IAEA Coordinated Research Activities in 2014–2015

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 and its development and practical applications. The IAEA's programme and budget for 2014–2015 accordingly provides 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 and 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 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 research coordination meetings at the IAEA's expense.

I.3. Selection of Institutions

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 to the programme, priority is normally given to proposals received from institutions in developing Member States and to qualified 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 institution, 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.15 (Nov.12) must be used. Proposals for research agreements should be made on the Proposal for Research Agreement form N-21/Rev.14 (Nov.12). These forms are available on the Coordinated Research Activities (CRA) 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 contract. However, a progress report must accompany each renewal application. Agreement holders must submit a report at each meeting of the research coordination project.

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, 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 2014–2015

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 in the IAEA's programme. The following list includes CRPs under which the IAEA may consider supporting research in 2014–2015. Additionally, the Coordinated Research Activities website: **http://cra.iaea.org** will list all CRPs open for proposals.

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 by Major Programme, Programme and Project that are Open for Submission of Proposals in 2014–2015

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Major Programme 1: Nuclear Power, Fuel Cycle and Nuclear Science

1.1 Nuclear Power	
Project 1000136	**1.1.5.005 Support Related to Advanced Reactor Lines**
CRP Title:	**Development and Assessment of Water Cooled Reactor (WCR) Technologies to Cope with Fukushima-type Accidents**
CRP Code:	**2014**
The nuclear accident at the Fukushima Daiichi nuclear power plant demonstrated that severe accidents can occur under certain conditions and that there is a need for more knowledge to fill knowledge already identified before the accident. In order to strengthen global nuclear safety, WCR technologies to prevent and mitigate Fukushima-type accidents should be reassessed or newly developed based on technical lessons learned from the accident. This CRP is intended to facilitate the exchange of technical information among participating institutes and to enhance collaboration in new technology development and assessment.	
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:	**2011**
Wireless technology provides excellent solutions to the problem of high cost of industrial wiring and also provides a convenient and fast way to install temporary instrumentation to monitor the health of selected plant equipment. The potential cost reductions to be achieved by avoiding wire/cable installation and maintenance is creating an expanding market for wireless applications. Battery operated devices with low power consumption 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, which provides an adverse environment for wireless communication. The use of wireless technology also creates problems of security and privacy for industrial networks. The scope of the research will cover issues including: electromagnetic compatibility, cybersecurity, reliability, transmission delay, cost, issues surrounding deployment of additional sensors in existing network infrastructures, 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 1000153	**1.1.5.002 Small and Medium Sized Reactor (SMR) Technology Development**
CRP Title:	**Design and Performance Assessment of Non-Electric Engineered Safety Features in Advanced SMRs**
CRP Code:	**2012**
The purpose of this CRP is to support the global development of advanced nuclear reactor designs, including small modular reactors, with non-electric engineered safety features, such as passive residual heat removal and containment cooling systems and gravity driven core injection by incorporating the lessons learned from major accidents to enhance the design and performance of engineered safety features to cope with extended station blackouts and severe accidents. The CRP will bring together global research and development activities	

that aim to design reactors that have the highest possible safety level by substantially reducing, compared to existing reactors, both the probability and consequences of severe accidents. The CRP will focus on four key topics (1) separation and independence of reactor trip and safety system actuation logics, (2) diversity of ways of depressurizing the reactor coolant pressure boundary, (3) diversity and redundancy of core cooling, and (4) diversity of ways of assuring containment structural integrity.	
Project 1000154	**1.1.5.003 Advanced Technology for Fast and Gas Cooled Reactors**
CRP Title:	**Source Term for Radioactivity Release Under Fast Reactor Core Disruptive Accident (CDA) Situations**
CRP Code:	**1738**
In a sodium cooled fast reactor (SFR), a hypothetical core disruptive accident (CDA) is a beyond design basis event resulting from the mismatch of power produced and power removed from the reactor and the shutdown system not responding on demand, typically under conditions of either unprotected loss of flow or unprotected transient over power events. The assessment of the consequences of a CDA in terms of radioactivity release to outside the containment system which may affect the environment and the public is of paramount importance from a public acceptance point of view, especially after the Fukushima event. The objective of this CRP is to make realistic estimates, through numerical simulation, of the fission products 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 MWe capacity fuelled with mixed oxide fuel with an idealized core bubble.	
CRP Title:	**Modular High Temperature Gas Cooled Reactor Safety Design**
CRP Code:	**I31026**
The CRP will investigate and make proposals on safety design criteria for modular high temperature reactors. It is expected that these criteria will refer to light water reactor (LWR) safety standards (e.g. *Safety of Nuclear Power Plants: Design*, IAEA Safety Standards Series No. SSR-2/1), and the deterministic and risk-informed safety design standards under development for existing and planned high temperature gas cooled reactors (HTGRs) worldwide that apply to the wide spectrum of design 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) at 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-TECDOC to be made available to the HTGR community. It could also provide the technical information for future separate development of IAEA safety standards for HTGRs with the cooperation of the IAEA's 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 NPPs and Non-electric Applications**
CRP Code:	**I35005**
Future nuclear power plants (NPPs) could be made more economical through cogeneration and waste heat recovery and 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 NPP's overall efficiency and achieve better energy utilization. At the same time, the vulnerability of NPPs created by water shortages in the event of an accident or terrorist attack can be further reduced by introducing advanced technologies for low temperature desalination, specifically	

distillation using waste heat or any other innovative means which makes it possible to produce the necessary quantities of fresh water to meet on-site NPP requirements and make the NPP more secure against external threats. The CRP has been planned based on extensive feedback from many participants in Technical Meetings on non-electric applications and desalination technologies and further recommended by the Technical Working Group on Nuclear Desalination and will be conducted by the Nuclear Power Technology Development Section.	
Project 1000166	**1.1.5.001 Technology Development for Water Cooled Reactors**
CRP Title:	**Understanding and Prediction of Thermal Hydraulics Phenomena Relevant to SCWRs**
CRP Code:	**I31025**
The supercritical water cooled reactor (SCWR) is one of the innovative water cooled reactor (WCR) concepts designed mainly for large scale production of electricity. With its high coolant temperature, the SCWR is expected to achieve much higher thermal efficiencies than those of current WCRs, and thereby promises to provide 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 analyses. Several key phenomena, such as heat transfer, pressure drop and flow stability, have been identified as crucial to success in developing 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.	
1.2 Nuclear Fuel Cycle and Materials Technologies	
Project 1000033	**Nuclear Power Reactor Fuel Research and Development, Design and Manufacturing**
CRP Title:	**Reliability of High Power, Extended Burnup and Advanced PHWR Fuels**
CRP Code:	**T12027**
There is increased interest among the Member States to introduce advanced fuels and extend the discharge burnup of fuel assemblies in pressurized heavy water reactors (PHWRs) to achieve better resource utilization and improved economics. Higher burnup and advanced fuels pose new challenges to fuel design and manufacturing techniques, and may require new cladding materials. Fuel reliability issues include release of gaseous and volatile fission products, pellet–clad interaction, build-up of internal pressure, fuel swelling, degradation of thermophysical properties of fuel, cladding corrosion and stress corrosion cracking, etc. Attention is also needs to be given to the performance of fuels under off-normal and accident conditions. Similar issues have been addressed for LWR fuel and fuel assemblies. PHWR fuel characteristics are quite different from LWR fuel characteristics with respect to clad thickness, high linear power, high centre line temperature, absence of plenum volume, online refuelling, etc., which affect fuel performance. This CRP is intended to encourage the development and sharing of work on resolving the above challenges.	
CRP Title:	**Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits**
CRP Code:	**2016**
With increased need for an uninterrupted, long-term and sustainable supply of uranium, it has become important to look into augmenting the resource base, and making 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 mineralizing processes by analysing the geochemical and mineralogical characteristics of each deposit. Such information will be helpful in guiding further exploration, optimizing extraction/production, and ensuring effective environmental management. The proposed CRP will look at the 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 (UDEPO and ThDEPO) and help understand the global distribution of uranium and thorium resources in a consistent	

manner and thus provide valuable input for its sustainable development.	
Project 1000137	**1.2.3.003 Support Related to Spent Fuel Management**
CRP Title:	**Management of Severely Damaged Spent Fuel and Corium**
CRP Code:	**T13015**
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 examinations; fuel debris and fuel damaged during fuel handling operations; fuel damaged as a result of loss of cooling; corium; molten core–concrete interaction products.	
Project 1000156	**1.2.1.001 Uranium Resources and Production**
CRP Title:	**Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits**
CRP Code:	**2006**
With the increased need for an 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 environmental friendly. This requires a deeper understanding of the genesis of uranium and thorium deposits in various geological environments with complex mineralizing processes by analysing the geochemical and mineralogical characteristics of each deposit. Such information will be helpful in guiding further exploration, optimization of extraction/production and in effective environmental management. The proposed CRP will examine the complete geochemical and mineralogical characterization of uranium and thorium deposits, including the production of high precision data on major, minor and trace elements; stable and radioactive isotopes; the identification of major uranium, thorium and other ore minerals; and fluid inclusion studies. The outputs are expected to enrich the IAEA's databases on uranium and thorium (UDEPO and 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 HTGR Applications for Energy Neutral 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 is constrained by the availability large amounts of energy, since the thermal process is best suited in such cases. These processes are sustainable only if low-cost, carbon free, reliable energy is available for comprehensive extraction of all valuable commodities, for the entire life of the project. The availability of energy in many cases will also promote added value and provide higher purity end products, which will improve the overall economics of the project. These processes are usually cleaner and generate lesser quantities of wastes. Thermal processing using high temperature gas cooled reactors (HTGRs) could be a sustainable and environmentally friendly alternative to the currently used various conventional chemical processes. As most of the suggested mineral deposits contain low concentrations of uranium and thorium, this could be recovered during the thermal process and used as fuel at the HGTRs. The proposed CRP is intended to generate basic data on the availability and characteristics of mineral resources such as phosphates, copper, rare-earth elements, gold ores and coal; or of process residues such as phosphogypsum and gold tailings. It will also involve conceptual and feasibility level studies on appropriate energy neutral thermal processes in which uranium thorium fuelled HTGRs will provide the required energy.	
Project 1000157	**1.2.2.003 Support Related to Nuclear Power Reactor Fuel**
CRP Title:	**Fuel Modelling in Accident Conditions (FUMAC)**
CRP Code:	**2005**
The Fuel Modelling in Accident Conditions (FUMAC) CRP aims to analyse and create a better understanding of fuel behaviour in accidental situations by identifying best practices in	

the application of the relevant physical models and computer codes used in different Member States, and by enhancing their predictive capacities. Well checked results of accident simulation experiments will be selected, integrated into the joint NEA-IAEA International Fuel Performance Experiments database, and used for verifying and comparing codes.	
CRP Title:	**Analysis of Options and Experimental Examination of Accident Tolerant Fuels for Water-Cooled Reactors**
CRP Code:	**2018**
Globally, there is a great deal of experience with the performance of reactor fuel in off-normal conditions. Theoretical studies and experiments have been performed and there have been excursions from normal operating conditions in a few power reactors. During such an excursion, the difference between an incident of limited consequence and an accident, such the one at Fukushima, depends on the conditions in the reactor and the performance of the fuel under those conditions. This CRP will examine and improve the ability of Member States to model the performance of nuclear fuel under accident conditions, such as loss of coolant accidents.	
1.3 Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	
Project 1000046	**Techno-economic Analysis**
CRP Title:	**Assessing the National and Regional Economic and Social Effects of Nuclear Programmes**
CRP Code:	**I12005**
Participants in this CRP will review, test and apply prototype methodologies (quantitative models) to analyse the economic and social impacts of nuclear programmes at the national and regional level. These methods help policymakers to analyse key implications from nuclear projects. The IAEA has already initiated preparatory work on developing a set of analytical tools and frameworks for assessing the social and economic impacts of nuclear programmes. CRP participants will share their experiences in using IAEA tools for quantitative macroeconomic analysis of nuclear projects or their own existing models or tools, but Member States with limited experience (“newcomers”) are also expected to benefit from this CRP. This CRP will seek innovative ways of quantitative impact analysis by coordinating research efforts in Member States and supporting IAEA activities.	
Project 1000158	**1.3.3.001 Implementing Knowledge Management in Nuclear Organizations**
CRP Title:	**Developing Indicators to Measure Knowledge Management Effectiveness in Nuclear Organizations**
CRP Code:	**2020**
The objectives of this CRP are to provide specific indicators to measure the effectiveness of knowledge management (KM); benchmarks, including a contribution of KM to organizational performance and safety; and alternative methods and tools that can be used for nuclear KM in different projects and applications in nuclear organizations. This will be achieved by development, research and comparative analysis of different KM solutions used by Member States. Expected research results will also promote the general benefits of KM (which include reduced risks to overall operations by understanding important concepts such as risk of knowledge loss), and retention of valuable organizational competence to sustain high levels of performance. Benefits also include achieving greater safety and productivity by making KM considerations part of the organization’s safety culture and improvement efforts. The following areas that will be taken into consideration are KM practices, organizational and safety culture, organizational performance and effectiveness, technology support, the quality of knowledge processes, management competence, information management, and human resource management. The proposed period for the CRP is four years: 2014–2017. More information and updates will be posted at the following link: http://www.iaea.org/nuclearenergy/nuclearknowledge/	

1.4 Nuclear Science	
Project 1000067	**Enhancement of Utilization and Applications of Research Reactors**
CRP Title:	**Standardization of Small Neutron Source Facilities and Neutron Beam Condition Management for Medical Applications**
CRP Code:	**2024**
The objective of this CRP is to review and formulate a standard guideline on the use of neutron beams for medical diagnostic and treatment applications, taking into account the fact that thermal, epithermal and fast neutrons from small research reactors, accelerator-driven neutron generators and compact neutron generators have different energy spectra, intensity and beam sizes, while different medical treatment and diagnostic techniques require different neutron beam conditions. Due to the specific requirements of different medical techniques, neutron beam conditions have to be adjusted accordingly. The technical aspects of primary importance include (depending on the type of neutron source): the design of neutron production target and neutron beam channels; the selection of moderator, reflector and filter materials; the design of appropriate shielding structures; and the design of experimental hall and its auxiliary components, etc. These design technical criteria and specifications are therefore important for reference guidelines on beam quality requirements for medical applications. The new CRP was recommended by the participants of the IAEA's Technical Meeting on Research Reactor Users' Networks: Advances in Neutron Therapy" held in Mainz (Germany) in 2013.	
Project 1000069	**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. Firstly, 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 using a standard approach and compared to potential regional and multinational fuel take-back options, including commercially available or otherwise agreed back end services. Secondly, 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 that do not have 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 discuss the strategies.	
CRP Title:	**Innovative Methods in Research Reactor Analysis: Benchmarks Against Experimental Data on Fuel Burnup and Material Activation**
CRP Code:	**2026**
With the progress that has been made in computer technology and numerical methods, the capabilities of computer codes have been substantially enlarged. The recent development of these methods and codes allows for better simulation of the complex processes taking place during the routine operation and transient conditions of research reactors (RRs). Correct application of these methods and codes is essential to improve the design, operation/utilization, and safety aspects of RRs and associated experiments. However, the validation process for computational codes is not easy. In order to demonstrate the quality of these computational methods and codes, it is necessary to benchmark against experimental data, through a formal qualification process, before judging the validity of their application to the design, operation and safety analysis of RRs. This new CRP is a follow-up of the already terminated CRP J71013 on "Innovative Methods in Research Reactor Analysis: Benchmark against Experimental Data on Neutronics and Thermalhydraulic Computational Methods and Tools for Operation and Safety Analysis of Research Reactors". The new CRP will collect available experimental data and assess the computational methods and tools used for fuel burnup and material activation in RR analysis.	

Project 1000070	Research Reactor Operation
CRP Title:	Condition Monitoring and Incipient Failure Detection of Rotating Equipment in Research Reactors
CRP Code:	T34003
This CRP was launched in November 2013 to provide a forum for the establishment of a material properties database for irradiated core structural components. A structured database is required to understand the material behaviours in core components of research reactors to ensure their continued safe operation and the lifetime extension of ageing research reactors. This database can be used by research reactor operators and regulators to help predict ageing related degradation. This will be useful to minimize unpredicted failures of core components and to mitigate lengthy and costly shutdowns. The database will be a compilation of data from research reactor operator input, comprehensive literature reviews and experimental data from research reactor. The database will be provided to all potential end users in Member States. Moreover, the CRP will specify further activities needed to address the identified data gaps in the database for potential follow-on activities required by Member States	
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:	2023
Various kinds of reduced activation steel are being considered as wall material for a fusion reactor, but not enough is known about plasma 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 removes 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 plasma 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 1000161	1.4.1.002 Nuclear Data Developments
CRP Title:	Recommended Input Parameter Library (RIPL) 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 modelling fission cross sections for actinides based on microscopic and phenomenological approaches. Significant improvement in fission modelling will have a very positive impact on the efficient operation, safety, security and reliability of nuclear power plants.	
Project 1000162	1.4.3.001 Fostering Accelerator Applications in Multiple Disciplines
CRP Title:	Development of Elemental and Molecular Imaging and Characterization of Soft Matter with MeV Heavy Ions
CRP Code:	F11019
Secondary ion mass spectrometry (SIMS) has developed over the years into a powerful analytical tool for elemental analysis. Over the past 40 years this technique has been utilized to make molecular concentration maps of surfaces and even to provide full 3D maps of molecular materials. Conventionally low energy atomic and cluster ions (keV) are used to physically sputter the materials from the surface. Recently it has been demonstrated that the SIMS technique can also be used with higher energy MeV ions and, unlike the keV ions, the MeV ions also yield a PIXE signal and can be extracted into air, providing a completely new working regime for the SIMS analysis technique. Development of this new MeV-SIMS technique for molecular concentration mapping in combination with ion beam analysis — especially the PIXE technique — for elemental analysis is the target of this CRP. Possible areas of application of this technique are art, archaeology, materials science, organic electronics, forensics, geology, biomedical science etc.	

Project 1000163	1.4.3.002 Facilitating Experiments with Accelerators
CRP Title:	Experiments with Synchrotron Radiation for Modern Environmental and Industrial Applications
CRP Code:	G42005

The CRP aims at expanding and strengthening the research capacity of Member States in multidisciplinary applications of synchrotron radiation based X-ray spectrometry (XRS) techniques. The Physics Section of the IAEA has recently developed and installed an experimental XRS facility as an end-station at the X-ray fluorescence (XRF) beam line of Elettra Sincrotrone Trieste (EST), Trieste, Italy. Under a cooperation agreement between the IAEA and EST, 40% of the beam time has been granted to the IAEA, accessible to end users by the second semester of 2014. The IAEA multipurpose beam line end-station allows the synergistic application of various variants of XRF techniques such as, grazing incidence/exit and total reflection XRF in combination with X-ray reflectometry and X-ray absorption spectrometry (XAS). Targeted applications refer to the characterization of modern nano-structured materials with relevance to energy storage and conversion technologies, micro- and nano-electronics, the investigation of environmental and biological samples, as well as non-destructive characterization of cultural heritage materials. The CRP will connect large laboratories hosting synchrotron facilities in Member States with small, but leading, research groups in developing countries, whereas the CRP participants are expected to perform individual or collaborative experiments at the IAEA end-station at Elettra Sincrotrone Trieste.

Project 1000164	1.4.3.003 Nuclear Instrumentation
CRP Title:	In Situ Measurements for Rapid Environmental Mapping of Contaminated Sites
CRP Code:	G42006

Recent progress in nuclear electronics and nuclear instrumentation creates the opportunity to develop optimum instruments in terms of cost and performance, and to apply them to environmental monitoring; particularly in situ measurements and characterization of industrial materials. This CRP will address the potential options of new technologies, in particular low cost detector materials and multi-element detector systems. This CRP will be targeted at complementing the activities of the Working Group on In Situ Techniques for Radiological Characterization within the Network on Environmental Management and Remediation (ENVIRONET).

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 (NIF) 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) power plants. One key set of areas requiring substantial further study are the myriad issues surrounding the choice of materials to be used within the unique environment of a high temperature, high flux pulsed inertial fusion 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 extreme particle fluxes. This CRP seeks to coordinate and encourage focused effort 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 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 the 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 will be protocols and guidelines for the selection of disease resistant lines for plant breeding.	
Project 2000005	**2.1.1.001 Land Management for Climate Smart Agriculture**
CRP Title:	**Minimizing Farming Impacts on Climate Change by Enhancing Carbon and Nitrogen Capture and Storage in Agroecosystems**
CRP Code:	**2037**
This CRP will explore potential farming practices under different agroecosystems to enhance soil carbon accumulation-sequestration and reduce greenhouse gas (GHG) emissions. Its main objectives are to (i) develop land management practices for reducing soil carbon depletion and enhancing soil carbon and nitrogen capture and storage; (ii) identify factors that influence GHG emissions from farmlands; and (iii) develop soil-water-nutrient management guidelines to enhance soil carbon and nitrogen capture and storage. Stable isotopic signatures of nitrogen-15 and carbon-13 will be used to identify sources of carbon dioxide (CO_2) and nitrous oxide (N_2O) emission and accumulation of carbon and nitrogen under different land uses	
CRP Title:	**Enhancing Soil Resilience to Drought and Flooding Events Through Ecosystem Approaches Accounting for Soil–Plant–Animal Interactions**
CRP Code:	**2038**
This CRP aims to (i) identify the effect of land management practices on the capacity of soils and crop cover to cope with alternate wetting and drying events, and (ii) increase soil resilience to drought and flood through improved land management practices. Nuclear techniques, including soil moisture neutron probe, the Cosmic Ray Moisture Observation System and stable isotopes of oxygen-18 and hydrogen-2 will be used to investigate the effects of drought and floods on soil nutrient dynamics, water retention and soil quality	
CRP Title:	**Soil Fertility and Quality Enhancement Using Cover Crops and Strategic Fertilizer and Animal Manure Applications: Role of Nuclear Techniques**
CRP Code:	**2039**
The objectives of this CRP are to (i) identify the effect of cover crops, fertilizer applications and animal manure on soil fertility, soil quality and soil water retention capacity and (ii) develop integrated soil, fertilizer and land management practices and guidelines to improve soil fertility, soil quality and land productivity. Nitrogen-15 and carbon-13 stable isotopes will be used to quantify carbon and nitorogen accumulations in soils under different cropping and land use systems.	

Project 2000011	2.1.2.001 Improving Animal Production and Breeding
CRP Title:	**Use of Molecular and Nuclear Technologies to Characterize Animal Genetic Variation to Improve Livestock Disease Resistance**
CRP Code:	**2043**
Indigenous breeds are an important component of animal biodiversity and they possess advantageous traits influencing disease resistance, adaptability to harsh environments or productivity. However, indigenous animals are underutilized in conventional breeding programmes, due to a lack of knowledge and failure to identify breeds and animals carrying the most advantageous traits. There are indigenous breeds with some degree of enhanced resistance, as compared to exotic ones reared in the same environment, especially for gastrointestinal nematode infections. The present CRP aims to characterize phenotypes of sheep and goats that have resistance to gastrointestinal parasites and to identify genes responsible for variations in phenotypes through genomic studies such as those that use radiolabelled nucleotides in DNA hybridization, DNA characterization, and single nucleotide polymorphism. The CRP activities will help identify molecular markers of economic interest, which will open possibilities in the future to select and breed animals for enhanced resistance to diseases. The CRP is also aimed at strengthening capacity in developing countries in the use of molecular and related technologies and creating opportunities for international research collaboration.	
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 — second phase - 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. This CRP will focus on improved and rapid detection platforms and the use of effective prophylactic control strategies.	
CRP Title:	**Early and Rapid Diagnosis and Control of Animal Trypanosomosis**
CRP Code:	**2044**
Infections threatens an estimated 50 million head of cattle and about 60 million people in regions of sub-Saharan Africa where the tsetse fly vectors of the disease occur. Every year, African animal trypanosomosis, caused by *Trypanosoma vivax*, *T. congolense* and *T. brucei*, known collectively as “nagana”, results in some three million deaths in cattle, while approximately 35 million doses of trypanocidal drugs are administered in order to treat infected animals, or to prevent infection in animals at risk from disease by using prophylactic drugs. In addition, 50 000 to 70 000 people are infected with human African trypanosomosis caused by *T. rhodesiens*e or *T. gambiense*. Nagana has a severe impact on agriculture in sub-Saharan Africa. The economic losses in cattle production alone are in the range of US $1.0–1.2 billion. The objective of this CRP is to apply early and rapid pen-side diagnostic technologies to differentiate infections with different species of pathogenic trypanosomes, thereby enabling more efficient use of drugs and to provide real-time information on the distribution of the disease. In addition, the CRP will investigate the potential for using irradiation attenuated trypanosomal vaccines in the control of the disease.	
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:	**2082**
The majority of food irradiation facilities rely on the radionuclide cobalt-60 (Co-60) to generate the rays that irradiate food. The amount of Co-60 available worldwide is limited and it is proving difficult to deliver large radioisotope sources in many parts of the world because of the fear of terrorism and increasing logistical complexities associated with transboundary shipments. If the technology is to become more widespread there is therefore a need to ensure that alternative technologies are also available. Electron beam or X-ray machines provide an alternative technology that employ electricity to generate beams of radiation and avoid the procurement, transport, storage, disposal and safeguards issues associated with	

radionuclides. An additional benefit is the fact that the machines do not involve a nuclear connotation and so mitigate negative consumer perceptions. Therefore, research is necessary to (1) identify new technological approaches to food irradiation which are applicable to food issues of international importance (e.g. reducing food waste and improving food security, safety and affordability); (2) develop new approaches for the application of food irradiation technologies in order to support shelf-life extension, microbial decontamination and insect disinfestation (quarantine treatment) of various commodities to ensure wholesome, safe and high quality food; (3) develop harmonized protocols and approaches for the use of electron beam and X-ray irradiation (machine source) technology that builds on procedures used with established gamma irradiation (radionuclide source) technology in order to facilitate the production of affordable, safe and high quality foods; and (4) develop new standards and protocols for the application of electrically generated food irradiation technologies to promote safe food and regional/international trade. Ideally, participants should have access to an irradiator and those with gamma irradiation facilities may wish to collaborate with researchers using machine source technologies.	
Project 2000021	**2.1.4.001 Use of the Sterile Insect Technique and Related Technologies to Manage Major Insect Plant Pests**
CRP Title:	**Comparing the Performance of Sterile Males Produced by Genetic, Transgenic or Paratransgenic Technologies**
CRP Code:	**2046**
There is a great demand by Member States to develop sterile insect technique (SIT) strategies for the population control of major agricultural insect pests and disease vectors. Classical and/or molecular genetic technologies have developed, and continue to develop, elegant sexing and sterility systems in targeted insect species with the real expectation that these strategies can be extended to SIT programmes. It is important therefore to compare the performance of sterile males produced by all these technologies. The objectives of this CRP are: 1) to continue the development of sexing and sterility systems for all major agricultural pests and disease vectors; 2) to make a comparative evaluation of the performance of sterile males produced by genetic, transgenic or symbiont-based technologies; and 3) to exploit the new knowledge for the improvement of ongoing SIT programmes and/or the development of new ones.	
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 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.	
2.2 Human Health	
Project 2000010	**2.2.1.001 Nutrition through the Life Cycle**
CRP Title:	**Energy Requirements of Children Assessed Using the Doubly Labelled Water Technique**
CRP Code:	**2048**
The doubly labelled water technique is the reference method to assess total energy expenditure in people going about their normal daily living activities. Total energy expenditure is an indicator of energy requirements in adults and in children. The energy requirements of children from developing countries may be very different from children living in the industrialized world due to differences in lifestyle. The need for more information on	

the energy requirements of infants and young children living in resource limited settings was highlighted in the current recommendations on human energy requirements (FAO/WHO/UNU, 2004). This CRP will address that knowledge gap.	
CRP Title:	**Prevention and Treatment of Malnutrition in Young Children**
CRP Code:	**2049**
Malnutrition remains the single largest cause of child mortality; more than 35% of child deaths worldwide are due to maternal and child undernutrition, but childhood mortality can be substantially reduced by following the WHO/UNICEF recommendations on exclusive breastfeeding for the first 6 months, followed by appropriate complementary feeding and continued breastfeeding for up to two years. This CRP will include evaluations of programmes to prevent and treat malnutrition in infants and young children in collaboration with WHO. UNICEF, WFP and other organizations. Stable isotope dilution techniques will be used to assess breastfeeding practices and changes in body composition to evaluate the quality of weight gain during treatment or the quality of growth during malnutrition prevention. The CRP will enhance Member States' capability to combat malnutrition in all its forms.	
CRP Title:	**Assessment of Nutrition Interventions in Patients with Cancer Using Stable Isotope Techniques**
CRP Code:	**2050**
Patients with cancer cachexia, characterized by loss of appetite, chronic inflammation and wasting of muscle mass, have special requirements for amino acids in the diet. Providing additional calories without paying attention to the amino acid composition of the diet does not attenuate wasting in these patients. If the amino acid composition of the diet is not sufficient to meet the demands of acute phase protein synthesis in patients with chronic inflammation, muscle protein is used as the source of amino acids and this leads to muscle wasting and loss of lean body mass. This CRP will use stable isotope techniques based on deuterium dilution to assess changes in body composition following nutritional interventions in patients with cancer cachexia.	
Project 2000015	**2.2.2.001 Diagnostics and Therapy of Non-Communicable Diseases (NCDs) using Nuclear Techniques**
CRP Title:	**Radiation Therapy Planning of Non-small cell lung cancer based on PET/CT. (Diagnostic Component)**
CRP Code:	**E13042 (conducted jointly with E33038)**
Non-small cell lung cancer (NSCLC) is considered in many countries as a leading cause of cancer-related morbidity and mortality. While curative radiation therapy can be performed on patients who are surgically inoperable, local control and overall survival rates have historically been low, possibly due to inappropriate selection of patients and uncertainties in target definition. It is hoped that radiation therapy planning (RTP) based on the use of fluorodeoxyglucose (fluorine-18 labelled deoxyglucose) (FDG) with positron emission tomography/computed tomography (PET/CT) will make it possible to select patients who would benefit from curative radiation therapy and to improve the target volume definition (TVD), leading to better outcomes following curative radiation therapy. There are two complementary CRPs, this one and CRP No. E33038, that involve PET/CT based RTP and aim to improve the clinical outcomes for patients diagnosed with NSCLC, This CRP will focus on the diagnostic aspects of introducing FDG PET/CT for RTP, including quality control, acquisition and processing protocols, and imaging analysis and interpretation. PET/CT based RTP will be introduced to patients with stage III A/B NSCLC in participating centres that are suitably equipped, but unable to implement this technology properly. This CRP will be conducted in two phases: a preparatory phase to acquire and maintain competencies in PET/CT based RTP for NSCLC, followed by a prospective clinical trial to evaluate the effect of PET/CT based RTP in recruited patients. Research institutions willing to participate in this CRP must have the required infrastructure and be able to nominate a chief scientific investigator from the nuclear medicine department to be involved in the diagnostic component of this CRP.	

CRP Title:	**Use of FDG PET/CT for Imaging Patients with Tuberculosis and Related Conditions (HIV/AIDS): Focus on Drug Resistant Extrapulmonary Tuberculosis**
CRP Code:	**E15021**

Nearly 11% of all deaths from infectious diseases are caused by tuberculosis (TB) and over 95% of deaths from TB occur in low- and middle-income Member States, where TB is among the top three causes of death for women of reproductive age. This disease has become or is becoming a medical emergency, not only in developing Member States, but also in some high-income countries, because of migration of people from low-income to higher-income areas, because of frequent co-infection with HIV/AIDS, and because of the development of drug-resistant strains of TB. The aim of this study is to engage Member States in a CRP to develop a comprehensive TB imaging strategy through the use fluorodeoxyglucose (fluorine-18 labelled deoxyglucose) (FDG) positron emission tomography/computed tomography (PET/CT) for imaging TB patients with special focus on: (a) extrapulmonary TB (b) multi drug resistant TB and (c) monitoring the response to therapy (baseline FDG PET scan and repeat scan at 2 months and 6 months post therapy) in order to reduce rates of TB and deaths from TB, especially drug resistant TB. Radionuclide imaging of infection has for long time relied almost exclusively on single-photon-emitting agents, evolving from early applications of gallium-67-citrate scintigraphy to scintigraphy with autologous leucocytes, labelled either directly (by in vitro incubation with agents such as indium-111-oxine or technetium-99m-hexamethylpropyleneamine oxime before reinfusion) or indirectly (e.g. administering radiolabelled antibodies binding to surface antigens expressed by granulocytes). The latest entry for radionuclide imaging of infection in the clinical setting is represented by PET with FDG, based on non-specific enhanced glucose consumption of inflammatory cells and/or growing bacteria at the site(s) of infection. This CRP will contribute to the overall improvement of health care by accurate and early diagnosis of intractable TB infections in high risk patients through a multicentre imaging trial using FDG by increasing the detection rate of respiratory, abdominal, central nervous system, and postoperative infections related to TB. Overall, infectious disease constitutes a big burden to healthcare systems, not only because of the direct costs related to treatments, but also in terms of the overall economic and social burden as a result of the associated disabilities and chronic debilitating illnesses, such as the disability-adjusted life years and the health-adjusted life expectancy. The top infectious diseases causing deaths worldwide are lower respiratory infections (including pneumonia and influenza), chronic obstructive pulmonary disease, diarrhoeal diseases, HIV/AIDS, and TB. While the impact of radionuclide imaging in the first four such infectious conditions is rather limited, nuclear medicine imaging does have a potential role in certain stages of TB infection, not at the diagnostic stage, but at subsequent stages in order to characterize the disease and assess its response to therapy.

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), a major health problem worldwide, 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 Asia and Africa, while in the United States; 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 the minority (in less than 20% cases) of tumours results in 5-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 radiofrequency ablation (RFA) or alcohol injection may be used as curative therapy for early HCC. For unresectable HCC that are not suitable for ablative therapies, transarterial chemoembolization (TACE) has a survival advantage as compared to the best supportive care. Stereotactic body radiotherapy (SBRT), an emerging treatment method that enables high precision and high dose delivery to a tumour using a small number of fractions, has the 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 treatment 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 this CRP will have a worldwide impact; its results will be particularly relevant for developing countries mainly in Asia and Africa, where the disease is common.	
CRP Title:	**Radiation Therapy Planning of Non-Small Cell Lung Cancer based on PET/CT (Radiation Oncology Component).**
CRP Code:	**E33038 (conducted jointly with E13402)**
Non-small cell lung cancer (NSCLC) is considered in many countries as a leading cause of cancer-related morbidity and mortality. While curative radiation therapy can be performed on patients who are surgically inoperable, local control and overall survival rates have historically been low, possibly due to the inappropriate selection of patients and uncertainties in target definition. There are two complementary CRPs, this one and CRP No. 13042, that involve positron emission tomography/computed tomography (PET/CT) based radiation therapy planning and aim to improve the clinical outcomes for patients diagnosed with NSCLC, This CRP will concentrate on PET/CT utilization for target volume definition and on the clinical outcomes of such a treatment approach. Research institutions willing to participate in this CRP must have the required infrastructure and be able to nominate a chief scientific investigator from the radiation oncology department to work on the activities related to this CRP.	
CRP Title:	**Quality Assurance of Volume Definition for Three-Dimensional Treatment Planning**
CRP Code:	**2059**
The definition and contouring of targets is one 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 3D treatment planning and develop a methodology to minimize them. A specific delineation tool will be selected and will be made available to a number of radiotherapy departments in Member States that are introducing 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 of IAEA and external consultants will study these cases and make an assessment of the accuracy and uncertainties in the delineations. The research group will attempt to systematize the variabilities and compare them against published delineation guidelines. The objectives of the CRP are (1) to validate the specific contouring software as a teaching tool, (2) to assess the accuracy and uncertainties associated with its use in common cancers, and (3) to train radiation oncologists in the participating centres on target volume delineation in common cancers for 3D conformal radiotherapy. The plan is to implement this research project in cross-cutting collaboration with the European Society for Radiotherapy and Oncology.	
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 decrease the need for human donors. It will also be considered as a forum for information, knowledge, and technology exchange among participating institutions and facilitate the formation of a network between the diverse disciplines involved. Radiation technologies plays a role in facilitating and accelerating the development of tissue engineering by addressing some of its challenges and opportunities, 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). 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.	
2.3 Water Resources	
Project 2000123	**2.3.2.002 Management Strategies for Groundwater and Surface Water Resources**
CRP Title:	**Application and Development of Isotope Techniques to Evaluate Human Impacts on Water Balance and Nutrient Dynamics of Large River Basins**
CRP Code:	**F33021**
This CRP will focus on assessing our understanding of the hydrology of large river basins by applying water isotopes and additional geochemical and isotope parameters as a means to constrain water balance and nutrient dynamics in large river basins. Environmental and anthropogenic land-use changes at basin-scales have dramatically altered the dynamics of the world's largest rivers and have adversely impacted water quantity as well as quality. The CRP was formulated based on the conclusions and recommendations of a consultants' meeting in November 2012 and will improve expertise among Member States in the use of environmental isotopes. Furthermore, it will increase our understanding of the relationship between hydrological and biogeochemical processes in large river basins. The aim of the CRP is to target more than fifty of the largest rivers of the world, in order to obtain an improved and quantitative understanding of how human impacts directly influence the water quality of our river and surface water systems, and to enhance and improve the IAEA's Global Network of Isotopes in Rivers.	
2.4 Environment	
Project 2000076	**2.4.3.001 Radioactive and Non-Radioactive Pollution and Impact on the 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 as a result of 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 help them decide on measures to minimize river, estuary, coastal and marine pollution. The main CRP tasks are to revise existing methodologies on suitable environmental archives for dating methods and to use pollution indicators. A database of global trends of pollution will be implemented and the results will be disseminated through a website and presentation to relevant stakeholders. Nuclear and isotopic techniques are the best option for studying environmental archives. Sediment and coral cores are dated through the determination of natural and artificial radionuclides, such as lead-210/polonium-210, radium-226 and caesium-137, and X-rays.	
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 supply. Isotopic and radioisotopic methods (such as receptor binding assay or measurement of isotopic signatures) can be used to identify and measure algal toxins in seafood, and improve knowledge about 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), to i) better assess the extent of the adverse effects on the environment of the toxic benthic microalgae responsible for the neglected tropical disease ciguatera (i.e. Gambierdiscus spp.), and ii) raise environmental and safe seafood sustainability awareness and understanding.	

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

The CRP is a fundamental contribution to the IAEA's subprogramme entitled "Nuclear Techniques to Understand Climate and Environmental Change". Climate projections rely on the knowledge of the basic processes responsible for climate variability and the calibration and/or validation 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 that 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 about recent climate change, through a synthesis of existing knowledge and 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, using its collaborating centre in Seville, multi-collector inductively coupled plasma mass spectrometry, laser ablation mass spectrometry and isotope ratio mass spectrometry), X ray images 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 through various radionuclides such as lead-210, carbon-14 and thalium-230 and other pertinent isotopes. This CRP is a development of the previous and successful CRP entitled "Nuclear and Isotopic Studies of the El Niño Phenomenon in the Ocean". Through this proposal, the objectives and expected membership is enlarged to encompass climate variability worldwide and, thus, have a wider regional coverage and involve a wider range of experience and technology. This 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 Released Radionuclides from the Fukushima Daiichi Nuclear Power Plant**
CRP Code:	**2068**

The accident at the Fukushima Daiichi nuclear power plant released huge amounts of radioactive substances into the Pacific Ocean. These radionuclides will be transferred and dispersed over the Pacific Ocean during the next years. There are a number of different ocean dispersion models to predict the dispersion of pollutants over time. These hydrodynamic ocean models can be used to predict the dispersion and uptake in biota and to assess the potential radiation exposure to humans and the environment. Similar studies can be applied to other nuclear facilities and in other emergencies. The CRP aims to compare available ocean models and assist Member States in the development of such tools for emergency planning. The Fukushima discharges will be used as a benchmark study in the Pacific. The objective of this CRP is to compare predictions and to 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 simulated data should be compared with measurements in the Pacific Ocean. Data could be used from the IAEA/RCA TC Project RAS 07/021 "Marine Benchmark Study on the Possible Impact of the Fukushima Radioactive Releases in the Asia-Pacific Region". The predictions can be used for recommendations for the Pacific Member States for measures with regard to seafood consumption or export or import of marine food and also provide valuable tools in other emergency situations resulting from marine pollution. The CRP will be related to the newly initiated Modelling and Data for Radiological Impact Assessments (MODARIA) project in order to improve capabilities in the field of environmental radiation doses assessments.

2.5 Radioisotope Production and Radiation Technology	
Project 2000090	**2.5.1.001 Development and production of medical radioisotopes**
CRP Title:	**Therapeutic Radiopharmaceuticals Labelled with New Radionuclides such as Astatine-211, Copper-67, Lead-212/Bismuth-212**
CRP Code:	**2073**
The objective of this CRP is to coordinate the research on new radionuclides having nuclear properties not yet exploited for radionuclide therapy. The type of radiation decay and nuclear characteristics are critical factors in determining the efficacy of the treatment. Thus, the study of new radionuclides is of utmost importance for progress in this field. This CRP includes as specific objectives (a) the development of efficient production methods for a selected radionuclide; (b) the rational design of various classes of molecular agents devised from the fundamental chemical properties of the selected radionuclide; (c) the development of efficient labelling methods; (d) the development of accurate quality control procedures for the resulting radiopharmaceuticals; (e) the determination of the in vitro and in vivo stability of the radiolabelled compounds; and (f) the preclinical evaluation of the pharmacokinetic and pharmacodynamics properties of the radiocompounds in animal models.	
Project 2000091	**2.5.1.002 Development of Diagnostic and Therapeutic Radiopharmaceuticals**
CRP Title:	**Nano-sized Delivery Systems for Radiopharmaceuticals**
CRP Code:	**F22064**
The aim of this CRP is to provide significant improvement in the delivery of therapeutic radiopharmaceuticals through the use of nanotechnology. It is expected to result in new nanoparticles capable of forming stable bonds with diagnostic and therapeutic radioisotopes, and with tumour specific biomolecules and proteins (including monoclonal antibodies) leading to well-defined delivery devices. Such nano constructs built from radiation-synthesized polymeric nanoparticles could be potentially capable of reaching and selectively penetrating the tumour sites, thus affording highly effective molecular imaging and therapeutic tools to combat various forms of human cancers. The proposed CRP will provide tremendous benefits to Member States because the nano-sized diagnostic and therapeutic agents that are planned to be developed might be potentially used in alleviating pain and suffering of human patients globally.	
CRP Title:	**Positron Emission Tomography (PET) Radiopharmaceuticals Using Fluorine-18 and Gallium-68 Radionuclides for Infection, Inflammation Imaging and Stem Cell Tracking**
CRP Code:	**2075**
The objective of this CRP is to coordinate the development of new PET radiopharmaceuticals, particularly, PET based tracers which could offer improved specificity and better resolution of the images than the currently utilized single photon emission radionuclides such as technetium-99m, indium-111 or gallium-67. Similarly, early diagnosis of tuberculosis is essential for community health and infection control, as well as for starting appropriate therapy for patients. This CRP will provide a coordinated approach to select a few promising peptides, saccharides or blood cell elements which, once they have been labelled with gallium-68 or fluorine-18, can pinpoint the sites and extent of infection or inflammation. In collaboration with the Nuclear Medicine and Diagnostic Imaging Section in the IAEA's Division of Human Health, the objectives will include developing radiolabelling and quality control methodologies for clinical use of PET radiopharmaceuticals in infection, inflammation and stem cell tracking imaging studies.	
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:	**2076**
Radiation techniques are increasingly applied and continuously evolving for 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 objectives of the CRP will be the development of nuclear techniques and associated methodologies such as nuclear borehole logging systems for exploration purposes; radiotracers to investigate mineral treatment processes, deriving data in a simple manner from a variety of complex and closed systems and thus providing information for optimal recovery of the desired mineral; and nucleonic control systems for online measurements on processing lines such as elemental analysis, real-time quality control of products and process management. Within the CRP, the introduction of new technologies such as miniature neutrons generators, X-ray generators, new detectors, data acquisition systems with user friendly software, etc. will be considered.

Project 2000095	**Radiation Technology Support for Materials Development and Nanoscience**
CRP Title:	**Disinfection and Consolidation of Archived Materials and Cultural Heritage Artefacts by Radiation Processing Techniques**
CRP Code:	**2077**

The preservation of world cultural heritage is a key issue for maintaining national identity, and understanding the exchanges among civilizations throughout history. Cultural heritage artefacts that are based on paper, textiles or wood are prone to biological attack if they are not properly conserved. The application of ionizing radiation for the disinfection of cultural heritage artefacts has been successfully demonstrated in recent years with the participation of museums and libraries. The wider use of this technique is dependent on 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 base materials of artefacts, minor constituents, post-irradiation effects and appropriate irradiation procedures for wider use of the technology.

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 the Material Properties of Structures and Components Utilizing Actual Aged Materials Removed from Decommissioned Reactors**
CRP Code:	**2078**

For safe long term operation, international collaboration aimed at collecting, measuring, recording and analysing the properties of sample materials removed from systems, structures and components of decommissioned NPPs, or the properties of components subject to physical ageing that have been replaced, addresses the synergetic effects of combining different degradation mechanisms in real operational conditions, provides a basis for comparison of the results of laboratory tests and calculations, and provides the possibility for avoiding unnecessary conservatism. The specific objective of the CRP will be to address degradation mechanisms of mechanical, electrical and instrumentation and control (I&C) components and structures. Phase 1 (2014–2017) will cover neutron irradiation embrittlement of reactor pressure vessel internals and irradiation assisted stress corrosion cracking of reactor pressure vessel internals. Phase 2 (to be initiated in 2015 or later) will cover strength, stiffness, shielding and other 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.