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**Specific Monitoring Report on research activities for nuclear safety and security
supported by the Euratom Framework Programme 2012 – 2013**

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This report outlines direct and indirect research activities that were carried out during the Euratom Framework Programme for research and training activities (2012-2013). Those activities should be placed in the context of the different events that occurred during this period and in particular the Fukushima accident in Japan.

*This report covers only the safety and security research related to **nuclear fission** and **radiation protection**. It excludes activities related to fusion, which is a technology still far from reaching a demonstration phase.*

**Specific Monitoring Report
on research activities for nuclear safety and security
supported by the Euratom Framework Programme 2012 – 2013**

1. RATIONALE

The rationale for this report, in accordance with the Council decision concerning the Euratom Framework Programme for 2012-2013¹, hereinafter FP7+2, is that the Commission should prepare "*in early 2013 a specific monitoring report, to be presented to the Council, dedicated to the implementation of nuclear safety and security research activities of the Framework Programme*". The specific monitoring report constitutes an important deliverable that the Council could consider when examining the proposal for the Euratom part of Horizon 2020.

Nuclear safety and security are key priorities of the European Union energy policy^{2,3,4}. The Euratom nuclear safety and security research activities cover a field wider than the use of nuclear energy for production of electricity and in particular, include the use of ionising radiation for applications in research, industry and health. Continuous research on safety and security is a prerequisite for the implementation of the Euratom Treaty, which aims at improving the standard of life of citizens in Member States in the fields where nuclear energy plays a role. The current Euratom research orientations in the domain of nuclear safety and security have been defined in the Euratom Framework Programme for nuclear research and training for the period 2012 to 2013. The Specific Programmes, linked to the Framework Programme, define in more detail the activities to be implemented by the direct actions of the Joint Research Centre (JRC) and the indirect actions of DG RTD.

Research on nuclear safety applies to the full range of provisions from the design of nuclear installations to their operation and final decommissioning including the disposal of radioactive waste. They are aimed at protecting people and the environment against the adverse effects of ionising radiation. Radiation safety applies to the safe use of ionising radiation for medical imaging and therapy as well as the use of radiation sources for industrial radiography. Research on nuclear security encompasses the fields of verification, detection and prevention of proliferation as well as detection of and response to malevolent acts involving nuclear and radioactive materials. Nuclear security is exclusively addressed within the direct actions.

2. BACKGROUND (UP TO END OF 2011)

The **Euratom Treaty** establishing the European Atomic Energy Community (Euratom) was created to coordinate the Member States' (MS) programmes to develop the peaceful use of nuclear energy. The Euratom Treaty today continues to help pooling knowledge, infrastructure, and funding of nuclear energy research.

¹ Article 6(1) of the Council Decision 2012/93/Euratom of 19 December 2011.

² Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations

³ Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, adopted by the Council of the European Union on 19 July 2011

⁴ Basic Safety Standards Directive sets out standards for radiation protection in the Member States, Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation

The 7th Euratom Framework Programme⁵ was set out to develop Euratom research activities, under two specific programmes for direct and indirect actions. The first specific programme, managed by DG RTD, covers nuclear fission and radiation protection, with the objective of enhancing in particular the safety performance, resource efficiency and cost-effectiveness of nuclear fission and other uses of radiation in industry and medicine. The second specific programme covers the activities of the JRC in the field of nuclear energy which were divided in three main categories: (a) nuclear waste management, environmental impact; (b) nuclear safety; and (c) nuclear security.

2.1 DG RTD - indirect actions

The general objective of the Specific Programme implementing the Euratom Seventh Framework Programme (FP7) for nuclear research and training activities (2007 to 2011)⁶ in nuclear fission and radiation protection reads as follows: "*Establishing a sound scientific and technical basis in order to accelerate practical developments for the safer management of long-lived radioactive waste, enhancing in particular the safety performance, resource efficiency and cost-effectiveness of nuclear energy and ensuring a robust and socially acceptable system of protection of man and the environment against the effects of ionising radiation*". The main activities are described below.

2.1.1. Management of radioactive waste

European research and training programmes on radioactive waste management have been implemented since 1975 under the provisions of the Euratom Treaty. A key principle of these programmes is the support for EU collaborative activities in implementation of safe and publicly acceptable solutions in the processing and disposal of radioactive waste. While disposal of short-lived low and intermediate level waste has reached industrial maturity, there is world-wide that deep geological disposal represents the safest and most sustainable solution for the management of high-level waste and spent fuel considered as waste.

Following more than 30 years of research, FP7 has focussed its support on all remaining key scientific and technological aspects required for actual implementation of deep geological repositories. Through the EC support (about 33 M€) of fifteen (15) projects, the programme has sought the continuing development of a common understanding of the scientific issues in supporting coordination and joint implementation of priority research. One notable success has been the establishment of the Implementing Geological Disposal Technology Platform (IGD-TP) in 2009, managed by the leading European radioactive waste management organisations, with the objective of sustaining a long-term joint strategic research agenda.

⁵ Council decision of 18 December 2006 (2006/970/EURATOM) concerning the Seventh Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities (2007 to 2011).

⁶ Council decision of 19 December 2006 (2006/976/Euratom) concerning the specific programme implementing the Seventh Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities (2007 to 2011).

2.1.2. Reactor systems

The European Union (EU) promotes high safety standards in all types of civilian nuclear activities, including nuclear power production. EU Nuclear safety standards are based on the requirements of the main international agreements, namely the Convention on Nuclear Safety and the Safety Fundamentals established by the International Atomic Energy Agency (IAEA). The Western European Nuclear Regulators Association (WENRA) is also supporting to develop a common approach to nuclear safety, to provide an independent capability to examine nuclear safety in applicant countries and to be a network of chief nuclear safety regulators in Europe exchanging experience and discussing significant safety issues. All EU Member States are also represented within in the European Nuclear Safety Regulators Group (ENSREG) by senior officials from their national regulatory authorities or nuclear safety authorities. All Member States of the EU are party to the Convention and the Community established by the Euratom Treaty shares jurisdiction with Member States in the fields governed by the Convention.

The research on reactor systems had two main focused areas under FP7, where forty-one (41) projects were supported (about 129 M€ of EC funds):

- *Nuclear installation safety*: RTD in operational safety of current and future nuclear installations, especially plant life assessment and management, safety culture (minimising the risk of human and organisational error), advanced safety assessment methodologies, instrumentation and control, and prevention and mitigation of severe accidents, with associated activities to optimise knowledge management and maintain competence.
- *Advanced nuclear systems*: RTD to improve the systems' efficiency and to investigate aspects of selected advanced reactor systems in order to assess their potential, proliferation resistance and their effects on long-term sustainability, including waste management aspects (aiming at reducing the amount and hazard of radioactive waste).

In 2007, the Sustainable Nuclear Energy Technology Platform (SNETP) was launched with the objective to promote research, development and demonstration of the nuclear fission technologies necessary to achieve the goals of the SET-Plan (European Strategic Energy Technology Plan) in this field: (i) maintain safety and competitiveness in fission technology, (ii) complete the demonstration of a new generation of fission reactors with increased sustainability, (iii) enlarge nuclear fission applications beyond electricity production. SNETP issued a Strategic Research Agenda (SRA) in 2009 and a deployment Strategy in 2010.

2.1.3. Radiation protection

The overall objective of radiation protection is to protect human health against the dangers arising from ionising radiation, resulting from practices using radiation or radioactive substances, notably for medical, industrial and energy applications. Ionizing radiation has been used in medicine for more than a century and has proven to be an essential component of modern medical diagnosis and treatment. The technology has made much progress in the past decades, in X-ray imaging, in nuclear

medicine, and in radiotherapy. At present, the overall population exposure due to medical procedures hugely exceeds any other man-made exposure. The protection of the patients and other individuals exposed in medical practice, is therefore one of a main priority task for the European Commission under the Health and Safety Chapter of the Euratom Treaty.

The risks arising from the acute and instantaneous exposure to radiation are well known from studies carried out during the follow up of populations having survived Hiroshima and Nagasaki bomb detonations. However, a wide uncertainty is associated to the risk assessment of low doses and protracted exposures. Research on radiation protection under FP7 is subdivided into 3 topics sharing a common baseline understanding on the risk associated with low doses of ionising radiation: the medical use of ionising radiation; the protection of the environment; the preparation to nuclear accidents and the management of post-accident situations. Under FP7, nineteen (19) projects were supported with around 58 M€.

Low dose research was a topic per se at the beginning of the 7th Framework Programme and became progressively a cross-cutting topic of radiation protection.

2.1.4. *Infrastructures*

Research infrastructures are an essential part of RTD in nuclear and radiological science and technology, ranging in size from very large and expensive facilities, outside the reach of individual Member States, to networks of smaller facilities, but of pan-European interest, such as databases, numerical simulation tools and tissue banks.

A major objective of FP7 was to provide support for key infrastructures where there is clear European added value especially in order to establish critical mass and for the replacement of ageing research facilities. Infrastructures also make an important contribution to the training of scientists and engineers. The eleven (11) projects supported under FP7 (about 22 M€ of EC funds) contribute to maintaining the high standards of technical achievement, innovation and safety in the European nuclear sector, including in the medical field (production of radio-isotopes). Under FP7, Euratom also supported the development of the Jules Horowitz Reactor (JHR), which will be one of the very few large research reactors still in operation in Europe, as from the start of its operation in 2017, enabling a European irradiation capacity for the research on structural materials and nuclear safety.

2.1.5. *Human resources, mobility and training*

Sustaining scientific competence in Europe on nuclear fission safety and radiation protection, and making lifelong learning and borderless mobility a reality are two of the objectives of Euratom. Another goal is to promote a mutual trust, transparency and recognition of learning outcomes across Member States and their associated countries.

To ensure the highest achievable standards for nuclear education and training, a non-profit association was formed in September 2003: the European Nuclear Education Network (ENEN). FP7 supported the development of synergies between ENEN and

national education and training networks and the European Technological Platforms. In this context, six Euratom Fission Training Schemes (EFTS) have been launched during the period 2007-2011. A regional centre of competence for the safety of VVER reactors of Russian design and in operation in some Members States was also established to provide a structure for training and qualification of personnel working at these reactors, in line with the standards of the IAEA. On 16 September 2011, the EC adopted the 1st Situation Report on Education and Training in the Nuclear Energy Field in the European Union. The report provides a comprehensive picture of the situation of human resources in the nuclear energy sector in the EU, identifies the current challenges, and presents the spectrum of both current and planned EU, national and international initiatives in this field.

2.1.6. Cross-cutting actions

The FP7 addressed different cross-cutting issues relevant for different parts of the programme. The most important area in this respect is materials for nuclear installations. In 2009-2010 the establishment of the Joint Programme of the European Energy Research Alliance (EERA) on materials for nuclear was supported. In 2010-2011 Euratom contributed to elaboration of the “*Materials Roadmap Enabling Low Carbon Energy Technologies*”. Euratom also actively supported another strategic issue, namely the use of high power computing for nuclear safety.

In summary, under FP7 (2007-2011) ninety-nine (99) collaborative projects have been supported, for a budget of about 250 M€, the large majority of which being safety-oriented.

		Waste	Reactor Systems	Radiation Protection	Infrastructures	Human Resources & Training	Cross-cutting Actions	TOTAL
FP7	Number of projects	15	41	19	11	9	4	99
	Project EC Contribution (€)	33.588.092	128.753.640	58.549.398	21.660.954	6.717.078	1.503.257	250.772.420

2.2 DG JRC - direct actions

Nuclear safety and security have always been the focus for the JRC's nuclear activities. The general objective of the FP7 Specific Programme covering the activities of the Joint Research Centre was:

To provide customer driven scientific and technical support to the Community policy-making process in the nuclear field, ensuring support to the implementation and monitoring of existing policies while flexibly responding to new policy demands.

The main activities of the JRC were linked to supporting both Commission and Member States within Euratom obligations in the field of: nuclear waste management and environmental impact; safety of nuclear installations and the fuel cycle; and nuclear security, safeguards and non-proliferation. Cross-cutting activities such as international cooperation, standardisation, and education and training were also performed throughout FP7. Within each topic research and development was pursued, developing scientific/technical data and in specific cases, support to Euratom policy was delivered. The work programme was aligned so as to maintain a good balance between scientific outputs, stakeholder-requested deliverables

and ad-hoc policy support. A short description and few examples of the activities in each domain are described below⁷:

⁷ For more details on the JRC work programme : <http://projects.jrc.ec.europa.eu>

2.2.1 Nuclear safety

The nuclear safety activities within FP7 were linked to:

Nuclear reactor safety, nuclear fuel safety in power reactors operating in the EU; the safe operation of advanced energy systems

In 2008 the JRC developed a new initiative on Nuclear Power Plants (NPPs) providing operational feedback in cooperation with the EU nuclear national nuclear safety authorities. This initiative, called “EU Nuclear Safety Clearinghouse for Operational Experience Feedback”, organised via a network of EU regulators and their Technical Support Organizations (TSOs), is operated by a centralised office located at the JRC. This allows the leveraging of resources (experts, data) for technical work and further enhanced cooperation. In this frame the JRC delivered regular topical reports on subjects important to the safe operation of EU NPPs, and published quarterly reports on worldwide NPP operational events. The JRC also provided continuous support to DG DEVCO and DG ELARG on safety improvements for both western and Russian type of NPPs of neighbourhood countries, as well as on nuclear issues for pre-accession countries. Nuclear safety research also addressed the performance / degradation of structural materials of importance for safety for present and innovative nuclear reactor systems. In this context JRC was one of the driving forces for the establishment of the EERA (European Energy research Alliance). The JRC performed post irradiation examinations of safety related fuel properties at high burn-up and tested properties and behaviour of nuclear fuel under extreme conditions, encompassing normal and accident conditions. By so doing the JRC continued to strengthen its involvement in the European Research Area by supporting the Member States in the establishment of new projects that aim at improving the nuclear fuel safety of current and innovative fuels, as well as of alternative fuel cycles.

Cooperation with Member States was pursued, with international strategic partners and organisations (e.g. OECD/NEA, IAEA). The JRC has played an important role as the coordinator of the Euratom contribution to the Generation IV International Forum (GIF). In this role the JRC focussed on: the execution of pre-normative Research and Development into harmonised testing procedures and design codes for advanced nuclear reactor systems; advanced nuclear fuels, system integration capability; and evaluation methods to assess and compare safety and performance of next generation concepts.

The JRC also started an EU-wide monitoring on training and education needs on human resources in the nuclear sector. Through the European Human Resource Observatory - Nuclear (EHRO-N), it analysed the supply and demand for nuclear experts in the EU and contributed to the development of the "1st Situation Report on Education and Training in the Nuclear Energy Field in the European Union".

2.2.2 Nuclear security

The nuclear security activities were linked to:

Nuclear safeguards, additional protocol, open source information on nuclear non-proliferation, combating illicit trafficking of nuclear materials, including nuclear forensic analysis

The R&D in nuclear security, safeguards and non-proliferation at JRC continued to be oriented towards the needs of its main customers. These are within the European Commission, in particular DG ENER (Euratom safeguard inspectorates), the Member States and the IAEA.

Nuclear safeguards: The JRC supported DG ENER and IAEA activities on destructive analysis by developing dedicated techniques and instrumentation and providing its analytical services at its laboratories. The JRC's in-house expertise continued to contribute to standardisation and innovation by developing material standards and reference methods as well as documentary standards. In the field of non-destructive assay, JRC pursued investigations of suitable technologies for Helium-3 replacements (due to its shortage) by testing the performances of innovative neutron sensors and by analysing their possible application to nuclear detection instruments.

JRC developed and produced seals for both Euratom and IAEA inspectorates. In parallel, continuous improvements were made to the existing design of the JRC Candu Sealing System. In support to the safeguards inspectors the JRC undertook R&D on process monitoring and the modelling of material flows at nuclear facilities, including laser-based systems to create accurate 3D models of nuclear facilities as well as specific global in-field information instruments.

Additional Protocol: Environmental sampling and support to inter-laboratory analyses were regularly performed by the JRC. In the field of trade analysis and export control, the JRC supported DG TRADE with different types of activities concerning harmonisation of implementation. This included technical support to the amendment of EU regulation for dual use goods as well as a contribution to International regimes and EU control lists review. The JRC has also actively contributed to all proliferation resistance activities within GIF as well as the IAEA.

Open Source information on nuclear non-proliferation: To help verifying the compliance of a country with its nuclear safeguards obligations, JRC has developed and has been operating a "Nuclear Security Media Monitor" (NSMM), a web-based multilingual news aggregation system that automatically collects news articles from pre-defined web sites, and groups them into various areas of interest.

Combating illicit trafficking of nuclear materials, including nuclear forensic analysis: In this area, the JRC activities are mainly focused on the detection of, and response to (including nuclear forensics), theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear or other radioactive substances or their associated facilities. In the field of detection, the JRC has supported DG HOME and the Member States, in managing the ongoing ITRAP+10 (Illicit Trafficking

Radiation Assessment Programme) project for testing equipment for the detection of radioactive/nuclear material against international standards.

The JRC Pulsed Neutron Interrogation Assay PUNITA was used for the evaluation of active neutron interrogation for the detection of fissile materials (mainly Uranium 235). In the field of Nuclear Forensics, the JRC has developed and refined experimental techniques for the age dating of small samples of uranium, and engaged in the production of the first uranium reference material certified for the chemical separation date of thorium from uranium. A novel age dating method has been also developed and tested as a complementary technique. On behalf of the EU, the JRC is coordinating the following at the international level: the Border Monitoring Working Group (BMWG) established between the US, the EU and IAEA in the field of detection; the Nuclear Forensics International Technical Working Group (ITWG) in the field of nuclear forensics.

Training and Education: Dedicated training sessions on different safeguards techniques and methods were organised by the JRC for Euratom and IAEA inspectors. More specifically, training courses were organised in High Performance Trace Analysis, and on the use of analytical techniques developed by JRC for in-field uranium determination at Low Enriched Uranium fuel fabrication plants. Training on advanced mass spectrometry measurement techniques was also given at the Safeguards Analytical Services (SGAS). Other courses provided included: the regular annual ESARDA courses on Nuclear Safeguards and Non-Proliferation, training events in collaboration with US DOE NNSA in the field of export control, and training and workshops for front-line officers were delivered in the field of nuclear security.

2.2.3 *Nuclear waste management and environmental impact,*

As specified in the FP7 Specific Programme, the waste management and environmental impact activities were linked to:

Spent fuel characterisation, storage and disposal; partitioning, transmutation and conditioning; basic actinide research; nuclear data; medical applications from nuclear research; measurement of radioactivity in the environment; knowledge management and training and education

The JRC performed research for high level nuclear waste management, especially in the field of the direct disposal of spent fuel, and partitioning and transmutation. The basic research into actinides continued to improve knowledge on the processing or conditioning of long-lived waste minor actinides separation and complexation behaviour. In addition the JRC provided data and analysed surface corrosion and dissolution mechanisms concerning spent nuclear fuel, instant release fractions, reduction-oxidation conditions in the aqueous phase, and microstructure properties. The research also focussed on the experimental investigation of the fission process and its theoretical models. Nuclear data research produced high quality, new experimental data for specific neutron-induced reactions which are of interest to the safety of reactors and spent fuel and to the minimisation of nuclear waste. Regular support to IAEA and OECD/NEA was provided by delivering evaluated physical data to the Joint Evaluated Fission and Fusion library. In this context the JRC

continued to have a prominent and leading role in all FP7 indirect actions relevant to the generation of nuclear data.

In the frame of medical applications a range of new techniques were developed. This included Targeted Alpha Therapy for cancer treatment, as well as alternative methods for the production of radionuclides and chelate molecules, and labelling protocols for clinical application. The JRC also reported regularly on environmental radioactivity in the EU Member states as well as performing continuous monitoring. Inter-laboratory comparisons for instrumentation that monitor radioactivity in water, soil, and food were performed to improve the reliability and comparability of measurement results reported under Articles 35 and 36 of the Euratom Treaty.

The EURDEP (European Radiological Data Exchange Platform) developed and operated by the JRC proved to be an effective tool for the exchange of radioactivity monitoring information during the 2011 Fukushima event.

Laboratory training courses were continuously delivered during FP7 in radiochemistry, on measurement capability in ionizing radiation metrology and in mass spectrometry for practitioners from south-east European and neighbourhood policy countries (JRC Enlargement & Integration action). Furthermore, to counter the loss of knowledge and expertise in the nuclear field, the JRC acted as a European reference centre for the dissemination of information, training and education for young scientists and provided user access to its nuclear infrastructures. The JRC laboratories continued to provide transnational access to their facilities for researchers from the Member States.

3. RESEARCH ACTIVITIES SUPPORTING NUCLEAR SAFETY LAUNCHED UNDER EURATOM FRAMEWORK PROGRAMME (2012-13)

After the Fukushima accidents in 2011, the general objective of FP7+2 was refocused on nuclear safety and security. As a consequence, the name of the thematic area was changed to *nuclear fission, safety and radiation protection*. The main impact on the objectives was that R&D on advanced nuclear systems should concentrate on safety only.

3.1 DG RTD - indirect actions

Following two calls for proposals under FP7+2, thirty-three (33) new collaborative projects are being supported, for a budget of about 109 M€, representing about 44% of the first part of FP7.

		Waste	Reactor Systems	Radiation Protection	Infrastructures	Human Resources & Training	Cross-cutting Actions	TOTAL
FP7+2	Number of projects	3	12	6	3	4	5	33
	Project EC Contribution (€)	14.003.520	47.731.639	24.826.000	12.700.000	5.948.000	4.222.068	109.431.227

The collaborative projects selected are more focused and stimulate a better joint European approach, which explains that their size is in average 30% bigger than for those of FP7.

3.1.1 *Management of ultimate radioactive waste*

Under the umbrella of IGD-TP, two large projects have been funded to solve key issues for geological disposal. The first one is a Full Scale Demonstration of Plugs and Seals, to demonstrate the compliance of reference design basis of these techniques in deep geological disposal facilities. The second one develops understanding of the generation and release of the Carbon-14 source term from radioactive waste materials under conditions relevant to waste packaging and disposal. The successful implementation of IGD-TP will help reducing the practice of spent fuel storage on reactor sites and thereby increasing the safety of nuclear installations.

3.1.2 *Reactor systems*

Few months after the Fukushima event, SNETP published a report entitled "*Identification of Research Areas in Response to the Fukushima Accident*". In parallel, SNETP issued in February 2013 a revised version of the SRA, the Strategic Research and Innovation Agenda (SRIA), focusing on nuclear safety.

The Euratom work programmes 2012 and 2013 gave also total emphasis on nuclear safety, in particular on the management of possible severe accident at the European level. Two priority topics emerged: (i) impact of the nuclear accident in Japan on severe accident management and (ii) consequences of combination of extreme external events on the safety of Nuclear Power Plants. As a result, three collaborative projects were funded on (a) the investigation of passive and active systems on severe accident mitigation and enhanced safety of future reactors, (b) the upgrade of the computer code for European severe accident management and (c) the establishment of best practice guidelines for the identification of consequences of combination of extreme external events on the safety of nuclear power plants. Another project was funded to complete the roadmap of a European informatics platform to perform multi-scale and multi-physics computation for the safety of existing reactors. The emphasis on nuclear safety was also reflected in the selection of two projects, one on minor actinide separation processes from high level waste for the global safety of the long-lived waste management and the other on the safety of the MYRRHA project for which two main types of accident, the uncontrolled power excursion and the residual heat removal after reactor shutdown should be surpassed. In the 2013 call, three additional projects were selected for funding a preparatory phase, which should aim at optimal coordination, cross-border operation and possible integration of national research actions of pan-European interest in the field of nuclear fission and safety.

3.1.3 *Radiation protection*

Due to the condensation of radioactive vapours on the containment structures of damaged Fukushima reactors and meteorological conditions, exposures to the population remained in the range of low dose. But the exposed populations as well as consumers of goods originating from Japan are legitimate to raise questions about the risk from low dose and long term exposures. As a result of the Euratom call in 2012, a project was selected for funding, which establishes an innovative integrative set of tools for the preparedness to radiological emergencies and post-accident response in

Europe. The cross cutting nature of low dose research is also reflected in the support provided to research on the contamination of the food chain and the environment. Moreover, these two fields have been integrated to the Multidisciplinary European Low Dose Initiative to foster coordination of Member State research and EU research in radiation protection. In doing so, the basic scientific evidence necessary to appraise the overall risk from ionising radiation, for people, the environment and food products will be gathered in a more comprehensive manner.

3.1.4 Infrastructures

Support to large infrastructures was obviously continued in FP7+2 and the MYRRHA project was retained as a priority topic in order to bring it to the level of maturity required to enable the construction work to start. This will be a multi-purpose infrastructure enabling notably efficient research for nuclear waste management and materials science. Two projects on transnational access to large infrastructures were also funded, one for the safe management of actinides (the most constraining radionuclides in radioactive waste management), and the other on data management for nuclear safety and nuclear applications.

3.1.5 Human Resources and training

The launching of Euratom Fission Training Schemes (EFTS) has been continued in FP7+2 in four areas: nuclear safety, diagnostic and interventional radiology, nuclear chemistry, radioactive waste disposal. A new project also contributes to increasing nuclear safety competence, drawing the lessons from Fukushima, related to cultural issues and integrating the scientific and socio-economical view point.

3.1.6 Cross-cutting actions, support to new Member States and cooperation with Third Countries

FP7+2 continued providing the support for the nuclear materials science field, as well as for numerical simulation tools. Support was also provided for activities leading to a greater involvement of New Member States, representing an increase of funding by a factor of more than 2.5. Ultimately, these activities contribute to the dissemination of the safety culture across the EU. A structured dialogue was also reinforced, under the umbrella of bilateral cooperation agreements, with Russia and China, and with other third Countries, e.g. USA (in the context of the EU-US Energy Council) and Ukraine.

3.2 DG JRC - direct actions

JRC's 2012 activities further focussed along the orientations already taken in 2011 as an immediate response to the Fukushima Event. A high priority within the JRC was therefore given to the support to the implementation of the EU NPP "Stress tests" that followed. Other topics such as research in decommissioning, and providing a major contribution to the implementation of the EU-CBRN (Chemical Biological Radiological Nuclear) Action plan were also set as new priorities. The section below gives some examples of JRC activities in 2012:

3.2.1 *Nuclear safety*

The EU "stress tests" were the main reaction of the EU to the Fukushima nuclear accident. The nuclear stress tests were organized under the umbrella of ENSREG, the European Nuclear Safety Regulators' Group gathering the EC and the nuclear Safety Authorities of the 27 EU Member States. The stress tests consisted of 3 main steps: self-assessment by each NPP licensee, review at national level by each national nuclear Safety Authority, and a final international peer review of the national reports and country visits. Seventeen European countries were peer reviewed. The JRC provided staff for technical and administrative support throughout the whole peer review process which lasted the whole year. JRC staff participated in each NPP visit organised and supported the development of relevant peer review reports. The accident underlined the need to better assess plant behaviour beyond the design base accidental conditions. In response, a new activity has been established in the JRC to underpin research and to build expertise in nuclear accident modelling. Active participation in the OECD/NEA Accident Management group has also been pursued on issues identified in the EU Stress test such as Filtered Venting System and Spent Fuel Pools. JRC also initiated a project to examine spent fuel behaviour in accidental conditions similar to the ones experienced in Fukushima and a longer term project on cross comparisons and analysis of nuclear accidents.

3.2.2 *Nuclear security*

The nuclear security, safeguards and non-proliferation activities at JRC continued to be oriented towards the needs of its main customers in the EC, the Member States and the IAEA. In particular the European Commission Cooperative Support Programme to the IAEA provided technology and expertise in technical areas related to the effective implementation of safeguards verification measures, including the detection of undeclared materials, activities, and facilities. Strong collaboration was further developed between the JRC and the US-DoE. A Memoranda of Understanding with Japan was extended. JRC also continued to contribute to the Instrument for Nuclear Safety Cooperation, including safeguards, and to the IfS (Instrument for Stability, including the non-proliferation work). More recently support was delivered to DG HOME via the implementation of the EU CBRN action plan. Support was also given to DG TRADE and DG TAXUD on issues related to trade analysis and border control.

Due to its central role in the field, the JRC has coordinated the development of the reference document⁸ for the EU participation to the Seoul 2012 Nuclear Security Summit.

Nuclear Safeguards: In the context of destructive analysis, the JRC continued to support DG ENER's on-site labs in Sellafield and La Hague as well as continuing to support IAEA activities. More specifically, a new state-of-the-art thermal ionisation mass spectrometer (TIMS) instrument was installed and commissioned at the on-site lab in Sellafield (UK) in 2012. The JRC actively contributed to the compilation of the International Target Values for Measurement Uncertainties in Safeguarding Nuclear Materials document and provided Euratom safeguards, IAEA and Japan with

⁸ "EU efforts to strengthen nuclear security" – SWD(2012)70 final

the necessary certified nuclear reference materials. In the frame of material standards and reference methods, the JRC presented a recently developed "memory corrected double standard" (MCDS) technique for accurate isotopic measurements. In the field of non-destructive assay, a prototype of a neutron well coincidence counter based on liquid scintillators was designed in collaboration with the IAEA. In 2012, the JRC developed for DG ENER and IAEA its indoor and outdoor Design Information Verification (DIV) laser-based systems to create accurate 3D models of nuclear facilities as well as of infield tools for the safeguards investigative inspector. The JRC implemented and demonstrated a prototype system of a multi-functional hand-held device equipped with positioning sensors and a combined real-time 2D/3D data capture to assist inspectors in performing a complementary access inspection.

In 2012, in the frame of process monitoring and modelling of material flows at nuclear facilities, the JRC performed R&D on the follow-up of itemised Nuclear Materials, and on tank calibration methods. In parallel, the monitoring of load cells in Gas Centrifuge Enrichment Plants was studied.

Nuclear Non Proliferation: In 2012 the JRC has inaugurated the Large Geometry - Secondary Ion Mass Spectrometry, a tool which greatly improves the accuracy for uranium isotope measurements for the verification of the absence of undeclared activities. The JRC also organised an inter-laboratory comparison, NUSIMEP-7 (Nuclear Signatures Inter-lab Measurement Evaluation Programme) focusing on measurements of uranium isotope amount ratios in uranium particles and underpinned the recent advances in instrumental techniques in the field of particle analysis.

Combating illicit trafficking of nuclear materials, including supporting for implementation of EU CBRN related policies: As an example of cooperation with Member States and international laboratories in the field of illicit trafficking, the JRC during 2012 launched an inter-comparison exercise on age dating of "young" uranium materials. Moreover, the JRC is currently carrying out a study on the development of plutonium reference materials for measuring reliably the separation of plutonium from its daughter nuclides. Within the frame of the implementation of the EU-CBRN Action plan, in 2012 several new actions have been allocated to JRC which cover major areas of security concern. For example, the JRC is working with the IAEA on the improvement of its Illicit Trafficking Data Base (ITDB), working with the Member States on the screening and eventually benchmarking the existing modelling tools used for the dispersion of radioactivity at urban scale in case of incident. Under the IfS, the JRC provided the technical support to DG DEVCO for the implementation of the CBRN Centres of Excellence initiative. The EU has also been supporting the project "Enhancing the Capabilities of the International Atomic Energy Agency Safeguards Analytical Services" (IAEA-ECAS) from the Instrument for Stability for the construction of the new nuclear material laboratory.

Training and education: Training on different safeguards/nuclear security techniques continued and in 2012 more than 25 training events were organised. In the field of nuclear security, the European Nuclear Security Training Centre (EUSECTRA) has been established with the support of DG HOME and in 2012 the infrastructure has been upgraded to provide a dedicated facility for regular trainings.

3.2.3 *Nuclear waste management and environmental impact*

As a consequence of Fukushima, and in response to the EU Parliament demand for work on decommissioning in November 2012, the JRC organised a high level roundtable on “Scientific support for nuclear decommissioning” to identify scientific needs, future prospects and priorities for European nuclear decommissioning research. The JRC is developing a research programme focussed on: dissemination of experiences; training and education; research on waste reduction techniques; harmonisation and standardisation of technologies; contamination, characterisation and waste qualifications.

The long-term storage of spent fuel beyond the original design basis raises concerns amongst nuclear stakeholders (both regulatory authorities and industry). In this context, research is being performed on the impact of ageing on structural integrity during long-term storage. The JRC developed a new crash test device to simulate this impact on safety in accidental conditions (e.g. spent fuel pool in Fukushima). Dry-out experiments to assess the safety of storage tank of high level liquid waste during an accident scenario concerning the loss of coolant were performed in collaboration with Japan.

After Fukushima, the importance of a well-organised and coordinated emergency preparedness and response activities structure was recognised as a crucial issue in the management of a nuclear accident, and the JRC reinforced its capacities and its scientific support in this domain.

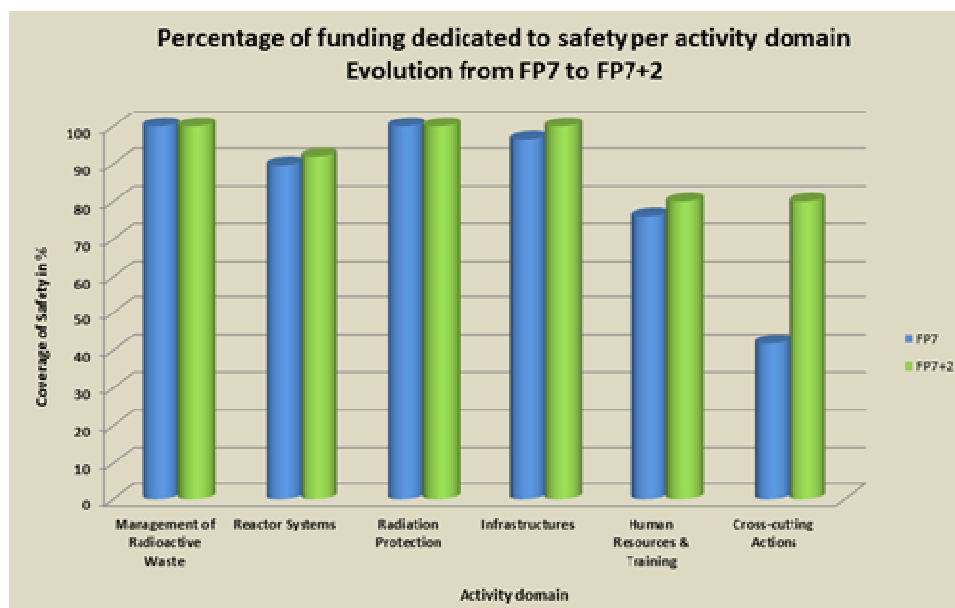
The JRC also reported regularly on environmental radioactivity in the EU Member states and performed continuous monitoring in close collaboration with DG ENER, the Member States’ National Authorities and other international organisations (e.g. IAEA). Following the Fukushima accident and the assessment of the lessons to be learned, the IAEA came to the conclusion that a common data format and data-exchange protocol to exchange automatic emergency preparedness monitoring data world-wide would be highly beneficial. EURDEP was selected by the IAEA to be the technical and principle basis for implementing the world-wide system, called IRMIS.

In the frame of training and education, the JRC developed an integrated approach in specialised topics strongly related to the nuclear fuel cycle for its training and education activity under the umbrella of a European Nuclear Safety and Security School (EN3S).

4. EVOLUTION OF R&D ACTIVITIES UNDER EURATOM PROGRAMME (DIRECT AND INDIRECT ACTIONS)

4.1 Collaborative research

As shown in the graph below, the safety related part of the Euratom programme was already very high under FP7, with around 90% share in four activity domains: management of radioactive waste, reactor systems, radiation protection and infrastructures.

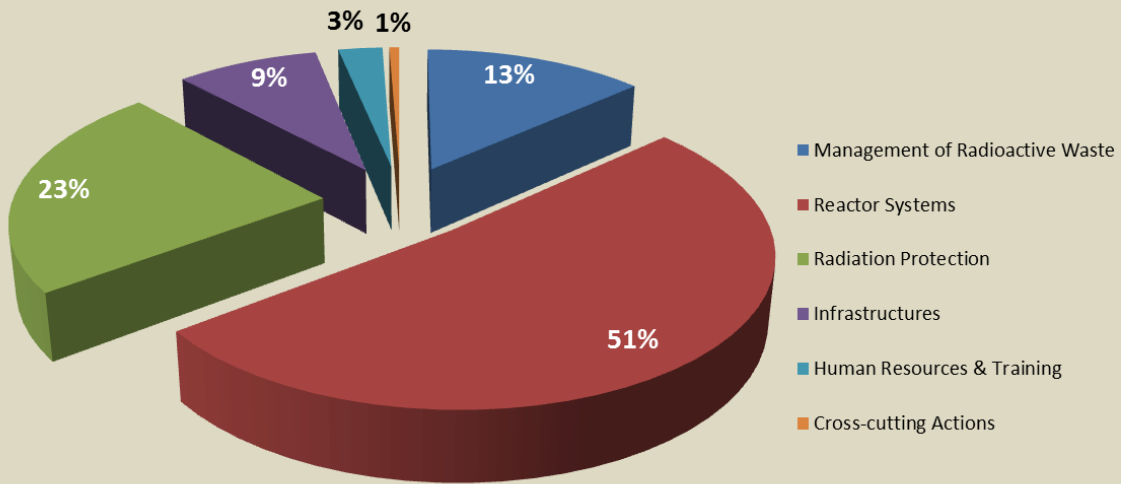


Following the re-orientation decided by the Council in 2011, the percentages in these activity domains have nevertheless been slightly increased further. In the domain of reactor system part of the funding is necessarily dedicated to coordination with non-nuclear domains, such as robotics and materials, which limits the scope for further increase.

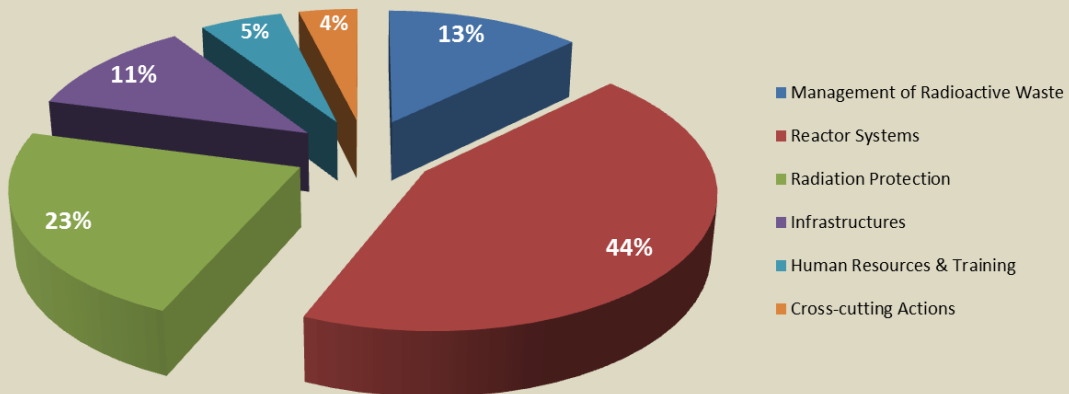
The most significant increase in the part of the funding dedicated to safety aspects was actually achieved in the activity domains of human resources and cross-cutting actions, thereby targeting to strengthen the European capacity for the development of the basic necessary knowledge in the field of safety and radiation protection. This is exemplified by training initiative organised by the European Nuclear Education Network (ENEN), and by projects SEMI-NUC dealing with cohorts of people exposed to radiation at the Kazakhstan weapon test site and EAGLE, a project dealing with training and education in radiation protection.

This evolution can also be noted (see graphs below) in the breakdown of the Commission contribution per activity domains. The most significant increase between FP7 and FP7+2 is being observed in human resources and training and cross-cutting actions, at the expense of reactor systems.

Project EC Contribution per domain activity in FP7

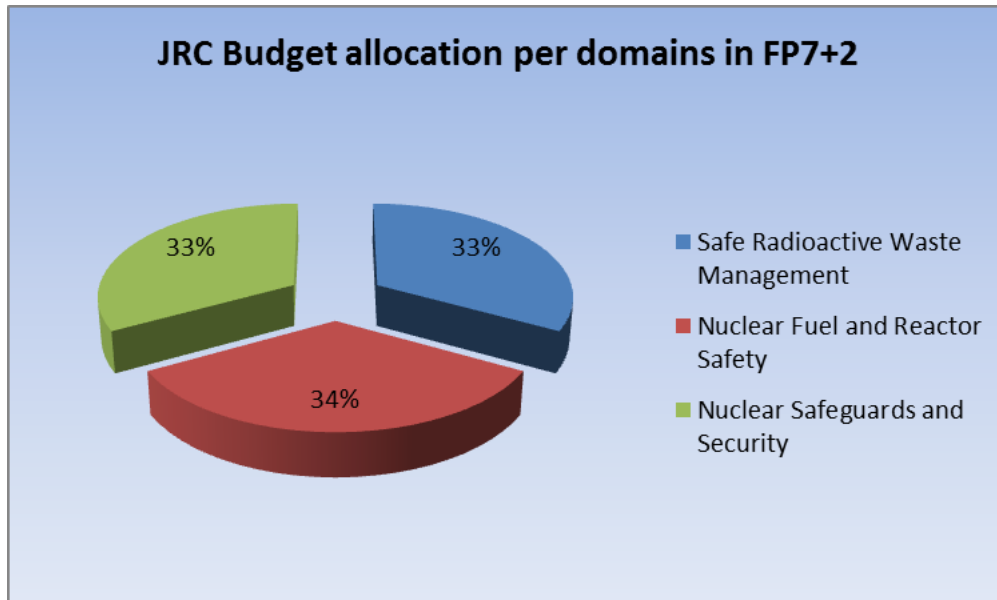


Project EC Contribution per domain activity in FP7+2



4.2 Direct research

As concerns the direct actions, the FP7+2 budget was spent as foreseen and was distributed approximately equally among the three major domains: nuclear fuel and reactor safety, safe radioactive waste management and nuclear safeguards and security.



The JRC resources were kept constant in 2012 but the activities were further focussed within the nuclear safety domain, on Fukushima related topics such as the EU Stress tests, nuclear accident modelling and severe accidents management.

During 2013, the JRC is continuing its nuclear activity along the priorities defined in 2012 which are: nuclear reactor safety, emergency preparedness and modelling, nuclear fuel and fuel cycle safety, waste management and decommissioning, nuclear safeguards, non-proliferation and security as well as knowledge management and training and education. It will continue to review and further realign its activities towards the priorities defined in Horizon 2020.

4.3 Latest developments

The activities in the European Nuclear Energy Forum (ENEF) on transparency issues as well as the opportunities and risk of nuclear energy, and the experience of European Stress Tests on Nuclear Safety have also demonstrated the relevance of the contribution of civil society to a continuous improvement and strengthening of the safety of nuclear installations.

The Aarhus Convention establishes a number of rights of the public with regard to the environment. Since September 2009, the European Commission and the National Association of Local Information Commissions and Committees (ANCCLI) have opened a dialogue on the practical implementation of the Aarhus Convention in the nuclear field, in partnership with the European Forum of Nuclear Energy (ENEF) and the French Ministry of Ecology and Sustainable Development. The European Commission and the ANCCLI also organized European Roundtables on thematic issues. The first European Roundtable was held in April 2010 on the practical implementation of the Aarhus Convention in the field of radioactive waste management. The second Roundtable addressed issues of access to expertise and capacity building and was held in January 2011. The third Roundtable took place in February

2012 and focused on issues of preparation and management of nuclear and post-nuclear emergencies. Following the Symposium on 26-27 February, a new event took place in March 2013 on public participation in decision making in the nuclear domain, and priorities for future work.

The European Commission sets transparency as a high priority in the nuclear field and has clearly indicated it in the 2011 Radioactive Waste Directive with a specific Article 10. To this aim, the Commission, notably through the JRC, is going to provide scientific and technical support as may be required by the Member States and EU policy makers.

5. CONCLUSIONS

The Euratom Framework Programme (2012-13) pursues its contribution to improving the standard of life of citizens in Member States in the number of fields for which nuclear energy plays a role. This is achieved through the improvement of science based knowledge on nuclear safety, on the protection of people against the adverse effects of ionising radiation and through the harmonisation in the European Union of scientific references for a common nuclear safety and security culture^{9,10,11}. The Euratom programme supports such a harmonisation by promoting research initiatives in this field of research through joint programming initiatives, successfully launched by Technology Platforms (SNETP and IGDTP) and dedicated Associations (NUGENIA and MELODI. The Commission proposed to continue this successful approach under the Euratom Research and Training Programme (2014-2018) complementing Horizon 2020¹².

The JRC has been working during the previous and present Framework Programmes on a structured work programme focussed on nuclear safety and security and was also capable to respond immediately to an unexpected strong demand for nuclear expertise after Fukushima, in particular by contributing to the EU Stress Tests exercise. The direct actions are now being reoriented to meet the new post Fukushima demands as well as the key objectives defined in Horizon2020. JRC also supports the further development of transparency in the nuclear sector in particular in the context of the possible application of the Aarhus Convention in nuclear field.

After the Fukushima accident in 2011, the general objective of the Euratom Framework Programme (FP7+2) for nuclear research and training activities (2012 to 2013) was refocused on nuclear safety and security, although support to safety was already very high under FP7.

Horizon 2020 should continue such approach towards safety and security and foster further joint programming actions in cross-cutting areas within Euratom and between EU and Euratom research to help tackling societal challenges identified in Horizon 2020.

⁹ Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations

¹⁰ Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, adopted by the Council of the European Union on 19 July 2011

¹¹ Basic Safety Standards Directive sets out standards for radiation protection in the Member States, Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation

¹² COM (2011)812

Annexes

Annex I: Projects from Indirect Actions

Annex II: Direct Actions of 2012 and 2013

Annex III: Extract of the European Ethics Group Report

Annex IV: Conclusions of the Symposium

Annex I: Projects from Indirect Actions

Project acronym and title	Key areas of R&D	<u>Coordinating organisation & no of partners</u>	Start date & duration	Total budget / EU contribution
ALICE – Access to Large Infrastructures in China and Europa	EU-China cooperation on irradiation of structural materials for advanced nuclear systems	<u>SCK-CEN (BE)</u> 5 partners (from 5 countries)	01/06/2012 48 months	€1.1M / 0.63M
ALISA – Access to Large Infrastructures for Severe Accidents	EU-China Large scale experiments under prototypical conditions addressing severe management in LWR	<u>KIT (DE)</u> 2 partners (from 2 countries)	01/06/2012 48 months	€1.6M / €1.0M
ALLIANCE – Preparation of ALLEGRO - Implementing Advanced Nuclear Fuel Cycle in Central Europe	To focus on the preparatory phase for developing ALLEGRO demonstrator	<u>MTA-KFKI (HU)</u> 9 partners (from 6 countries)	01/10/2012 24 months	€1.5M / 0.85M
ANDANTE – Multidisciplinary evaluation of the cancer risk from neutrons relative to photons using stem cells and the induction of second malignant neoplasms following pediatric radiation therapy	Multidisciplinary approach, including physics measurements and modelling, molecular biology, radiobiology and epidemiology	<u>UNIPV (IT)</u> 15 partners (from 12 countries)	01/01/2012 48 months	€4.2M / €3.0M
ASAMPSA_E - Advanced Safety Assessment : Extended PSA	To develop good practices in identification of extreme external events using PSA level 1-2 for decision making in the European context.	<u>IRSN (FR)</u> 27 partners (from 20 countries incl. CH, UA)	Under Negotiation 36 months	€3.7M / €3.0M
ASGARD – Advanced fuels for Generation IV reactors, Reprocessing and Dissolution	Cross-cutting studies innovative fuels to develop compatible techniques for dissolution, reprocessing and manufacturing of new nuclear fuels	<u>CHALMERS (SE)</u> 17 partners (from 10 countries)	01/01/2012 48 months	€9.6M / €5.8M

BELBAR – Bentonite Erosion, effects on the long term performance of the engineered Barrier and Radionuclide Transport	To increase the knowledge of processes that controls clay colloid stability, generation and ability to transport radio-nuclides.	<u>SKB (SE)</u> 14 partners (from 6 countries + RU)	01/01/2012 48 months	€5.2M / €2.6M
CAST – Carbon-14 Source Term	To develop understanding of the generation and release of C14 from radioactive waste materials under conditions relevant to waste packaging and disposal to underground geological disposal facilities	<u>NDA (UK)</u> 32 partners (from 15 countries incl. CH and JP)	Under negotiation 54 months	€14.4M / €4.5M
CEREBRAD – Cognitive and Cerebro-vascular Effects Induced by Low Dose Ionising Radiation	Risk estimates of the effects from internal and external exposures and cancer radiotherapy initial and late effects	<u>SCK-CEN (BE)</u> 11 partners (from 10 countries + UA)	01/10/2011 36 months	€4.7M / €3.0M
CESAM – Code for European Severe Accident Management Fukushima accidents, ASTEC, decision-making tool, spend fuel pond, numerical simulation	Improvement of the European reference code ASTEC towards a usage in severe accident management analysis and to improve the understanding of the Fukushima accidents.	<u>GRS (DE)</u> 18 partners (from 13 EU countries incl CH and IN)	01/04/2013 48 months	€8.3M / €3.6M CP
CHANDA – Solving CHallenges in Nuclear DATA	A pan-European infrastructure to support the coordination of nuclear data research programmes, infrastructures and capabilities of EU MSs	<u>CIEMAT (ES)</u> 36 partners (from 18 EU countries incl CH and NO)	Under Negotiation 48 months	€10.2M / 5.4M
CINCH-II - Cooperation in education and training In Nuclear CHEmistry	Towards a European Master in Nuclear Chemistry, modular ECVET training courses and Training Passport for the customers from the end users	<u>CTU (CZ)</u> 11 partners (from 7 countries incl. NO)	Under Negotiation 36 months	€1.85M / €1.16M
CO-CHER – Cooperation on Chernobyl health research	To build partnerships on research activities that Chernobyl provides regarding radiation risks	<u>IARC (FR)</u> 8 partners (from 4 EU incl. UA, BY, RU and US)	Under negotiation 30 months	€2.4M / 1.0M

COMET – COordination and iMplementation of a pan-European instrument for radioecology	To strengthen the pan-European research initiative on the impact of radiation on man and the environment by facilitating the integration of radio-ecological research.	<u>SCK-CEN (BE)</u> 13 partners (from 10 EU countries incl. UA, JP)	Under negotiation 48 months	€6.0M / 3.4M
CORONA – Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications	To provide a structure for training and qualification of personnel serving VVER technology and unification of training schemes according to IAEA standards	<u>KNPP (BG)</u> 11 partners (from 6 EU countries + Russia and UA)	01/12/2011 36 months	€2.1M / 1.0M
DARK-RISK – Studies on a cohort of Serbian children exposed to x-irradiation to determine the contribution of the non-coding genome to susceptibility at low doses	To prepare the way to use SRTCC biomaterials to quantify contribution of individual differences in sensitivity to risk from low doses of ionizing radiation.	<u>HZDR (DE)</u> 5 partners (from 4 EU)	01/10/2012 36 months	€2.3M / 1.7M
DOPAS – Full Scale Demonstration of Plugs and Seals	To demonstrate the compliance of reference designs to the design basis, for plugs and seals in geological disposal facilities	<u>POSIVA (FI)</u> 10 partners (9 countries incl. CH)	01/09/2012 42 months	€16.9M / €8.7M
EAGLE – Enhancing educAtion, traininG and communication processes for informed behaviors and decision-making reLatEd to ionizing radiation risks	To analyse the state of the art and the existing needs in education, training and information, and to coordinate the information and communication about ionising radiation at EU level	<u>SCK-CEN (BE)</u> 10 partners (from 8 EU countries)	Under Negotiation 36 months	€0.87M / €0.77M
ESNII Plus – Preparing ESNII for Horizon 2020	Preparatory Phase of SET-Plan ESNII to ensure an efficient European coordinated research on Reactor Safety for the next generation of nuclear installations and linked to SNETP SRiA	<u>CEA (FR)</u> 37 partners (from 14 countries + CH)	Under Negotiation 48 months	€10.4M / €6.5M
EURECA! – Cooperation between EU and Canada in Education, Training and Knowledge management on Gen-IV SCWR concept	EU-Canada collaboration, mirrored projects, Education and Training activities related to SCWR and LWR NPP.	<u>DUT (NL)</u> 6 partners (from 6 countries)	01/08/2012 Negotiation 24 months	€0.69M / €0.5M

EUTEMPE-RX – EUropean Training and Education for Medical Physics Experts in Radiology	To develop a new pilot EFTS scheme for Medical Physics Experts (MPE) in Diagnostic and Interventional Radiology to foster MPE radiation protection advocate for patients.	<u>KU LEUVEN (BE)</u> 13 partners (from 9 countries + CH)	Under Negotiation 36 months	€1.65M / €1.65M
FIRST-NUCLIDES – Fast / Instant Release of Safety Relevant Radionuclides from Spent Nuclear Fuel	To improve understanding of fast / instantly released radionuclides from disposed high burn-up UO ₂ spent fuel as IGTP SRA High Priority	<u>KIT (DE)</u> 10 partners (from 7 countries)	01/01/2012 36 months	€4.7M / €2.5M
GENTLE – Graduate and Executive Nuclear Training and Lifelong Education	A pan-European effort in the field of education and training (E&T) on Nuclear Energy including an Executive master course (60 ECVET)	<u>TU Delft (NL)</u> 12 partners (from 11 countries + CH)	01/01/2013 48 months	€2.1M / 1.7M
HPMC – High Performance Monte Carlo reactor core analysis	To develop full core Monte Carlo calculation for time-dependent safety analysis with thermal-hydraulic feedback and burn-up using high performance computing	<u>KIT (DE)</u> 4 partners (from 4 countries)	01/10/2011 36 months	€0.8M / 0.55M
JASMIN – Joint Advanced Severe Accidents Modelling and Integration for Na-cooled fast neutron reactors	To develop a new European code ASTEC-Na to capitalise SFR severe accident knowledge, with improved physical models to support the development of a Gen-IV European SFR	<u>IRSN (FR)</u> 9 partners (from 5 countries)	01/12/2011 48 months	€5.6M / €3.0M
MARISA – MyrrhA Research Infrastructure Support Action	To support to the MYRRHA research infrastructure for its development as a pan-European and world-level	<u>SCK-CEN (BE)</u> 16 partners (from 9 EU countries)	Under Negotiation 24 months	€4.6M / €3.3M
MATISSE – Materials' Innovations for a Safe and Sustainable nuclear in Europe	To support the EERA Joint Nuclear Material Programme R&D and pan-European integration	<u>CEA (FR)</u> 24 partners (from 12 countries + CH)	Under Negotiation 48 months	€11.1M / 4.75M
MAXSIMA – Methodology, Analysis and eXperiments for the "Safety In MYRRHA Assessment"	To contribute to the "safety in MYRRHA" assessment to support the licensing of MYRRHA.	<u>SCK-CEN (BE)</u> 12 partners (from 8 countries)	01/11/2012 72 months	€10.9M / €5.5M

MULTIMETAL – Structural performance of multi-metal component	Structural performance and ageing of dissimilar metal welds (DMW), modelling towards harmonised European code and standards	<u>VTT (FI)</u> 11 partners (from 9 countries)	01/02/2012 36 months	€3.1M / €1.7M
NC2I-R – Nuclear Cogeneration Industrial Initiative - Research and Development Coordination	To structure the European public and private R&D capabilities for delivering a nuclear cogeneration European Industrial Initiative	<u>NCBJ (PL)</u> 20 partners (from 11 countries + ZA)	Under Negotiation 24 months	€2.5M / 1.8M
NEWLANCER – New MS Linking for an Advanced Cohesion in Euratom Research	To enhance NMS involvement in future Euratom FP and strengthen full NMS R&D potential and cohesion	<u>INR (RO)</u> 15 partners (from 12 countries)	01/11/2011 24 months	€0.91M / €0.90M
NUGENIA-Plus – Preparing NUGENIA for HORIZON2020	Preparatory Phase of GenII-III NUGENIA to ensure an efficient European coordinated research on Reactor Safety for the existing generation of nuclear installations and linked to SNETP SRiA	<u>VTT (FI)</u> 15 partners (from 7 countries)	Under Negotiation 48 months	€10.3M / €6.0M
NURESAFE – NUclear REactor SAFETY simulation platform	To deliver to EU stakeholders multi-physics and fully integrated applications for safety analysis needs and high level of expertise in LWR simulation tools	<u>CEA (FR)</u> 23 partners (from 14 countries incl. CH)	01/01/2013 36 months	€10M / €5.6M
OPERRA – Open Project for the European Radiation Research Area	Preparatory Phase of MELODI, NERIS and Alliance to ensure a long-term EU research in radiation protection, radio-ecology and nuclear emergency management	<u>IRSN (FR)</u> 14 partners (from 10 countries)	Under negotiation 48 months	€12.0M / €8.0M
PASSAM – Passive and Active Systems on Severe Accident source term Mitigation	To produce simple models and/or correlations to enhance code for current and future NPPs.	<u>IRSN (FR)</u> 8 partners (from 6 countries incl CH)	01/01/2013 48 months	€5.1M / 3.6M CP
PELGRIMM – PELLets versus Granulates: Irradiation, Manufacturing and Modelling	Gen-IV Minor Actinide (MA) bearing fuel developments and investigation of two fuel forms pellet and spherepac	<u>CEA (FR)</u> 12 partners (from 7 countries)	01/01/2012 48 months	€7.2M / €3.0M

PETRUS-III – Implementing sustainable E&T programmes in the field of Radioactive Waste Disposals	Further practical implementation of PETRUS EFTS training programme through ECVET and building Competency-based curricula	<u>Univ.Lorraine (FR)</u> 18 partners (from 11 EU countries)	Under Negotiation 36 months	€1.6M / €1.4M
PLATENSO – Building a platform for enhanced societal research related to nuclear energy in Central and Eastern Europe	To enhance capabilities of research institutes in Central and Eastern Europe to take part in EU research, social and societal aspects.	<u>KARITA (SE)</u> 19 partners (from 13 EU countries)	Under Negotiation 36 months	€1.25M / €1.0M
PREPARE – Innovative integrative tools and platforms to be prepared for radiological emergencies and post-accident response in Europe	Update of emergency management and rehabilitation strategies and expertise in Europe following Fukushima accident	<u>KIT (DE)</u> 46 partners (from 19 EU countries + UA, NO, CH)	01/02/2013 36 months	€6.75M / 4.0M
PROCARDIO – Cardiovascular Risk from Exposure to Low-dose and Low-dose rate Ionizing radiation	To further study inconclusive evidence between cardiovascular disease and exposure of the heart and major vessels to doses below 500mGy	<u>HMGU (DE)</u> 12 partners (from 7 countries + RU)	01/10/2011 36 months	€5.5M / 3.0M
RENEB – Realising the European Network in Biodosimetry	To create a sustainable network in biological dosimetry and improve EU accident and emergency response capabilities	<u>BFS (DE)</u> 23 partners (from 16 EU countries)	01/01/2012 48 months	€1.55M / 1.0M
RISK-IR – Risk, Stem Cells and Tissue Kinetics – Ionising Radiation	Using techniques emerging from stem cell biological and tissue kinetics research to address several major areas of uncertainty in low dose cancer risk estimates	<u>HPA (UK)</u> 13 partners (from 7 countries)	01/11/2012 48 months	€8.9M / €6.7M
SACSESS - Safety of ACTinide Separation proceSSes	To demonstrate fuel cycle safety and potential benefits of actinide partitioning to the global safety of the long-lived waste management P&T	<u>CEA (FR)</u> 27 partners (from 12 countries incl.CH, JP)	01/03/2013 36 months	€12.5M / €5.5M

SARGEN-IV – Harmonized European methodology for the Safety Assessment of innovative GEN-IV reactors	Safety R&D assessment and methodologies in support to ESNII gathering European TSOs, designers, vendors and Research organisations	<u>IRSN (FR)</u> 22 partners (from 12 countries)	01/01/2012 24 months	€1.0M / 1.0M
SARRAH – Sustainable Approach for Regional Research Active Integration in Horizon 2020 (**)	To support coordination actions enabling the sustainable formation of competences in NMS	<u>R.A. PENTR (RO)</u> 20 partners (from 11 EU countries)	Under Negotiation 36 months	€1.2M / €1.0M
SEARCH – Safe Exploitation Related Chemistry for HLM reactors and Lead-cooled Advanced Fast Reactor	Investigating safe chemical behaviour of fuel and coolant in lead-cooled reactor and support of Myrrha LFR technology	<u>SCK-CEN (BE)</u> 12 partners (from 8 countries)	01/11/2011 36 months	€5.4M / 3.0M
SecIGD2 – Secretariat of the Implementing Geological Disposal of Radioactive Waste - Technology Platform Phase 2	To further integrate and coordinate the activities of IGD-TP participants	<u>ANDRA (FR)</u> 4 partners (from 4 countries)	01/01/2013 36 months	€1.4M / €0.8M
SEMI-NUC – Prospective cohort study of residents near the Semipalatinsk nuclear test site – feasibility	To conduct a feasibility study to set up a unique cohort to address dose-effect relationship for both cancer and non-cancer effects from low to moderate chronic doses (external and internal)	<u>IARC (FR)</u> 6 partners (from 5 countries incl. NO, KZ and JP)	01/04/2013 48 months	€1.7M / €0.95M
SILER – Seismic-Initiated events risk mitigation in Lead-cooled Reactors	To study risks associated to seismic initiated events in Gen-IV Heavy Liquid Metal reactors and develop adequate measures	<u>ENEA (IT)</u> 18 partners (from 8 countries)	01/10/2011 36 months	€5.3M / €3.0M
SITEX – Sustainable network of Independent Technical Expertise for radioactive waste disposal	To identify efficient means to establish a sustainable network regulatory bodies, TSOs and waste management organisations	<u>IRSN (FR)</u> 12 partners (from 9 countries + CA)	01/01/2012 24 months	€0.98M / €0.98M

TALISMAN - Transnational Access to Large Infrastructure for a Safe Management of ActiNide	Transnational access to infrastructures in actinide sciences by European scientists	<u>CEA (FR)</u> 12 partners (from 9 countries incl. CH)	01/01/2013 36 months	€6.2M / €4.0M
WINSR – Widening Involvement of New Member States in H2020 in Nuclear Safety Research (**) WINSR to be merged with SARRAH	To enhance involvement of NMS and their organisations in “Fission, Safety and Radiation Protection” Programme.	<u>LEI (LT)</u> 10 partners (from 8 EU countries including HR)	Under Negotiation 24 months	€0.9M / €0.5M
NUSHARE – Project for Sharing and growing Nuclear Safety Competence	A Euratom Training initiative drawing lessons from Fukushima from a 'Research and Innovation' prospect and in two areas: (a) further strengthening of the nuclear safety culture throughout Europe, with particular emphasis on the human element; (b) public understanding of nuclear fission technologies and radiation protection issues in general.	<u>ENEN (FR)</u> 1 partner (from 1 EU country)	01/01/2013 48 months	€1.1M / €1.0M
SAFEST - Severe Accident Facilities for European Safety Targets	To support joint experimental research towards severe accident R&D programmes that are being set up after Fukushima and the subsequent European stress tests addressing both national and European objectives	<u>KIT (DE)</u> 8 partners (from 6 EU countries)	<u>Reserve List</u> 48 months	€5.0M / €4.0M
ENEN-RU-II - Strengthening of Cooperation and Exchange for Nuclear Education and Training between the European Union and the Russian Federation	Two parallel projects in the EU and the Russian Federation, basis for a mutual recognition of E&T programmes, exchange of researchers at master and postgraduate levels and young professionals from nuclear research institutes and industry.	<u>ENEN (FR)</u> 11 partners (from 8 EU countries)	<u>Reserve List</u> 36 months	€0.79M / €0.70M
ENETRAP-III - European Network for Education and Training in Radiation Protection	To further develop European reference training schemes and specialized modules for Radiation Protection Experts in medical, waste management and NPP fields. Implementation of ECVET and fostering assistance from regulators that will play a crucial role towards the endorsement of the proposed courses and learning objectives.	<u>SCK-CEN (BE)</u> 14 partners (from 11 EU countries)	<u>Reserve List</u> 48 months	€1.80M / €1.20M

Annex II : Direct Actions of 2012 and 2013

Acronym	Title	JRC Institute
NWD2	Nuclear Waste Disposal & Decommissioning	Institute for Transuranium Elements
ANFC	Alternative Nuclear Fuel Cycles	Institute for Transuranium Elements
FPANM	Fundamental Properties of Actinides and Nuclear Materials	Institute for Transuranium Elements
ND Stds	Basic research in nuclear physics and nuclear data standards	Institute for Reference Materials and Measurements
ND-MINWASTE	Nuclear data for radioactive waste management and safety of new reactor developments	Institute for Reference Materials and Measurements
AIT	Alpha-Immunotherapy	Institute for Transuranium Elements
REM	Radioactivity Environmental Monitoring	Institute for Transuranium Elements
RADMET	Radionuclide metrology for primary standardisation and policy support	Institute for Reference Materials and Measurements
NUSAC	Centralised EU Nuclear Safety Clearinghouse for Operational Experience Feedback	Institute for Energy and Transport
NURAM	Nuclear Reactor Accident Analysis and Modelling	Institute for Energy and Transport
SNF	Safety of Nuclear Fuels and Fuel cycles	Institute for Transuranium Elements
CAPTURE	Knowledge Management, Training and Education in Reactor design and Operation	Institute for Energy and Transport
MATTINO	MATerials performance assessment for safety and Innovative Nuclear reactors	Institute for Energy and Transport
NuTraSeal	Nuclear Traceability and Sealing Systems	Institute for Transuranium Elements
METRO	Providing metrological tools to support nuclear safeguards activities	Institute for Reference Materials and Measurements
FACIL	Forensics Analysis and Combating Illicit Trafficking	Institute for Transuranium Elements
IANUS	Information Analysis for Nuclear Security	Institute for Transuranium Elements
NUVER	Nuclear Facilities Verification	Institute for Transuranium Elements
NUMAMET	Nuclear Materials Measurements Techniques	Institute for Transuranium Elements
NTAS	Nuclear and Trace Analysis for Safeguards	Institute for Transuranium Elements
NUSIM	Nuclear Fuel Cycle Simulations	Institute for Transuranium Elements

Annex III: Extract of the European Ethics Group Report (delivered in January 2013)

Research on energy is crucial if the European Union goals and targets stated in the roadmap 2050 are to be achieved. Research priorities need to be consistent with these and should include the integrated ethics approach the EGE has adopted in this opinion. This implies that priorities for nuclear research should include research on:

- Technologies that would contribute to the development of European smart grid infrastructure;
- Interdisciplinary research on storage and transport of materials and residues related to energy production and use;
- Analysis on residue production of (nuclear) energy sources, its reduction or elimination and possible re-use;
- The area of psychosocial modelling of individual and community behavioural interventions in order to support energy-efficiency initiatives in setting new standards beyond current best practice;
- Comparative impact assessment of all energy sources, using the integrated methodology of technological, social, and political scenarios. They should include scenarios of worst case (social, environmental), short term and long-term prognoses, geopolitical contexts and safety risks for workers;
- Social sciences, psychology, social anthropology, sociology, ethics and law.

The EGE is of the view that, as argued in previous opinions, the development of science and technology requires critical and independent ethical analysis which can be facilitated by supporting a community of experts. In order to help this process, the Group therefore recommends interdisciplinary research on the ethical, legal and social implication of (nuclear) energy to be financed in Horizon 2020.

Annex IV: Conclusions of the 26-27 February 2013 Symposium

The symposium took note of the interdisciplinary study on nuclear energy and the opinion of the European Group on Ethics and:

- NOTED the major societal challenges Europe has to address, not only the current economic crisis, but also security of energy supply, food security, protection of the environment, including climate change, and social welfare;
- EXPRESSED its concern notably about the energy challenge and CALLED upon the public and the private sector to step-up their research investments in all forms of sustainable energy to ensure an equitable transition to a low carbon economy, while fulfilling the overall goals of the EU Energy policy (Sustainability, Security and Reliability of Supply; Competitiveness and Affordability)
- RECOGNISED that nuclear fission for energy production is an important political issue in most Member States and for the general public. Therefore nuclear fission research must be considered as a joint endeavour involving the research community, politicians and the public; in addition scientific support to policy on nuclear safety should be further developed, notably the setting of a framework for harmonisation of national standards.
- HIGHLIGHTED that, following Fukushima, future Euratom research cannot be "business as usual" and its orientation should be more focused on safety, risk-mitigation, safeguards and security, as well as waste management and decommissioning; research efforts should evolve towards a wider systemic approach and be integrated with other policy streams, ensuring transparency and cost effectiveness; Euratom should also not ignore the necessity and stimulus of research into new and emerging technologies, not only for safety and security, but also in innovative sectors such as nuclear medicine;
- EMPHASISED that Europe, through the Euratom programme, should keep its competences at the highest level, to allow all citizens to benefit from publicly financed, transparent, independent knowledge in nuclear fission safety; European skills have to stay up to date, supported by capacity building and continuous strengthening of the human resource base;
- CALLED for the development of stronger links between science, civil society, industry and policy makers, with possible consequences on the governance of the future Euratom programme, including the composition of the Euratom Scientific and Technical Committee (STC), and on the way research associations and technology platforms interact with the general public;
- UNDERLINED that the Euratom activities would greatly benefit from structured and regular interactions with the European Economic and Social Committee (EESC), in particular to help deal with the implications of the rapidly growing demand for energy and the evolution of the energy mix.

- RECALLED that the Commission's Joint Research Centre is recognized as a EU Centre of Excellence for nuclear safety, safeguards and security science; consideration should be given to opening the JRC Clearinghouse on Operational Experience Feedback to all national nuclear regulatory authorities, who want to participate, in order to establish a permanent European Nuclear Safety Laboratory for the continuous improvement of safety;
- REITERATED that, in line with the changing research and innovation scene world-wide, Euratom should take a full part in international discussions, forming partnerships with other regions of the world, to promote the highest safety standards.