO governing body of all the utility CEOs. The strong peer pressure to maintain high standards is reinforced by INPO giving each plant a rating on one of four levels which directly affects insurance premiums. INPO has strong ties with WANO, acting as WANO representative on US soil, and its staff often have key positions as Team Leaders or Assistant Team Leaders in WANO peer reviews.

In Japan, the **Japan Nuclear Technology Institute** (JANTI) Safety Culture Division periodically organises peer reviews 'tailored to the corporate structure'. JANTI's Operating Experience Analysis Division collects and analyses operating experience information that was previously handled by the Central Research Institute of Electric Power Industry (CRIEPI). The Safety Culture Division cooperates with INPO and WANO. However, in 2012 JAIF announced the formation of a new operators' body modelled on INPO, with greater authority than JANTI, and working more closely with WANO.

International Cooperation – Industry

The most significant safety-related cooperation internationally is through the World Association of Nuclear Operators (WANO). This was formed over a couple of years following the Chernobyl accident to maximise the safety and reliability of nuclear plant operation. It held its inaugural meeting in Moscow in 1989. With regional centres in Atlanta, Moscow, Paris and Tokyo and a coordinating centre in London, WANO links all 115 operators of nuclear power plants in 34 countries. Today it also involves reactor designers and vendors, so that there is better feedback of experience.

WANO has four major programmes:

- peer reviews;
- operating experience;
- technical support and exchange; and
- professional and technical development.

WANO peer reviews are the main proactive way of sharing experience and expertise. They have been focused on operations, not the design (or siting) of power plants.

The exchange of information on operating experience is the basis of WANO's various programs. Information and event reports are submitted by each operating organisation to its regional centre where they are reviewed for clarity and completeness and then distributed to all WANO members using an international exchange system. If particular trends or concerns become evident a SOER (special operating event report) may be drawn up and circulated, and this has the force of a recommendation arising from peer review. For instance one was issued six days after the Fukushima accident, with detailed responses then received in the London office from every nuclear plant in the world (other than Fukushima) within two months.

WANO Event Reports
(for WANO members to exchange information)

Event Notification Reports
For reporting significant consequential events even if causes are not yet fully known, and where immediate action is required to avoid the same event occurring elsewhere.

Event Analysis Reports
For reporting significant consequential events once full analysis has been completed and consequences, together with direct and root causes, have been understood.

Event Topic Reports
For two or more events that contain a similar theme or problem areas. Prepared by members directly or by WANO regional centres.

Miscellaneous Event Reports
For events that do not meet the above criteria but which are likely to be of interest to other members.

One of WANO's first objectives was for operating staff from every nuclear plant in the former Soviet Union to visit plants in the West for technical exchange, and for personnel from the West to visit every plant in the former Soviet Union. This was accomplished in the first two years of WANO's existence. A great deal of ongoing plant-to-plant cooperation (twinning) grew out of these original exchange visits.

Since then WANO has fostered a voluntary peer review program, and by the end of 2009 a significant milestone had been reached, with every one of the world's commercial nuclear power plants having been peer-reviewed at least once. A key goal was to establish a system whereby every plant hosts an outside review of its performance every three years, and a full WANO peer review at least every six years, and preferably more often. These mainly focus on how a plant is operated but in 2011 their scope widened to include severe accident management/mitigation (SAM) guidelines and also some design matters, as outlined below. Peer reviews result in reports to the operator, and if these are not acted on, follow-up visits ensue with special reports, and ultimately if necessary confrontation with the utility's board.

In recent years WANO has introduced pre-startup reviews as part of its peer review programme, particularly to address the situation of new plants in countries and organisations without previous nuclear power experience. WANO performs a pre-startup review on all new units before initial criticality. In September 2012 WANO opened a dedicated office in Hong Kong so that a pre-startup review team could be based in the region with greatest construction activity. The reviews seek to evaluate how each operating organization is prepared for startup and make recommendations for improvements based on the collective experience of the world industry. The transition from a "construction mentality" to an "operations mentality" at a nuclear power plant is a delicate period, and many incidents occur during the early months of plant operation – both Three Mile Island 2 and Greifswald 5 were almost new units when accidents destroyed them. A new base in Shenzen, southern China, is being established as a world centre for pre-startup reviews.

In October 2011 members unanimously approved a series of recommendations from its post-Fukushima Commission, endorsed by its Board. These include changes to the core peer reviews, establishment of a worldwide integrated event response strategy, and extending the scope of reviews from operational safety to include plant design upgrades. They represented a shift from just accident prevention to prevention and mitigation. Peer reviews will now be every four years, with follow-up visits in between, and sanctions to apply for non-compliance. The extended role for WANO will require a near-tripling of staff for the organization's four regional centres and the London coordinating centre, from 0.3 person per reactor unit to 0.8 person/unit, and a corresponding funding increase (though WANO fees are still only about 5% of what a typical utility pays for insurance).

WANO said that Fukushima "was not a failure of WANO" but that the accident had identified "gaps" in its activities, and that the new measures "will close these gaps." WANO membership involves all of the world's nuclear power plant operators, as well as reactor vendors and other organisations involved with nuclear safety.

WANO also undertakes some corporate reviews on a peer basis.

A brief outline of WANO's *Principles for a Strong Safety Culture* is appended.

Parallel to WANO, the **World Institute for Nuclear Security** (WINS) was set up in 2008 as an independent not-for-profit foundation headquartered in Vienna. It aims to counter theft of nuclear materials and terrorism based on them by promoting best security practices and eliminating weak links in global security. It facilitates cooperation between organisations responsible for security at nuclear facilities worldwide, both private and government-owned. WINS aims to maintain the level of security awareness and preparedness which developed after the World Trade Centre attacks in 2001, and has been fostered by the head of the Nuclear Threat Initiative (NTI). There has been strong support from the US Department of Energy and close consultation with the IAEA. Security operators have a great deal in common at different plants and will benefit from enhanced communication in the same way as very many staff did as a result of the establishment of WANO two decades earlier. The initial focus of WINS is sites handling fissile materials.

A further nuclear industry initiative was announced in April 2010, when leaders of many of the industry's major companies affirmed their intent to back a collaborative effort to achieve greater international standardization in reactor design. The **Cooperation in Reactor Design Evaluation and Licensing (CORDEL)** expert working group was set up to promote the standardization of nuclear reactor designs. It reflects a broad consensus that increased standardization, which must necessarily be supported by international harmonization of regulatory requirements, will enable the nuclear industry to attain even higher levels of safety assurance in reactor operations while significantly lowering the cost of nuclear power. Gains in safety assurance and cost reduction will inevitably occur when feedback from worldwide nuclear operations is systematically focused on perfecting a small number of standard designs which have been certified and approved by a recognized competent authority in the country of origin. While the leaders acknowledged the sovereignty of national regulators and the important role of international standard-setting organizations, they pledged to engage with these nuclear authorities in a cooperative effort to achieve harmonization of regulatory requirements.

The CORDEL initiative arose out the **World Nuclear Association** (WNA) and reflected a commitment to supply the resources by which the industry will assemble its relevant expertise so as to contribute its best recommendations to a cooperative dialogue directed at the standardization goal. In 2014, CORDEL started implementing its Strategic Plan. This effort saw an increase in member participation both in the working group and in its numerous task forces. Key successes included issuance of a report by the Codes & Standards Task Force on *Certification of NDE Personnel* and an *Outlook Report* by the Digital I&C Task Force. Four other task forces are also active.

At the back end of the fuel cycle is the **International Association for the Environmentally Safe Disposal of Radioactive Materials** (EDRAM) which was founded in 1998 and has membership of 12 nuclear waste organizations from 11 nuclear power countries: Belgium, Canada, Finland, France, Germany (two members), Japan, Spain, Sweden, Switzerland, the USA and the UK. It is concerned to promote national repository projects ahead of regional or international ones.

In September 2011 the **world's reactor vendors** together set up a code of conduct to ensure best practice in the export of nuclear power plants, especially to countries that are embarking on their nuclear power programs. Twelve companies, embracing all current exporters of nuclear reactors, have signed up to the Nuclear Power Plant Exporters' Principles of Conduct expressing the expected standards for corporate self-management in that business. The six principles, which

incorporate recommended best practices in safety, security, environmental protection and spent fuel management, non-proliferation, business ethics and internationally recognized systems for compensation, are the culmination of a three-year-long drafting process. This was completed under the leadership of the Carnegie Endowment for International Peace. While conforming with the guidelines of the International Atomic Energy Agency (IAEA) and the Nuclear Suppliers Group, the principles were drawn up as a fully private enterprise initiative, without governmental or IAEA oversight.

An important international organisation which is not specifically nuclear is CIGRÉ, the International Council on Large Electric Systems (*Conseil International des Grands Réseaux Électriques*), with headquarters in Paris and founded there in 1921. It has members in 90 countries, and addresses the issues concerned with development, operation and management of electric power systems, including the design, construction, maintenance and disposal of equipment and plants.

INTERNATIONAL COOPERATION – UN, IAEA

The International Atomic Energy Agency (IAEA), headquartered in Vienna and with 126 member states, is the peak international organisation for the peaceful uses of nuclear energy and technology. The IAEA, set up in 1957, is an independent inter-governmental organisation within the United Nations system. The IAEA's areas of international cooperation cover all aspects of reactor operations, the nuclear fuel cycle, radioactive waste management, human health and radiation protection, and safeguards.

The IAEA **Convention on Nuclear Safety** (CNS) was drawn up during a series of expert level meetings from 1992 to 1994 and was the result of considerable work by governments, national nuclear safety authorities and the IAEA Secretariat. It came into force in 1996, and legally commits participating states operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which states subscribe.

The obligations of the parties are based to a large extent on the principles contained in the IAEA Safety Fundamentals document *The Safety of Nuclear Installations*. These obligations cover for instance, siting, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness. In 2017 for the first time all national reports on the implementation of these obligations, open to review by others among 81 contracting parties, were made publicly available.

The IAEA has a safety assessment review service which on request undertakes **technical safety reviews** (TSRs) in member states at all stages of development and deployment of nuclear power programs. The TSR is based on the IAEA Safety Standards and incorporates services dedicated to six specific areas.

The Convention is an incentive instrument. It is not designed to ensure fulfillment of obligations by parties through control and sanction, but is based on their common interest to achieve higher levels of safety. These levels are defined by international benchmarks developed and promoted through regular meetings of the parties. The convention obliges parties to report on the implementation of their obligations for international peer review. This mechanism is the main element of the convention. Under the **Operational Safety Review Team** (OSART) program dating from 1982 international teams of experts conduct in-depth reviews of operational safety performance at a nuclear power plant. They review emergency planning, safety culture, radiation protection, and other areas. OSART missions are on request from the government, and involve staff from regulators, in these respects differing from WANO peer reviews. Nearly 200 OSART missions had been completed by late in 2017. IAEA offers Pre-Operational Safety Review Teams (Pre-OSART) also, as part of the OSART programme.

Since 2006 the IAEA also has an **Integrated Regulatory Review Service** (IRRS) which leads peer review teams to similarly scrutinise the regulatory structures in particular countries, upon invitation from the government.

In 2009 the IAEA began offering **Integrated Nuclear Infrastructure Review** (INIR) missions to to evaluate the status of countries' nuclear infrastructure development, building on member states' self-evaluation. The first three were to Jordan, Indonesia and Vietnam. Over 25 INIRs have now been completed. In 2013 an INIR mission was to South Africa – the first country with an operating nuclear power program that has requested this service.

More broadly than these INIR missions are IAEA **Nuclear Energy System Assessments** (NESA), using the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) methodology to help countries develop long-term national nuclear energy strategies. The INPRO methodology identifies a set of Basic Principles, User Requirements, and Criteria in a hierarchical manner as the basis for the assessment of an innovative and sustainable nuclear system. The NESA program helps members "in gaining public acceptance, getting assistance in nuclear energy planning in their country, and increasing awareness of innovations in nuclear technologies". NESAs have been carried out in Belarus, Kazakhstan, Ukraine and Indonesia. (INPRO is described in the Governments section below.)

A recent IAEA safety initiative was the establishment in November 2016 of the **European and Central Asian Safety Network** (EuCAS Network), bringing together 20 member states and 22 organisations with a responsibility for nuclear safety. It operates within the framework of the Global Nuclear Safety and Security Network (GNSSN), set up to share information,

knowledge and experience among the global expert community. The EuCAS Network will initially address the management of radioactive wastes resulting from nuclear power plants and other nuclear applications.

IAEA **Site and External Events Design** (SEED) missions review the design and siting of nuclear plants against external hazards specific to the site. The program arose from the Fukushima accident and involves the IAEA's International Seismic Safety Centre (ISSC), which has conducted over 430 site external hazard evaluations since 1980.

Since 2007 the IAEA also undertakes **Safety Aspects for Long-Term Operation** (SALTO) peer-review missions on the request of operators. Evaluation of the potential for safe long-term operation is made on the basis of IAEA Safety Standards and guidelines. The approach is based on the OSART experience. By mid-2015, 22 SALTO missions (including eight pilot missions) had been conducted at 13 nuclear power plants.

Another IAEA instrument is the **Convention on the Physical Protection of Nuclear Materials** (CPPNM) of 1987, an amendment of which came into force in May 2016. The 1987 CPPNM covered the physical protection of nuclear materials used for peaceful purposes during international transport. The amendment broadens its scope to cover the protection of nuclear facilities or nuclear material in domestic use, storage and transport and makes it legally binding for states to establish, implement and maintain an appropriate physical protection regime applicable to nuclear material and nuclear facilities under their jurisdiction. Under the amendment, countries are required to establish appropriate physical protection regimes for nuclear material. They also take on new obligations to share information on sabotage and credible threats of sabotage.

The IAEA's **International Physical Protection Advisory Service** (IPPAS) conducts missions to provide "expert advice on the physical protection of nuclear and other radioactive material and associated facilities, and on implementing international nuclear security commitments." Since the programme began in 1995, IPPAS had completed 77 missions in 48 countries to late 2017, and since 2010 it had trained "more than 10,000 police, border guards and other officials in detecting and preventing the smuggling of nuclear and other radioactive materials."

The IAEA **Emergency Preparedness Review Service** (EPREV) is a service provided by the IAEA's Incident and Emergency Centre (IEC) to appraise the level of preparedness for nuclear or radiological emergencies in member states.

The IAEA has designated several international research hubs under the **International Centre based on Research Reactors** (ICERR) program launched in 2014. These include French CEA's nuclear research centres in Saclay and Cadarache, Russia's RIAR and Belgium's SCK-CEN. The ICERR program allows participating research reactors in its framework to coordinate and rationalize their offer of facilities, resources and services to interested IAEA member states.

An important IAEA initiative addresses **knowledge management** over the full life-cycle from design, through construction and operation to decommissioning for reactors and other facilities. This may span a century and involve several countries, and involve a succession of companies. Major changes may be made to the design over the life of the plant, so original documentation is not sufficient, and loss of design base knowledge can have huge implications (Pickering A and Bruce A in Ontario). Knowledge management is often a shared responsibility and is essential for effective decision-making and the achievement of plant safety and economics. The approach to engineering, assessment, licensing, and on-going maintenance of new build designs is a significant challenge today and will be even more so in the future.

In 2015 the IAEA and the UN Environment Program (UNEP) formally set up a practical arrangement for enhancing their cooperation. The areas of common interest between the two organizations include: climate science and climate change adaptation, ecosystem management, sustainable production and consumption, waste management and disposal, and scientific inputs to environmental policy-making.

Early Russian reactors – IAEA programs

In 1994 IAEA's International RBMK Safety Review Project brought together engineers and technicians from Russia, Ukraine, Lithuania and eight Western countries to focus on safety improvements for this type of reactor. *(See also information paper on the Chernobyl Accident.)*

The IAEA had similar programs for each model of Soviet-designed reactor up to about 2000. These initially identified design and operational weaknesses and prioritized safety improvements. Subsequent assistance is related to generic issues for each reactor type, plant-specific issues and training.

The IAEA's technical co-operation projects have created linkages with the European Commission (EC), the European Bank for Reconstruction and Development (EBRD), the OECD Nuclear Energy Agency and WANO to upgrade the safety of Soviet-designed reactors.

IAEA technical co-operation projects, especially those in eastern and central Europe, have focused mainly on enhancing national regulatory capability and improving plant safety. Under the Soviet Union almost all nuclear activities were handled by Russian experts. National regulators lacked both information and independence, while laws and regulations were

inadequate. Projects to strengthen regulation have been undertaken in Romania, Slovakia, Ukraine and Armenia.

In 1997 a maintenance training centre was opened at the Paks nuclear plant in Hungary, complete with all the key parts of the core area of a VVER 440/230 reactor. The project is particularly important because this early Soviet type was not designed for regular safety inspections or maintenance, and in earlier IAEA projects, remote control devices had to be used to reach inaccessible areas. The centre trains operators from several central and eastern European countries, as well as Hungary. It was funded by Hungary, with IAEA, Japan, USA and a number of European governments.

Low-enriched uranium reserve or 'nuclear fuel banks' under the IAEA

In 2006 a proposal was brought forward by a US organisation, the Nuclear Threat Initiative, for an international nuclear fuel bank under IAEA supervision. It would essentially take the form of supply guarantees based on a stockpile of low-enriched uranium managed by the IAEA. The NTI pledged $50 million towards setting it up, if others from around the world promised a further $100 million, or nuclear fuel of equivalent value. By March 2009, five international contributors responded, committing a total of $107 million among them: the European Union ($32 million), Norway ($5 million), the United Arab Emirates ($10 million), the USA ($50 million) and then Kuwait ($10 million). The NTI's pledge then came into effect, taking the overall sum to initiate the project to $157 million. In June 2015 the IAEA Board approved plans for the **IAEA LEU Bank** to be located at the Ulba Metallurgical Plant at Oskemen in northeast Kazakhstan which has 60 years' experience in handling UF_6. The 90 tonnes of LEU as UF_6 with a nominal enrichment of U-235 to 4.95% will be owned by the IAEA and the facility will be operated by Kazakhstan. A transit agreement with Russia for shipping LEU was also approved. Details in the Kazakhstan paper.

Parallel with this, in November 2009 the IAEA Board approved a Russian proposal to create an international guaranteed reserve or 'fuel bank' of low-enriched uranium under IAEA control at the IUEC at Angarsk. This was established a year later and comprises 123 tonnes of low-enriched uranium as UF6, enriched 2.0-4.95% U-235 (with 40t of latter), available to any IAEA member state in good standing which is unable to procure fuel for political reasons. It is fully funded by Russia, held under safeguards, and the fuel will be made available to IAEA at market rates, using a formula based on spot prices. Following an IAEA decision to allocate some of it, Rosatom will transport material to St Petersburg and transfer title to IAEA, which will then transfer ownership to the recipient.

A complementary initiative not directly under IAEA control is the American Assured Fuel Supply, comprising 230 tonnes LEU and guaranteeing supply to third parties in good standing with the IAEA under specified conditions. Details in US Nuclear Fuel Cycle paper.

International fuel cycle facilities under the IAEA

The International Uranium Enrichment Center (IUEC) concept was inaugurated at the end of 2006 in collaboration with Kazakhstan, and in March 2007 the IAEA agreed to continue developing the proposal. In September 2007 the joint stock company Angarsk International Uranium Enrichment Center (JSC Angarsk IUEC) was registered and a year later Rostechnadzor licensed the centre. National companies of Kazakhstan, Ukraine and Armenia each have 10% shares, the balance held by Tenex.

The IUEC is to provide assured supplies of low-enriched uranium for power reactors to new nuclear power states and those with small nuclear programmes, giving them equity in the project, but without allowing them access to the enrichment technology. Russia will maintain majority ownership. The IUEC will sell both enrichment services (SWU) and enriched uranium product. While the IUEC is established within the Angarsk complex, it can use capacities of the other three Russian enrichment plants to diversify production and optimize logistics.

Development of the IUEC was envisaged in three phases:

1. Use part of the existing capacity at Angarsk under IAEA supervision.
2. Expand Angarsk capacity (perhaps double) with funding from new partners by 2017.
3. Full internationalisation with involvement of many customer nations under IAEA auspices.

The IAEA envisages international reprocessing centres sometime in the future.

INTERNATIONAL COOPERATION – OECD

The OECD Nuclear Energy Agency (NEA), representing 33 countries with 84% of the world's nuclear capacity, assists member countries in developing the scientific, technological and legal bases required for the use of nuclear energy. It fosters a number of international collaborative programs, and produces many publications arising from these. The programs include:

- Costs of Decommissioning.

- Decommissioning and dismantling.
- Uranium resources (with the IAEA).
- Waste management, including the NEA Clay Club and NEA Salt Club (focused on repositories in clay and salt respectively).
- Operational safety.
- Nuclear law.
- Medical radioisotopes.

With the OECD International Energy Agency (IEA) it publishes the joint Nuclear Technology Roadmap.

In mid-2017 the NEA commenced a collaborative arrangement with the Electric Power Research Institute (EPRI) based in the USA.

INTERNATIONAL COOPERATION – GOVERNMENTS

Several important projects involve international collaboration at government level: the Generation IV International Forum (GIF), the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), the Global Nuclear Energy Partnership (GNEP) which in 2010 became the International Framework for Nuclear Energy Cooperation (IFNEC), and the Multinational Design Evaluation Program (MDEP). In addition there is the ITER project focused on nuclear fusion.

The **Generation IV International Forum (GIF)** is a US-led grouping set up in 2001 which has identified six reactor concepts for further investigation with a view to commercial deployment around 2030-2040. It is focused on new reactor technology. See information paper on Generation IV Nuclear Reactors.

The IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) is focused more on assessment methodology for developing country needs. It involves users as much a technology holders and has 39 countries including several which do not yet have nuclear power. INPRO supports countries as they develop long-range national nuclear energy strategies using INPRO's nuclear energy systems assessment (NESA) and the INPRO Methodology (see section on *INTERNATIONAL COOPERATION – UN* above). There are seven projects within INPRO which provide insights into various aspects of nuclear energy systems development – from infrastructure to economics, non-proliferation and safety. It is now funded through the IAEA budget.

Both these projects are aimed at enhancing safety, reducing capital costs, improving utilisation of natural resources, reducing wastes, and improving proliferation resistance and physical protection.

The **Global Nuclear Energy Partnership** (GNEP) initiated in 2006 was US-led and aimed to "work with other nations possessing advanced nuclear technologies to develop new proliferation-resistant recycling technologies in order to produce more energy, reduce waste and minimize proliferation concerns." Two technical elements of it were new reprocessing technologies which separate all transuranic elements together (and not reactor-grade plutonium on its own) and Advanced Burner (fast) Reactors (ABR) to consume the result of this while generating power. The main political aspects are restricting deployment of enrichment and reprocessing technologies outside the main nuclear countries. In mid 2010 this became the International Framework for Nuclear Energy Cooperation (IFNEC), a partnership of countries aiming to ensure that new nuclear in initiatives meet the highest standards of safety, security and non-proliferation.

Russia has made a corresponding proposal for a global network of fuel cycle facilities under UN oversight, in proposing the **International Fuel Cycle Centre** (INFCC) concept. These would include international uranium enrichment centres such as that being set up by Russia and Kazakhstan at Angarsk in Siberia (utilising one of its enrichment plants to be under international control), reprocessing and waste management centres, training centres and R&D centres.

This leads to consideration of **fuel leasing**, whereby a utility leases its fabricated fuel from a supplier, probably in another country, and after it has been used that supplier takes it back. This concept is not yet in use except for some very limited applications. The supplier would then add the leased used fuel to its own larger stocks to be stored for later disposal or reprocessing and recycling, in which case the valuable components would belong to the fuel supplier/leaser. Of all the nuclear suppliers, Russia has expressed the most support for fuel leasing and take-back. Russia's fuel supply contract with Iran involves leasing, and Iran is required to send the used fuel back to Russia. Current Russian law makes it possible for Russia to take back Russian-origin fuel without requiring return of the wastes, which appears to be the approach in the contract with Iran.

Related to both IFNEC and the Russian initiative is the question of **international guarantee of fuel supplies** for countries which do not have enrichment and related facilities, and which agree not to embark upon building them. The IAEA has taken a lead in asserting the need for this and is proposing to consult its member states and others on a possible new framework to set up a multilateral nuclear fuel supply assurance system. This could involve setting up virtual or actual fuel banks – as proposed by the USA and other countries – and/or international enrichment centres – as being undertaken by Russia. The IAEA is also assessing the technical, institutional and legal implications. Practical problems include how to assure supply of fabricated fuel assemblies, given problems of design and intellectual property rights.

The **Contact Expert Group** (CEG) was established in September 1995 by a group of interested countries and international organisations with the IAEA as its secretariat. Its aim is to enhance safety of waste management in Russia and to promote international co-operative efforts aimed at resolving radioactive waste management issues. Its members include Belgium, Finland, France, Germany, Norway, Russia, Sweden, UK, USA, European Union, as well as the International Institute for Applied Systems Analysis (IIASA), and the International Science and Technology Centre (ISTC), with Japan and the Nordic Environment Finance Corp as observers.

ISTC is an intergovernmental organisation based in Moscow, established in 1992 by the EU, Japan, Russia and the USA. It offers weapons scientists from CIS countries the chance to use their skills for peaceful purposes. Since 1992, other countries have joined including Norway, South Korea, Armenia, Belarus, Georgia, Kazakhstan and Kyrgyzstan. By the end of March 2001, the ISTC's programs had funded 1250 projects worth $335 million, providing grant payments to over 30,000 individuals.

In 1985 the OECD Nuclear Energy Agency set up an international Co-operative Program on Decommissioning nuclear facilities, and this has grown into a major success, sharing knowledge and experience.

INTERNATIONAL COOPERATION – REGULATORS

The Multinational Design Evaluation Programme (MDEP) was launched in 2006 by the US Nuclear Regulatory Commission (NRC) and the French Nuclear Safety Authority (ASN) to develop innovative approaches to leverage the resources and knowledge of national regulatory authorities reviewing new reactor designs. It is led by the OECD Nuclear Energy Agency and involves the IAEA and 16 countries. It aims to develop multinational regulatory standards for design of Generation IV reactors. The US NRC has proposed a three-stage process culminating in international design certification for new reactor types, notably Generation IV types. See also information paper on Generation IV Nuclear Reactors.

In North America the NRC has a series of cooperation agreements with the Canadian Nuclear Safety Commission (CNSC), including sharing classified information. The CNSC maintains similar agreements with nuclear regulators in many other countries, including Argentina, Australia, Brazil, China, Finland, France, Indonesia, Israel, Jordan, Romania, Russia, South Africa and the UK. Many of these extend to nuclear security, safeguards and non-proliferation matters.

INTERNATIONAL COOPERATION – RESEARCH

Several major research reactor programs have invited international participation, particularly in the light of international cooperation directed to Generation IV reactor designs and fuel cycles.

The European Sustainable Nuclear Industrial Initiative (ESNII), brings together industry and research partners in the development of Generation IV fast neutron reactor technology, as part of the EU's Strategic Energy Technology Plan (SET-Plan). ESNII was set up under the umbrella of the Sustainable Nuclear Energy Technology Platform (SNETP), formed in 2007 and bringing together more than 90 stakeholders involved in nuclear fission. A part of SNETP is the Nuclear Cogeneration Industrial Initiative (NC2I), focused on high-temperature reactors.

Belgium's SCK.CEN is planning to build the **MYRRHA** (Multipurpose Hybrid Research Reactor for High-tech Applications) research reactor at Mol. Initially it will be a 57 MWt accelerator-driven system (ADS), but later on it is intended to be run as a critical fast neutron facility, decoupling the accelerator and removing the spallation loop from the reactor core. Then MYRRHA (as a lead-bismuth cooled fast reactor – LFR) will be used for fuel research, for materials research for Generation IV reactors, and for the production of radioisotopes and doped silicon (an essential component of high-grade electronic circuits). It is envisaged as a partnership of Belgium, the European Union, the European Investment Bank and other partners, with 70% of the funding from EU countries under ESNII. Following an independent international evaluation, Belgium approved its 40% share of the funding in March 2010 – about €384 million. In October 2010 SCK-CEN signed two international agreements to collaborate on the Myrrha project. The first is with the China Academy of Sciences, since China sees Myrrha as a way forward in treating nuclear wastes. The second is with Kazatomprom and the Kazakh National Nuclear Centre (NNC). A reduced-power model, Guinevere, became operational at Mol in March 2010. (Details in Fast Reactors paper.)

In mid-2006 the French Atomic Energy Commission (CEA) was commissioned by the government to develop two types of fast neutron reactors which are essentially Generation IV designs: an improved version of the sodium-cooled type (SFR) which already has 45 reactor-years operational experience in France, and an innovative gas-cooled type. Both would have fuel recycling. The 600 MWe sodium-cooled prototype at Marcoule, **Astrid** (Advanced Sodium Technological Reactor for Industrial Demonstration), is a high priority in R&D on account of its actinide-burning potential. The CEA is seeking support under the EC's European Sustainable Nuclear Industrial Initiative and partnerships with Japan and China to develop Astrid, which will have great flexibility in breeding ratios. In May 2014 Japan committed to support Astrid development. In June 2018 the project was scaled down from 600 MWe to 100-200 MWe. **Allegro** is the second line of French-led FNR development – also an EU Euratom project under ESNII. This is a gas-cooled fast reactor (GFR). A 50-100 MWt experimental version is envisaged by about 2025. (Details in Fast Reactors information paper.)

At Russia's Research Institute of Atomic Reactors (RIAR or NIIAR) in Dimitrovgrad, Rosatom is setting up an International Research Centre (IRC) based on its planned **multi-purpose fast neutron research reactor (MBIR)** and is inviting international participation. The full MBIR research complex is now budgeted at $1 billion, with the Russian budget already having provided $300 million from the federal target program. Pre-construction shares of 1% are being offered for $10 million, allowing involvement in detailed design of irradiation facilities. RIAR will be the legal owner of MBIR, performing operational and administrative functions, while the International Research Centre will be the legal entity responsible for marketing and research management.

At the Shanghai Institute of Nuclear Applied Physics (SINAP, under the China Academy of Science) the **thorium-breeding molten-salt reactors** (TMSR) Research Centre has a 5 MW solid-fuel MSR prototype under construction. This is also known as the fluoride salt-cooled high-temperature reactor (FHR) in Generation IV parlance, or Advanced HTR (AHTR). The US Department of Energy (especially Oak Ridge NL) is collaborating with the Academy on the program, which had a start-up budget of $350 million.

The Nuclear Power Institute of China (NPIC) has an agreement with Candu Energy (Canada), the Third Qinshan Nuclear Power Company (TQNPC), and China North Nuclear Fuel Corporation to develop technology for recycling uranium recovered from used nuclear fuel from other Chinese reactors (PWRs) with up to 1.6% fissile content for use in the Qinshan Phase III Candu units. In 2012 this focused on undertaking a detailed conceptual design of the **Advanced Fuel Candu Reactor** (AFCR), which is described as "a further evolution of the successful Candu 6 and Generation III Enhanced Candu 6 (EC6), optimized for use of recycled uranium and thorium fuel." At the completion of the agreement in 2014, the parties "expect to have the basis of a pre-project agreement for two AFCR units in China, including site allocation and the definition of the licensing basis." A July 2009 agreement among these four parties is to jointly develop and demonstrate the **use of thorium fuel** and to study the commercial and technical feasibility of its full-scale use in Candu units such as at Qinshan.

INTERNATIONAL COOPERATION – BRICS

International cooperation not fitting other categories is that among five major national economies – Brazil, Russia, India, China and South Africa (BRICS). This has a nuclear energy component.

INTERNATIONAL COOPERATION – NATIONAL-BASED

The **Agency France Nuclear International (AFNI)** under the French Atomic Energy Commission (CEA) provides a vehicle for international assistance. Its purpose is to help to set up structures and systems to enable the establishment of civil nuclear programs in countries wanting to develop them and will draw on all of France's expertise in this. It is guided by a steering committee comprising representatives of all the ministries involved (Energy, Foreign affairs, Industry, Research, etc) as well as representatives of other major French nuclear institutions including the CEA itself. Its work will be confined to countries with which France has signed a nuclear cooperation agreement. It will function on a fee for service basis.

The JAIF International Cooperation Center (JICC) was established by the Japan Atomic Industrial Forum (JAIF) in March 2009 to provide a one-stop service to countries planning to introduce nuclear power, primarily to help them develop their infrastructure in such area as human resources, financing and legal structures. JICC provides cooperation and assistance, supported by government subsidies, to countries that have concluded agreements with the Japanese government on cooperation in the nuclear area. As of fiscal 2009, those countries are Vietnam, Indonesia, the United Arab Emirates and Kazakhstan. JICC coordinates the integrated efforts taken by the Japanese government, industry, and academic world toward that end.

EUROPEAN COOPERATION – GOVERNMENTS

Cooperation within Europe and between Europe and third countries operates at several different levels. The European Atomic Energy Community (**EURATOM**), was established by one of the Treaties of Rome in 1958 to form a common market for the development of the peaceful uses of atomic energy. It initially comprised Belgium, France, West Germany, Italy, Luxembourg, and The Netherlands at a time when energy security was a prime concern. The Treaty originally envisaged common EU ownership of nuclear materials. Politically it was both a counter to US dominance and a means of cooperation with the USA by providing guarantees of peaceful use, being the basis of the first multilateral safeguards system. It now includes all European Union (EU) members. The former East Germany was admitted as part of reunified Germany in 1990.

The Euratom Treaty provided a stable legal framework that encouraged the growth and development of the nuclear industry while enhancing security of fuel supply for it and nuclear plant safety. It covers all civil nuclear activities in the European Union and aims to provide a common market in nuclear materials, to ensure nuclear fuel supplies, and to guarantee that nuclear materials are not diverted from their intended purpose.

Euratom has signed bilateral co-operation agreements to ease trade with its major partners. It also operates a comprehensive regional system of safeguards designed to ensure that materials declared for peaceful use are not diverted to military use. Today Euratom in its own right is a member of the Generation IV International Forum and the ITER

consortium building a fusion reactor. It has remained substantially unchanged and is largely independent of EU parliament's control – a major point of criticism of it.

In March 2013, 12 EU states joined together to **promote the role of nuclear energy** in the EU's energy mix. The countries that signed the agreement are the UK, Bulgaria, Czech Republic, Finland, France, Hungary, Lithuania, the Netherlands, Poland, Romania, Slovakia and Spain. The Czech Republic will coordinate of this group. A joint statement said that they are "committed to collaboration on safety and creating greater certainty for investors in low-carbon infrastructure projects." They pledged to press ahead with the deployment of low-carbon technologies, including nuclear power, renewable energy, and carbon capture and storage. In addition to the joint statement, the UK and France pledged to invest GBP12.5 million in funding for the 100 MWt Jules Horowitz research reactor being built in France. This is a EUR 500 million project, half funded by France's CEA and 20% by EU research institutes.

In Eastern Europe, consideration of future options involves the contiguous Visegrad group (V4) countries – Poland, Slovakia, the Czech Republic and Hungary – which are cooperating closely on nuclear power issues, including in research into future reactor designs and infrastructure development. Cooperation occurs on the back end of the fuel cycle, with Czech Republic and Slovakia signing an agreement in mid-2018 on disposal of used fuel and the eventual creation of seperate spent fuel repositories. They are all keen to reduce reliance on Russian gas imports. The Visegrad alliance was established in 1991 and its members became part of the EU in 2004, though the name reflects a similar alliance from 1335 set up in the Hungarian town of that name.

The EU's **Sustainable Nuclear Energy Technology Platform** (SNETP) agreed by member countries, is structured around three main pillars:

- NUGENIA, an association coordinating R&D supporting safe, reliable, and competitive Gen II and Gen III nuclear systems, with France's IRSN in a significant role.
- The Nuclear Cogeneration Industrial Initiative (NC2I) for the low-carbon cogeneration of process heat and electricity based on nuclear energy.
- The European Sustainable Nuclear Industrial Initiative (ESNII) which promotes advanced fast reactors with the objective of resource preservation, plutonium management, and minimizing the burden of radioactive wastes. ESNII is focused on three technology streams: SFR Astrid, LFR Myrrha and Alfred, and GFR Allegro (see Fast Reactors paper).

Energy co-operation and integration of energy networks is developing rapidly, both within the EU and between East and West Europe. The framework for such developments includes the **European Energy Charter**, the Energy Charter Treaty (ECT), and the Trans-European Energy Networks (TENs). The Synergy program governs the Community's general energy relations with third countries.

In 1991 EDF from France, Nuclear Electric from UK, UNESA from Spain, Vereiningung Deutscher Elektrizitäteverke from Germany and Tractebel from Belgium started a collaboration to produce standardised European Utility Requirements for light water reactors. The EUR organisation today includes 17 European utilities that might build new Generation III plants in the future (CEZ, EDF Energy, EDF, Endesa, EnergoAtom, Fortum, Gen Energija, Iberdola, MVM, NRG, RosEnergoAtom, SOGIN, Swissnuclear, GDF-Suez/Tractebel Engineering, TVO, Vattenfall, VGB Powertech). The specified common requirements serve as an important guide within Europe and beyond.

EUROPEAN COOPERATION – REGULATORS

While there is no formal wide international cooperation among nuclear regulators, within Europe two organisations promote this.

The **Western European Nuclear Regulators' Association** (WENRA) is an influential network of Chief Regulators of EU countries with nuclear power plants and Switzerland, with membership from 18 countries. In March 2015 the State Nuclear Regulatory Inspectorate of Ukraine was accepted as a member. Other interested European countries including Poland and Belarus have observer status, and in 2016 Japan joined them. WENRA was formed in 1999 and has played a major role in coordinating safety standards across Europe including significant involvement in Eastern Europe. It is seeking increasing engagement with regulators in Armenia, Ukraine and Russia. Its safety objectives have been used in the UK for evaluating the EPR and in France for ATMEA1.

In Europe, six national agencies from the European Community have combined to form a group to assist Eastern European countries with radioactive waste management.

The **European Nuclear Safety Regulators Group** (ENSREG) is an independent, authoritative expert body created in 2007 by the European Commission to revive the EU nuclear safety directive, which was passed in June 2009. It comprises senior officials from the national nuclear safety, radioactive waste safety or radiation protection regulatory authorities from all 27

EU member states, and representatives of the European Commission. Its role is to help to establish the conditions for continuous improvement and to reach a common understanding in the areas of nuclear safety and radioactive waste management. It continues to make recommendations to and through the European Commission.

The national progress reports on European stress tests in 2011 are published by ENSREG.

Early in 2010 four national technical safety organizations set up a European Nuclear Safety Training and Tutoring Institute (ENSTTI) to help strengthen European research and assessment in the fields of nuclear safety and radiation protection. The institute is a joint initiative of France's Institut de Radioprotection et de Sûreté Nucléaire (Institute for Radiological Protection and Nuclear Safety, IRSN); Germany's Gesellschaft für Anlagen- und Reaktorsicherheit (GRS); the Nuclear Research Institute Rez (UJV) of the Czech Republic; and the Lithuanian Energy Institute (LEI).

Also in Europe the Heads of the European Radiological Protection Competent Authorities (HERCA) are working to improve cross-border communication among European nuclear regulators in the event of a major accident. HERCA works closely with WENRA.

OTHER REGIONAL COOPERATION

Fifteen countries in **Central and South America** cooperate under the Regional Cooperative Arrangement for the Promotion of Nuclear Science and Technology in Latin America (ARCAL) in activities related, among other, to the use of research reactors, nuclear techniques in agriculture and activities on food irradiation.

Since it was established in 1972, fifteen countries in the **Asia Pacific Region**, including Australia, have cooperated under the Regional Cooperative Agreement for Research, Development, and Training related to Nuclear Science and Technology. Over the past two decades RCA activities have covered agriculture, industry, medicine, radiation protection and basic nuclear science. In 1987, the programme's scope was enlarged by the start of a project on energy and nuclear power planning.

Japan, South Korea and China have agreed to form a network to cooperate on nuclear safety and quickly exchange information in nuclear emergencies, especially those rating at level 2 or above on the International Nuclear Event Scale. At a meeting of nuclear regulators and other experts in Guangdong in December 2013, a framework was agreed, despite regional tensions. In addition to exchanging information on civil nuclear accidents, the three countries will share standard information such as safety plans. The agreement was signed by officials from Japan's Nuclear Regulation Authority (NRA), South Korea's Nuclear Safety and Security Commission (NSSC) and China's National Nuclear Safety Administration (NNSA). Ministerial-level discussions in Seoul in September 2014 among the three countries focused on creation of a three-nation nuclear cooperation body modelled on Euratom.

The Arab Atomic Energy Agency is an **Arab League** organisation concerned with nuclear science and its application, as well as the introduction of nuclear power to Arab countries.

The African Union established the **African Commission on Nuclear Energy** (AFCONE) in November 2010, following the entry into force of the African Nuclear-Weapon-Free Zone Treaty in July 2009, which required the parties to establish a commission for the purpose of ensuring states' compliance with their treaty obligations and promoting peaceful nuclear cooperation, both regionally and internationally. AFCONE became fully operational in July 2012 after the commissioners adopted the rules of procedure, structure, work program of work and budget. The commission will focus on four areas: monitoring of compliance with non-proliferation obligations; nuclear and radiation safety and security; nuclear sciences and applications; and partnerships and technical cooperation, including outreach and promotion of peaceful uses of nuclear energy. The budget is about $800,000 per year for the period 2012-2014, with a scale of assessment for contributions. A key role is to promote nuclear science and applications. The South African government and the African Union have finalized a hosting agreement, under which South Africa will provide AFCONE with office space and equipment in Pretoria.

The **Forum of Nuclear Regulatory Bodies in Africa** was set up under the African Union, involving 30 national authorities, as a result of the 1996 Pelindaba Treaty, and in 2013 it formalised collaboration with the IAEA. FNRBA has the goal of enabling member countries to improve nuclear regulation, by dealing with outdated practices, gaps in legislation, gaps in compliance, and ensuring adequate regulatory independence. Apart from Koeberg NPP in South Africa, there are eight research reactors across the continent and major uranium mining operations. Radioactive sources are increasingly used for science, agriculture, industry, water management and health care.

In East Asia the **Regional Seminar on Nuclear Security, Safety and Safeguards (3S)** is directed at assisting countries considering nuclear power. It is sponsored by the IAEA and Japan's Ministry of Foreign Affairs.

The **Arctic Military Cooperation Program** (AMEC) is a trilateral cooperative effort including the US, Norway and Russia, launched in 1996. It addresses radioactive waste in the Arctic, the decommissioning of nuclear-powered submarines, and the role of environmental risk assessments. This appears to have been superseded by bilateral Russia-Norway programs, in particular a new five-year one from 2006.

Several of the IAEA programs described above are, effectively, regional programs.

BILATERAL COOPERATION

In May 2007 a memorandum of understanding between China's National Nuclear Safety Administration and the US Nuclear Regulatory Commission was signed regarding Westinghouse's AP1000 reactor design. The AP1000 gained US design certification in 2005 and Westinghouse has applied for pre-licensing design approval for it in UK, expressing its policy of global standardisation. (See also MDEP above, re broader collaboration based on new designs.)

Typical of country-to-country cooperation is US assistance to Ukraine. This deals with nuclear plant licensing, operational safety analyses, the development of supervisory inspection procedures, radioactive waste and spent fuel management, the safe transport of radioactive materials and the medical and industrial use of radioisotopes.

A US DOE team worked at Chernobyl on a long-term project to improve operating safety. The DOE also set up training centres equipped with simulators for the most modern Russian reactor designs both in Ukraine and Russia.

The USA has provided funding to Russia through a number of other initiatives over the past decade which have generally proved successful. Since the early 1990s, efforts have focused on protection, control, and accounting of nuclear materials. This began in 1992 as the Government-to-Government Program, part of the Department of Defense Cooperative Threat Reduction (CTR) initiative. In 1994, DOE launched a separate, parallel effort, then in 1997 DOE consolidated these programs into the Material Protection, Control & Accounting (MPC&A) Program.

The Nuclear Cities Initiative (NCI), established by a US-Russian agreement in 1998, aims to promote military conversion projects in **Russia's Nuclear Cities**. It rests on cooperation between the US National Nuclear Security Administration and Russia's Nuclear Energy Ministry (Minatom). Steps are now under way to set up a European Nuclear Cities Initiative (ENCI) to help commercialise technologies developed in the nuclear cities. An International Working Group (IWG) is being established for this initiative, supported primarily by the EU. It is seen as a complementary and synergetic program with ISTC and the US initiatives.

In addition, some Russian institutes and other organisations have close links with similar US bodies through the Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM) set up in 1990. This was based on a Memorandum of Co-operation between the US DOE and Minatom. Its purpose is to co-ordinate collaborative projects between Russian academic and governmental laboratories and the US National Laboratories on nuclear waste management and disposition. The DOE also cooperates with the Russian Academy of Sciences through the Joint Coordinating Committee on Science and Technology Cooperation (JCC).

France is cooperating with Bulgaria on nuclear power safety and radiation surveillance; with Pakistan on nuclear technology in agriculture, medicine, the environment, industry, and radiation protection; and with Ukraine in nuclear fuel cycle and waste treatment techniques.

Japan has previously trained key nuclear power personnel from Russia, Ukraine, Bulgaria, Hungary and the Czech Republic and Slovakia in all aspects of nuclear safety.

Elsewhere, Finland is cooperating with Russia on nuclear fire safety; Sweden with Lithuania on radioactive waste disposal; and Australia (ANSTO) with the former East Germany on the clean-up of uranium mining operations.

Under the auspices of WANO and the EU Technical Assistance program, seven major west European utilities have focused efforts on assisting ten particular plants, mostly operating VVER reactors, in eastern Europe: RWE (Germany) with Balakovo (Russia), Tractabel (Belgium) with Kalinin (Russia), EdF (France) with Kola (Russia) and Rovno (Ukraine), Magnox Electric (UK) with Leningrad (Russia), British Energy (UK) with Smolensk (Russia), DTN (Spain) with South Ukraine, and GKN (Germany) with Zaporozhe (Ukraine). In addition NERSA (France) assisted Beloyarsk (Russia) and formerly also Aktau (Kazakhstan) – both had fast neutron reactors.

At the level of utility-to-utility cooperation many reactors in the west have 'twinned' with nuclear plants in central Europe, Russia and the newly independent states.

Typical is the cooperation of the Bugey plant in France with the Zaporozhe plant in Ukraine, where the main areas of cooperation are station organisational structures, safety during operation, shut-down and refuelling, and maintenance.

In 1992 German utility operators launched a twinning program with VVER plants in Eastern Europe, and this grew to 16 twinnings, with many exchange visits.

FUNDING SAFETY IMPROVEMENTS

The **European Bank for Reconstruction and Development** (EBRD) was founded in 1991 to be an international development bank for former communist countries, though its remit was extended to Turkey in 2009 and some MENA countries in 2012. It administers three funds for nuclear safety on behalf of the G24 countries and the EU for which EUR 1.5 billion has been

pledged: the Nuclear Safety Account (NSA); the International Decommissioning Support Funds (IDSFs) for Bulgaria, Lithuania and the Slovak Republic; and the Chernobyl Shelter Fund (CSF). The EBRD provides technical, financial, legal and administrative services.

At their Munich Summit in July 1992, the G7 countries initiated a multilateral program of action to improve nuclear power plant safety in Eastern Europe. In February 1993 the G7 officially proposed that the EBRD set up a Nuclear Safety Account, to receive contributions by donor countries to be used for grants for safety projects. The first four projects financed safety upgrades for Bulgaria's Kozloduy plant, Lithuania's Ignalina plant, Russia's Leningrad, Novovoronezh and Kola plants and for Chernobyl in Ukraine.

In November 2013 the European Parliament backed a €631 million program over 2014-20 to support nuclear safety in countries aspiring to join the EU, or in neighbouring EU countries. This continues from a similar 2007-13 program.

Euratom has a loan facility which has been used for safety upgrades in Central and Eastern Europe such as upgrading of Kozloduy 5&6 in Bulgaria, the upgrading of Khmelnitski 2 and Rovno 4 in Ukraine and also the completion of Cernavoda 2 in Romania.

The Nuclear Safety Assistance Coordination Centre database lists Western aid totalling almost US$1 billion to more than 700 safety-related projects in former Eastern Bloc countries.

The EU also supports nuclear safety through various agencies and programmes such the TACIS (CIS states) and PHARE (East Europe including the Baltic states) programs and various funds. In addition, the European Investment Bank (EIB), the financing arm of the EU, administers a US $1.4 billion long term loan facility loan facility for Euratom to fund nuclear safety projects in eastern Europe, in particular those related to later-model VVER reactors. Further funding comes from the European Commission's Directorate General for Transport and Energy which also has a direct responsibility for nuclear safety.

The US Export-Import Bank guaranteed a US $317 million loan to the Czech utility CEZ for Westinghouse to help upgrade and complete two late-model VVER reactors at the Temelin plant. The original instrumentation and control systems were scrapped and replaced by up to date Western digital versions.

NUCLEAR LIABILITY

The lack of adequate third-party liability protection has impeded implementation of technical improvements to Soviet-designed reactors in some countries. Western contractors and suppliers feared they would be held liable in the event of an accident.

The key legislation here includes the Vienna Convention on Civil Liability for Nuclear Damage of 1963 and the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960 which entered into force in 1968 and was bolstered by the Brussels Supplementary Convention in 1963. Vienna and Paris/Brussels Conventions were linked by the Joint Protocol adopted in 1988. In September 1997, further improvements were made when delegates from over 80 states adopted a Protocol to Amend the Vienna Convention and also adopted a Convention on Supplementary Compensation for Nuclear Damage. (See also paper Liability for Nuclear Accidents.)

All the states of Eastern Europe and the former USSR with nuclear facilities have now signed the Vienna Convention except Kazakhstan. However Russia did not ratify until 2005, and Ukraine did not become a party until 1996. This had the effect of delaying delivery of some Western equipment supplied under assistance agreements to these countries. Supplier concern extended to neighbouring states such as the Baltics and Belarus which could also be affected and claim compensation. Latvia was the last Baltic state to accede in 1995 but Belarus did not become a party until 1998. Most west European countries are party to the Paris Convention.

For status of Vienna Convention see: http://www.iaea.org/Publications/Documents/Conventions/liability_status.pdf
Paris Convention: http://www.nea.fr/html/law/paris-convention-ratification.html
Brussels Supplementary Convention: http://www.nea.fr/html/law/brussels-convention-ratification.html
Joint Protocol: http://www.iaea.org/Publications/Documents/Conventions/jointprot_status.pdf

Appendix

WANO: Principles for a Strong Safety Culture

1. Everyone is personally responsible for nuclear safety.
Responsibility and authority are well-defined, corporate policies and structures reinforce safety.

2. Leaders demonstrate commitment to safety.
This needs to be consistent in word and action.

3. Trust permeates the organization.
This is fostered by timely communication where issues are raised and addressed. Employees are expected to speak up.

4. Decision-making reflects safety first.
Operators are given authority to place safety as a prime priority, and leaders reinforce conservative decision-making.

5. Nuclear technology is recognised as special and unique.
In particular, reactivity control, continuity of core cooling and integrity of fission product barriers are understood.

6. A questioning attitude is cultivated.
Individuals are encouraged to challenge assumptions, investigate anomalies and consider possible adverse consequences of actions.

7. Organisational learning is embraced.
Operating experience is highly valued, and learned from.

8. Nuclear safety undergoes constant examination.
Assessment and review is vital.

Notes & references

General sources

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