IAEA Coordinated Research Activities in 2015

I. General Information

I.1. Statutory Provisions

The International Atomic Energy Agency (IAEA) is authorized under its Statute to encourage and assist research on atomic energy for peaceful uses throughout the world as well as on its development and practical applications. The IAEA's programme and budget for 2015 accordingly provide for the placing of research, technical and doctoral contracts and research agreements with universities, colleges, research centres, and laboratories, and other institutions in Member States on subjects directly related to the IAEA's work.

I.2. Financial Support

The IAEA's financial support of a project is normally in the form of a lump-sum cost-sharing contract. The Contractor is usually expected to bear part of the cost of the project and, in any case, to continue to make normal contributions covering overheads and other expenses, while the IAEA contributes an appropriate percentage of the total estimated costs. Owing to the limited resources available, the amounts awarded are rarely large — the present average being approximately €6000 per annum per contract. Larger awards may, however, be considered. In addition to the contract award, Contractors participating in IAEA coordinated research projects (CRPs) are invited to attend periodic Research Coordination Meetings (RCMs) at the IAEA's expense.

Agreements may be awarded to institutes, normally in developed countries, for participation in an IAEA CRP. Under such agreements, no financial award is made to the agreement holder other than the provision to attend RCMs at the IAEA's expense.

I.3. Selection of Institution

The IAEA selects the institutions to which research contracts and agreements will be awarded. When a specific proposal for research is made by an institution in a Member State, the decision to award a research contract or agreement is made after careful consideration of the technical merits of the proposal, the compatibility of the project with the IAEA's own functions and approved programmes, the availability of appropriate facilities and personnel in the institution and previous research work related to the project.

Additionally, where it is recognized that the award of a particular research or technical contract or research agreement would materially assist one of the IAEA's programmes, an invitation is sent to those institutes believed to have the necessary facilities and personnel, and the Government of the Member State concerned is kept informed.

In providing research support from the limited funds available, priority is normally given to proposals received from institutions in developing Member States and to qualified young and female researchers.

I.4. Formal Submission of Proposals

Based either on a proposal made by the IAEA, or a proposal developed at a research institute, a formal submission of a project proposal should be made by the institute concerned, and **submitted directly to the IAEA's Research Contracts Administration Section**.

If the proposed project is approved, a contract or agreement will be sent to the head of the institution for approval and signature, and the Government of the Member State will be duly notified through the appropriate channels of the conclusion of the contract or agreement. For all research contract proposals, the "Proposal for Research Contract" form N-18/Rev.16 (Dec.14) must be used. Proposals for research agreements should be made on the "Proposal for Research Agreement" form N-21/Rev.15 (Dec.14). These forms are available on the IAEA Coordinated Research Activities website: **http://cra.iaea.org**.

II. General Conditions of Contracts and Agreements

II.1. Period of Contract or Agreement

All research contracts are normally awarded for a period of one year and may be renewed each year for the duration of the project. Research agreements are awarded for the duration of the CRP.

II.2. Reports

Each Contractor must submit a final report at the end of the contract. If a contract is renewed, the requirement for a final report is waived until the end of the final year of the contract. However, a progress report must accompany each renewal application. Agreement holders must submit a report at each meeting of the CRP.

II.3. Conditions of Payment under Contracts

The timetable of the IAEA's payments is established when the contract is negotiated. Cash payments are normally made to the Contractor for expenses covered under the contract, except in cases where the IAEA is requested to procure equipment or other project-related supplies on behalf of the Contractor. In such cases, the portion of the total amount designated for equipment and supplies is withheld.

Payment is normally made in two equal instalments, the first being made at the start of the contract and the second upon the successful completion of the work envisaged in the contract. If the contract is renewed, one half of the amount is normally paid at the start of the contract renewal and the second half upon the successful completion of the work envisaged under that contract. Under contracts providing for purchase of equipment by the IAEA on behalf of the Contractor, only one cash payment will be made at the start of the contract. Second and final cash payments for each contract or renewal are made upon receipt of a satisfactory progress or final report evaluated positively by the IAEA. Funds awarded under research contracts will remain available for three years (the year in which the contract was awarded, plus two further years). All efforts should be made to submit the required reports in a timely manner.

II.4. Publication of Results and Patent Rights

Publication, either by the institution or the IAEA, of the results of work performed under research contracts and agreements is recognized as being normally the most appropriate and effective way of bringing these results to the notice of other scientists. The Contractor must acknowledge the IAEA's support of the work in any publication. Appropriate provision for patent rights is also made in the contract/agreement.

II.5. Provision of Equipment

The Contractor may wish to use a portion of the funds provided by the IAEA for the purchase of equipment required in connection with the contract. Only items relating to the project concerned can be purchased from the funds provided by the IAEA. These items can be purchased directly by the Contractor or, upon request, the procurement of equipment items can be arranged by the IAEA in cases where this expedites their supply. Funds reserved for the purchase of project-related supplies and equipment by the IAEA on behalf of the Contractor are transferred to a Trust Fund in which they remain until all foreseen purchases are made. No orders for supplies or equipment will be made by the IAEA after the contract is terminated.

II.6. Other Provisions

Each contract/agreement provides that the IAEA shall not be liable for any death, injury or damage arising out of the implementation of the research project; as a rule, a clause is included requiring the Contractor or agreement holder to hold the IAEA harmless from any damage suits. Provision is also made for the settlement of disputes, usually by arbitration, and for the adoption by the Contractor of the applicable health, safety and other standards.

III. IAEA Coordinated Research Projects for Which Research May be Supported in 2015

Most of the research supported by the IAEA is related to its CRPs developed in line with overall IAEA goals. Only in exceptional cases will research contract funds be used to finance individual contract proposals that, while not forming part of a CRP, deal with topics covered by the IAEA's programme. The following list includes CRPs under which the IAEA may consider support of research in 2015. Additionally, the Coordinated Research Activities website: **http://cra.iaea.org** will list new CRPs which have received approval and those for which proposals are solicited.

All proposals will be carefully considered. Enquiries concerning specific CRPs should be addressed to the IAEA's Research Contracts Administration Section, Email: **research.contracts@iaea.org**.

List of IAEA Coordinated Research Activities That Are Open for Submission of Proposals in 2015

(by Major Programme, Programme and Project)

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[1] AIPS: Agency-wide Information System for Programme Support.
[2] AP: IAEA Action Plan on Nuclear Safety.

[3] SIT: sterile insect technique.

Major Programme 1: Nuclear Power, Fuel Cycle and Nuclear Science	
1.1 Nuclear Power	
Project 1000145	**1.1.1.001 Engineering Support for Operating Nuclear Facilities**
CRP Title:	**Application of Wireless Technologies in Nuclear Power Plant Instrumentation and Control Systems**
CRP Code:	**I31028**
Wireless technology provides excellent solutions to the problem of the high cost of industrial wiring and also provides a convenient and fast way to the installation of temporary instrumentation to monitor the health of selected plant equipment. The potential cost reduction of avoiding wire/cable installation and maintenance is creating an expanding market for wireless applications. Low power consumption, battery operated devices can avoid the need for power supply cables as well as communications cables. The CRP will focus on resolving problems with the operation of wireless systems in the electrically noisy environment of a nuclear power plant (NPP). Most of the heavy physical structures in an NPP are characterized by high reverberant radio frequency (RF) environments, which cause multi-path interference in RF signals. Also, wireless devices using RF are subjected to many sources of electromagnetic interference in the NPPs. Large motors, motor controllers, electric devices, process controllers, digital equipment, and radio communication devices are obvious sources of electromagnetic interference, and altogether they constitute a negative environment for wireless communication. The use of wireless technology also brings problems of security and privacy to industrial networks. The scope of the research will cover issues including: electromagnetic compatibility, cybersecurity, reliability, transmission delay, cost, issues surrounding deployment of additional sensors on existing network infrastructure, communication spectrum management, power and cabling concerns, etc. The IAEA will launch this CRP based on the recommendation of the Technical Working Group on Nuclear Power Plant Instrumentation and Control.	
Project 1000166	**1.1.5.001 Technology Development for Water Cooled Reactors**
CRP Title:	**Prediction of Axial and Radial Creep in Pressure Tubes**
CRP Code:	**I31023**
Pressure tube deformation is a critical ageing issue in operating heavy water reactors (HWRs). Depending on the years of service, horizontal pressure tubes may show one of three kinds of deformation: diametral creep leading to coolant flow bypass in the fuel bundles and a related penalty to the critical heat flux for fuel rods; longitudinal creep leading to disruption of the feeder pipes and/or the fuelling machine; and sagging leading to interference with in-core components and potential contact between the pressure tube and calandria tube. The CRP scope includes the establishment of a database for pressure tube deformation, microstructure characterization of pressure tube materials collected from HWRs currently operating in Member States, and development of a prediction model for pressure tube deformation. The CRP has been planned on the advice and with the support of the IAEA Department of Nuclear Energy's Technical Working Group on Advanced Technologies for Heavy Water Reactors. The CRP is conducted by the Nuclear Power Technology Development Section within the Department of Nuclear Energy.	
CRP Title:	**Understanding and Prediction of Thermal Hydraulics Phenomena Relevant to Supercritical Water Cooled Reactors**
CRP Code:	**I31025**
The supercritical water cooled reactor (SCWR) is one of the innovative water cooled reactor (WCR) concepts mainly for large scale production of electricity. By utilizing its high coolant temperature, the SCWR is expected to achieve much higher thermal efficiencies than those of current WCRs, and thereby promise improved economics. The objective of the CRP is to improve the understanding and prediction accuracy of thermal hydraulics phenomena relevant to SCWRs and to benchmark numerical toolsets for their analysis. Several key phenomena, such as heat transfer, pressure drop and flow stability, have been identified as	

crucial to the successful development of SCWRs. This CRP will enhance understanding of thermal hydraulics phenomena, sharing of experimental and analytical results, prediction methods for key thermal hydraulics parameters, and cross-training of personnel between participating institutes.	
Project 1000153	**1.1.5.002 Small and Medium-Sized Reactor Technology Development**
CRP Title:	**Design and Performance Assessment of Non-Electric Engineered Safety Features in Advanced Small Modular Reactors**
CRP Code:	**2012**
The purpose of this CRP is to support global development of advanced nuclear reactor designs, including small modular reactors that incorporate non-electric engineered safety features, such as passive residual heat removal and containment cooling systems and gravity driven core injection. The CRP will take into account lessons learned from major accidents to enhance the designs and the performance of such features to cope with extended station blackout and severe accidents. It will bring together global research and development activities aiming at reactor designs with the highest possible safety levels by substantially reducing both the probability and consequences of severe accidents compared to existing reactors. The CRP will focus on four key topics: (1) separation and independence of reactor trip and safety system actuation logics; (2) diversity and redundancy for depressurizing the reactor coolant pressure boundary to facilitate safety injection during a high pressure transient; (3) diversity and redundancy of core cooling; and (4) options and approaches for assuring containment structural integrity.	
Project 1000154	**1.1.5.003 Advanced Technology for Fast and Gas Cooled Reactors**
CRP Title:	**Radioactive Release from the Prototype Fast Breeder Reactor under Severe Accident Conditions**
CRP Code:	**I32009**
In a sodium cooled fast reactor (SFR), a severe transient condition (i.e. hypothetical core disruptive accident (CDA)) is the design extension condition resulting from the mismatch of power produced and power removed from the reactor, as well as from the shutdown system not responding on demand, typically under conditions of either unprotected loss of flow or unprotected transient overpower events. The assessment of the consequences of a CDA in terms of radioactivity release outside the containment system, which may affect the environment and the public, is of paramount importance from the point of view of public acceptance of nuclear power, especially after the Fukushima Daiichi accident. The objective of this CRP is to make realistic estimates, through numerical simulations, of the fission product transport mechanisms in typical pool type SFRs and to determine the fission products retained within the reactor primary vessel and ejected into the reactor containment building. The exercise would be carried out for a reference pool type SFR of 500 MW(e) capacity fuelled with mixed oxide fuel, i.e. the Prototype Fast Breeder Reactor in Kalpakkam (India).	
CRP Title:	**Modular High Temperature Gas Cooled Reactor Safety Design**
CRP Code:	**I31026**
The CRP will investigate and make proposals on modular high temperature gas cooled reactor (HTGR) safety design criteria. It is expected that these criteria would refer to light water reactor safety standards (e.g. *Safety of Nuclear Power Plants: Design* (IAEA Safety Standards Series No. SSR-2/1, Vienna, 2012)), and the deterministic and risk-informed safety design standards under development for existing and planned HTGRs worldwide that apply to the wide spectrum of design basis and beyond design basis events. The CRP would also take into account the effect of the Fukushima Daiichi accident, clarifying the safety requirements and safety evaluation criteria for design extension conditions, especially those events that can affect multiple reactor modules or are dependent on the application (such as process heat or hydrogen production) on the plant site. The logical flow of criteria is from the fundamental inherent safety characteristics of modular HTGRs and associated expected performance characteristics, to the safety functions required to ensure those characteristics, and finally to specific criteria related to those functions. The initial focus will be on the criteria for a specific HTGR concept (e.g. steam cycle) but other concepts (e.g. gas turbine and process heat) will also be looked at. Both prismatic and pebble bed modular	

HTGR designs will be considered. Several publications and presentations were identified as important input to the CRP and will be used as the point of departure. The results of the CRP will be documented in an IAEA Technical Document (TECDOC) to be made available to the entire HTGR community. The CRP could also provide technical information for future separate activities on the development of IAEA safety standards for HTGRs with the cooperation of the IAEA Department of Nuclear Safety and Security.

Project 1000155	**1.1.5.004 Non-Electric Applications of Nuclear Power**
CRP Title:	**Application of Advanced Low Temperature Desalination Systems to Support Nuclear Power Plants and Non-Electric Applications**
CRP Code:	**I35005**

Future nuclear power plants (NPPs) could be made more economical through cogeneration and waste heat recovery, as well as more accident proof through the introduction of low temperature (i.e. 40–50°C in some cases requiring a temperature gradient of 10°C) on-site desalination systems. Countries embarking on nuclear power could exploit the prospects of cogeneration and the use of waste heat from an NPP to increase the plant's overall efficiency and achieve better energy utilization. Simultaneously, NPPs' vulnerability to water shortage (e.g. in case of an accident or terrorist attacks) can be further reduced through the introduction of advanced technologies for low temperature desalination, specifically the distillation processes with utilization of waste heat or any other innovative means which allow for the production of necessary quantities of fresh water to meet on-site NPP requirements and make the plant more secure against external threats. The CRP has been planned on the basis of extensive feedback from many participants in Technical Meetings on non-electric applications and desalination technologies, and was further recommended by the Technical Working Group on Nuclear Desalination. It will be conducted by the Nuclear Power Technology Development Section within the IAEA Department of Nuclear Energy.

1.2 Nuclear Fuel Cycle and Materials Technologies

Project 1000156	**1.2.1.001 Uranium Resources and Production**
CRP Title:	**Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits**
CRP Code:	**T11007**

With increased need for uninterrupted, long-term and sustainable supply of uranium, it has become important to look into augmenting the resource base, and making the mining and extraction more efficient and environmentally friendly. This requires a deeper understanding of the genesis of uranium and thorium deposits under various geological environments with complex mineralization processes through analysis of the geochemical and mineralogical characteristics of each deposit. Such information will be helpful in guiding further exploration and optimization of extraction and production, and in effective environmental management. The proposed CRP will look into complete geochemical and mineralogical characterization of uranium and thorium deposits, including production of high precision data on major, minor and trace elements; stable and radioactive isotopes; identification of major uranium, thorium and other ore minerals; and fluid inclusion studies. The outputs are expected to enrich the IAEA databases on uranium and thorium — World Distribution of Uranium Deposits (UDEPO) and World Thorium Deposits and Resources (ThDEPO) — and help understand the global distribution of uranium and thorium resources in a consistent manner and thus provide valuable inputs for their sustainable development.

CRP Title:	**Uranium/Thorium Fuelled High Temperature Gas Cooled Reactor Applications for Energy Neutral and Sustainable Comprehensive Extraction and Mineral Product Development Processes**
CRP Code:	**T11006**

Increased demand for mineral commodities is growing exponentially and high-grade, easily extractable resources are being depleted rapidly. This shifts the global production to low-grade or, in certain cases, unconventional mineral resources, the production of which depends on the availability of large amounts of energy, since thermal processes are the most appropriate in such cases. These processes can be sustainable only if low-cost, carbon free, reliable energy is available for comprehensive extraction of all valuable commodities, for the entire lifetime of the project. The availability of energy in many cases will also promote value addition and provide higher purity end products, which will improve the overall economics of the project. These processes are usually cleaner and generate lower quantities of wastes. Thermal processes using high temperature gas cooled reactors (HTGRs) could be a sustainable and environmentally friendly alternative to the presently used various conventional chemical processes. As most of the suggested mineral deposits contain low concentrations of uranium and thorium, these could be recovered by a thermal process and used as fuel in the HTGRs. The proposed CRP is intended to generate basic data on the availability and characteristics of such mineral resources as phosphates, copper, rare-earth elements, gold ores and coal, as well as process residues such as phosphogypsum and gold tailings, and to conduct conceptual and feasibility level studies on appropriate energy neutral thermal processes in which thorium/uranium fuelled HTGRs will provide the required energy.

Project 1000157	**1.2.2.003 AP[1] Support Related to Nuclear Power Reactor Fuel**
CRP Title:	**Analysis of Options and Experimental Examination of Accident Tolerant Fuels for Water Cooled Reactors**
CRP Code:	**2018**

This CRP will examine approaches for the development of water cooled reactor fuels with improved tolerance to severe accident conditions, i.e. accident tolerant fuel (ATF). This is a process which has intensified after the Fukushima Daiichi accident, and its ultimate goal is to replace or sufficiently protect the currently used zirconium alloy fuel cladding, which is vulnerable to steam–zirconium reaction and hydrogen release when active cooling in the reactor core is lost. Technological, operational and economic aspects of ATF manufacturing and implementation will also be considered.

Project 1000136	**1.2.3.001 Spent Fuel Storage**
CRP Title:	**Demonstrating Performance of Spent Fuel and Related Storage System Components during Very Long Term Storage**
CRP Code:	**T13014**

As spent fuel from power reactors continues to be stored for longer periods of time, the management of spent fuel has become one of the more important factors influencing the future of nuclear energy. Extrabudgetary funds support the CRP to target anticipated technical needs for demonstrating the performance of spent fuel from heavy and light water reactors as well as the related system components during dry storage within the long term (not expected to last more than approximately 100 years, and with a defined end point) and beyond. The following specific research objectives are being addressed: stress corrosion cracking mechanisms and monitoring; rod behaviour; concrete systems; bolted closed systems; neutron shielding; and full-scale systems for demonstrating performance.

Project 1000137	**1.2.3.003 AP Support Related to Spent Fuel**
CRP Title:	**Management of Severely Damaged Spent Fuel and Corium**
CRP Code:	**T13015**

The Fukushima Daiichi accident (March 2011) resulted in severe damage and reported fuel core meltdown in three of the reactors on the nuclear power plant site. A fourth reactor, although shutdown, suffered severe damage to its structure from a hydrogen explosion, which resulted in plant and roofing materials being deposited in the fuel storage pool. The fuel in this pool may also have been damaged due to loss of cooling water and the introduction of seawater as a replacement. In terms of multiple failures, an accident of this scale has not been experienced previously resulting in a substantial remediation challenge. The objective of this CRP is to expand the existing knowledge base and identify optimal approaches for managing severely damaged spent fuel. Severely damaged spent fuel covers: material from post-irradiation examination; fuel debris, fuel damaged during fuel handling operations; fuel damaged as a result of loss of cooling; corium; molten core–concrete interaction products.

[1] AP: IAEA Action Plan on Nuclear Safety.

1.3 Capacity Building and Nuclear Knowledge for Sustainable Energy Development	
Project 1000050	**1.3.3.002 Facilitating Sustainable Education in Nuclear Science and Technology**
CRP Title:	**Sustainable Education in Nuclear Science and Technology**
CRP Code:	**L53003**
The main objective of the CRP is to conduct research projects to understand the current status of nuclear education, and recommend best practices for improving efficiency and effectiveness. The research scope will include the investigation of new and emerging practices and the assessment and analysis of status and tendencies in different countries and regions. It will mainly focus on: • The impact of further adopting information and communication technologies on the advancement of nuclear education; • Cooperation and collaboration approaches and formats between industry, universities and government, and among countries and regions (e.g. networking and resource sharing mechanisms); • Outreach best practices applied by academia to address schools and society; • Demographics and gender in nuclear education (including supply and demand issues); • Benchmarking and assessment of/in nuclear education; • Challenges and experience in 'nuclearization' of non-nuclear engineers and scientists, and • Competency mapping, knowledge domains, and taxonomy in nuclear education. The proposed period for the CRP is four years: 2015–2018. More information and updates will be posted at the following link: http://www.iaea.org/nuclearenergy/nuclearknowledge/	
1.4 Nuclear Science	
Project 1000161	**1.4.1.002 Nuclear Data Developments**
CRP Title:	**Recommended Input Parameter Library for Fission Cross Sections**
CRP Code:	**2021**
The aim of this new CRP is to provide a comprehensive set of input parameters with estimates of uncertainties needed for the modelling of fission cross sections on actinides based on microscopic and phenomenological approaches. A significant improvement to fission modelling will have a very positive impact on the efficient operation, safety, security and reliability of nuclear power plants.	
Project 1000121	**1.4.1.003 Atomic and Molecular Data Developments**
CRP Title:	**Plasma–Wall Interaction with Reduced Activation Steel Surfaces in Fusion Devices**
CRP Code:	**F43022**
Various kinds of reduced activation steel are being considered as wall material for a fusion reactor, but not enough is known about plasma–wall interaction, erosion and tritium retention in such steels. Erosion brings impurities into the plasma and limits the lifetime of the wall. Hydrogen penetration and retention in the surface remove tritium from the plasma, making it unavailable for fusion. This CRP will enhance the knowledge base and develop new databases on the interaction of fusion plasmas with reduced activation steel alloys that are considered for fusion. The CRP will seek to quantify the erosion due to exposure to plasma and to quantify the retention and transport properties of tritium in the surface.	
Project 1000069	**1.4.2.003 Addressing Research Reactor Fuel Cycle Issues**
CRP Title:	**Options and Technologies for Managing the Back End of the Research Reactor Nuclear Fuel Cycle**
CRP Code:	**T33001**
This CRP will review and summarize the options and technologies available for managing the back end of the research reactor nuclear fuel cycle. This project will achieve two key objectives. First, past work will be leveraged to identify and define a comprehensive set of short- and long -term strategies for managing the back end of the research reactor nuclear fuel cycle. Single-country strategies will be analysed by using a standard approach and compared to potential take-back regional and multinational options, including commercially available or otherwise agreed back-end services. Second, the economic, technological and	

infrastructural requirements for enabling each strategy will be defined. The focus will be on matching options to the capabilities of countries with research reactors but lacking an industrial-scale civilian nuclear power industry. Country-specific case studies will be developed. Three Research Coordination Meetings and two workshops will be held in order to ensure that Member States are well aware of the options available to them.	
CRP Title:	**Innovative Methods in Research Reactor Analysis: Benchmarks against Experimental Data on Fuel Burnup and Material Activation**
CRP Code:	**T12029**
With the progress in computer technology and numerical methods, the capabilities of computer codes have been substantially enhanced, which allows for improved simulation of the complex processes taking place during routine operation of research reactors and under transient conditions. Correct application of these methods and codes is essential to improve design, operation/utilization, and safety aspects of research reactors and associated experiments. However, the validation of computational codes is not an easy task. In order to demonstrate the capabilities of these computational methods and codes, it is necessary to benchmark them against experimental data, before assessing the validity of their application to the design, operation and safety analysis of research reactors. This CRP will support the validation process by collecting available experimental data and assessing the computational methods and tools used for fuel burnup and material activation in research reactor analysis. The outputs of the CRP will be a database of experimental results, measurements and associated facility specifications, and a publication comparing the experimental and computational results of the benchmark studies.	
Project 1000070	**1.4.2.004 Research Reactor Operation and Maintenance**
CRP Title:	**Condition Monitoring and Incipient Failure Detection for Rotating Equipment in Research Reactors**
CRP Code:	**T34003**
The purpose of this CRP is to investigate and report on the latest advances in rotating equipment monitoring and diagnostic techniques. This will also include the use of state-of-the-art rotational monitoring sensors and data transmission techniques, including wireless technologies. The proposed CRP will follow on from the now completed CRP entitled “Improved Instrumentation and Control Maintenance Techniques for Research Reactors using the Plant Computer” (T34001).	
Project 1000165	**1.4.4.001 Nuclear Fusion Research and Technology**
CRP Title:	**Pathways to Energy from Inertial Fusion: Materials beyond Ignition**
CRP Code:	**2035**
Following 50 years of development of the physics and technology required for the initial demonstration of ignition and the recent construction and commissioning of the National Ignition Facility in the USA, it is now timely to pursue more focused studies on the many issues associated with post ignition development of inertial fusion energy (IFE)-based power plants. One key set of areas requiring substantial further study involves the myriad issues surrounding the choice of materials to be used within the unique environment of a high temperature, high flux pulsed IFE power plant. Whilst there has been much study into the materials required for advanced nuclear and magnetic fusion energy facilities, there is a lack of data, modelling and understanding associated with pulsed operation and the extreme particle fluxes. This CRP seeks to coordinate and encourage focused efforts in this area in readiness for inertial fusion plasma ignition.	

Major Programme 2: Nuclear Techniques for Development and Environmental Protection	
2.1 Food and Agriculture	
Project 2000005	**2.1.1.001 Land Management for Climate Smart Agriculture**
CRP Title:	**Soil and Water Conservation for Climate Change Adaptation in Agricultural Uplands**
CRP Code:	**2038**

Upland agro-ecosystems — defined as the less favoured higher altitude environments, including areas with low soil quality and/or limited access to water — will face three major challenges related to food security and climate change in the coming decades: (1) increasing food production while improving, protecting and optimizing soil and water use efficiency; (2) adapting to the impact of climate change on soil and water resources; and (3) contributing to climate change mitigation.
This CRP aims to: (i) identify and test combinations of nuclear and conventional techniques to assess the impacts of changes occurring in upland agro-ecosystems; (ii) distinguish and apportion the impact of climate variability and agricultural management on soil and water resources in uplands; and (iii) support adaptive agricultural management for soil and water conservation in uplands to reduce impacts of climate variability. Nuclear techniques — including the use of fallout radionuclides such as caesium-137, lead-210, beryllium-7 and potentially also plutonium-239 and -240, compound specific stable isotope techniques based on the measurement of carbon-13 natural abundance signatures of specific organic compounds (e.g. fatty acids), and the use of cosmic-ray neutron probes for the measurement of soil moisture — will be used to fulfil these specific objectives.

Project 2000012	**2.1.2.002 Decreasing Transboundary Animal and Zoonotic Disease Threats**
CRP Title:	**Early and Rapid Diagnosis and Control of Transboundary Animal Diseases — Phase II: African Swine Fever**
CRP Code:	**D32031**

African swine fever is a highly fatal pig disease rapidly spreading through Africa and into Europe. Control measures are poorly understood. Thus, research and development conducted under this CRP will focus on the development of improved and rapid detection platforms and the use of effective prophylactic control strategies.

Project 2000016	**2.1.3.001 Food Irradiation Applications Using Novel Radiation Technologies**
CRP Title:	**Development of New Applications of Machine Generated Food Irradiation Technologies**
CRP Code:	**D61024**

The majority of food and agricultural products treated by irradiation are processed in facilities using gamma radiation from cobalt-60 as the source of ionizing radiation. Gamma irradiation is a simple, robust and well-established technology. However, as cobalt-60 might become more difficult to obtain in the future, it is necessary to have other technologies ready to ensure the application of irradiation to food over the long term. Electron beam and X-ray machines employ electricity to generate ionizing radiation. The effects of electron beams and X-rays on food are similar to those of gamma irradiation. However, the use of electrical machine sources for food irradiation on a commercial scale has thus far been limited. A consultancy meeting held in May 2014 identified the need for internationally coordinated research to stimulate the development of machine sources and to establish the conditions that could broaden the choice of technologies to irradiate food.
The aim of this CRP is therefore to coordinate research and development (R&D) activities that are prerequisites for the practical implementation of processes using electron beams and X-rays, and to unlock the potential of machine sources for radiation treatment of agricultural and food products. The project will adopt an international and multidisciplinary approach involving cooperative R&D between food scientists, universities, equipment manufacturers, and stakeholders within the agri-food industry.

Project 2000023	2.1.4.003 Development of the SIT[2] for Control of Disease Transmitting Mosquitoes
CRP Title:	**Mosquito Handling, Transport, Release and Male Trapping Methods**
CRP Code:	**D44002**
The burden of mosquito transmitted diseases remains enormous; in fact, the incidence of dengue and other diseases has been growing dramatically around the world in recent decades while vector control effectiveness has significantly decreased as mosquitoes develop insecticide resistance. The focus of this CRP is to develop handling, transport and release methods for several million adult mosquitoes, and to assess new methods developed within the framework of this CRP in pilot sites to ensure the quality and the sexual capacity of the released sterile males. The development and evaluation of affordable and efficient trapping methods for male mosquitoes are of high importance for the assessment and success of suppression programmes. So far, mosquito traps have been developed mostly for females, which are the vectors of the pathogens.	
Project 2000031	**2.1.5.001 Mutation Induction for Better Adaptation to Climate Change**
CRP Title:	**Enhancement of the Efficiency of Mutation Induction by Physical and Combined Mutagenic Treatments**
CRP Code:	**2086**
Increased biodiversity is needed to meet the breeding goals of the 21st century, in particular to provide stable yields in an era of population growth, climate variability and rising food costs. The need to generate new genetic biodiversity and increase productivity, especially in regions affected by climate variation, requires a number of approaches, including striking new paths in mutation induction techniques. The objective of the CRP is to enhance mutagenesis through irradiation activation of genetic elements that move within the genome (transposons), and cause identifiable secondary mutations. The main task is to develop more efficient methods, protocols and guidelines for X- or gamma ray driven mutation induction, including innovative efficient irradiation treatments to increase genetic diversity for plant breeding.	
Project 2000003	**2.1.5.002 Integrated Techniques for Mutation Breeding and Biodiversity**
CRP Title:	**Efficient Screening Techniques for Mutants with Disease Resistance**
CRP Code:	**2085**
New technologies will be exploited in developing techniques aimed at increasing the efficiency of detecting disease resistant mutants for plant breeding in Member States. Diseases and priority regions will be defined according to demands from Member States. The objective of the CRP is to provide screening methods for useful mutations needed for disease resistance to safeguard crop yields in an era of increased population growth and climate variation. This CRP is based on enhancing the efficiency of the use of induced mutations, primarily from gamma and X-ray irradiator sources, and also possibly from electron and ion beam irradiation. The outputs of the CRP are protocols and guidelines for the selection of disease resistant lines for plant breeding.	
CRP Title:	**Improving Crop Resistance to Abiotic Stresses through Mutation Breeding for Sustainable Agriculture**
CRP Code:	**2127**
Abiotic stresses (majorly drought) limit crop productivity, reducing average yields for major crop plants worldwide. The development of viable strategies for improving crop tolerance is urgently needed. Techniques involved in mutation breeding include: creation of new genetic variation; screening of, and selection in, existing germplasm; identification of useful variation; and using plant mutation breeding programmes to develop new stress tolerant varieties. The objectives of this CRP are to: (i) establish robust experimental, physiological, phenotypic, genetic and molecular protocols for rapid and efficient screening of mutant	

[2] SIT: sterile insect technique.

populations; (ii) enhance crop resilience to abiotic stress through mutation breeding; and (iii) disseminate methods and guidelines to the broader plant breeding community.

2.2 Human Health

Project 2000010	**2.2.1.001 Nutrition through the Life Cycle**
CRP Title:	**Bioavailability of Proteins from Plant Based Diets**
CRP Code:	**2048**

Recently, protein quality has emerged as an important health issue, especially in developing countries where plants form the main source of protein in the diet. This CRP will develop and validate novel, minimally invasive techniques to assess protein digestibility and utilization from plant based diets, as they are consumed by vulnerable populations, in regions habitually relying on plant based diets. Intrinsically labelled local varieties of grain legumes will be grown in collaboration with local agriculture colleges/institutes.

Project 2000015	**2.2.2.001 Diagnostics and Therapy of Non-Communicable Diseases (NCDs) Using Nuclear Techniques**
CRP Title	**Imaging of Neurodegenerative Disorders with a Focus on Parkinson's and Alzheimer's Disease**
CRP Code:	**1978**

Alzheimer's disease (AD) is a devastating pathological process that constitutes by far the leading cause of dementia. The current global estimated prevalence is as high as 26.6 million, and is predicted to double every 20 years up to 2040, thus constituting a huge burden of disease worldwide. Unfortunately there is no effective treatment that could stop or reverse the progression of disease. Therefore, as the disease progresses, the affected person increasingly relies on carers for assistance. This frequently translates into significant social, psychological, physical and economic pressures for patients and carers. Consequently, in developed countries AD is one of the most costly diseases to society.
Over the last few years, there has been great emphasis placed on early detection of AD with the hope that currently available treatments could at least delay the appearance of the full-blown form of the disease. Thus, mild cognitive impairment (MCI) — i.e. the pre-dementia stage — has become a topic of more intense medical research. As non-communicable diseases become more prevalent in developing countries, AD appears to rise in importance, further straining the already overloaded health care systems of many low and middle income countries. There is a need to investigate the value of neuroimaging with modern techniques such as positron emission tomography–computed tomography (PET-CT) (which is becoming increasingly available in many developing countries) to properly diagnose patients with MCI and determine to what extent — if any — the presence of comorbidities such as AIDS, cardiovascular disease, and traumatic brain injury, can impact on the accurate diagnosis in comparison to patients without comorbidities. Currently, there is limited scientific evidence on this subset of patients, and therefore gaining information could be of great benefit to many Member States. This CRP will provide the opportunity to refine currently available quantitative brain mapping software and imaging biomarker indices in the core laboratories, which will then be used for data analysis by institutions participating in this CRP. There will also be an important educational value for participating Member States. It is planned to distribute quantitative imaging mapping software to participating centres free of charge in order to enable them to analyse images with the added potential of improving day-to-day clinical scan interpretation.

CRP Title:	**PET–CT in the Evaluation of Solitary Pulmonary Nodule (SPN) and Guided Biopsy for SPN**
CRP Code:	**2052**

The accurate characterization as benign or malignant of a solitary pulmonary nodule (SPN) found on routine chest imaging is a diagnostic dilemma that has perplexed clinicians for several decades. This dilemma is becoming more pronounced today as the volume of diagnostic imaging performed continues to increase. In the USA, more than 150 000 new SPNs are identified each year by conventional chest radiography. A considerably greater number of indeterminate pulmonary nodules will be detected annually by low-dose screening chest computed tomography (CT) as this technique becomes more widely used in certain patient populations. In a recent Mayo Clinic study, 69% of patients screened using low-dose CT exhibited indeterminate pulmonary nodules. Clinicians must be able to accurately characterize an SPN as benign or malignant not only to avoid missing a potentially life-threatening disease, but also to avoid unnecessary and costly invasive procedures with the accompanying postoperative morbidity and mortality. Numerous studies have been performed comparing the ability of various imaging techniques to adequately characterize SPNs as benign or malignant. Two techniques currently used to characterize indeterminate SPNs are nodule-enhancement CT and fluorine-18 fluorodeoxyglucose positron emission tomography (^{18}F-FDG PET). Nodule-enhancement CT is performed under the premise that a neoplastic lesion, with its increased vascularity, will enhance when imaged with intravenous contrast material. Lesions that enhance greater than 15 Hounsfield units (HU) from the unenhanced level to peak contrast-enhancement are considered likely malignant, whereas those that enhance less than 15 HU are considered likely benign. A recent multicentre analysis of nodule-enhancement CT using these criteria showed a sensitivity of 98% and a specificity of 58%. Fluorine-18-FDG PET uses ^{18}F-FDG as a marker of metabolism with lesions localizing 18F-FDG proportionate to their metabolic activity. Solitary pulmonary nodules with hypermetabolism greater than the mediastinal blood pool are likely malignant. To further quantify metabolism in individual nodules, a standardized uptake value (SUV) can be calculated. An SUV greater than 2.5 defines the SPN as malignant with a relatively high degree of sensitivity and specificity. Using these criteria, recent studies have shown a sensitivity of 92–96% and a specificity of 77–90% using ^{18}F-FDG PET. The CRP will evaluate the current benefit of FDG PET–CT to characterize SPNs and how to refine the diagnostic algorithm, in order to avoid as much as possible unnecessary lung biopsies.

Project 2000024	**2.2.3.001 Clinical Radiation Oncology**
CRP Title:	**Randomized Phase III Clinical Trial of Stereotactic Body Radiation Therapy versus Transarterial Chemoembolization in Hepatocellular Carcinoma**
CRP Code:	**E33036**

Hepatocellular carcinoma (HCC) is a major health problem worldwide: it is the sixth most common cancer and the third most common cause of cancer death. Eighty-five percent of cases occur in developing countries (largely in Asia and Africa), while in the USA it is the fastest growing cancer. Risk factors for HCC include hepatitis B, hepatitis C, alcohol ingestion and cirrhosis from any cause. The majority of cases are found in countries with endemic hepatitis B. Chronic hepatitis C viral infection is a leading cause of HCC in Europe, Japan, and North America. Surgical resection, an option for a minority of tumours (less than 20% of cases), results in five-year survival rates of 60% to 70%. Liver transplantation can cure both the cancer and underlying liver disease in highly selected cases only. As an alternative to surgery, percutaneous or laparoscopic radio frequency ablation or alcohol injection may be used as curative therapy for early HCC. For unresectable HCC that is unsuitable for ablative therapies, transarterial chemoembolization (TACE) has a survival advantage as compared to best supportive care. Stereotactic body radiotherapy (SBRT), an emerging treatment method that enables high precision and high dose delivery to the tumour using a small number of fractions, has a capacity to serve as a potent cytoreductive intervention offering potentially curative therapy or potentially valuable salvage therapy for many tumour types, including all stages of HCC. The emerging data indicate that SBRT compares favourably with other ablative procedures for HCC in terms of local control, safety and survival. The role of SBRT versus other treatments for HCC warrants further investigation. This CRP proposes to evaluate the precise role of SBRT in the management of unresectable HCCs in comparison with TACE, in a prospective randomized setting. It is expected that the results of this CRP will have a worldwide impact, and that they will be particularly relevant for developing countries mainly in Asia and Africa where the disease is common.

CRP Title:	**Improving Radiotherapy Treatment Planning for Patients with Nasopharyngeal Carcinoma in Low and Middle Income Countries**
CRP code:	**E33039**

This CRP has as its primary objective to reduce death (mortality) and suffering (morbidity) from nasopharyngeal carcinoma (NPC) by improving the quality of radiotherapy treatment. Epidemiological data from GLOBOCAN 2012 show that the total number of new cases of NPC in the world amounted to 86 691 and that the number of deaths was 50 828. This cancer has a uniquely skewed geographic distribution: 81% of new cases occurred in Asia

and 9% in Africa. Among all countries, China had the largest number of new patients in 2012 (33 198). There is a clear correlation between the quality of radiotherapy plans and clinical outcomes in this disease.
The CRP will investigate and identify gaps in the process of treatment planning which may be responsible for poor outcomes in patients treated in high incidence countries. The CRP will include a focused survey and 'dry run' exercises on treatment planning for NPC with identification of inaccuracies and uncertainties. There is provision for a training event for radiation oncologists in participating centres followed by a new series of treatment planning exercises. Local quality assurance (QA) committees will be set up in participating centres as well as a central QA committee to review all radiotherapy plans.
The CRP includes the initiation of an online meetings network (NPCnet) for the technical discussion of NPC radiotherapy plans.

CRP Title:	**Quality Assurance of Volume Definition for Three Dimensional Treatment Planning**
CRP Code:	**E33040**

The definition and contouring of targets constitute an important step in the process of treatment planning in modern conformal radiotherapy. It is a step usually done by the radiation oncologist and studies have shown that there is a significant element of uncertainty and inter-observer variations associated with it. This CRP will address this important question and will investigate variability and inconsistencies in contouring target volumes in computerized radiotherapy three dimensional (3D) treatment planning and develop a methodology to minimize these. A specific software tool for delineation will be selected and made available to a number of radiotherapy departments in Member States that are transitioning to the implementation of 3D conformal radiotherapy. Radiation oncologists in these departments will be asked to use the tool to delineate target volumes in cases of common cancers such as lung, breast, prostate, head-and-neck or rectal cancer, and submit them back to the Project Officer. A panel of experts from the IAEA and external consultants will study these cases and make an assessment of accuracy and uncertainties in the delineations. The research group will attempt to systematize the variabilities and compare them to published delineation guidelines. The objectives of the CRP are to: (1) validate the specific contouring software as a teaching tool; (2) assess the accuracy and uncertainties associated with its use in common cancers, and (3) train radiation oncologists in the participating centres on target volume delineation in common cancers for 3D conformal radiotherapy. The plan is to implement this CRP in cross-cutting collaboration with the European Society for Radiotherapy and Oncology (ESTRO).

Project 2000042	**2.2.3.002 Biological Effects of Radiation**
CRP Title:	**Instructive Surfaces and Scaffolds for Tissue Engineering Using Radiation Technology (conducted jointly with F23030)**
CRP Code:	**E31007**

This CRP will support interested institutions in the preparation and testing of instructive scaffolds and surfaces using radiation technology to create tissue grafts and help to decrease the need for human donors. It could also be considered as a forum for information, knowledge and technology exchange among participating institutions and could facilitate the formation of a network of specialists from the diverse disciplines involved. Radiation technologies can play an important role in facilitating and accelerating the development of tissue engineering by addressing some of the challenges and opportunities involved, such as preparation/optimization of instructive scaffolds and their sterilization. The CRP is jointly conducted by the Division of Physical and Chemical Sciences (NAPC) and the Division of Human Health (NAHU) within the IAEA Department of Nuclear Sciences and Applications. While NAPC will implement the part related to the development and testing of the instructive surfaces and scaffolds, NAHU will carry out the biomedical application part related to the end uses of the instructive surfaces and scaffolds.

Project 2000004	**2.2.4.002 Developments in Radiation Dosimetry**
CRP Title:	**Evaluation and Optimization of Paediatric Imaging**
CRP Code:	**E24020**

Paediatric patients comprise a critical group of patients in medical imaging because of their special requirements related to dose (increased radiosensitivity) and imaging (range of body sizes). Optimized paediatric imaging applying ionizing radiation depends not only on the application of established protocols, but also on the experience of the personnel and the suitability of the equipment. This leads to wide variations in image and dose characteristics between departments, which have to be investigated and optimized. Under the framework of this CRP, participants are expected to: (i) contribute to the coordinated research activities, which are designed to evaluate current practice and facilitate the development of optimization strategies for paediatric imaging; and (ii) propose individual research activities of local interest on the optimization of paediatric imaging. Through this CRP, the potential of the Member States to develop and implement state-of-the-art research and optimization strategies in paediatric imaging will be enhanced.

Project 2000029	**2.2.4.003 Clinical Medical Radiation Physics**
CRP Title:	**Testing of the Code of Practice on Small Field Dosimetry**
CRP Code:	**E24021**

Recent trends in radiotherapy techniques have increased substantially the use of small radiation fields. A key step in the radiotherapy process is the requirement for consistent reference dosimetry. For conventional radiotherapy, this has been achieved by universally adopted codes of practice such as *Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry Based on Standards of Absorbed Dose to Water* (Technical Reports Series No. 398, IAEA, Vienna, 2000), but the latter is not applicable to small fields. The development in small field radiotherapy techniques has increased the uncertainties in clinical dosimetry because traditional dosimetry protocols are not applicable to small fields. Therefore, a joint working group made up of experts from the IAEA and the American Association of Physicists in Medicine (AAPM) has developed an international code of practice for small static photon fields. The aim of this CRP is to provide practical guidance to clinical medical physicists in Member States on the implementation of this code of practice. Through this CRP, the participants are expected to carry out extensive dosimetry measurements in various clinical radiotherapy beams, using different set-ups and detectors to test the procedures recommended in the above-mentioned new code of practice. The results of the CRP will be published by the IAEA to support routine implementation of the code of practice in Member States.

2.4 Environment

Project 2000131	**2.4.2.001 Isotopic Tools to Study Climate and Environmental Change**
CRP Title:	**Application of Nuclear Analytical Techniques to Marine Environmental Studies of Climate Trends and Variability**
CRP Code:	**2067**

This CRP is a fundamental contribution to the IAEA's programme on the use of nuclear techniques to understand climate and environmental changes. Climate projections rely on knowledge of the basic processes responsible for climate variability and the calibration and/or validation of climate models. For this, climatologists study environmental climate records, such as those found in corals and sediments. The use of nuclear techniques allows precise dating of temporal records and the analysis of minute traces of isotopes and other parameters which provide information about the past climate (known as 'proxies'). With this CRP, the IAEA will provide Member States with an assessment of the most recent advances in climate variability reconstruction and a better knowledge of recent climate change, through the synthesis of existing knowledge and the study of new records in relevant regions. The study of climate variability through the analysis of temporal records of various proxies critically depends on the use of advanced analytical technologies and accurate dating. The CRP will revise and use a large variety of nuclear analytical techniques to establish the climate records, such as alpha and gamma spectrometry, liquid scintillation, several kinds of mass spectrometry (including accelerator mass spectrometry, multi-collector inductively coupled plasma mass spectrometry, laser ablation mass spectrometry, and isotope ratio mass spectrometry), X-ray imaging and high-resolution X-ray fluorescence analysis. These are fundamental for both accurate dating and sensitive determination of several proxies. Accurate radiochronology will be achieved by using various radionuclides such as lead-210, carbon-14, thorium-230 and other pertinent isotopes. This CRP is a development of the previous successful CRP entitled "Nuclear and Isotopic Studies of the El Niño Phenomenon in the Ocean". The new CRP has an expanded scope and larger expected membership as it seeks to cover climate variability worldwide. It will thus be able to draw on wider regional experience and technology. The CRP could support the creation of a regional or interregional technical cooperation project on climate change and variability.

CRP Title:	**Benchmark Ocean Models for the Dispersion and Radiological Impact of Radionuclides Released from Nuclear Power Plants in Emergency Situations**
CRP Code:	**2068**

The 2011 accident at the Fukushima Daiichi nuclear power plant has released huge amounts of radioactive substances into the Pacific Ocean. These radionuclides are being dispersed and transferred through the ocean, and numerous studies of these processes have been carried out using three-dimensional hydrodynamic circulation models, dispersion models and compartmental models on different space- and time-scales to predict the behaviour of the radionuclides and, further on, to estimate doses to biota and human populations. Similar studies, focusing mainly on short-term and short- to medium-range predictions, can be applied to other coastal nuclear facilities and various emergency scenarios. The objective of this CRP is to compare available ocean models, adapt operational models to radionuclide modelling, work out connections to real-time data streams and assist Member States in the development of expert systems for emergency preparedness. The Fukushima discharges will be used as a benchmark study for the Pacific Ocean. The simulated data will be compared with actual measurement results from that region. Measurement data can be used from the Asia–Pacific Marine Radioactivity Database (ASPAMARD), which is currently being updated under the IAEA regional technical cooperation project RAS/7/021, “Marine Benchmark Study on the Possible Impact of the Fukushima Radioactive Releases in the Asia–Pacific Region”. The CRP will also compare predictions obtained from different models and further develop models for dispersion and transfer of radionuclides in the marine environment, which can be used for radiological and environmental impact assessments in support of decision-making in case of accidental releases of radionuclides to the marine environment. The CRP will develop the scientific basis of marine modelling during nuclear and radiological emergencies and will be coordinated with relevant activities under the IAEA’s Modelling and Data for Radiological Impact Assessments (MODARIA) programme in order to improve capabilities in the field of environmental radiation dose assessment.

Project 2000076	**2.4.3.001 Radioactive and Non-Radioactive Pollution and Impact on Environment**
CRP Title:	**Study of Global Temporal Trends of Pollution in Selected Coastal Areas by the Application of Isotopic and Nuclear Tools**
CRP Code:	**2070**

Coastal ecosystems are under high stress due to numerous human activities. Dated environmental archives such as sediments, corals and shells, provide useful information to coastal zone managers on the temporal trends of pollution and can assist them in taking decisions regarding measures to minimize river, estuary, coastal and marine pollution. Nuclear and isotopic techniques are the best option to study environmental archives. Sediment and coral cores are dated through the determination of natural and artificial radionuclides such as lead-210, radium-226 and caesium-137, and other nuclear analytical and associated techniques. The main CRP tasks are to revise existing methodologies on suitable environmental archives for dating methods and the use of pollution indicators. The CRP will address the synergetic impact of multiple stressors, including ocean acidification (OA), on pollution trends in various types of coastal ecosystems and will consider the effect of different climate/OA scenarios on the future behaviour of contaminants in coastal regions. A database of global trends of pollution will be developed and the results will be disseminated through a website and presentations to relevant stakeholders.

CRP Title:	**Levels, Trends and Radiological Effects of Radionuclides in the Marine Environment**
CRP Code:	**2135**

This CRP aims to provide a timely follow-up to previous assessments coordinated by the IAEA under two earlier CRPs: “Sources of Radioactivity in the Marine Environment and their Relative Contributions to Overall Dose Assessment from Marine Radioactivity” (MARDOS; completed in 1990, with the results published in 1995) and “Worldwide Marine Radioactive

Studies" (WOMARS; concluded in 2000, with the results published in 2005). The new assessment will result in an up-to-date picture of worldwide marine radioactivity. It will provide a comprehensive assessment of the status and trends of radioactivity in the world's oceans and seas, together with an analysis of sources and their relative contributions, as well as a comparative assessment of radiological doses through seafood ingestion, from natural and anthropogenic radionuclides. There is a huge pool of new marine radioactivity data accumulated since the time of the last assessment coordinated by the IAEA in the year 2000, sufficient to support a reliable new assessment. A significant volume of new data is expected to be contributed through this CRP to the IAEA's online marine radioactivity database MARiS (Marine Information System). The CRP aims to process and synthesize the data into different types of products (space and time averages, trends, maps, interactive models etc.) by reaching consensus in a broad experts' community on representative levels, trends and radiological impacts. An IAEA Technical Document (TECDOC), project reports and scientific publications are planned to be produced within the framework of the project. The CRP will address the current need for a reference publication on the state of marine radioactivity — something that is particularly important to document the dynamics of marine radioactivity following the radionuclide releases into the ocean from the Fukushima Daiichi accident in 2011. The CRP results will allow for comparison of local, regional and global scale marine environmental effects and will provide pre- and post-Fukushima baselines and trends of anthropogenic radionuclides. Past assessments which looked at anthropogenic radionuclides against the background of natural radioactivity also in terms of radiological doses from seafood ingestion, indicated that doses from natural polonium-210 are several orders of magnitude higher than those corresponding to anthropogenic radionuclides and are associated with a high variability. The study will be expanded to include the additional data collected since the year 2000.

Project 2000077	**2.4.3.002 Nuclear Techniques for Marine Resource Management and Seafood Safety**
CRP Title:	**Toxicological and Ecotoxicological Assessment of Benthic Algae and Their Toxins to Achieve Sustainable Management of Marine Ecosystem Services**
CRP Code:	**K41014**

Harmful algal blooms (HABs) represent a growing threat to coastal marine ecosystems and sustainable safe seafood supplies. Isotopic and radioisotopic techniques (such as the receptor binding assay or the measurement of isotopic signatures) can be used to identify and measure algal toxins in seafood, and improve knowledge on the impact of environmental and climatic variability on HABs. This project proposes to bring together scientists (and end users) with complementary capacities and expertise, and from different regions (including the vulnerable small island developing States), in order to: (i) better assess the fate and impact on marine organisms and seafood safety of the toxic benthic microalgae responsible for the neglected tropical disease ciguatera (i.e. *Gambierdiscus* spp.), and (ii) raise awareness and understanding of environmental sustainability and seafood safety.

2.5 Radioisotope Production and Radiation Technology

Project 2000090	**2.5.1.001 Development and Production of Medical Radioisotopes**
CRP Title:	**Sharing and Developing Protocols to Further Minimize Radioactive Gaseous Releases to the Environment in the Manufacture of Medical Radioisotopes, as Good Manufacturing Practice**
CRP Code:	**F23031**

This CRP will identify and present solutions to important technical issues related to the radioactive gaseous emissions from current and possible future medical isotope production facilities. This CRP will build on international work already completed to study how these emissions affect the environment and the public health, as well as the monitoring for nuclear explosions, and to develop a plan to keep gaseous emissions at medical radioisotope production facilities below a desired target. The objectives of this CRP are to: (1) foster collaboration between current and potential future producers of medical radioisotopes, such as molybdenum-99 and iodine-131, from the fission of uranium; (2) determine internationally accepted targets for selected radioactive gaseous emissions; (3) produce a summary of the factors which most significantly affect such emissions; and (4) determine methods which can

be utilized to reduce emissions to the determined level.	
Project 2000094	**2.5.2.001 Industrial Applications of Radioisotopes and Radiation Techniques**
CRP Title:	**Development of Radiometric Methods for Exploration and Process Optimization in Mining and Mineral Industries**
CRP Code:	**F22065**
Radiation techniques are being increasingly applied and are continuously evolving for the exploration and efficient tapping of natural resources by the mining, metallurgy and mineral processing industries. Such industries are present in practically every country and often are the major contributors to the national economies. The CRP's objectives will be the development of nuclear techniques and associated methodologies related to the following topics: use of radiotracers to derive data in a simple manner from a variety of complex and closed systems; use of radiotracers to provide vital information which can be gathered for optimal recovery of the desired mineral; geophysical radiation techniques, such as nuclear borehole logging systems, used for exploration purposes and new technologies that have to be introduced; and nucleonic control systems used for online measurements on processing lines for elemental analysis, quality control and real-time process management. New radiotracers, miniature neutron generators and X-ray systems, user friendly software, new detectors and data acquisition systems are being developed and introduced in practice. Representatives of the exploration, mining, mineral and metallurgical industries are invited to express their specific needs that can be addressed and potentially solved by radiation technologies. Finding solutions to these issues is the objective of this CRP.	
Project 2000095	**2.5.2.002 Radiation Technology for Health Care and Environmental Applications**
CRP Title:	**Developing Radiation Treatment Methodologies and New Resin Formulations for Consolidation And Preservation of Archived Materials and Cultural Heritage Artefacts**
CRP Code:	**F23032**
The preservation of world cultural heritage is a key issue for maintaining national identity and understanding the exchanges among civilizations throughout history. Cultural heritage (CH) artefacts that are based on paper, textiles or wood are prone to biological attack under improper conservation conditions. The application of ionizing radiation for the disinfection of CH artefacts has been successfully demonstrated in recent years, with the participation of museums and libraries. The wider use of this technique requires conclusively establishing that irradiation does not lead to unacceptable changes in the functional or decorative properties of the artefact and that its authenticity is not compromised. The CRP will focus on evaluating the effect of irradiation on the functional properties of such artefacts' base materials and minor constituents, as well as on post-irradiation effects and appropriate irradiation procedures for wider use of the technique.	
Major Programme 3: Nuclear Safety and Security	
3.2 Safety of Nuclear Installations	
Project 3000167	**3.2.4.004 Supporting Long Term Operation Safety**
CRP Title:	**Evaluation of Structures' and Components' Material Properties Utilizing Actual Aged Materials Removed from Decommissioned Reactors**
CRP Code:	**2078**
To ensure safe long term operation of nuclear power plants, international collaborative research aimed at collecting, measuring, recording and analysing the properties of sample materials removed from systems, structures and components of decommissioned plants, as well as of replaced components that are subject to physical ageing, is very important. Such research should address synergetic effects from a combination of different degradation mechanisms in real operational conditions, provide a basis for comparison with the results of laboratory tests and calculations, and make it possible to remove unnecessary conservatism in predicting the status of components important to safety. The specific objective of this CRP	

is to address degradation mechanisms in mechanical, electrical and instrumentation and control (I&C) components and also structures, specifically through a Phase 1 (2016–2019) which will cover neutron irradiation embrittlement of reactor pressure vessel (RPV) and irradiation-assisted stress corrosion cracking of RPV internals, and then a Phase 2 (to be initiated in 2019 or later) covering various types of degradation of concrete structures; low-cycle fatigue, including environmentally-assisted fatigue of primary circuit components; thermal ageing of two-phase stainless steels; and degradation of cable insulation and electrical and I&C penetrations.

3.5 Nuclear Security

Project 3000152	**3.5.2.001 Integrated Nuclear Security Approaches for the Nuclear Fuel Cycle**
CRP Title:	**Nuclear Security for Research Reactors and Associated Facilities**
CRP Code:	**J02006**

The objective of this CRP is to simplify the process for establishing, and enhance the effectiveness of, nuclear security programmes to reduce the risk of theft of nuclear and/or other radioactive materials and sabotage at research reactors and associated facilities (RRAFs).

Research reactors, because of their diverse objectives, settings, funding arrangements and staffing, present a particular set of challenges to the implementation and maintenance of an effective nuclear security programme. As it is critical to ensure a robust security programme, the IAEA and its Member States have recognized the importance of enhancing security at RRAFs.

This CRP includes the following activities: (1) Reviewing the assessment methodologies for regulated facilities developed by the CRP on nuclear security assessment methodology (launched in 2013) in relation to RRAFs and developing case studies for RRAFs; (2) Identifying factors for developing a comprehensive normalized ranking scheme for security risk posed by nuclear and radioactive materials while considering the unique characteristics of RRAFs; (3) Identifying and assessing open source data to develop a general threat basis statement for RRAFs; (4) Identifying and assessing available computer-based analytical tools that are suitable to be used by non-security experts to evaluate dispersal consequences arising from the introduction of external energy; and (5) Identifying and assessing available databases for evaluating the performance effectiveness of nuclear security of RRAFs.

The outputs of the CRP will include: case studies and methodologies to normalize attractiveness risk factors; threat basis statements; methodologies and analytical tools to evaluate dispersal consequences; and a database to support the evaluation of effectiveness that can be used in enhancing nuclear security systems. This CRP is the first IAEA research activity specifically devoted to nuclear security for RRAFs. It will create an environment for sharing and transferring knowledge and experience, and provide guidance and specific examples of good practices in enhancing nuclear security at RRAFs.

CRP Title:	**Development of Nuclear Security Culture Enhancement Solutions**
CRP Code:	**J02007**

In view of the critical importance of a strong nuclear security culture, there is a strong need to provide Member States with practical tools and approaches that they can use to apply the nuclear security culture concept to their activities. The primary objective of this CRP is to develop practical and effective solutions to enhance nuclear security culture within operating organizations responsible for handling nuclear and other radioactive material, as well as for associated facilities and activities under regulatory control. A secondary objective is to create an environment for the exchange and transfer of knowledge and experience, and to provide guidance on, and specific examples of, good practices in enhancing nuclear security culture. The shared outcomes of the CRP will serve to further improve nuclear security culture and address relevant challenges.