African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology

Profile Of The Regional Strategic Cooperative Framework (2008–2013)
AFRICAN REGIONAL COOPERATIVE AGREEMENT FOR RESEARCH, DEVELOPMENT AND TRAINING RELATED TO NUCLEAR SCIENCE AND TECHNOLOGY

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

In 1988, African Member States requested the IAEA to help establish a regional arrangement for cooperation in the field of nuclear science and technology in Africa. This initiative laid the foundations for the African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology, or AFRA. AFRA entered into force on 4 April 1990 as an intergovernmental agreement that states the responsibilities of the AFRA Member States and the cooperation modalities as well as defining the interface between the Member States and AFRA partners. Although the IAEA is not party to AFRA, it is mandated to provide technical and scientific backstopping and administrative support, in accordance with the rules and procedures that govern the provision of technical assistance to Member States.


At the AFRA High Level Policy Review Seminar held in Aswan in November 2007, the AFRA Member States 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:

**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 interact continuously 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 the management of activities in the region.

A.2. Purpose of the RCF

The achievement of regional strategic goals requires active cooperation among African countries based on the 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 socioeconomic context. The RCF is also meant to facilitate the building of strategic partnerships with other relevant bilateral and multilateral bodies, agencies and organizations. The RCF serves 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 importance of technical cooperation between developing countries (TCDC), AFRA emphasizes the use of available regional expertise and existing facilities for the planning and implementation of cooperative programmes under five thematic areas,
namely, (i) human health, (ii) food and agriculture, (iii) water resources, (iv) energy and (v) industrial applications. In this regard, the establishment of an appropriate regulatory infrastructure is a necessary pre-condition for the application of nuclear technology in these thematic areas. This calls for proactive cooperation in the establishment and consolidation of a radiation and waste safety infrastructure in Member States. The modalities of technical cooperation in each thematic area are described in chapters 3 to 8 of the RCF.

B.1. Human health

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

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

A number of ongoing programmes are expected to improve the current situation, but many threats remain, including the lack of sustained funding and human resources.

AFRA plans to focus on cancer control, malnutrition and child mortality, and communicable diseases.

B.1.1. Cancer

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

The majority of countries in Africa have no cancer control policy. Health care professionals often face ethical dilemmas when assigning priorities, owing to the limited resources available to them. Early detection, comprising screening of asymptomatic populations and awareness of early signs and symptoms, increases the probability of a cure. This should be supported by diagnosis and treatment facilities. However, most countries in Africa do not have a satisfactory infrastructure and facilities for cancer therapy requiring surgery, chemotherapy or 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 will 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 their 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. Undernutrition contributes to the death of more than half of the children who die in developing countries.

Many countries in Africa have programmes for the nutritional rehabilitation of malnourished children. With support from the IAEA, AFRA will 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 three million deaths occur in the world each year. It is estimated that 90% of these deaths are of children under the age of five.

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

HIV/AIDS is a global pandemic that has been challenging scientists and other stakeholders for decades.

AFRA, as a continental cooperative framework, should trigger and encourage the following actions:

- Education and training of human resources in the use of nuclear techniques for the control of communicable diseases;
- Quality assurance;
- Provision of equipment, quality assurance and maintenance;
- Provision of expertise, data exchange, standardized guidelines and protocols;
- Local recognition and status to ensure staff retention.

AFRA should also build partnerships by:

- Encouraging bilateral African cooperation whenever possible;
- Establishing multicentric studies/activities/protocols between countries and regions;
- Increasing cooperation with other regional institutions outside Africa;
- Promoting better use of potential local/regional/international funding sources.

B.2. Food and agriculture

Food security remains a major constraint, limiting many development initiatives in Africa. 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 plans will focus on the following:

B.2.1. Animal production

AFRA will promote the use of an integrated package of technologies to include artificial insemination and progesterone measurement using radioimmunoassay 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 will 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 vaccination needs are made. Nuclear related techniques exist and are in wide use in veterinary laboratories, but not as yet in the field. Isotopic techniques used in reproduction and nutrition work have the advantage of high sensitivity but require a laboratory infrastructure to conduct the work.

AFRA will 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 tools and capacity development listed below to improve crop production:

- Seed irradiation and flow-cytometric services;
- Provision of a DNA fingerprinting service for mutated plant germplasm characterization;
- Development of methodologies and guidelines (including pilot testing and demonstration);
- Development of molecular tools and editing of related guidelines and protocols for high throughput mutant germplasm characterization, based on micro-array technology, transferable to Member States’ laboratories;
- Increased availability of the mutant variety
database, which collects and compiles information from Member States on crop mutant genetic resources and provision of an 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

Inherently low soil fertility and its continuous depletion under traditional cropping systems are a fundamental cause 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 the efficiency of nitrogen applied under different irrigation and cropping systems through the use of labelled fertilizers (nitrogen-15).

AFRA will promote regional 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 meet International Plant Protection Convention standards as well as to address technical barriers to trade and other phytosanitary issues covered by the World Trade Organization.

AFRA will promote regional approaches for the use of 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 polymerase chain reaction primers specific for genomic or mitochondrial DNA;

• The development and transfer, as part of SIT for tsetse eradication, of the pupal sexing systems using near infrared spectroscopy; semi automated membrane-feeding and holding systems; non-destructive polymerase chain reaction method for detection of salivary gland hypertrophy virus 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, the efficient use of the SIT against the tsetse and trypanosomosis problem and the application of the 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. These practices require strengthening in order to ensure food safety and the reduction at 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 the application of good production practices, including the identification and use of environmental indicators related to water and to soil.

To help meet these needs, protocols have been developed for the use of radiolabelled compounds to optimize different steps and to 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 subregional level;
• Providing upstream project planning, technical backstopping and integrated monitoring approaches that feed back results to producers and decision makers;
• Utilizing 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 pertinent international standard setting forums;
• Strengthening joint efforts in capacity building and international standard setting;
• Food contamination monitoring, including establishment of internationally accredited regional reference laboratories;
• Information sharing and facilitating effective linkage, cooperation, collaboration and coordination among food safety agencies.

B.3. Water resources

Africa faces serious water security challenges despite highly variable levels of rainfall resulting in floods and droughts in different parts of the region at different times of the year. The continent has the potential to increase its water storage capacity by harnessing excess and harmful floodwaters for use during adverse drought conditions. In Africa, about 300 million people lack access to adequate water supply. Low levels of access to sanitation and water is the root cause of many diseases that affect Africa. It has been estimated that if no serious intervention is made, the number of people without access to an adequate water supply and without access to sanitation could double by the 2015 Millennium Development Goals target date.

One of the key requirements for effective interventions in sustainable water resource management in the priority areas of Agenda 21 is an improved hydrological knowledge base for decision making.

Isotope and related nuclear techniques are unique, effective tools for obtaining hydrological information for a broad range of water resource management issues. In particular, isotope techniques help determine the adequacy of water supplies, support the development of strategies to optimize resource management by aiding a better understanding of aquifer recharge–discharge relations, and can show how the hydrological 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

AFRA aims to develop African capacity and self-sufficiency to address practical water resource 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 training of young water professionals and to help Member States set up laboratories to undertake isotope measurement.

B.3.2. Integrated water resources assessment

AFRA’s support to water resource 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. Core activities will include monitoring, collection and evaluation of isotope data for purposes of water resource management. The development objective pursued is to enhance the capacity of existing African transboundary river and lake institutions to manage water resources better, based on an improved understanding of the water cycle within their basins.

B.3.3. Groundwater and dependent ecosystem protection

Wetland restoration activities may disturb shallow groundwater flow dynamics. Unintentional sources of water may flow into a constructed wetland, compromising the long term viability of the 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 groundwater flow systems.

Hydraulic head measurements may not provide sufficient detail of shallow flow disturbances and can be complemented by analysing isotopes in waters flowing through the wetland. It is proposed to use isotopic and
hydrochemical techniques to assess sources of pollution in a transboundary shallow groundwater basin, e.g. the alluvial aquifer system of the River Senegal basin.

AFRA will contribute to the control and prevention of negative health effects and environmental deterioration due to water pollution, to obtain a better understanding of factors that contribute to the distribution of nitrates (NO₃⁻) in groundwater and to detecting possible nitrate 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. AFRA aims to use isotope techniques to expand and consolidate technical and scientific knowledge and to create a database of selected aquifer systems and to develop groundwater management plans 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 on the basis of an improved understanding of the properties of these systems.

B.3.5. Application of nuclear technology in the production of potable water

AFRA will promote the use of isotope methods to determine 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 arid and semi-arid areas, by providing them with water security through water harvested for agriculture and domestic use.

B.3.6. Dam safety and sustainability

This programme is a continuation of existing efforts 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 States 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 States on the use of isotope and tracer techniques during the site investigation and design phase of dam projects.

B.4. Sustainable energy development

In the African region, limited access to energy hinders the fight against poverty. The challenges facing the energy sector in Africa are many and greatly affect the overall performance of the region’s social and economic indicators.

Key challenges include extremely low generation, transformation and transportation capacities; low access to, and supply of, modern forms of 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 organized energy activities, including energy planning, to facilitate informed energy decision making.

Developing a competitive energy sector requires large numbers of highly skilled personnel in many specialized areas, especially in energy planning and modelling. Some skills do exist, but not in sufficient quantities to meet the demand. Improving skills to meet 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
threat requires collective actions by all nations, including African countries. Nuclear power is becoming increasingly important as a means of addressing climate change and enhancing socioeconomic development. AFRA will promote technical cooperation in the following areas:

B.4.1. Energy planning

The similarities between energy problems in the region and the need for collaboration by the countries suggests that further strengthening of regional cooperative efforts to enhance energy planning capabilities will help in addressing all the energy issues mentioned above.

AFRA provides a suitable framework for such an undertaking. Under the AFRA arrangements, African countries have cooperated and collaborated successfully 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 the IAEA. The regional effort will provide strong linkages across the region with respect to options for energy planning and strategy development.

The wide variation in the stages of development in AFRA Member States in the field of energy planning, however, requires a careful approach to the design of the mechanism and framework under which all African countries will benefit from regional cooperation. An analysis of ongoing activities, constraints and specific needs has identified the following areas having a regional dimension which should seek to:

- Strengthen and sustain institutional capability for energy planning;
- Legislate for the collection of appropriate energy data and the development of appropriate statistics;
- Raise the awareness of policy makers of the benefits and shortcomings of energy modelling;
- Increase access, improve infrastructure and upgrade maintenance of energy equipment;
- Encourage/support individual/group/institutional excellence;
- Develop and implement human resource development programmes in the field of energy planning;
- Strengthen collaboration at the national level among energy bodies and national development organs;
- Enhance regional cooperation and networking for energy planning.

B.4.2. Human resource 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 energy modelling skills in relevant African energy institutions. However, it is necessary to ensure that the skills of these modellers are fully utilized by the country/region planners.

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

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

B.4.3. Regional designated centres (RDCs)

RDCs in the region, under the AFRA Agreement, play a key role in promoting 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 of consolidating national and regional capabilities and expanding the scope of regional cooperation. Given that development stages in this field vary widely in Africa, representing an opportunity for exchange of experience and
information, AFRA programmes should include activities to strengthen regional networking and to facilitate and promote linkages with potential partners such as the New Partnership for Africa’s Development (NEPAD), the United Nations Industrial Development Organization (UNIDO), the United Nations Economic Commission for Africa (UNECA) and the African Energy Commission (AFREC). Moreover, as several regional organizations (ECOWAS, East, West, Central, and Southern African Power Pools, SADC, Comité Maghrébin de l’Energie Electrique, United Nations Department of Economic and Social Affairs) hold regular training activities in the field of energy planning and interconnection of electricity grids, coordination with these organizations should be achieved and, wherever possible, combined training activities should be held to optimize resources and increase effectiveness.

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

Subregional energy planning studies should be carried out by integrating the national studies carried out by the appropriate institutions.

B.4.5. Nuclear power programmes

Although there is only one African country operating nuclear power reactors (South Africa), 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 consider nuclear power.

Towards this end, AFRA will:

- Work together with Member States and 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 with respect to peaceful nuclear power programmes;
- 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 programmes;
- 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 the processing of selected material for agricultural, healthcare and industrial applications.
- To promulgate and enforce the legislative framework in each AFRA Member State on radiation processing and applications in the various socioeconomic 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 great potential for additional income generation and self-reliance and helps ensure sustainability.
- To ensure the continuous recognition of the establishment of a fixed quality management system and quality control procedures, as well as a quality assurance programme that conforms to international standards.
- To improve human resource programmes (retention and replacement) for skilled and trained personnel. This major objective could be accomplished through radiation technology transfer from AFRA Member States that are more advanced in nuclear sciences and applications.
• To integrate radiation processing projects into African national development objectives within a regional framework, which could guide regional efforts in the field of nuclear science and its applications in socioeconomic development.

B.5.2. Radioisotopes for troubleshooting

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 wastewater treatment plants and oil recovery mechanisms in oil fields.
• To develop national capabilities in nucleonic control systems applications.
• To facilitate and promote regional and TCDC activities in the field of radioisotope technologies.
• To develop and disseminate ICT based training/learning materials, particularly for the most necessary applications of radioisotope technology, such as gamma scanning and neutron backscattering, leak detection in heat exchangers and buried pipelines, residence time distribution and flow rate measurements and nucleonic control system applications.

For the period 2011–2013, effort should continue with the reinforcement of established techniques in African countries as well as the introduction of new technologies, including:

• Improving the quality and quality control of mineral products in the AFRA region’s metalliferous mining industries through the application of off-belt and on-belt neutron–gamma nucleonic analysis systems.
• Gamma tomography as an advanced technology for process control and visualization. Gamma tomography in multiphase systems is the most promising approach, allowing visualization of structures and the movement of material inside the industrial processing column in real time without interrupting the operation.

Other objectives no 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 RDCs in the field of radioisotope technology.
• Partnership and networking with the aim of consolidating national and regional capabilities and expanding 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 optimizing industrial processes (the possibility of using the AFRA web site and country homepages could be of interest);
  — Each country to organize national seminars during which potential end-users will be appraised of 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. There is an urgent need for Member States to develop strategic and marketing plans as a prerequisite to participating in projects. Improving managerial capability in the AFRA Member States and ensuring 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 regional self-reliance in NDT, and to ensure that capabilities are sustainable.
- To increase the number of RDCs in order to meet the needs of the continent.
- 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 capacities, 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 organizations in several Member States.
- To keep abreast of the latest developments in NDT technology. Automation and mechanization of the test techniques will result in significant increases in equipment costs. This is a challenge to African independence in the technology but it may be countered by shared expenditure and usage of the more costly and sophisticated equipment.
- That AFRA interest in NDT technologies has generally been confined to common test methods. However, 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 specialized methods that should be considered are infrared and acoustic emissions.

**B.5.4. Research reactors**

Research reactors operating in the African region have the potential to be widely used in a range of fields. For these reactors to be fully utilized, regional cooperation is needed to:

- Follow the AFRA Guidelines and Indicators for the Achievement of Sustainable National Nuclear Institutions.
- Perform proficiency tests by following quality assurance/quality control procedures and eventually obtain certification and accreditation for laboratories.
- Develop strategic/business plans with marketing plans to address the socioeconomic 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 Basic Safety Standards requirements. Member States should sign and ratify international conventions on safety and security. This will ensure availability of fuel to avoid interruptions to operations.
- Develop appropriate human resources for the design, operation and utilization of research reactors and associated facilities.
- Collaborate with neighbouring Member States 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**

Nuclear and radiation safety and nuclear security are important for all of the AFRA Member States. This covers three main thematic areas (i) radiation, transport and waste safety, (ii) nuclear installation safety and (iii) nuclear security.

The regional strategy for each area may include the following:

**B.6.1. Regulatory infrastructure**

1 Emergency preparedness is proposed to be considered as a sector in its own right outside the radiation safety area.
Legislation

- All Member States planning to use Category 1 and 2 sources in any application must have legislation to ensure the safety and security of these sources.

- Regulatory authorities in all Member States should collaborate with professional organizations in their respective countries to ensure that all activities involving radiation sources are licensed.

Regulatory authority staffing

- Member States should be encouraged to utilize the two existing institutions in the region for training in radiation protection (Morocco and South Africa).

- Member States are urged to conduct training of trainers programmes.

- Member States are urged to certify national centres for radiation protection training.

Regional cooperation

- National regulatory authorities are encouraged to establish a forum for cooperation in the region.

- The regional regulatory authorities should cooperate with other regional professional organizations using ionizing radiation.

- The regional forum of regulatory authorities should cooperate with other regional security organizations (customs, police, etc.).

Regulatory authority funding

The regional regulatory authorities should, in collaboration with the African Union, encourage Member States to incorporate radiation safety programmes into their national planning processes, with a view to enhancing funding for national regulatory authorities.

Quality assurance

The regional regulatory authorities should establish peer review missions within the region to assess the functions of the regulatory authority in the AFRA Member States.

B.6.2. Radiation protection services

Occupational exposure monitoring

- Member States should have the means to provide such services.

- Member States should provide individual personnel monitoring for radiation workers.

- To reduce regional population exposure, AFRA should promote intercomparison 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 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 physicists as essential components in the practice of radiotherapy and nuclear medicine in the region.

- AFRA, in collaboration with regional professional associations of radiologists, should enhance radiation protection training for radiologists carrying out fluoroscopy procedures.

- AFRA, in collaboration with regional professional associations of radiographers (for all nuclear medical applications), should encourage Member States to adopt the IAEA quality assurance/quality control 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 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 international standards, taking into consideration the ALARA\(^3\) 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 a radiological emergency.

Radioactive waste management

- AFRA should harmonize national policies and regulations on waste management (including spent sealed sources, NORM\(^4\) and TENORM\(^5\) waste) so as to comply with international standards.
- AFRA should establish 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 to the Emergency

and Assistance Conventions to accede to these conventions.

- AFRA should promote the exchange of information between Member States in the event of radiological emergencies, using existing international arrangements.
- AFRA should encourage the exchange of experts in the event of a radiological emergency, using existing international arrangements.
- AFRA should, in collaboration with Member States, designate medical centres within the region to provide medical care in case of a radiological emergency, using the existing arrangements for international assistance.
- AFRA should encourage the harmonization of emergency preparedness and response arrangements in the region.
- AFRA should, in collaboration with Member States, promote the education and training of emergency preparedness and response personnel and should also utilize a training of 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 the intraregional shipment of scrap metals.
- AFRA should promote awareness among front line responders (customs, police, etc.).

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3 ALARA: as low as reasonably achievable.
4 NORM: naturally occurring radioactive material.
5 TENORM: technologically enhanced naturally occurring radioactive material.