GOVERNMENT OF THE
REPUBLIC OF CROATIA

INTERNATIONAL ATOMIC
ENERGY AGENCY

COUNTRY

PROGRAMME FRAMEWORK

2014 – 2019

On behalf of the Government:

Mr. Saša Medaković
Director General
State Office for Radiological and Nuclear Safety

12. 11. 2014.

Date

On behalf of the International Atomic Energy
Agency:

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Deputy Director General

Head, Department of Technical Cooperation

24-11-2014, Vienna

Date

CROATIA
Country Programme Framework

October 2014

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EXECUTIVE SUMMARY

The new approach to the TC Program Cycle Management Framework (PCMF) establishes the CPF as the starting point for the programming process. Thus, the level of definition and agreement on the opportunities identified in the CPF process must be sufficient to establish a specific and detailed plan of action that can lead to project concept(s). The CPF and its annexes define mutually agreed priority development needs and interests that are to be supported through technical cooperation activities. These activities are based on the national development plan, country specific analyses and lessons learned from past cooperation.

Since February 1993 the Republic of Croatia participates in technical cooperation program with the IAEA, the last Country Program Framework (CPF) was signed in April 2002, focusing on national development goals that have implications and advancements in areas of:

- Radiation application in medicine;
- Improvement of nuclear and radiation safety infrastructure and
- Development and implementation of nuclear technologies.

Substantial progress has been achieved so far in these areas and there is Government interest and commitment to continue technical cooperation in the above areas by placing emphasis on the following specific goals:

- ✓ Radiation Medicine and Health;
- ✓ Nuclear Energy Development and Radioactive Waste Management, including Nuclear and Radiation Safety and Security;
- ✓ Application of Isotopes and Radiation and
- ✓ Development and implementation of nuclear techniques in environment, industry, agriculture and education.

The endorsement of the CPF Document by relevant Governmental bodies and the Agency, while not being legally binding, demonstrates common commitment and shared responsibility to implement a sustainable near- and mid-term TC strategy.

I. INTRODUCTION AND GENERAL OBJECTIVE

Since February 1993 Croatia is the full scope Member of the International Atomic Energy Agency and completely shares all goals and visions of the IAEA directed towards peaceful use of nuclear energy, protection of human health and the environment from hazardous impact radiation and promotion of cooperation and information exchange in order to achieve these goals.

In order to further develop and enhance technical cooperation with the Agency Croatia initiated for the second time the signing of the CPF to four priority development needs and interests.

This particular CPF is designed for a Mid-term period and is based on national development plan, Croatia specific analysis and lessons learned from past cooperation with the IAEA.

The first CPF document for Croatia was endorsed and signed on April 2002.

On behalf of the Croatian Government this CPF document for the period 2014-2019 will be signed by the Mr Saša Medaković, Director General of the State Office for Radiological and Nuclear Safety, which was authorised by the Government of Croatia to coordinate cooperation of other central executive authorities with the IAEA, and, on behalf of the IAEA, by Deputy Director General - Head of Department of Technical Cooperation Mr. Kwaku Aning.

The CPF for technical cooperation is aimed at identifying and highlighting key areas of development which are a priority for the Government of Croatia and to meet the country's needs, which are end-user oriented, sufficiently justified, and have a noticeable impact in areas and fields where cooperation with the Agency yields the most positive results.

Approval of the CPF document, while not legally binding, demonstrates joint commitments, shared responsibility, and is a solid guarantee for the implementation of a medium-term cooperation strategy.

This document serves as reference guide regarding future programming of technical cooperation between the IAEA and Croatia. It aims at providing clear communication between all stakeholders directly involved in the development priorities of the country as coupled to the management priorities and resource limitations of the IAEA. The objective is to provide focus on a few areas of development, which are of high priority to the Government and where technology available through the Agency can make a significant contribution leading to high quality projects. This will result naturally in providing priority guidelines for allocating resources when faced with requests for support.

II. COUNTRY PROFILE

A. History

Croatia is located in south-eastern Europe, bordering Italy, Bosnia and Herzegovina, Slovenia, Hungary, Serbia and Montenegro. Its shape resembles that of a crescent or a horseshoe. The part of the Adriatic Sea belonging to Croatia is the east-coast including all islands, islets and cliffs along the coast, and the archipelago of Palagruza.

The history of Croatia reaches back to the 7th century when Croats and other Slavs settled on the east coast of the Adriatic Sea and the Pannonian lands, forming two principalities, Dalmatia and Pannonia. The establishment of the Trpimirović dynasty ca. 850 strengthened the Dalmatian Croat duchy, which became a kingdom in 925. It was followed by the dynastic union with Hungary (12th century) and then by becoming part of Austria (1527).

In 1918, at the end of World War I, the Croatians, Serbians, and Slovenians formed a kingdom known after 1929 as Yugoslavia. After World War II, Croatia became one of the republics (federal units) of the Socialist Federal Republic of Yugoslavia. First multi-party elections were held in 1990, Croatia declared its independence from Yugoslavia in 1991 and was internationally recognized in 1992. After declaring independence, Croatia was invaded and occupied by Serb armies. In that time around 30 per cent of the territory of Croatia was under occupation. It took four years of war – which official name is the Homeland War, before occupying Serb armies were defeated and majority of occupied territories liberated. Under UN supervision, the last Serb-held enclave in eastern Slavonia was returned to Croatia in 1998.

Croatia, the official name being Republic of Croatia, is a parliamentary democracy and comprises the capital Zagreb's city district and 20 counties. Once one of the wealthiest of the Yugoslav republics, the country's economy suffered badly during the 1991-95 war. Since the end of the war, Croatia's economic development improved slowly, but in the last several years, it was slowed down due to general economic crisis.

Croatia joined NATO in 2009 and became 28th Member State of European Union on 1 of July 2013. Developing bilateral and multilateral international cooperation and enhancing relations with countries in the region are present and future Croatian foreign policy goals.

B. Geography and Population

Geography	
Capital	Zagreb
Major cities	Zagreb, Split, Rijeka
Location	Southeastern Europe, bordering the Adriatic Sea, between Bosnia and Herzegovina and Slovenia
Country area in sq. km	56,594 sq. km

Population			
Population (2011)	**Total** 4,475,611	**Urban (%)** 58.11	**Rural (%)** 41.89
Census data	**Last census** July 2011	**Next census**	
Age distribution (2011)	**Under 15** 14.6%	**15–64** 68%	**65+** 17.4%
Median age (2011)	**Total** 41.8 years		
Life expectancy at birth (2011)	**Total** 76.2 years	**Male** 72.6 years	**Female** 80 years
Birth rate/1 000 population (2005-2014)	9.53 births/1,000 population		
Under-5 mortality rate/1 000 live births (2013)	**Total** 5	**Male**	**Female**
Maternal mortality ratio/100 000 live births (2010)	17 deaths/100,000 live births		
Languages	Croatian (official) 96.1%, Serbian 1%, other and undesignated (including Italian, Hungarian, Czech, Slovak, and German) 2.9% (2001 census)		
Religions	Roman Catholic 87.8%, Orthodox 4.4%, other Christian 0.4%, Muslim 1.3%, other and unspecified 0.9%, none 5.2% (2001 census)		
Literacy (%) (2011)	**Total** 98.9%	**Male** 99.5%	**Female** 98.3%

The official language is Croatian, which is an Indo-European (Slavic) language.
National currency is Kuna (HRK).

Map of Croatia

C. Economy

Croatia is a service-based economy with the tertiary sector accounting for 70% of total gross domestic product (GDP). Croatian economy was badly affected by the Global Financial Crisis, and contracted by 6.9% in 2009, 1.4% in 2010, then showed signs of recovery in 2011 with 0.0% real GDP growth, but contracted again in 2012 by 1.8%. Croatian National Bank's forecast shows signs of recovery in 2013, and the real GDP growth of 0.3%. According to the EBRD forecast, the real GDP growth should continue in 2014 with 1.9%.

Croatia joined European Union on 1 July 2013, and in spite of the rather slow post-recession recovery, in terms of income per capita it is still ahead of some European Union member states such as Bulgaria, Romania, and Latvia. In terms of average monthly wage, Croatia is ahead of 9 EU members (Czech Republic, Estonia, Slovakia, Latvia, Poland, Hungary, Lithuania, Romania, and Bulgaria). With unemployment rate of 18.6% as of June 2013, Croatia has the third highest unemployment rate in the European Union, after Greece (27%), and Spain (26.8%).

The industrial sector with exports of over €1 billion annually is dominated by shipbuilding which accounts for over 10% of exported goods. Food processing and chemical industry also

account for significant portions of industrial output and exports. Industrial sector represents 27% of Croatia's total economic output while agriculture represents 6%. Industrial sector is responsible for 25% of Croatia's GDP, with agriculture, forestry and fishing accounting for the remaining 5% of Croatian GDP.

Croatian agricultural sector subsists from exports of blue water fish, which in recent years experienced a tremendous surge in demand, mainly from Japan and South Korea. Croatia is a notable producer of organic foods and much of it is exported to the European Union. Croatian wines, olive oil and lavender are particularly sought after.

Tourism is traditionally a notable source of income, particularly during the summer months, but also more recently during the winter months as well, due to an increase in popularity of snow sports such as skiing. With over 10 million foreign tourists annually, tourism generates revenue in excess of €7 billion. Croatia is ranked among the top 20 most popular tourist destinations in the world, and was voted world's top tourism destination in 2005 by Lonely Planet.

Trade plays a major role in Croatian economic output. In 2007 Croatia's exports were valued at USD 12.84 billion (24.7 billion including service exports). According to Healy Consultants, trade in Croatia is bolstered by its low trade-weighted average tariff of just 1.2%. Croatia has a stable market economy accompanied by a strong and stable currency, the Kuna.

Croatia and Slovenia, the two westernmost republics in what was formerly SFR Yugoslavia, accounted for nearly half of the total Yugoslav GDP, and this was reflected in the overall standard of living which in Croatia's case was more than 50% above Yugoslav average, and close to 90% in Slovenia. Nevertheless, since the late 1980s and the beginning of economic transition, Croatian economy experienced difficulties due to deindustrialization, war destruction and the loss of Yugoslav and Comecon markets. Persistent economic problems still remain and include a rather high unemployment rate, and the slow progress of necessary economic reforms. Unemployment is regionally uneven: it is very high in eastern and southern parts of the country, nearing 20% in some areas, while relatively low in the north-west and in larger cities.

D. Energy

Croatia has an electricity generating capacity (in 2012) of about 4,268 MW out of which 2,112 MW is installed in hydro, 1,811 MW thermal and 133 in wind power stations. The yearly total electricity production is about 10 - 13 billion kWh. However, Croatia's electricity generation has increased; the electricity consumption has risen from 10.9 billion kWh in 1992 to 17.6 billion kWh in 2012, and now exceeds domestic generation. Hydropower stations along Adriatic coast and close to the border with Slovenia and Hungary are the main source of electricity. The country is co-owner of NPP Krsko which is located in Slovenia close to the Croatian border. State owned Hrvatska Elektroprivreda (HEP) is managing of 95% of the power sector controlling production, distribution and transmission of electricity. The government energy policy elaborated in 2009 as National Energy Strategy is to restructure and liberalize the energy sector. All energy sector laws are in compliance with the European Union regulations. Croatia plans to increase generating capacity.

E. Legislative and regulatory framework

The new Act on Radiological and Nuclear Safety was promulgated in December 2013. That Act established the State Office for Radiological and Nuclear Safety (SORNS) as the national regulatory body for nuclear and radiological safety. The Act establishes measures for safety and protection against ionizing radiation and measures for physical protection in performing nuclear activities and practices involving sources of ionizing radiation, with the aim of ensuring adequate protection of individuals, society and the environment, in the present and in the future, from harmful effects of ionizing radiation, and ensuring the safe performance of practices involving ionizing radiation sources, nuclear activities, radioactive waste (RW) management and disposal and the physical protection of ionizing radiation sources and nuclear facilities. According to the Act, SORNS is responsible for coordinating technical cooperation with the International Atomic Energy Agency for all participants from the Republic of Croatia. An IAEA Integrated Regulatory Review Service (IRRS) mission is scheduled for 2015 and in preparation for that mission SORNS is currently engaged in a comprehensive self-assessment of the national infrastructure for safety using the IAEA self-assessment methodology and software. Recent changes in the organization, staffing and competences of SORNS will be reflected in the self-assessment report.

In October 2009 the Croatian Government adopted their National Energy Strategy, the basic Act that outlines energy policy and planning of the development of the energy sector in Croatia. The National Energy Strategy is prepared for the period up to year 2020, with an outlook till year 2030. Regarding nuclear energy, the formal statement/decision in the Strategy says: *Republic of Croatia is starting the Croatian nuclear energy programme.* The Republic of Croatia has already experience with the construction and operation of Krško NPP (which it is a co-owner of along with Slovenia) and belongs to the group of countries which use nuclear power for energy production. However, before the decision on building a new NPP is made, it is necessary to carry out the whole set of preparatory activities in compliance with the methodology of the IAEA. Activities for siting, design, construction, and operation of NPP are divided into three phases. The first phase is State's obligation, and it encompasses creation of national infrastructure necessary for making a decision on construction of NPP. It will be possible to support decision making on construction of NPP after preparatory activities. Preparatory activities for a nuclear energy program is a demanding, comprehensive and long lasting task, and therefore, the role of Croatian Government is crucial for its successful finalization. Regardless of designation as national or international projects, as Croatia has already experienced through Krško NPP, the introduction and maintenance of a nuclear energy program in cooperation with the IAEA is faced with continuous process of conforming to international standards related to safety, efficiency in infrastructure construction, and fulfilment of all relevant legal international obligations. The Government of the Republic of Croatia will elaborate the programme of preparatory activities, as a part of the Strategy Implementation Programme, in order to come up to the decision making on the construction of NPP. The decision on construction of NPP will be made by the Croatian Parliament.

Croatian Government approved national Radioactive Waste and Spent Fuel Management Strategy for the forthcoming period and sent it to the Croatian Parliament for adoption. The strategy, among other things, addresses management of the Croatian's portion (50%) of RW (mostly low- and intermediate-level waste) and SF generated during the operation of NPP Krško. Strategy provides an analysis of the state, circumstances and methods for the management of RW and SF, in order to ensure availability of sufficiently qualified staff and adequate financial services, in order to support the safety of facilities for SF and LILW management during their operating lifetime and for decommissioning. In particular, Strategy confirms Croatia's intention to search for common solutions with Slovenia on the

management of RW and SF. Also, Strategy confirms Croatia's ongoing commitment to continue with activities related to site exploration for a potential LILW and SF storage and disposal on Croatian territory. Croatia is taking into account in its national Radioactive Waste and Spent Fuel Management Strategy requirements set out in the Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. Regarding institutional RW in the Republic of Croatia, from waste producers in medical, industrial and scientific research fields, there are plans to establish storage facility at the national level.

F. Health

Since the leading cause of death in Croatia, after lung cancer, are breast, prostate, gynecological and head and neck cancers, maintaining high professional cancer treatment standards and introduction of new curative treatment modalities that could improve a therapeutic ratio in terms of the disease control and survival remain a high priority in a health sector in the country.

The development of oncology service, with emphasis on setting up radiotherapy centers with operational 3D conformal radiotherapy (3DCRT) as a standard, and gradual introduction of other modern techniques, such as intensity modulated radiation therapy (IMRT) and image guided radiation therapy (IGRT), has been one of the recent focal points of the government's policy in cancer management. During the past 5 years all radiotherapy centers in Croatia were equipped with the state-of-the art radiotherapy (RT) treatment units: linear accelerators with image guided RT option (IGRT), CT simulators and adequate dosimetry equipment to implement a high standard QA programme.

Hybrid imaging like SPECT/CT and PET/CT can be used for oncologic imaging and management of other chronic diseases and conditions like painful prostheses, sarcoidosis, and inflammatory bowel disease. The use of hybrid imaging is increasing steeply achieving more accuracy in assessment of anatomical and functional information regarding extent of disease in benign chronic conditions as well as primary staging and detection of recurrent disease in oncologic patients. Combining functional and anatomical data in one study, hybrid imaging has potential to improve patients' management.

A request for the conduct of an imPACT mission (cancer control assessment mission) to Croatia was sent by the Minister of Health in March 2013. The mission was conducted from 29 September to 3 October 2014. The purpose of the mission was to carry out a comprehensive assessment of Croatia's cancer control capacity in the areas of cancer control planning, cancer information, prevention, early detection, diagnosis and treatment, palliative care, training and civil society activities, as well as carry out a capacity and needs assessment for the effective implementation of the country's radiation medicine programme, including radiation safety infrastructure, as a component of a comprehensive National Cancer Control Programme.

The report of the mission, which includes detailed mission findings and recommendations for each area of cancer control, will be submitted to the Minister of Health.

G. Agriculture

Because of the comparative advantages, i.e. developed agricultural resources, land, natural and climatic conditions, as well as developed water resources, the Republic of Croatia has good prospects for agricultural development. This activity has a significant impact on other economic sectors, such as food-processing industry, but also on trade, tourism, transport, energy, chemical industry, marine and many others. (Agricultural and Fisheries Strategy of the Republic of Croatia).

More than 70% of the farms in Croatia are small in size (< 3 hectares). Like many other countries worldwide, Croatia is also prone to climate change and variability and drought is a reoccurrence phenomenon in Croatia. It is therefore imperative to build soil resilience to supply more nutrients and hold more water when drought recurs. The risk of soil erosion by water in Croatia was assessed using the qualitative cartographic method of the CORINE program and maps of potential and actual erosion risk (scale 1:300.000) were made for the entire area of the Republic of Croatia. As reported by Stjepan Husnjak et al. (2008), high actual soil erosion risk is affecting around 1/4 of the cultivated agricultural land of the Republic of Croatia.
The successful application of sterile insect technique to control insects and pest in Croatia in part as an alternative to insecticide/pesticide use is a most welcome support from the IAEA. This however indicates that farmers in Croatia have long relied on - and perhaps continue to need – agrochemicals, e.g. insecticides/pesticides to control plant and animal diseases. Residues of such chemicals tend to pose food safety and environmental risks to consumers and should be monitored and controlled. Other contaminants that could be monitored include veterinary drug residues such as chloramphenicol, sulfonamides, tetracyclines, gentamicin, streptomycin, dihydrostreptomycin, flumequine and enrofloxacin among others that have been reported in foods in the country. Radionuclides, mycotoxins and heavy metals in foods and animal feeds may also be considered for monitoring and control.

Croatia has significant animal resources of approximately 470.000 cattle, 600.000 sheep, 70.000 goats and 1.700.000 pigs. There are basically 2 types of animal production systems: 1) the industrial, characterized by relatively closed production system with centralized farm management and 2) backyard farming, a traditional animal husbandry based on the family property of the owners. Notifiable animal diseases are covered with official surveillance programs. However, regional trends of disease spread (trade, animal movement, climatic changes etc.) are affecting Croatia also. From these reasons, intervention of the IAEA programs in selected areas of animal production would be very welcome.

Croatia has well established conventional methodologies for animal disease diagnosis, management of animal reproduction and increased production through modern animal nutrition solutions. However there is a rising interest in application of nuclear and nuclear related techniques for these areas of animal production, especially in sectors where multi-disciplinary and multi sectorial approaches are aquired, such as spread of vector diseases, influence of environmental changes on animal production, isotope hydrology etc.

Preparedness for response to nuclear emergencies in agriculture is the field which is still not well established and requires specific attention, as if affects the whole food chain (farm inputs, management of agricultural production, food processing and placement of food products on the markets). Therefore, detailed protocols for response to nuclear and radiological emergencies in all the sectors of agriculture would be priority for Croatia.

III. OVERVIEW OF PAST AND PRESENT TECHNICAL COOPERATION ACTIVITIES

National projects which were implemented in the project cycle 2005-2006 are:

- CRO/9/008 Evaluation of Medical Exposure and Optimization of Patient Protection in Diagnostic Applications of Radiation,
- CRO/8/006 Application of Isotope Techniques to Investigate Water Resources in a Karstic Area,

- CRO/1/005 Nuclear Techniques for the Analysis and Preservation of Cultural Heritage,
- CRO/9/009 Management and Safe Storage of Spent or Disused Sealed Sources,
- CRO/0/008 Upgrading the Training Laboratory for Nuclear Science, Phase II.

National projects which were implemented in the project cycle 2007-2008 are:

- CRO/4/005 Setting Up a Demonstration Positron Emission Tomography Model for Teaching Purposes,
- CRO/5/002 Feasibility Study for the Suppression of the Mediterranean Fly by Integrating Sterile Insect Technique on an Area-Wide Basis in the Neretva Valley,
- CRO/6/006 Introduction of Positron Emission Tomography in Croatia,
- CRO/8/007 Using Isotope Tracers as a Tool for Groundwater Vulnerability Assessment in the County of Split, Dalmatia.

National projects which were implemented in the project cycle 2009-2011 are:

- CRO/6/007 Introducing Interstitial Brachytherapy in Managing Gynecological, Breast and Prostate Cancer,
- CRO/6/008 Upgrading the Quality Assurance and Quality Control Programmes in Radiotherapy,
- CRO/3/002 Establishing a National Radioactive Waste Storage and Processing Facility,
- CRO/6/009 Upgrading a Secondary Standards Dosimetry Laboratory at the Ruder Boskovic Institute, Zagreb,
- CRO/8/008 Upgrading Nuclear Analysis Techniques for Air Pollution Monitoring.

National projects which were implemented in the project cycle 2012-2013 are:

- CRO/9/010 Licencing the Centralised Institutional Radiation Waste Storage and Processing Facility,
- CRO/2/003 Identifying and Managing Financial, Economical and Energy Risks for Nuclear Power Plant Projects in Small Economy – Case Study,
- CRO/6/010 Reinforcing and Further Developing a Quality Assurance/ Quality Control Programme in Radiotherapy,
- CRO/6/011 Establishing High Dose Rate Interstitial Brachytherapy Procedures in Cancer Treatment.

Here are few examples of good practice of technical cooperation in the health and agriculture sector:

Almost 20 years ago, the strong and fruitful collaboration between the **University Hospital Centre "Sestre milosrdnice", Department of oncology and nuclear medicine**, started with the TC project CRO/9/006 "Strengthening Applications of Radiation in Medicine", with a goal to evaluate doses to patients and staff in X-ray diagnosis, nuclear medicine and radiotherapy and to implement routine quality control programs, and evaluate the results in order to optimize exposure. Later, CRO/6/002, under the title "Upgrading Radiotherapy for the Treatment of Cancer" aimed at improved radiotherapy services and practices in the treatment of cancer in our department. The Agency provided a three-dimensional treatment planning system, dosimetry equipment for brachytherapy, mould room equipment for patient immobilization, immobilization systems, as well as textbooks and publications. The available volume of more advanced radiotherapy treatments in the department was increased.

CRO/6/003 "Improved Use of Imaging and Radiotherapy Technology" was designed to increase the scope and quality of clinical interventions in three medical centres in Zagreb: University Hospital "Sestre milosrdnice" (UHSM), University Hospital for Tumours (UHT), and the Clinical University Hospital Centre Rebro (now Zagreb). The project contributed to increasing the quality of health services in Zagreb by improving the use of imaging and radiotherapy technology for a better diagnostics and treatment of cancer and cardiovascular diseases. The large component of the project was the man-power development in external beam radiotherapy, brachytherapy and nuclear medicine imaging.

CRO/6/004 Feasibility Study on Extending Use of Positron Emission Tomography strengthened expertise of selected nuclear medicine specialists and physicists in positron emission tomography (PET) imaging modalities and to evaluate the feasibility of creating a comprehensive PET centre in Croatia. The main objective of CRO/6/006 was to improve the health service standard in Croatia through the introduction of PET technology. The first PET-CT centre was established in UHSM as a joint public-private partnership and later four more centres were established together with the PET radionuclide cyclotron production at the Institute Ruđer Bošković.

Department of oncology and nuclear medicine, University Hospital Centre "Sestre milosrdnice", as the counterpart institution in the CRO/6/007 and in the on-going project CRO/6/011 TC projects, proposed further development of the comprehensive high dose rate brachytherapy (HDRBT) programme, through the introduction of additional techniques and procedures such as HDRBT interstitial gynaecological, breast and prostate cancer treatments since interstitial brachytherapy has been well recognised, highly recommended and cost efficient conformal therapy that could be applied in curing such patients.

The project CRO/6/007 contained the large equipment purchase component, based on a core IAEA funding and the Croatian government cost sharing. The following items were acquired: HDRBT unit GammaMedPlus iX, treatment planning system BrachyVision 3D, basic accessory kit for intracavitary, intraluminal and interstitial applications,and image plate reader. The project was successful since it enabled our institution to continue with gynaecological cancer treatments and treatments of gynaecological, oesophageal and bronchial cancer with improved 3D image based treatment planning that was not available before.

The objective of the CRO/6/011 TC project is to enhance the capabilities of the existing HDRBT programme by introducing high dose rate interstitial brachytherapy for head and neck cancers and to continue with the activities initiated in the previous project cycle.

University Hospital for Tumors (now merged with the University Hospital "Sestre milosrdnice"), in the past had a fruitful cooperation with the Agency. The main support was in equipment and education. Main equipment is: system for preparing blocks and, what was especially important, the first multileaf collimator (MLC) in Croatia in the frame of the project CRO/6/005, which gave the ability to be the first Clinic in Croatia which implemented 3D conformal radiotherapy. Agency also granted numerous scholarships for the education in the frame of the various RER projects mainly for the ESTRO courses.

In the previous years **The University hospital centers of Rijeka and Osijek and Medical faculty of JJ Strossmayer University in Osijek** had very good cooperation backed up by the IAEA technical cooperation projects. All of the projects had the same goal: Strengthening the radiation safety in medicine. One of them was regional (RER9093) and it was mostly of radiation safety in radiology. Few surveys were done in Croatia of QA/QC programs and patient doses in different radiological modality and afterword's we did few national

workshops on the same subject. During this time, radiation safety programs were implemented in some hospitals and the results of image quality and patient doses were compared to the situation before.

Similar projects in radiotherapy (CRO6008 and CRO6010) were implemented with good results that resulted with better legislation and implementation of safety barriers in order to improve radiation safety in radiotherapy. Since this goal needs a lot of time, mostly because radiation safety culture is low, we will need more time to achieve this. This is especially true when advanced techniques will be employed.

Neretva Valley is the largest citrus producing area in Croatia. It has been noted that the greatest damage caused by the Mediterranean fruit fly (medfly) is along the border area with Bosnia where up to 30% of the mandarin crop has been destroyed. Over 80% of Croatian national citrus production valued at €20 million per year is concentrated in Neretva Valley. Interest from the Croatian Government in introducing the Sterile Insect Technique (SIT) on an area-wide basis as an alternative to insecticide-based medfly control started in 2002 when the **Croatian Institute for Plant Protection** in consultation with the Joint FAO/IAEA Division determined that Neretva Valley would be a good location for this environmentally friendly pest control method as part of an integrated pest management system. Neretva Valley on both sides of the border is an isolated ecosystem. This means that there is a good chance of successful medfly suppression, since such isolation by mountains and the absence of hosts would strongly limit the movement of wild medfly adults into the Valley. Economic and technical feasibility studies conducted under Agency TC project CRO/5/002 showed enormous economic and environmental advantages of the use of the SIT on an area-wide basis compared with ongoing medfly control (insecticide treatments) in the Neretva valley mandarine production area. The Croatian Government strongly supported the project since the medfly has become a serious pest in the Valley interfering with mandarine exports. Medfly suppression using SIT on an area-wide basis has been implemented in a pilot area since 2010 and expanded to half of the Valley (4000 ha) in 2013 resulting in a reduction of 96% of infestation in the treated area and with significant reduction of insecticide use. This is of economic benefit for all local stakeholders including growers and fruit and vegetable consumers at large (general public) by giving them greater access to fresh fruit with fewer insecticide residues. Given the economic importance of the production in the region, the programme is benefiting from the support of the local authorities and the growers and exporters.

Croatia joined INIS in 1994. Modest contribution has been seen from the national INIS centre. Further support from the government to the national INIS centre to derive maximum benefits from the INIS system is of paramount importance to enable the country to benefit from INIS system, in particular to provide end users with reliable nuclear information services in support to their national nuclear activities, to promote INIS and reach potential end users, as well as contributors, within the national boundaries, including universities students.

National technical cooperation projects in the project cycle 2014-2015 are:

- CRO/6/012 Developing a Quality Assurance and Quality Control Programme for the Clinical Use of Advanced Radiotherapy Techniques,
- CRO/9/011 Supporting an Integrated Regulatory Review Service Mission,
- CRO/1/006 Upgrading the the Cobalt-60 Panoramic Irradiation Facility,

- CRO/0/009 Improving Capabilities for the Application of Positron Annihilation Spectroscopy.

IV. RELEVANT INTERNATIONAL DEVELOPMENT ASSISTANCE

The most important international development assistance in the field of nuclear safety and radiation protection was in the framework of pre-accession programmes of EU (PHARE and IPA):

Projects in the field of nuclear safety and radiation protection, which were implemented by the State Office for Radiological and Nuclear Safety:

- ✓ PHARE 2005 Installation of the RODOS System in the Republic of Croatia;
- ✓ PHARE 2005 - Border Control of Nuclear and Other Radioactive Materials with Mobile Portal Monitor;
- ✓ PHARE 2006 Support to the SONS in Upgrading and Modernization of the Croatian Early Warning System;
- ✓ PHARE 2006 Border Control of Nuclear and Other Radioactive Materials with Stationary Portal Monitor Practices in Croatia;
- ✓ IPA 2008 Strengthening Administrative Capacity of the State Office for Radiological and Nuclear Safety, Regulatory Body for the Radiological and Nuclear Safety and Security;
- ✓ IPA 2008 Health Protection in Relation to Medical Exposure;
- ✓ IPA 2011 Upgrading of Emergency Preparedness System in the Republic of Croatia;
- ✓ IPA 2011 Upgrading the Systems for the On- and Off-line Monitoring of Radioactivity in the Environment in Croatia in Regular and Emergency Situations.

Projects from PHARE and IPA 2008 programmes were successfully realized and projects from IPA 2011 programme are in implementation.

V. ENVISION COUNTRY TECHNICAL COOPERATION PROGRAMME OULTLINE

Cooperation with the IAEA in the medium term will proceed in accordance with national priorities, taking into account global trends in the development of nuclear technologies.

In the framework of cooperation with the IAEA, topmost priority is given to:

- ➢ Radiation Medicine and Health;
- ➢ Nuclear Energy Development and Radioactive Waste Management, including Nuclear and Radiation Safety and Security;
- ➢ Application of Isotopes and Radiation and
- ➢ Development and implementation of nuclear techniques in environment, industry, agriculture and education.

Hybrid imaging is defined as the fusion of two or more imaging technologies into a single, new form of imaging. Hybrid imaging modalities which are most used is single photon emission computed tomography (SPECT)/CT and positron emission tomography (PET)/CT. The most exciting characteristic of hybrid imaging is its potential to show molecular processes with functional imaging capabilities of SPECT or PET with the precise anatomical overlay of CT images, all performed in the one imaging session. To realize the full potential of hybrid imaging, diverse kinds of clinical and technical expertise must be brought together. Because the use of SPECT/CT and PET/CT is growing so rapidly, it is important for nuclear medicine physicians and radiologists to establish new pathways of collaboration within institutions, nationally and internationally. Issues they must confront include when to use hybrid imaging, how to ensure quality imaging and optimal clinically relevant interpretation. Furthermore, recognizing that globalization is inevitable, leaders in both specialties must work toward global standardization of hybrid imaging to promote rapid exchange of information in clinical research and patient care.

The introduction of curative treatment modalities, such as high dose rate brachytherapy (HDRBT), could significantly influence disease control, quality of life and overall survival of cancer patients in Croatia. University Hospital Centre "Sestre milosrdnice", Department of Oncology and Nuclear medicine currently performs HDRBT intracavitary gynecological treatments, intraluminal bronchial, head and neck, and esophagus treatments. In Croatia, more than 40% of the breast, prostate, and gynecological cancer population, at the time of diagnosis, have reached a locally advanced and surgically inoperable form of the disease. Therefore, managing such patients with a curative intent requires radiation conformal therapy with organ sparing technique. Interstitial brachytherapy is one of the most acceptable, highly recommended and cost efficient conformal therapies that could be applied in curing such patients. To provide a comprehensive HDRBT programme, additional techniques and procedures such as interstitial gynecological and breast and prostate cancer treatments with HDRBT are needed. The current professional standards regarding ongoing practices will be further expanded.

IMRT treatments and volumetric modulated arc therapy (VMAT), that delivers a precisely sculptured 3D dose in a single full circle rotation of the linac gantry, have shown improved dose distribution and a reduction in toxicity in some situations. Nevertheless, there is no strong evidence that clearly demonstrates the clinical benefits of IMRT and VMAT in many tumors. One of the goals in the near term programme of University Hospital Centre "Sestre milosrdnice", Department of oncology and nuclear medicine will be to collect the relevant data, carefully investigate the conditions mandatory for the introduction of at least one of these techniques with particular emphasis on the cost-effectiveness and cost-benefit.

After careful evaluation, in terms of infrastructural changes, man-power development, equipment needs and dosimetry requirements, the department will start with the IMRT (VMAT) introduction for carefully selected treatment sites. All necessary dosimetry measurements and the phantom verification studies will be carried out prior to the clinical implementation. This will be a natural development path after gaining experience with 3D CRT treatments. It is expected that this treatment option will be chosen for a quite limited number of patients. The introduction of these techniques is closely related to the introduction of a second treatment RT unit into the practice of University Hospital Centre "Sestre milosrdnice", Department of Oncology and nuclear Medicine.

In the field of HDRBT, further evaluation of interstitial brachytherapy for prostate, breast and head and neck procedures will be done. Recently introduced 3D image planning in

intraluminal brachytherapy enhances accuracy and precision in cancer management and should be further developed.

In the future, University Hospital for Tumors (as part of the University Hospital Centre "Sestre milosrdnice") is looking for support in new MDR Brachytherapy with appropriate treatment planning system and also for equipment for QA/QC for Brachytherapy as well as for 3D conformal radiotherapy. Support from the Agency will be crucial for improving the quality of conformal radiotherapy which involves new techniques like IMRT.

The University hospital centers of Rijeka and Osijek and Medical faculty of JJ Strossmayer University in Osijek are planning to further improve radiation safety in advanced radiotherapy techniques using help of technical cooperation of IAEA. Also they will try to improve radiation safety in diagnostic radiology by finding out and implementing diagnostic reference levels in different radiological modalities. This will be a part of QA/QC programmes that will be implemented in pilot hospitals.

Proposals of activities for the future TC cycles:

Short term

- Introduce additional techniques and procedures such as interstitial gynecological and breast and prostate cancer treatments to provide a comprehensive, high standard HDRBT programme at the Department of Oncology and Nuclear Medicine of the University Hospital Centre "Sestre milosrdnice".
- Collect the relevant data about IMRT treatments and volumetric modulated arc therapy (VMAT), that deliver a precisely sculptured 3D dose and have shown improved dose distribution, and a reduction in toxicity. Carefully investigate the conditions mandatory for the introduction of at least one of these techniques with particular emphasis on the cost-effectiveness and cost-benefit.

Mid term

- After an evaluation, in terms of infrastructural changes, man-power development, equipment needs, dosimetry requirements and possible installation of a second RT unit (linac), the department starts with the IMRT (VMAT) introduction for selected treatment sites. All necessary dosimetry measurements and the phantom verification studies will be carried out prior to the clinical implementation for a selected group of patients.
- In the field of HDRBT, evaluation of interstitial brachytherapy for prostate, breast and head and neck procedures will be carried out. Recently introduced 3D image planning in intraluminal brachytherapy that enhances accuracy and precision in cancer management will be further developed.

Nuclear Energy

In nuclear power, goal is to improve national capabilities in energy planning for sustainable energy strategies using IAEA methodologies by improving: analysis of economics and competitiveness of nuclear; financial analysis, national energy supply planning (national energy market analysis, survey of energy resources, energy demand forecast, energy supply planning, electric power system planning, power technology forecast, assessment of environmental burdens). Technical cooperation with the IAEA is important in training of using IAEA models for financial analysis and energy planning.

Recent assessments have clearly indicated the need to upgrade Croatian national emergency preparedness and response system in the areas of radiological and nuclear emergencies. Of utmost importance would be TC programme which would provide help in nuclear emergency planning zones sizes revision and harmonization with neighboring countries. Croatia would also benefit from TC on the implementation of new ICRP publication 103 recommendations, as well as on upgrading emergency preparedness and response system based on the lessons learned from the Fukushima accident.

Regarding existing NPP focus is at maintaining current plant safety level of operation and upgrading response of the plant during severe accident scenarios. Some modifications are currently underway in NPP Krsko to improve operational safety and to answer to new requirements after stress tests and PSR. It is important to maintain capability to analyze operating events and severe accident scenarios including consequences of the severe accident to the population and environment.

Focus for the mid-term national TC program in aforementioned fields is:

- Improvement of technical, economical and financial analysis capability for evaluation of sustainable energy development strategies, including nuclear option
- Preparing for development of nuclear power Infrastructures for possible developing of nuclear power programmes (CRONEP)
- Upgrading of radiological and nuclear emergency preparedness
- Development of NPP severe accident scenarios and supporting related plant modifications
- Supporting emergency planning through source term determination and calculation of consequences

Waste Management

The new Act on Radiological and Nuclear Safety prescribed the obligation on establishment of a central national temporary storage for institutional radioactive waste. Responsibility for such a project lies on State Office for Radiological and Nuclear Safety. Among others, particular attention within the project should be paid on facility design, waste characterization and waste acceptance criteria, safety, environmental protection and public acceptance. A related TC programme on capacity building (regulatory body and supporting professional organizations) for the purposes mentioned is highly recommended. Reasons for this are: necessity of construction of a proper storage facility for radioactive waste generated in medicine, research and industry; and future consideration of designing and construction of Croatian repository for a LL/IL waste.

Work on performing a feasibility study on disposal facility for radioactive waste has been started recently. A related program developed by Fund for financing Krško NPP decommissioning, spent fuel and radioactive waste management will be adopted till the end of 2014. Underlined topics within the programme are as follows: site investigation, facility design, waste acceptance criteria, safety analyses, environmental protection, public acceptance and licensing procedures. A related TC programme on capacity building (Fund for financing Krško NPP decommissioning, spent fuel and radioactive waste management, regulatory body and supporting professional organizations) for the purposes mentioned is highly recommended.

A new version of Krško NPP decommissioning programme has been developed two years ago. Decommissioning strategy chosen is immediate dismantling that assumes a dry storage facility for spent fuel. A programme on dry storage facility on-site for spent fuel has been

performed by Krško NPP recently. Regulatory body in charge will be Slovenian nuclear safety authority. Fund for financing Krško NPP decommissioning, spent fuel and radioactive waste management is the organization that is supposed to participate in the further programmes development and preparation of background studies. A related TC programme on capacity building (Fund for financing Krško NPP decommissioning spent fuel and radioactive waste management and supporting professional organizations) is highly recommended. Future cooperation should prioritize work/testing in underground research laboratories, site selection, rock characterization, as well as stakeholder involvement/communication and safety case development.

Proposals of activities for the future TC cycles:

- Development of central temporary storage facility for institutional radioactive waste
- Training in design, construction and maintenance of storage facilities for old sources and radioactive waste materials from medicine and industry, and also radioactive waste and spent fuel from NPP
- Investigation of location for low and medium level waste from NPP
- Development of long-term storage for LILW from NPP
- Development of radioactive waste disposal facility
- Development of decommissioning and spent fuel management programmes
- Development of the national underground research facilities and training for the near-surface and geological disposal technologies for radioactive waste.

Application of Isotopes and Radiation

Plant breeding has a key role in sustainable crop production and food security in the changing global climate. The available data (Breeding Agricultural Crops in Croatia, Monography, V. Kozumplik and I. Pejić ed., Zagreb 2012) show that in Croatia over the last 80 years, the yield of wheat has increased almost five-fold, of maize and barley almost four-fold, of sugar beet more than three-fold, etc. The research data indicate that almost 50% of that increase has been due to genetic improvement of varieties and better seed, which resulted from plant breeding.

A prerequisite for an effective crop improvement through breeding is the presence of sufficient genetic variability within the crop species. Implementation of innovative and effective plant breeding methods including radiation induced mutation, mutation detection and pre-breeding technologies can generate new genetic variability within crops and speed up the release of new crop varieties with improved agricultural as well as quality characteristics. In this respect Croatia has a particular interest in applying ion beam irradiation to produce new mutations for crop improvement.

Mutant varieties of major staple crops developed through mutation breeding can contribute to diversity of crop varieties in terms of their tolerance to a wide range of biotic and abiotic stresses as well as stability of yield and quality characteristics across different agro ecological conditions. They can also enhance rural income, improve human nutrition and contribute to environmentally sustainable food security.

Genetic variability of vegetatively propagated species, either those intended for food production or application in floriculture, can be enhanced through mutation induction. This includes *in-vitro* technology which is especially suitable for species that are difficult to propagate from seed. Beside major food crops, mutation breeding for other economically

important e.g. medicinal crops, fibre crops, biofuel crops and ornamental species could be innovative and produce novel varieties interesting for the market.

In the area of animal genetic resources especially in genetic and genomic analysis – Croatia is a part of biodiversity hotspot (Balkan peninsula was one of the important refugium in the Europe and place from where many animals were spreading to the other parts of Europe which is proved by haplotype diversity of the species on Balkan peninsula).

Insect Pest Control through the integrated use of Sterile Insect Technique (SIT) as a method to suppress the Mediterranean fruit fly populations and to contribute to the increase of quality of mandarine production and to the subsequent increase of the exports. So far the area under suppression using SIT needs to be expanded to all the Neretva Valley and to engage in collaboration with Bosnia and Herzegovina in the neighboring part of the Neretva Valley. The results on the reduction of fruit infestation by 96% in the SIT area and insecticide use in 20 000 liters per year show the importance of this technology for the Croatian mandarine production and farmers' income. Aditionally, Croatia as leader of the use of this technology in the Balkans and Eastern Mediterranean, has been requested to act as a training center on this technology application by the other countries in the Region.

Proposals of activities for the future TC cycles:

- Improving performance and stability of yield and quality traits of major food crops through radiation induced mutation, including the development of Ion Beam irradiation
- Improvement of food and other economically important species through seed and in vitro mutagenesis
- Genomic analysis of animal genetic resources by NGS technology with aim to search for the genes responsible for health status of animals and also for production
- Transboundary suppression of Mediterranean fruit fly in Neretva valley integrating SIT with other suppression methods on an area-wide approach
- Developing best management practices for soil and water resources on farm to increase crop productivity and minimizing the impact of soil erosion using isotopic and nuclear techniques
- Use of advanced technologies for detection of animal pathogens, multi target detection systems, as well as systems with automatic data transmission towards the central offices (as mentioned above);
- Use of nuclear and nuclear related techniques in the control of vector borne diseases, such as SIT combined with detection of pathogens in the vectors;
- Management of animal reproduction using nuclear techniques in order to improve the animal productivity;
- Management of animal nutrition through the application of nuclear techniques.
- Preparedness for response to nuclear emergencies in the animal production systems, to cover the whole chain of production and processing of the food of animal origin, aimed for human consumption.

Development and implementation of nuclear techniques

A major resource that is threatened and is, therefore, receiving global attention, is the rapidly encroaching shortage of clean water. Croatia, in recognizing that pollution, abuse, waste and expanding demand for water, are becoming critical factors, has committed itself to extensive applied studies of ground and surface waters, aquifers, springs, recharge characteristics, pollutant impacts, etc. to ensure that the country maintains an adequate and safe supply of

water for all purposes. Issues related to water resources management require more focused attention. Additionally, control of the food produced in the environment of the nuclear power plant (NPP Krško) using isotope methods (^{14}C) could be of importance for regular control. Use of nuclear techniques may therefore contribute to the solution.

Implementation of the nuclear techniques for the protection of cultural heritage artefacts using irradiation methods as well as radiocarbon dating is also of high importance for the country.

Available radiation facilities (accelerators and Co-60 source) that are already used in variety of applications require continuous assistance to enable their better utilization in country priority areas. These are in particular irradiation techniques of importance to health and safer food products, ion beams and neutrons in development and application of techniques for environment monitoring, security and demining as well as for fusion energy developments. Ion beams and gamma rays may be also used in development of advanced materials processing technologies.

Croatia could benefit from IAEA's technical cooperation (TC) support to strengthen capabilities of the laboratories for the quality and health inspection of foods and feeds, serving under the Croatian Food Agency, in accordance with the Food Act (OG 46/07, 55/11) and EC legal framework (EC, No 178/02). Nuclear and isotopic as well as complimentary analytical techniques will be promoted. Laboratory capabilities for food traceability/authenticity/quality could also be established or strengthened through IAEA's TC program. The Croatian Food Agency principles of independence, transparency and confidential will be further promoted and public health and competitiveness of food exports will be enhanced through such IAEA support.

Education and training of the experts in nuclear and medical physics and their application (medicine, radiation detection and protection, reactor theory and technology, monitoring and protection of the environment) will continue to be central issues in the mid-term period with a view to securing human resources development and preservation of knowledge in the field of radiochemistry and nuclear physics applications.

Industrial non-destructive evaluation and testing applications provides results as input for structural integrity assessment to ensure reliable operation of process and power plants, and consequently ensuring safety for the community and environment. Therefore there is a permanent demand to improve the reliability and confidence level of evaluation and testing results by development of emerging advanced non-destructive techniques.

Education and training of the experts in advanced NDT methods is a key issue enabling further human resources development and preservation of knowledge and competences in the field of industrial testing applications. Accordingly, there is an unavoidable necessity for support and enhancement of the national capabilities and infrastructure for continuous development and introduction of the advanced NDT methods such as Digital Industrial Radiography, Phased Array Ultrasonic and Phased Array Eddy Currents.

It is planned to further develop undergraduate, graduate and postgraduate NDT courses (at the moment 5 NDT courses at the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb) regarding advanced and automatized NDT techniques; to develop training courses in advanced NDT techniques heading to certification of NDT personnel; to develop and implement e-learning courses to achieve more effective and more efficient training and education; to introduce and develop industrial applications of advanced NDT techniques.

Proposals of activities for the future TC cycles:

- Establishment of Radiation Processing e-beam facility
- Strengthening Applications of Radiation Processing
- An Environmental Isotope Investigation of the Groundwater-Surface Water Interactions in the Area of the City of Zagreb
- Development of industrial non-destructive evaluation and testing applications using radiation sources including radiotracers applications.

VI. GENERAL SUPPORT ACTIVITIES

For the above high priority fields, better utilization of the capabilities, knowledge and infrastructure that already exist in the country and a selective approach to technical co-operation for the most essential priority needs, would help solve some of the specified issues in the country. It would also result in availability and possibility to offer relevant expertise through the IAEA TC scope of activities.

Identification and formulation of specific selected projects deriving from the above Programme Focus areas will be made at a later stage. This shall take into consideration the fact that some of the areas above shall continue to be addressed under the regional programme. Endorsement of projects, however, will follow relevant technical consultations and discussions with the Agency, including technical field missions as may be required, and the Agency's procedure for approval of TC projects.

General support activities under the TC Program will be mainly focused on sustaining a sufficient number of well-trained personnel and building capacity of young specialists to enhance the capabilities of governmental entities. The national authorities and the other scientific institutes have a clear vision and well developed plans for the implementation of their programs in the future years; the outcomes achieved thus far are thus expected to be mainly sustained through regular, national resources.

It is nonetheless noteworthy that a number of future, programmatic activities will rely to a certain extent on the decision of the current and subsequent governments, as well as on the international economic situation. To this end, assistance from international partners may become crucial to ensure that all relevant, governmental frameworks for safety are suitable to create an enabling environment for the envisaged program.

ANNEX 1

List of Major Resource Institutions

Competent National Authorities and Institutions

The State Office for Radiological Nuclear Safety (SORNS). According to the Act on Radiological and Nuclear Safety from 2010, a single regulatory body, the State Office for Radiological and Nuclear Safety, replaced the State Office for Nuclear Safety and State Office for Radiation Protection. SORNS is s an independent regulatory authority responsible for activities relating to radiological and nuclear safety and security and cooperation with the IAEA and other relevant international institutions. The SONRS reports directly to the Government of the Republic of Croatia and the Director of SONRS has been appointed by the Government. SONRS is funded from the state budget only. The tasks of SORNS are prescribed in the Act on Radiological and Nuclear Safety from 2013.

Ministry of Economy is state administration body responsible for energy sector including nuclear energy. It is also responsible on behalf of the Government of the Republic of Croatia to implement the Agreement between the Government of the Republic of Croatia and the Government of the Republic of Slovenia on the Regulation of the Status and other legal Relationships, Connected with Investments in the NPP Krško, its Exploatation and Decommissioning.

Fund for financing the decommissioning of the Krško NPP and the disposal of radioactive waste and spent nuclear fuel from Krško NPP (Fund) is governmental organization established in 2008. The Fund's scope of work includes activities related to the acquisition, maintenance and increase of value of assets for financing the preparation, review and implementation of the Programme for decommissioning of the Krško NPP and the disposal of radioactive waste and spent nuclear fuel from Krško NPP (Decommissioning Programme) in accordance with Articles 10 and 11 of the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of the Status and Other Legal Issues Regarding Investments in Krško NPP and its Exploitation and Decommissioning .

In October 2012 Fund was appointed as Croatian expert organization for coordination of activities in preparing and drafting Decommissioning Programme for NPP Krško in the line with National strategy of radioactive waste and spent fuel management. Fund would like to be involved in all forms of technical cooperation with the IAEA in the field of decommissioning and radioactive waste and spent fuel management (training courses, fellowship, scientific visits, expert peer reviews and technical projects).

Croatian Research Institutions are active in participating in the IAEA Coordinated Research Activities (CRA). Currently the Croatian Institutions have signed 10 research contracts with the IAEA in the fields of Human Health, Nuclear Science, Radioisotope Hydrology and Nuclear Power.

The **Ruđer Bošković Institute (RBI)** established in 1950 as the national research centre for natural sciences, is covering nuclear and nuclear-related techniques in the country as the main centre for research, applications and training in this field, source of expertise for the Government

and other state institutions. It is mainly financed by the state and partly self-sustained. The RBI actively cooperates with the IAEA. This includes bilateral Agreement between RBI and IAEA concerning the establishment of Agency beam line at the RBI accelerator facility since 1996.

RBI has long and active involvement in collaborative interdisciplinary research by exploiting radiation measurements and/or applications of different nuclear techniques

Division of experimental physics hosts the largest accelerator infrastructure in country that consists of two tandem accelerators (6.0 and 1.0 MV) producing variety of ion beams in 8 beam lines (including IAEA beam line). 350 kV CW accelerator is used as 14 MeV neutron generator. Accelerators are being used for basic research and applications of wide variety of nuclear techniques. Recently, 18 MeV cyclotron for PET isotope production has been installed through the joint venture of RBI and private company. Radiocarbon and Tritium Laboratory of this division has liquid scintillation counter (LSC) and electrolytic enrichment system for low-level tritium measurement as well as LSC and AMS methods for low-level ^{14}C environmental measurements with application in hydrology, geology, ecology, archaeology and paleoclimatology.

The Radiation Chemistry and Dosimetry Laboratory (RCDL) in the Department of Materials Chemistry of the IRB is the only unit in Croatia which has been dealing with all aspects of physico-chemical effects of ionizing radiations and their applications. RCDL covers both physical and chemical methods of dosimetry over many orders of magnitude in dose, from medicinal and occupational dosimetry and environmental monitoring to radiation processing. The span of metrological capabilities in dosimetry has been further extended by the establishment of a Secondary Standard Dosimetry Laboratory. The Laboratory operates several Co-60 sources (1-30 TBq) and a panoramic Co-60 irradiator (830 TBq) for basic research, calibrations and applications. The strongest panoramic Co-60 irradiation facility is being used to provide irradiation services including radiation sterilization, preservetion of cultural heritage and food irradiation. RCDL fulfils national, as well as regional needs for irradiation services and processing. Some 100 manufacturers of food, medical, pharmaceutical and cosmetic products have been the end-users of these services. Research in radiation processing provided the scientific, technical, economic, manpower and legal prerequisites for the technology transfer. A linear electron accelerator is planned to be added to radiation processing activities in the future.

Alpha, beta and gamma activity measurements are made in the Laboratory for Radioecology of the Centre for Marine Research of the RBI.

Institute for Medical Research and Occupational Health, Environmental Hygiene Unit
Investigations of air pollution in Zagreb atmosphere started in Environmental Hygiene Unit in early sixties. Today this laboratory performs monitoring of numerous air pollutants and is accredited according to EN 17025 for EN methods for the following: PM10 and PM2.5 fractions of suspended particulate matter, SO2, NOx, CO, O3, Pb, Cd, As and Ni in the PM10, EC/OC/TOC in PM2.5 and PAHs in PM10. In the year 2013 Unit became National Reference Laboratory for suspended particulate matter, conducting monitoring, inter-calibrations and inter-comparison exercises and supervising other institutions involved in airborne particulate matter (APM). It actively participates in IAEA national and regional projects investigating APM using nuclear methods since the year 2005. Elemental composition of APM using XRF method started in 2010.

The University Hospital Centre Zagreb (KBC Zagreb) is the biggest and most important hospital in Croatia as well as a unique institution regarding many medical procedures, diagnostic methods and therapeutic procedures including highly differentiated procedures of

top quality. KBC Zagreb has about 5300 employees in total, 3500 of which are medical staff committed to providing medical and nursing services to their patients.

KBC Zagreb has more than 50 reference centers of excellence acknowledged by the Croatian Ministry of Health. These centers are aiming at continuous monitoring and improving specific areas of the medical profession and science in Croatia.

The Department of Nuclear Medicine and Radiation Protection was founded in 1959. It is the oldest and the largest nuclear medicine department in Croatia. There are 135 000 various diagnostic studies and therapeutic procedures performed at the department every year, which accounts for about 30% of the overall nuclear medicine service in Croatia. 1999 was acquired triple-head coincident gamma camera for PET imaging, which allows application of F-18 FDG PET in Croatia for the first time.

Today the Department has eight gamma cameras, four of which are tomographic cameras (two SPECT and two SPECT/CT). 2012 was acquired dedicated PET/CT camera and still this is in Croatia the only one PET/CT machine in public sector.

The Department collaborates with other nuclear medicine departments in Croatia, with the nuclear power plant Krško in Slovenia, with the International Atomic Energy Agency (IAEA), the European Association of Nuclear Medicine (EANM) and also with many other foreign institutions in the field of nuclear medicine and radiation protection through scientific research and educational activities. Most of the physicians attended training courses organized by the IAEA held in the educational facilities of the EANM in Vienna and other cities in the region. The members of our Centre for Radiation Medicine and Protection participated in specialized training courses in Oak Ridge Associated Universities, Oak Ridge, USA and in the Center for nuclear science IPSN Fontenay aux Roses, Paris, France.

Reference centers of excellence in the Department of Nuclear Medicine and Radiation Protection approved by the Croatian Ministry of Health are Reference Centre for the Medical Care of Irradiated Persons and Reference Centre for the SPECT/CT.

The role of **University Hospital "Sestre milosrdnice"** is to continue providing comprehensive treatment for oncology patients by different modalities of radiotherapy, chemotherapy supported also through nuclear medicine diagnostics procedures. For that purpose, the transition from 2D conventional RT to 3DCRT took place and a number of new RT procedures, intracavitary and intraluminal high dose rate brachytherapy (HDRBT) for different sites and nuclear medicine imaging techniques (e.g. SPECT-CT) have been introduced into clinical practice during past years.

The University hospital centers of Rijeka and Osijek and Medical faculty of JJ Strossmayer University in Osijek have very good cooperation backed up by the IAEA technical cooperation projects. All of the projects had the same goal: Strengthening the radiation safety in medicine. Few surveys were done in Croatia of QA/QC programs and patient doses in different radiological modality and afterwards few national workshops were organized on the same subject. During this time, radiation safety programs were implemented in some hospitals and the results of image quality and patient doses were compared to the situation before. Similar projects in radiotherapy were implemented with good results that resulted with better legislation and implementation of safety barriers in order to improve radiation safety in radiotherapy.

The Faculty of Electrical Engineering and Computing (FER) of the University of Zagreb carries out safety analysis for the Krsko Nuclear Power Plant and provides consultancy on safety matters. Expertise in this area is shared between the Faculty and the Jozef Stefan Institute in Ljubljana. The Faculty carries out independent calculations and verification of calculations

performed by the plant vendors (issues of Final Safety Analysis Report (FSAR), Updated Safety Analysis Report (USAR), life-extension of the reactor components, replacement of old equipment, modeling environmental conditions of the plant under accident and normal operating situations. Safety assessment is based mostly on analytical tools obtained from NRC in frame of CAMP and CSARP programs (RELAP5, TRACE, MELCOR, PARCS, MACCS2). Radiological consequences of nuclear accidents are calculated using MACCS2, COSYMA, RASCAL and RADTRAD computer codes.

In the area of general nuclear power objective of the research is to develop methodologies for quantitative assessment of the energy, economic, financial and environmental impact of applicable energy technologies (electric power producing plants and their technology chains), as a base for estimating optimal long-term development strategy of the Croatian power system. Research work includes new strategies of energy sector and power system development for Republic of Croatia; preparing medium and long-term electricity generation expansion plan for power system; comparison of energy, economic and environmental characteristics of different options for electric power generation; Recent research covers development of new models for power system generation optimization and planning under uncertainties of the open electricity market. Research goal is also to improve capabilities in energy planning for sustainable energy strategies using IAEA methodologies and models (MESSAGE, WASP, SIMPACTS, FINPLAN).

Current work also include using IAEA models MESSAGE, WASP, SIMPACTS, FINPLAN: analysis of economics and financing of nuclear power (nuclear power generation costs - the cost of capital and the competitiveness of nuclear power); national energy supply planning (national energy market analysis, survey of energy resources, energy demand forecast, energy supply planning, electric power system planning, power technology forecast, assessment of environmental burdens).

FER is also included in IAEA TC projects that support the introduction of nuclear energy by the planning development of nuclear power program.

Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb has several laboratories as well as prominent scientists active in the field of soil and rock mechanics, engineering geology, hydrogeology, geochemistry etc. Faculty has been involved in Croatian program framework for technical co-operation since 2008 within the project: INT9173 "Training in Radioactive Waste Disposal Technologies in Underground Research Facilities-URFs". In total, four employees of the Faculty of mining, geology and petroleum engineering have taken part in several trainings, regional training courses, workshops and technical meetings organized by IAEA over the last six years. During this time, significant transfer of knowledge and experience among faculty's employees and foreign colleagues has taken place, primarily in the field of stakeholder involvement, potential site selection and characterization, host rock characterization, construction of underground spaces and monitoring. Possible areas of interest as well as cooperation for the Faculty of mining, geology and petroleum engineering in the future are:

- testing of bentonite and host rock/bentonite mixtures for buffer and backfill;
- in situ measurements of stress/strain within the host rock;
- hydrogeological studies and surveillance of groundwater properties;
- mineralogical/petrologic studies of host rock properties;
- testing of radionuclide transport in host rock;
- environmental impact assessment and monitoring techniques for soil, rock and underground water protection; etc.

Faculty of Mechanical Engineering and Naval Architecture (FMENA) of the University of Zagreb comprises areas of testing of materials and components at process and power plants. Laboratories that run a number of testing methods utilizing X-rays and isotopes are crucial for education and training of experts employed by end users for the purpose of structure integrity assessment. These experts play significant roles in the research and application, particularly in the field of non-destructive evaluation: e.g. In-Service Inspection (ISI) at NPP Krško, INETEC Institute of nuclear technology. In 2009 Faculty was the first institution in the Croatia and neighborhood region that purchased Computed Radiography system with support of Ministry of Science and Technology as a part of national scientific research project.

Energy institute Hrvoje Pozar (EIHP), Zagreb. The Institute's main tasks include: expert and scientific research in the field of energy for state, regional and local administration and energy companies; expertise and analyses for the Croatian Energy Regulatory Council; management of National Energy Programmes and pilot projects; organisation of seminars, workshops and courses; publication of editions, periodicals and other forms of communication with experts, scientists and the general public, especially via Internet. The Institute carries out its mission in cooperation with numerous scientists and institutions from Croatia and abroad. The institute is one of the main counterparts in capacity building activities and users of the IAEA energy planning tools and methodologies.

Faculty of Agriculture, University of Zagreb Department of plant breeding, genetics and biometrics participated in the TC Regional Project „ Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques (RER/5/013)" , 2007-2011.

The **Institute for Plant Protection, Croatian Centre for Agriculture, Food and Rural Affairs**, has been leading the implementation of the Sterile Insect Technique through TC projects CRO/5/002; RER/5/014, RER/5/018 and RER/5/020. The know-how and infrastructure acquired in the meantime can be used as a training center on the Use of SIT in the Balkans and Eastern Mediterranean.

Faculty of Veterinary Medicine, University of Zagreb: founded in 1919 as a four year college. On 7 December 1924 the school was renamed into the Faculty of Veterinary Medicine and it became a part of the University of Zagreb. Since then it has been the only faculty of that kind in the Republic of Croatia. The Faculty comprises a number of premises; lecture and teaching rooms, computer laboratories and laboratories and facilities where large and small animals are kept. Well-equipped infrastructure provides conditions for scientific research, teaching as well as cooperation with the economic sector (agriculture, biotechnology, animal origin food production). Striving to achieve international high teaching standards the Faculty has been evaluated by EAEVE (European Association for the Establishment of the Veterinary Education). The changes appointed by the EAEVE expert team are included in the new curriculum. The faculty participated in the Regional TC projects RER/5/015 and RER/5/016.

Croatian Veterinary Institute: The Croatian Veterinary Institute Zagreb was established based on a decision issued by the Ministry of Agriculture of 30 January 1933. As a research organization, it became a public institution upon taking effect of the Croatian Act on Institutions.
Currently, the Croatian Veterinary Institute is a leading research, diagnostic and analytical institute in the Republic of Croatia. It participated in the IAEA-TC projects RER/5/015 and RER/5/016 and hosted several fellowships.

Faculty of Science, University of Zagreb, Physics Department, is the central national institution for higher education in nuclear physics and its applications in Croatia, offering both undergraduate and graduate studies.

Three IAEA TC projects (CRO0005 and CRO0008 and CRO4005) have decisively contributed in establishing of nuclear physics laboratory with suitable laboratory exercises in nuclear physics and its applications for the undergraduate and graduate studies. The Department currently offers high quality education in nuclear science and its applications and one of the most important goals is to increase utilization of nuclear analytical techniques in industrial applications.

ENCONET Ltd. is consulting and engineering company founded in 1991 in Zagreb providing privately technical assistance services to the government, utilities and industry in the area of nuclear and radiological safety. ENCONET is authorized nuclear safety institution, both, by the Croatian State Office for Radiological and Nuclear Safety and by the Slovenian Nuclear Safety Authority. ENCONET capabilities are based on more than 20 years of experience that include preparation of technical basis for the nuclear and radiological safety regulations, policy documents and support in various projects like radioactive waste management and development of the national emergency preparedness infrastructure. ENCONET also provides support to NPP Krško operational safety through evaluation and review of plant modifications, evaluation of procedures, education and training of personnel, performing safety and reliability analyses, as well as more specific tasks like investigations, verifications, inspections, testing, and audits. In the field of off-site emergency preparedness and response the services provided by the company include performing threat assessments, organizing training and exercises and developing legislation, regulation, plans and procedures.

EKOTEH Dosimetry Radiation Protection Ltd., Zagreb (EKOTEH) is a specialized provider of services related to radiological protection and nuclear safety. It was founded in 1990. and recognized as the expert technical support organization for radiological safety by the regulatory authority in Croatia. EKOTEH is accredited according to ISO/IEC 17025 and approved by the State Office for Radiological and Nuclear Safety as the TSO.

EKOTEH offer a range of services including:
- personal monitoring service for radiation workers (TLD service);
- workplace monitoring in relation to radiation exposure;
- testing, monitoring and practical protection against ionizing radiation arising in various practices involving radiation sources and safety assessments;
- environmental monitoring including measurement of radioactivity in scrap metal cargoes, consumer products, construction materials, etc
- training and education in radiological and radioactive waste safety at national level;
- transport of radioactive sources and devices (in accordance with ADR regulations);
- export and import of radioactive sources;
- consultancy and safety assessments;
- assistance to regulatory authorities, utilities, medicine and industry related to radiological safety, etc.

EKOTEH was and still is engaged in a series of initiatives concerning improvements of radiation protection in Croatia (QA programme in medical institutions, search for disused or damaged sources during war activities in Croatia at the beginning of 90`s, remediation of closed radioactive waste storage facilities, conditioning of disused sealed sources etc.).

EKOTEH and its experts collaborate with IAEA on international projects (RECAN, INT9176 Strengthening Cradle-to-Grave Control of Radioactive Sources in the Mediterranean Region etc.)

EKOTEH is a member of European ALARA Network (EAN) and organized workshops with international participations.

Performance excellence has been achieved through continuous training of personnel and deployment of »state of the art« equipment. EKOTEH achieved a top ranking performance position in Croatia in the field of operational radiological safety by covering more than 70 % of users or licensees in Croatia with contracts.

ANNEX 2

Resource estimates and forecasts

Country Programme for 2016 – 2019

Date originated: 17 July 2014

Dated updated: 22 September 2014

			US$	
1.	Historical reference figure for approved national programme (average of e.g.; 2009-2011, 2012-2013, 2014-2015), as an indicative planning figure[1] for the period of coverage.		EUR	825.000
	Estimated Government cash contribution[2] for the planning period		EUR	50.000
	Estimated Government in-kind contribution[3] for the planning period		EUR	20.000
	Total estimated resources		EUR	895.000
2.	Preliminary estimates for the agreed programme/projects reflected in the CPF			
	Title			
	(i)	Radiation Medicine and Health	EUR	410.000
	(ii)	Nuclear Energy Development and Radioactive Waste Management, including Nuclear and Radiation Safety and Security	EUR	205.000
	(iii)	Application of Isotopes and Radiation	EUR	150.000
	(iv)	Development and implementation of nuclear techniques in environment, industry, agriculture and education	EUR	85.000
	Total estimated costs		EUR	850.000
3.	Total estimated resource (1) less total estimated costs (2)		EUR	45.000
4.	Estimated resource requirements		EUR	850.000

[1] The country indicative planning figure does not obligate the Agency to provide such funding, nor does it suggest the expectation of continued levels of Agency funding. The sole purpose is to assist planning and prioritization of the country framework.

[2] The indicative government cash contribution does not commit the government to the stated amount, but indicates the intent and likelihood of such support.

[3] In-kind contributions represent the value assigned to non-cash contributions such as providing experts, training courses, and infrastructure. Planning for in-kind contribution can also include bilateral trade and intergovernmental cooperation agreements in the respective programme area.

ANNEX 3
Plan of Action

Background	The plan of action is a joint activity undertaken by the CPF Development Team, under the direction of the National CPF Coordinator that is intended to provide the necessary inputs to initiate a project concept note. It is designed to provide an operational bridge between identified, needs, interests and priorities of Member States (as reflected in the CPF) and the major follow-up steps necessary to expand an idea for solving a problem or realizing an opportunity into an operational set of step-wise actions. The actions and steps identified establish the required understanding, agreements, information and data, and meet whatever preconditions such as studies, capacity assessments, reviews or feasibility studies that are needed to organize a TC solution for overcoming the problem or realizing an opportunity.
Key Elements of the Plan of Action	Member States and TC agree on what actions need further elaboration and are to be included in the CPF. The detailed plan sets out the major steps or actions to be taken, the responsible parties, the expected result and the time frame for completing these actions. The plan provides the context and content for organized and step-wise actions that lead to the formulation of a project concept.
Implementation Strategy	The principal steps or actions needed to elaborate each idea are captured with due regard to the appropriate sequence of events and interdependence of actions. The date on which the concept is integrated into the action plan is recorded, along with any potential resources required to complete the action. If successfully translated into a project concept note, the respective project concept number is eventually recorded and the completed actions are transferred to the Archive of Completed Actions. If the planned actions are found to be unfeasible or inappropriate, they are nonetheless transferred to the archive of completed actions. In this way a permanent record is established of agreements and understandings leading to the development of the national programme.

Detailed Plan of Action

CPF Referenced Planning Opportunities	*Proposed Action*	*Action Party*	*Expected Output*	*Time Frame (From-To)*	*Resource Requirements*	*Project Concept Number*
TC cycle 2016-2017	Submission	IAEA, Experts	List of project concepts developed	February – end of May 2014	IAEA, SORNS & other relevant ministries, institutions	4 national and 2 regional concepts
IAEA/ SORNS		IAEA,	CPF doc ready for internal clearances	June 2014		
2016-2017 Programme Cycle Management Framework	Submission	IAEA, NLO project counterparts	Projects designs developed	May 2014 – November 2015	IAEA, SORNS & other relevant ministries, institutions	
Signature of CPF		IAEA/ SORNS	Endorsement of an updated CPF	October-November 2014	IAEA, SORNS and other relevant ministries, institutions	
TC cycle 2018-2019	Experts	counterparts	Elaboration of project concepts	End of May 2016	IAEA, SORNS & other relevant ministries, institutions	
2018-2019 Programme Cycle Management Framework	Submission	IAEA, NLO project counterparts	Projects designs developed	May 2016 – November 2017	IAEA, SORNS and other relevant ministries, institutions	
TC cycle 2020-2021	Submission	IAEA, counterparts	Elaboration of project concepts	End of May 2018	IAEA, SORNS & other relevant ministries, institutions	

Attachments to Plan of Action

1. Archive of Completed Actions
2. Report on National Competence Assessment (by Technical Officer)
3. Mid-Term Review and Update (if CPF is being revised)

ANNEX 4

Compilation of Treaties under the Auspices of the International Atomic Energy Agency Signed By the Member State

Croatia is a Party to:

1. Vienna Convention on Civil Liability for Nuclear Damage, succession in 1992
2. Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, ratified in 1993
3. Convention on the Physical Protection of Nuclear Material, succession in 1992
4. Amendment to the Convention on the Physical Protection of Nuclear Material, signed in 2005, ratified in 2006
5. Convention on Early Notification of a Nuclear Accident, succession in 1992
6. Convention on Assistance in the Case of a Nuclear Accident of Radiological Emergency, succession in 1992
7. Convention on Nuclear Safety, signed and ratified in 1995
8. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, signed in 1998, ratified in 1999
9. Agreement Between the Republic of Croatia and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons, signed and ratified in 1994
10. The Protocol Additional to the Agreement Between the Republic of Croatia and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons, signed in 1998, ratified in 2000
11. Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the International Atomic Energy Agency to the Government of the Republic of Croatia, signed in 1997