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AFRICAN REGIONAL COOPERATIVE AGREEMENT FOR RESEARCH, DEVELOPMENT AND TRAINING RELATED TO NUCLEAR SCIENCE AND TECHNOLOGY

PROFILE OF THE REGIONAL STRATEGIC COOPERATIVE FRAMEWORK (2008 – 2013)

A. BACKGROUND

AFRA originated from an initiative of African Member States who requested the Agency in 1988 to help establish a regional arrangement for cooperation in the field of nuclear science and technology in Africa. AFRA entered into force on 4 April 1990 as an intergovernmental agreement, which spells out the responsibilities of the AFRA Member States as well as the cooperation modalities and defines the interfacing between the Member States and AFRA partners. Although IAEA is not party to AFRA, it has the mandate to provide technical and scientific backstopping as well as administrative support in accordance with the rules and procedures that govern the provision of technical assistance to its Member States.

As of October 2007, AFRA enjoys a membership of 34 African countries: Algeria, Angola, Benin, Botswana, Burkina Faso, Cameroon, Chad, D. R. of Congo, Central African Republic, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Madagascar, Mali, Mauritania, Mauritius, Morocco, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe.

At the AFRA High Level Policy Review Seminar held in Aswan in November 2007, the AFRA countries adopted a Regional Strategic Cooperative Framework (RCF). The present document, known as the Profile of the Regional Strategic Cooperative Framework, is a summary of the RCF.

A.1. AFRA STRATEGIC GOALS

AFRA has defined five strategic goals. These goals are:

Goal 1: To enhance the sustainable contribution of nuclear science and technology to meet the developmental needs and interests of Member States;

Goal 2**:** To entrench the culture of mutual assistance and regional cooperation in the effective utilization of available nuclear expertise and infrastructure;

Goal 3**:** To deepen the culture of nuclear safety and security at regional and national levels in the gainful exploitation of nuclear science and technology;

Goal 4**:** To continuously interact with and create awareness amongst decision-makers, civil society, users and the general public on the benefits of peaceful application of nuclear science and technology;

Goal 5: To institute good governance and excellence in management of the activities in the region.

A.2. PURPOSE OF THE REGIONAL STRATEGIC COOPERATIVE FRAMEWORK

The achievement of regional strategic goals requires active cooperation among African countries based on the Regional Strategic Cooperative Framework (RCF). The purpose of the RCF is to identify and prioritise regional cooperation opportunities for the sustainable promotion of peaceful applications of nuclear science and technology, on the basis of an in-depth assessment of the most pressing regional developmental problems, needs, and priorities in the African socio-economic context. The

RCF is also meant to facilitate building of strategic partnerships with other relevant bilateral and multilateral bodies, agencies, and organizations.

The RCF will serve as a basis for the formulation of AFRA regional programmes and, in turn, will be used as a frame of reference in the process of development of AFRA regional projects. In this context, it is expected that the RCF will lead to the implementation of effective and efficient regional cooperation mechanisms.

B. OPPORTUNITIES FOR FUTURE COOPERATION AND PROGRAMME FOCUS AREAS

Recognizing the need for technical cooperation between developing countries (TCDC) and for other technical assistance from developed countries, AFRA has put emphasis on the use of available regional expertise and existing facilities for the planning, implementation and auditing of cooperative programmes under five thematic areas, namely Human Health, Food and Agriculture, Water Resources, Energy and Industrial Applications. In this regard, the establishment of appropriate regulatory infrastructure is a necessary pre-condition for the application of nuclear of nuclear technology in these thematic areas. The modalities of technical cooperation under these thematic areas are described in the chapters 3 to 8 of the RCF. This therefore calls for a proactive cooperation in the establishment and consolidation of radiation and waste safety infrastructure in Member States.

B.1. HUMAN HEALTH

AFRA recognizes that, in many African Member States, health services are inadequate and health sector indicators are below the world average. Health status indicators in Africa, such as life expectancy at birth, infant mortality rate and maternal mortality rate are generally low compared to the world average.

Poor health is generally an indicator of and contributor to poverty. Major health problems include the prevalence of malnutrition and the high incidence of communicable diseases, including HIV/AIDS, malaria and tuberculosis and yellow fever, as well as non-communicable diseases, mainly cancer, prenatal mortality, child mortality, diabetes, coronary artery diseases, and short life expectancy in general.

Some ongoing programmes are expected to improve the current situation but many threats remain such as the lack of sustained funding and human resources. Increased incidence of non communicable diseases like cancer, diabetes and cardiovascular diseases is expected.

Major health problems identified in human health to be addressed by nuclear techniques are:

B.1.1. CANCER

The high burden of cancer in African countries is increasing. This trend is caused by changing lifestyles, environmental exposure, inaccessibility to appropriate health care technology, inadequacy of modern diagnostic and therapeutic centres and delays in seeking care by cancer patients.

The majority of countries in Africa have no cancer control policy and health care professionals often face ethical dilemmas when assigning priorities because of limited resources. Early detection which comprises screening of asymptomatic populations and awareness of early signs and symptoms, increases the probability of cure. This should be supported by diagnosis and treatment facilities. Most countries in Africa do not have satisfactory infrastructure and facilities for cancer therapy requiring surgery, chemotherapy and radiotherapy. In addition to the lack of equipment for the management of cancer, Africa has an acute shortage of cancer experts such as pathologists, surgical oncologists, radiation oncologists, medical oncologists, nuclear physicians and medical physicists. Radiation oncology plays a major role in the treatment of both early and advanced cancers.

AFRA shall promote:

- Optimum use of available radiotherapy facilities in the region as well as establishment of additional facilities.
- Education and training of medical physicists and radiation oncologists within the region.

B.1.2. MALNUTRITION AND CHILD MORTALITY

Out of ten children born in developing countries, one child will die before his or her fifth birthday. This extremely high death toll — in total more than 10 million young children die in developing countries each year — demonstrates the vulnerability of infants and young children to poor nutrition and poor health. Under-nutrition contributes to death in more than half of children who die in developing countries.

Many countries in Africa have programmes for nutritional rehabilitation of malnourished children. With support from the IAEA, AFRA shall promote the use of stable isotopes in the assessment of the effectiveness of these programmes.

B.1.3. COMMUNICABLE DISEASES

Humanity pays a tremendous price in terms of communicable diseases. Two billion people are exposed to malaria worldwide; about half a billion clinical cases and up to 3 million deaths occur in the world each year. It is estimated that 90% of these deaths are children under the age of five.

Tuberculosis is an equally widespread and global infectious disease that claims millions of lives every year. In addition, several other communicable diseases including pneumonia, diarrhea, measles, onchocerchiasis, trypanosomosis, shistosomiasis, dracunculosis, filariasis are also important health concerns.

HIV/AIDS is a global pandemic that has been challenging scientists and other stakeholders for decades. Approximately 70% of adults and 80% of children living with HIV/AIDS, live in Africa. In 2004, an estimated 2.3 million Africans died of HIV/AIDS and 3.1 million acquired the infection, bringing the total number of persons living with HIV/AIDS in Africa to over 25 million (UNAIDS, 2004).

AFRA as a continental organization should trigger and encourage the following actions:

- Education and training of human resources in nuclear techniques;
- Provision of equipment, quality assurance and maintenance;

- Provision of expertise, data exchange, standardized guidelines and protocols;
- Local recognition and status to ensure staff retentions;
- National and Regional programmes.

AFRA should also build Partnerships by:

- Encouraging bilateral African cooperation whenever possible;
- Establishing multi centric studies/activities/protocols between countries and regions;
- Increasing cooperation of other regional institutions outside Africa;
- Better use of the local/regional/international prospective funders.

B.2. FOOD AND AGRICULTURE

Food security remains a major constraint limiting many development initiatives in Africa. Over $18 billion is spent annually on food imports and in the year 2000, Africa received 2.8 million tons of food aid, a quarter of the world's total production. Over the past decade, the number of people receiving the World Food Programme (WFP) food aid in sub-Saharan Africa has doubled from 21.2 million in 1995 to over 43.04 million in 2005. Ensuring access to sufficient safe and nutritious food is the main priority. However, a new strategy is needed to address the root causes of food insecurity. Recent increases in food production observed in the continent have been due more to an increase in area cultivated than to agricultural intensification.

AFRA shall promote the use of nuclear techniques to enhance food production. Such techniques can increase food production without demand for additional lands resources.

B.2.1. ANIMAL PRODUCTION

AFRA will promote the use of an integrated package of technologies to include AI and progesterone measurement using RIA for diagnosis of non-pregnancy; ultrasonography for diagnosis and treatment of infertility and reproductive disorders; metabolic and mineral profiles for assessment of nutritional adequacy; and feed supplementation strategies for overcoming inadequacies.

B.2.2. ANIMAL HEALTH

AFRA shall promote disease prevention through improved laboratory services, vaccine production and extension services. Diagnostic tests both for field and surveillance purposes are the cornerstone on which decisions on the vaccination needs are defined. Nuclear related techniques exist and are in wide use in veterinary laboratories, but not yet in the field. Isotopic techniques in reproduction and nutrition have the advantage of a high sensitivity but require laboratory infrastructure to conduct the work.

AFRA shall also promote training and technology transfer to upgrade diagnostic capacity and thus enable strategic interventions to be planned and carried out.

B.2.3. CROP PRODUCTION

Radiation Induced Mutation has become a major tool for establishing the desired linkages between gene sequence, function and agronomic characters and hence for developing high saturation linkage maps required for marker assisted selection. In addition, molecular techniques will be used to generate fingerprints of mutated germplasm, thereby creating the basis for protection of intellectual property rights.

AFRA shall promote the use of some of the nuclear techniques and tools listed below to improve crop production.

- Seed irradiation and flow-cytometric services;
- Provision of a DNA fingerprinting service for mutated plant germplasm characterization;
- Developing methodologies and guidelines (including pilot testing and demonstration);
- Develop molecular tools and edit related guidelines and protocols for high-throughput mutant germplasm characterization, based on micro-array technology, transferable to Member States laboratories;
- The availability of Mutant Variety Database (MVD), which collects and compiles information from Member States on crop mutant genetic resources;
- Updated manual on mutant germplasm characterization using molecular markers, to include Biostatistics, Bioinformatics and high-throughput techniques such as micro-arrays and tilling.
- Strengthened capacities in Member States in molecular biology and *in vitro* methods related to induction, selection and characterization of crop mutants by providing training on induced mutations, *in vitro* and molecular techniques.

B.2.4. SOIL FERTILITY AND WATER MANAGEMENT

Inherent low soil fertility and its continuous depletion under traditional cropping systems are one of the fundamental causes of declining per capita food production in sub-Saharan Africa. Nuclear techniques are ideal for monitoring irrigation water uptake by plants and losses through evaporation or deep drainage; and for quantifying efficiency of nitrogen applied under different irrigation and cropping systems through the use of labelled fertilizers (nitrogen-15).

AFRA shall promote technical cooperation in the utilization and improvement of these techniques in the region.

B.2.5. INSECT AND PEST CONTROL

The sterile insect technique (SIT), when part of an area-wide integrated pest management (AW-IPM) approach, can be used for insect suppression, containment, and/or eradication. AW-IPM can be used to establish pest free areas and areas of low pest prevalence, thereby providing better options to address International Plant Protection Convention (IPPC) standards and technical barriers to trade and other phytosanitary issues covered by the World Trade Organization (WTO).

AFRA shall promote technical cooperation in the use of the IAEA supported technologies for the control of insects and pests. These techniques include:

- The development and transfer of a genetic sexing technology for the Mediterranean fruit fly (now used in South Africa and Tunisia and in preparation for use in Morocco), storage and long distance shipment protocols, and molecular marking technologies, using PCR (polymerase chain reaction) primers specific for genomic or mitochondrial DNA;
- The development and transfer, as part of tsetse SIT, of the pupal sexing systems using near-infra red spectroscopy; semi automated membrane-feeding and holding systems; non-destructive PCR method for detection of salivary gland hypertrophy virus (SGHV) and alternatives for the processing of blood for tsetse flies;
- The development of the SIT package for the mosquito *Anopheles arabiensis*, a vector of malaria;
- Technologies supportive to and essential for efficient use of the SIT against the tsetse and trypanosomosis problem and the application of the area-wide concept of integrated pest management (AW-IPM).

B.2.6. FOOD SAFETY

Recent trends in global food production processing, distribution and preparation have made it necessary to address food safety issues along the entire food chain - from production to consumption. Therefore, the role of the analytical laboratory in the application of good production practices throughout the food chain has become necessary, as opposed to the more traditional end-product testing of products. These require strengthening in order to ensure food safety and the reduction at their source of hazards arising from chemical and microbiological contamination. These activities entail the development of analytical methods and procedures that enable Member States to evaluate the impact of their application of good production practices, including the identification and use of environmental indicators related to water and soil. To help meet these needs, protocols have been developed for the use of radio-labelled compounds to optimise different steps, and estimate measurement uncertainty, during the development of analytical techniques used in regulatory programmes for residues of pesticides and other contaminants in food and environmental samples.

Specific regional priorities that AFRA may address include:

- Providing norms, standards and guidelines in an understandable form for adaptation and use at the regional and sub-regional level;
- Providing upstream project planning as well as technical backstopping as well as integrated monitoring approaches that feed back results to producers and decision makers;
- Utilize accelerated capacity building (eLearning courses, hands-on training and mentors) to address developmental barriers and facilitate effective participation in relevant committees of the Codex Alimentarius Commission and other relevant international standard setting fora;
- Strengthening joint efforts in capacity-building and international standard setting;
- Information sharing; food contamination monitoring, including establishment of internationally accredited regional reference laboratories;

- Facilitating effective linkage, cooperation, collaboration and coordination among food safety agencies.

B.3. WATER RESOURCES

Africa faces serious water security challenges despite high variable levels of rainfall resulting in floods and droughts in different parts at different times of the year. Currently the average storage capacity on the continent is about 200m^3/person/year while in North America the per capita is about 5 961m^3/person/year. Nevertheless, Africa has the potential to increase its water storage capacity by harnessing excess and harmful floodwaters for use during adverse drought conditions. In Africa, currently about 300 million people lack access to adequate water supply, and an estimated 313 million lack access to adequate sanitation. Low access to sanitation and water supply are the root causes of many diseases that affect Africa. In addition, people with HIV/AIDS and malaria, who are often victims of opportunistic diseases, are also affected by the situation. It has been estimated that if no serious intervention is made, the number of people without adequate water supply and access to sanitation could double by the 2015 Millennium Development Goals target date if the 'business as usual' approach is maintained.

One of the key requirements for effective interventions for sustainable water resources management in the priority areas of Agenda 21 is an improved hydrologic knowledge base for decision-making. Isotope and related nuclear techniques are effective and unique tools for obtaining hydrologic information for a broad range of water resource management issues. In particular, isotope techniques help determine the adequacy of water supplies, develop strategies for optimize resource management by aiding in better understanding of aquifer recharge-discharge relations, and how the hydrologic cycle operates and may be altered by natural climate change and variability and the world's increasing use of finite water supplies.

The following AFRA regional interventions are being proposed for the 2008-2013 project cycle:

B.3.1. CAPACITY BUILDING

The main objective is to develop African capacity and self sufficiency to address practical water resources management problems using isotope hydrology methods. The focus should be on establishing at least two regional centres of excellence in isotope hydrology application, to promote the training for young 'water' professionals and helping Member States set up laboratories to undertake isotope measurement.

B.3.2. INTEGRATED WATER RESOURCES ASSESSMENT

The effort in support of water resources management in African transboundary watersheds should be geared towards developing cooperative activities to improve the understanding of the functioning of the water cycle in at least two selected transboundary basins such as the Lake Chad basin and the River Zambezi basin. The core of the activities will be monitoring, collection and evaluation of isotope data for purposes of water resources management. The development objective pursued is to enhance the capacity of existing African transboundary river and lake institutions to manage the water resources better based on an improved understanding of the water cycle within their basins.

B.3.3. GROUND WATER AND DEPENDENT ECOSYSTEM PROTECTION

Wetland restoration activities may disturb shallow ground-water flow dynamics. There may be unintentional sources of water flowing into a constructed wetland that could compromise the long-term viability of a wetland function. Measurement of naturally-occurring isotopes in the hydrosphere can provide an indication of provenance, flow paths or components, and residence times or ages of wetland ground-water flow systems. Hydraulic head measurements may not provide sufficient detail of shallow flow disturbances and can be complemented by analyzing isotopes in waters flowing through the wetland. It is proposed to use isotopic and hydro-chemical techniques to assess sources of pollution in a transboundary shallow groundwater basin e.g. the alluvial aquifer system of the Senegal River basin.

The overall objective is to contribute to the control and prevention of negative health effects and environmental deterioration due to water pollution and to obtain a better understanding of factors contributing to the distribution of NO_3 in groundwater and to detect possible NO_3 sources.

B.3.4. USE OF ISOTOPE TECHNIQUES TO MANAGE SHARED AQUIFERS IN AFRICA

The development of a framework for the sustainable management and use of shared aquifers is a major challenge in Africa. This programme will aim to use isotope techniques to expand and consolidate the technical and scientific knowledge and database regarding selected aquifer systems and to develop groundwater management plan based on a monitoring network for the aquifer in consideration.

The ultimate goal will be to enhance the capacity of Africa to manage shared aquifers better based on an improved understanding of the properties of these systems.

B.3.5. APPLICATION OF NUCLEAR TECHNOLOGY IN PRODUCTION OF POTABLE WATER

AFRA will promote the use of isotope methods in determining recharge, leakage and evaporation from or into water harvesting systems. This will contribute to the protection of people from flood hazards and drought especially those in conflict-prone, arid and semi-arid areas by providing them water security with harvested water for agriculture and domestic use.

B.3.6. DAM SAFETY AND SUSTAINABILITY

This programme is a continuation of the existing effort in the field of dam safety and dam security. Its main objectives are:

- To empower the National Teams from the AFRA Member States to employ isotope and tracer techniques in the prediction, detection, monitoring and remediation of dam and reservoir leakage through training, provision of necessary equipment and sensitization of decision-makers and other relevant stakeholders;
- To develop and continuously update a database of dams and artificial reservoirs in AFRA Member countries where leakage is a problem and to compile major data on each case;

- To disseminate information and promote awareness amongst water resources development agencies in AFRA Member Countries of the use of isotope and tracer techniques during the site investigation and design phase of dam projects.

B.4. SUSTAINABLE ENERGY DEVELOPMENT

In the Africa region, limited access to the services provided by modern energy hinders the fight against poverty. The challenges of the energy sector in Africa are many and greatly impact on the overall performance of the region's social and economic indicators.

These key challenges include extremely low generation, transformation and transportation capacities; low access to and supply of modern energy, particularly in rural areas; weak human and institutional capacities especially related to governance in the energy sector; lack of adequate tools for effective energy planning and policy formulation; and a weak energy demand base. Overcoming these challenges will need intensive and organised energy activities including energy planning to facilitate informed energy decision-making.

The excessive dependence on traditional fuels, especially by the rural population is another challenge on the environment front. This has adverse health impacts mainly on women and children, and causes deforestation. The situation in urban areas is not very encouraging where pollution from a poorly maintained transport fleet and inhuman living conditions in the slums are worsening with time. Provision of cleaner modern fuels to rural as well as urban populations will considerably help to improve their living conditions.

The high dependence on traditional biomass energy by a large section of the population in Africa for cooking is a problem. Firewood and charcoal burn inefficiently, and can contribute to deforestation. The use of firewood and the production of charcoal produces adverse emissions which have great health impacts on users especially women and children.

Developing a competitive energy sector requires large numbers of highly skilled personnel in many specialised areas, especially in energy planning and modelling. Some skills do exist, but not in sufficient quantities to meet the demand. Improving skills to achieve optimal human resource requirements and strengthening institutions to compete internationally is an urgent concern, though retention of human capacity still remains a problem.

Several power interconnection facilities exist in Africa, but introducing more will improve network stability and reliability through diversification of energy resources and improvement of energy efficiency.

With increasing energy demand, the structure of future supply systems will have regional and global environmental consequences. The climate change threats require collective actions by all nations including African countries. Nuclear power is becoming increasingly important as a means of mitigating climate change and enhancing socio-economic development.

AFRA shall promote technical cooperation in the following areas:

B.4.1. ENERGY PLANNING

The similarities of energy problems in the region and the need for collaboration by the countries suggests strengthening further the regional cooperative effort to enhance energy planning capabilities

so that all the energy issues mentioned above can be addressed. The Intergovernmental Agreement AFRA provides a suitable framework for such an undertaking. Under the AFRA arrangements, the African countries have had successful cooperation and collaboration in various scientific and technical fields. AFRA would be one of the most appropriate mechanisms to foster regional collaboration in the field of energy planning because of its access to energy planning tools developed by IAEA. The regional effort will provide strong linkages across the region with respect to planning and strategizing energy options.

The wide variation in the stages of development in AFRA countries in the field of energy planning requires, however, a careful approach regarding the design of the mechanism and framework under which all African countries will benefit from the regional cooperation. The analysis of on-going activities, constraints and specific needs helped to identify the following areas which have a regional dimension and enjoy common interest:

- Need to strengthen and sustain institutional capability for energy planning;
- Legislate for the collection of appropriate energy data and development of appropriate statistics;
- Make ministers and other senior personnel aware of the benefits and shortcomings of energy modelling;
- Increase access, improve infrastructure and upgrade maintenance of energy equipment;
- Encourage/support individual/group/institution excellence;
- Development and implementation of human resources development programmes in the field of energy planning;
- Strengthening collaboration at national level among the energy bodies and the national development organs;
- Enhancement of regional cooperation and networking for energy planning.

B.4.2. HUMAN RESOURCES DEVELOPMENT

The development of skilled human resources in the field of energy planning is highly important. AFRA has already initiated a successful programme to increase the energy modelling skills in the relevant African energy institutions. However, there is the need to ensure that the skills of these modellers are fully utilised by the country/region planners.

AFRA project workplans should include activities that are expected to build in each country a multi-disciplinary team of well trained energy planners/economists/engineers to cover all aspects of energy planning. For the purpose of enabling the countries to train additional personnel at their pace and convenience, it is recommended that where possible, ICT-based training/learning materials be developed and disseminated under the relevant AFRA project, particularly for the use of the IAEA energy software and tools.

In order to sustain energy modelling and increase the planning skills in Africa, AFRA should review existing courses and introduce others on energy economics and energy modelling at the post-graduate level as well as taking the lead in opening discussions with relevant institutions and countries in energy planning.

B.4.3. REGIONAL DESIGNATED CENTRES (RDCS)

Regional Designated Centres (RDCs) in the region, under the AFRA Agreement, play a key role in promoting Technical Cooperation among Developing Countries (TCDC). In this connection, at least one RDC for Francophone countries and another for Anglophone countries in the field of energy planning should be established.

B.4.4. PARTNERSHIP BUILDING

Special attention should continue to be attached to building partnerships and networks in the field of energy planning with the aim to consolidate the national and regional capabilities and to expand the scope of regional cooperation. The fact that the stage of development in this field varies largely in Africa, which represents an opportunity for exchange of experience and information and for sharing experience, AFRA programmes should include activities that are designed to strengthen regional networking and to facilitate and promote linkages with potential partners such as NEPAD, UNIDO, UNECA, AFREC. Moreover, as several regional organizations (ECOWAS, East, West, Central, and Southern African Power Pools, SADC, Comité Maghrébin de l'énergie Electrique [COMELEC], United Nations Department of Economic and Social Affairs [UNDESA]) are having regular training activities in the field of energy planning and interconnection of electricity grids, coordination with these organizations should be achieved and where possible, combined training activities are held to optimize resources and increase effectiveness.

AFRA should collaborate with national governments and international organizations, such as IAEA, UNSD, UNDESA, and other organizations in the collection and maintenance of energy data bases in the African countries. This includes designing and conducting of surveys and the development and maintenance of databases. In particular, a comprehensive survey of renewable energy resources and their exploitation cost is required.

Sub-regional energy planning studies should be carried out by integrating the national studies by the appropriate institutions.

B.4.5. NUCLEAR POWER PROGRAMMES[1]

Although there is only one nuclear power reactor in operation in the region, there are ten research reactors in eight countries in the region. The increasing demand for electricity and fresh water in the region has opened up the prospect for Member States to install and operate nuclear power plants. Towards this end, AFRA shall:

- Work together with Member States and Africa Energy Commission (AFREC) to develop the expertise and infrastructure required to achieve the milestones for the implementation of nuclear electricity generation, in accordance with the Algiers' Declaration,
- Encourage Member States to comply with international requirements for peaceful nuclear power programs;
- Encourage Member States to develop national legislation and regulatory infrastructure for radiation safety and waste management including environmental safety;
- Promote upgrading of regional radiation protection programs; and
- Promote exchange of information between regulatory authorities within the region.

B.5. INDUSTRIAL APPLICATIONS

Industrial applications using nuclear and radiation techniques are divided into four categories:

B.5.1. RADIATION PROCESSING

AFRA will promote regional cooperation in order:

- To carry out and facilitate research and development as well as concrete applications of radiation technology in environmental studies and for processing of selected material for agricultural, health care and industrial applications;
- To promulgate and enforce the legislative framework in each AFRA Member State on radiation processing and applications in the various socio-economic development programmes;
- To intensify government commitment and willingness of public and private sectors to boost and popularize the applications of radiation technology. This approach adds a great potential for additional income generation, self-reliance and ensure sustainability;

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[1] Relevant IAEA publications include:

- Managing the First Nuclear Power Plant Project. IAEA TECDOC 1555 May 2007;
- Basic Infrastructure for a nuclear power plant project. IAEA TECDOC 1513 June 2006;
- Risk management of knowledge loss in nuclear industry organisations. Publication IAEA 2006;
- Knowledge Management for Nuclear Industry Operating Organisations. IAEA TECDOC 1510 October 2006;
- Competence Assessments for Nuclear Industry personnel. Publication IAEA 2006

- To ensure the continuous recognition of the establishment of a fixed quality management system (QMS), quality control (QC) procedures as well as a quality assurance (QA) programme rose to the international standards;
- To improve human resources programmes (retention and replacement) of skilled and trained personnel. This major objective could be accomplished through radiation technology transfer from the AFRA Member State developed in nuclear sciences and applications;
- To integrate radiation processing projects into the African national development objectives in a regional framework, which could guide the regional efforts in the field of nuclear sciences and their applications in the socio-economic development.

B.5.2. RADIOISOTOPES FOR TROUBLE SHOOTING

AFRA will promote regional cooperation in order:

- To promote radioisotope technology services at national and regional levels, through sensitization, partnership and networking;
- To upgrade national infrastructure for industrial radioisotope technologies;
- To optimize technical processes in petrochemical industries, mineral ore processing and chemical industries; such as cement, paper, sugar, etc;
- To maximize the utilization of radioisotope technologies to monitor and improve the efficiency of waste water treatment plants, oil recovery mechanisms in oil fields;
- To develop national capability on Nucleonic Control Systems (NCS) applications;
- To facilitate and promote regional and TCDC activities in the field of radioisotope technologies;
- To facilitate countries to train additional personnel at their pace and convenience, it is recommended that ICT-based training/learning materials be developed and disseminated under the AFRA projects, particularly for the mostly needed applications of radioisotope technology such as gamma scanning and neutron backscattering, leak detection in heat exchangers and buried pipelines, residence time distribution (RTD) and flow rate measurements and, nucleonic control system (NCS);

For the period 2011-2013 the effort should be continued by the reinforcement of established techniques among the African countries as well as the introduction in the Africa region of new technologies including:

- Improving quality and quality control of mineral product in the AFRA region’s metalliferous mining industries through the application of off-belt and on-belt neutron-gamma Nucleonic Analysis Systems (NAS);
- Gamma tomography as an advanced technology for process control and visualization. Gamma tomography technique in multiphase systems is the most promising, in order to visualize the structure and the movement of the material inside the industrial processing column in real time, without interrupting the operation.

Other objectives not less important than the above mentioned are:

- Development and validation of new software for radiotracer and sealed source applications;
- Validation and utilization of radionuclide generators for industrial radiotracer technology;
- Establishment of the Quality Control and Accreditation Systems in Radioisotope Application in Industry according to ISO standards, 9001-2000, and ISO 17025;
- Recognition of Regional Designated Centres (RDCs) in the field of radioisotope technology;
- Partnership and networking with the aim to consolidate the national and regional capabilities and to expand the scope of regional cooperation. Project workplans should include activities that are designed to facilitate and promote networking and linkage. It is also recommended that potential partners such as NEPAD and UNIDO be approached for cooperation and partnership;
- Communication with stakeholders in this field:
  - to publicize the potential of radioisotope technology in troubleshooting and optimising industrial processes; the possibility of using the AFRA Website and country homepages could be of interest).
  - Each country to organize national seminars during which potential end-users will be exposed to the many benefits that can be derived from the utilization of this technology.
- African Conference on radioisotope technology in industry to be held in conjunction with project coordination meetings;
- Sustainability of National Nuclear Institutions (NNIs): there is an urgent need for Member States to develop Strategic and Marketing plans as a pre-requisite for participating in the projects. Improving managerial capability in the AFRA Member States and adherence to guidelines and indicators for income generation are also of major importance.

B.5.3. NON- DESTRUCTIVE TESTING (NDT) TECHNIQUES

AFRA will promote regional cooperation in order:

- To increase the regional self-reliance in NDT and to ensure that the increased capabilities are sustainable;
- To increase the number of RDCs in order to meet the needs of the continent;
- For both AFRA and IAEA to recognise that combining NDT with other associated technologies will help achieve the goal of improving regional self-reliance and sustainability;
- To improve cooperation through the cross provision of supporting resources between well developed countries and less well developed countries.
- To support the African Federation of NDT as a forum for exchange of technology through regular conferences;

- To expand regional training capacity, where common interests are identified, through establishing Memoranda of Understanding. For example, it is quite likely that the RDCs will form alliances with the training organisations in several member countries;
- To keep abreast of the latest developments in NDT technology: automation and mechanisation of the test techniques will result in equipment costs increasing significantly. This is a challenge to African independence in the technology but this may be countered by shared expenditure and usage of the more costly and sophisticated equipment;
- AFRA interest in NDT technologies has generally been confined to the common test methods. Their electronic and mechanical development continues at a rapid pace, especially in the case of RT and UT where Digital Industrial Radiography and Time of Flight Diffraction are becoming standard test techniques. These new technologies need to be addressed in AFRA training programmes. Other more specialised methods that should be considered are infra red and acoustic emission.

B.5.4. RESEARCH REACTORS

The operating research reactors in the African region have potential for wide applications in various fields. For these reactors to be fully utilised regional cooperation is needed to:

- Follow the AFRA Guidelines and Indicators for the Achievement of Sustainable National Nuclear Institutions;
- Perform proficiency tests by following QA/QC procedures and eventually obtain certification and accreditation for laboratories;
- Develop Strategic/Business Plans with Marketing Plans to address the socio-economic problems of health, nutrition, industry, agriculture and environment. The programme for utilization should also focus on income-generation;
- Establish nuclear regulatory infrastructure and adhere to BSS requirements. The MSs should sign and ratify international conventions of safety and security. This will ensure availability of fuel to avoid interrupted operations;
- Develop appropriate human resources for design, operation and utilisation of research reactor and associated facilities;
- Collaborate with neighbouring MSs with or without research reactors to promote the utilization of these research reactors;
- Utilize the TCDC modality for the exchange of scientists and students to undertake R&D and educational activities at the centres.

B.6. RADIATION AND WASTE SAFETY

The Nuclear and Radiation Safety and Nuclear Security sector is important for all of the AFRA Member States . It covers three main thematic areas (a) Radiation, Transport and Waste Safety[2]; (b) Nuclear Installation Safety; and (c) Nuclear Security.

The regional strategy for each area may include the following:

B.6.1. REGULATORY INFRASTRUCTURE

Legislation

- All Member States planning to use Category[3] 1 and 2 sources in any application must have legislation to promote safety and security of these sources;
- Regulatory Authorities in all Member States should collaborate with professional organizations in their respective countries so as to ensure that all activities involving radiation sources are licensed.

Regulatory Authority staffing

- Member States should be encouraged to utilize the two existing institutions for training in radiation protection (Morocco and South Africa);
- Member States are urged to conduct Train of trainers program;
- Member States are urged to certify national centres for radiation protection training.

Regional Cooperation

- National Regulatory Authorities are encouraged to establish a forum of cooperation in the region;
- The regional Regulatory Authorities should cooperate with the regional professional organizations using ionizing radiation;
- The regional forum of Regulatory Authorities should cooperate with other regional security organizations (custom, police etc.)

Funding of Regulatory Authority

The regional Regulatory Authorities should, in collaboration with the African Union, encourage Member States to incorporate radiation safety programmes into the national planning process, with a view to enhancing funding of the respective national Regulatory Authority.

Quality Assurance

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[2] Emergency Preparedness is proposed to be considered as a sector in its own right outside the Radiation Safety area.

[3] According to the IAEAIAEA-TECDOC-1344 Categorization *of Radioactive Sources (2003),* Category 1 sources include those used in Radioisotope thermoelectric generators (RTGs), Irradiators, Teletherapy machines. While Category 2 Sources include those used in Industrial gamma radiography, High/medium dose rate brachytherapy

The regional Regulatory Authorities should establish peer review missions within the region for assessment of regulatory authority's functions in the AFRA Member States.

B.6.2. RADIATION PROTECTION SERVICES:

Occupationnel Exposure Monitoring

- Member states should have the means to provide such services;
- Member States should provide individual personnel monitoring for radiations workers;
- To reduce regional population exposure AFRA should promote inter-comparison measurements;
- AFRA should optimize the utilization of existing facilities in member states.

Medical Exposure Monitoring

- Regional professional bodies in radiology should use the services of qualified radiographers;
- In collaboration with the regional association of radiographers, AFRA should use the existing training facilities for radiographers in the region;
- In collaboration with the regional association of radiographers (for all nuclear medical applications), AFRA should promote the establishment of additional training schools for radiographers;
- In collaboration with regional professional bodies in diagnostic radiology, nuclear medicine, and radiotherapy, AFRA should promote, using the forum of the IAEA, the professional recognition of medical physicist as an essential component in the practice of radiotherapy and nuclear medicine in the region;
- AFRA in collaboration with regional professional association of radiologists should enhance readiation protection training for radiologists carrying out fluoroscopy procedures;
- AFRA in collaboration with regional professional association of radiographers (for all nuclear medical applications), should encourage Member States to adopt the IAEA QA/QC procedures for diagnostic and intervention radiology and radiotherapy;
- AFRA should encourage the establishment of calibration centres for radiotherapy and encourage the utilization of such existing facilities in the region.

Public Exposure Monitoring

- AFRA should harmonize the national transport regulations for radioactive sources in the region so as to meet international standards;
- AFRA should promote exchange of information in the region with regards to radiological pollutions;
- AFRA should harmonize limits related to contamination, doses, etc.., in accordance with the international standards, taking into consideration the ALARA principle.

Radiological Emergency

- AFRA should establish a Regional Emergency Response Group;
- AFRA should promote the exchange of information between Member States in the event of any radiological emergencies;
- AFRA should encourage the exchange of experts in the event of any radiological emergency;
- AFRA should in collaboration with Member States, designate medical centres within the region to provide medical care in case of radiological emergency.

Radioactive Waste Management

AFRA should harmonize national policies and regulations on waste management (including spent sealed sources, NORM and TE-NORM waste) so as to comply with the international standards;

AFRA should establish some regional training centres for radioactive waste management.

B.6.3. EMERGENCY PREPAREDNESS AND RESPONSE

- AFRA should establish a Regional Emergency Preparedness and Response Group;
- AFRA should encourage Member States which are not yet parties of the Emergency and Assistance Conventions to accede to the conventions;
- AFRA should promote the exchange of information between Member States in the event of radiation emergencies using the existing international arrangements;
- AFRA should encourage the exchange of experts in the event of a radiation emergency using the existing international arrangements;
- AFRA should in collaboration with Member States, designate medical centres within the region to provide medical care in case of a radiation emergencies using the existing arrangements for international assistance;
- AFRA should encourage harmonisation of emergency preparedness and response arrangements in the region;
- AFRA should in collaboration with Member States promote education and training of emergency preparedness and response personnel, utilizing also train-the-trainers approach.

B.6.4. NUCLEAR SECURITY

- AFRA should formally endorse the Code of Conduct on the Safety and Security of Radioactive Sources;
- AFRA should develop and harmonize regulations for the security of radiation sources;
- AFRA should develop guidelines on intra-regional shipment of scrap metals;
- AFRA should promote awareness among the front line responders (custom, police, etc.).