Nuclear research centres in the Islamic Republic of Iran

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Abstract. The Islamic Republic of Iran has a number of research centres devoted to various facets of nuclear energy. A reactor and a cyclotron have been successful producing radioisotopes for use in medicine, industry and agriculture. The use of gamma radiation and electron beams for radiation sterilization and radiation processing is widely practised. One centre is specifically devoted to fusion research and another for laser development. The important role played by IAEA in promoting applications of radioisotopes and radiation in the Islamic Republic of Iran is highlighted.

Past and present situation of nuclear research centres in the Islamic Republic of Iran

The infrastructure under the research vice president:

\[\text{Research Vice President} \rightarrow \text{nuclear research centre for Agriculture and Medicine} \rightarrow \text{Laser Research Centre} \rightarrow \text{Nuclear Fusion Research Centre} \rightarrow \text{nuclear research centre} \rightarrow \text{Yazd Radiation Processing Centre} \rightarrow \text{Gamma Irradiation Centre}\]

R&D programmes and the related finances, manpower and infrastructure.

Nuclear research centre (NRC)

The nuclear research centre has a five Megawatt swimming pool type reactor and has taken up a program for the production of short-live radioisotopes which were developed in 1981. Initially the purpose of this program was to deliver services to the isotope users in nuclear medical centres, producers of radiopharmaceutical kits and radioimmunoassay kits, as prime objectives of NRC/AEOL, for medical diagnostics and therapy.

This centre is also working on the production of high specific activity of radioisotopes used in brachytherapy and industries. These projects have been supported by the technical assistance of the IAEA since many years ago.

Nuclear Material Department

- Radio-metallurgy studies.
- Nuclear and Biological Ceramics.
• Production of materials for dosimetry such as LiF and CaSO4 as Thermo-luminiscence Detectors.
• Evaluation of pre and post irradiated specimens of critical structural materials of PWR reactors.
• Evaluation of PWR components and radiation damage and failure analysis of power reactor structural materials.
• Studying crystalline structure of ceramic materials.

Gamma irradiation centre (GIC)

• Following activities is the summary of what have been carried out at GIC over the past few years up to date
• Determining the specific dose and microbial QC for disinfecting and sterilising the disposable medical
  and hygienic products, as well as herbal drugs, spices, nuts, and packed food materials.
• Co-operation with food industry on as many as food products as possible.
• Studying the effects of irradiation on indotoxins.
• Studying the effects of irradiation in antibiotic sterilisation.
• Studying the effects of irradiation on polymeric materials.
• Studying the possibility of sterilising polymeric materials.
• Rendering services to the laboratories inside and outside of the AEOI.
• Analysing the wheat proteins with the method of SDS-Electrophoresis.
• Research in determining the micro-organisms of dates.
• Studying the effects of irradiation on herbal drugs and their colours.
• Design and construction of different dosimeters for irradiating system Dosimetry IR-136.
• Design and construction of ferric standard chemical dosimeters for Gamma cell irradiating system calibration.

Laser research centre (LRC)

The most important tasks at LRC are design and construction of various lasers development of related technologies such as optics, coating, glass blowing, establishing production lines of lasers and the related parts and manpower development.

Yazd Radiation Processing Centre (YRPC)

The installed electron accelerator at YRPC has the capability of emitting 5 and 10 MeV electron beams. Following is the summary of activities carried out over the past few years and some of the plans for the near future at YRPC.

• Irradiation of packaging materials.
• Food irradiation.
• Irradiation of glass.
• Irradiation of disposable medical products.
• Quality improvement of polymers.
• Production of Heat-Shrinkable Tubes and wrapping materials.
• Production of Head-Resistance Pipes.
Nuclear Fusion research centre (NFRC)

AEOI has been co-operating with the Kurchatov Institute of the Russian Federation since 1992. One of the outcomes of this co-operation has been the construction of Damavanc Tokomak for the purpose of fusion research. Presently joint research programs are being carried out with various universities incorporating postgraduate students working towards M.Sc. and PhD. degrees at NFRC. The design and construction of Plasma Nitriding system has already been completed. This system has many research and industrial applications.

Nuclear research centre for Agriculture and Medicine (NRCAM)

- Various radioisotopes such as Ga-67, TI-201, Kr-81m, In-111, and FDG for diagnostic purposes in medicine have been produced at the Cyclotron Department over the past few years. The scientists at this department are currently working on production of Iodine-123, and palladium-103 for prognostic purposes.

- Beside the researches done in radioisotope productions some other research programs such as nuclear-reaction-cross-section studies in the field of nuclear physics and beam-resolution-improvement-design as well as beam-eminence-measurements in the field of Beam Optics have been carried out by the PhD. students at the R&D division.

- Through applying the nuclear techniques in agriculture, noticeable accomplishments in quality and quantity of products have been achieved at the Nuclear Agriculture Research Department. For instance the Plant Breeding Group is in applied mutation through the aid of physical mutagen as a breeding technique to increase the genetic variety in different agronomic crops. Fixation of a desired mutated trait is pursued afterwards. So far mutation breeding on crops such as wheat, barley, rice, cotton, soy beans, sesames, and green beans have produced desirable traits such as early maturity, lodging resistance, shattering resistance, resistance to different biotic and abiotic stresses, and finally yield enhancements at this department. The Soil and Water Management & Crop Nutrition Group have optimised the ever more efficient ways of using water, fertilizers, natural resources, and soil fertility through utilising the applied nuclear techniques.

- The Food Irradiation and Pest Control Group has been aiming towards identifying food pests and eradicating them through the different developmental stages off growth by irradiation. This group has studied the γ-irradiation effect on ten important pests of stored-cereals at different stages of their growth. Survey of sunn pest (Eurygaster integriceb) migration with the use of P-32 and Zn-65 to determine their population distribution, winter’s habitual, and starting the new method of male insect sterilization technique to control rice stem borer.

- The Animal Husbandry Group has been focusing their activities towards nuclear techniques in diagnosis, prognosis, prophylaxis, controlling animal diseases, genetic improvements for better breeds, determination of the digestion coefficient as well as measuring the nutrients in animal feeds, hygienic states of animal feeds, and reproduction improvement of live stocks.

Currently, the scientists at this department are carrying some researches to substitute composites for metals in many structural applications.
Strength and limitations

Strength:

• Having sufficient well-trainable manpower to be trained in any desirable scientific and professional fields.
• Having the society's support for implementing any project under the peaceful applications of nuclear techniques.
• Our past experience shows that the trained personnel have often been able to transfer the subjects in which they had been trained.
• The government has been supporting the main portion of the expenses on almost every project under the peaceful applications of nuclear techniques so far.

Limitations:

• We have usually had difficulties in receiving spare parts needed for maintaining or repairing the equipment at our facilitated centres.
• The private organisations in the Islamic Republic of Iran have not got accustomed to financially support the AEOI towards implementing its new ideas. Even though they may be the very primary beneficiaries of the new techniques implemented which would help them to improve quality of their products.

Challenges faced by NRCs

New directions

We have basically done fundamental and scientific researches in the past. However, we are shifting emphasis towards applied research in the fields of Medicine, Industry and Agriculture.

Examples of successful orientation

Establishing the nuclear research centre for Agriculture and Medicine (NRCAM) could be counted as a successful example in changing the direction towards more of an applied research. The Secondary Standard Dosimetry Laboratory (SSDL) at NRCAM is counted as the national centre for accurate measurements of X and γ radiation fields as well as dose measurements in the Islamic Republic of Iran. This centre has been providing calibration services both in therapy and protection levels.

Preservation of expertise

Considering the new direction taken towards the applied researches at AEOI, we feel the even more lack and need for training expertise in different areas of the applied researches which we have very few of them at AEOI.

The technical co-operation of the IAEA has accelerated and enlarged these productions and in particular has provided the access to the application and utilisation of nuclear energy in the field of nuclear medicine and industries in the Islamic Republic of Iran. The transferring of these technologies by the IAEA's technical co-operation has promoted a tangible socio-economic impact in our country program frameworks.
Interaction of NRCs with their environment

Social and economic sector

The nuclear centres have always been worrying the society’s minds due the word “nuclear”. However, this mentality is changing ever since the peaceful applications of nuclear techniques in industry, medicine and agriculture have been implemented and eye witnessed by the people of our society.

Academia

About 50 PhD. and more than twice as many M.Sc. students are currently working throughout the nuclear centres at AEOI. Practically all of them are working on some interesting applied research projects. Basically in the third world countries such as ours the universities are very dependent on the existing nuclear centres to pursue their researches in the related nuclear fields.

Public

The NRCs have vast relations with nuclear medical centres, cancer institutes, therapeutically clinics, different industries, universities, and research centres throughout the country. Currently more than 65 nuclear medical centres in the Islamic Republic of Iran are receiving some type of radiopharmaceuticals from our centres. Prior to distribution to any of the nuclear medical centres in The Islamic Republic of Iran, the quality control of these productions is carefully investigated according to the IAEA regulations.

The end users of our products are quite satisfied with quality of our productions and the on time delivery of the products. Gladly, we have a very close collaboration and scientific relation with the doctors in the referred hospitals.

Our productions are used nearly by 5000 patients in the country every day. We have established a very close relation with the doctors in the field and the public in effect.

Collaboration and co-operation

North-south and south-south

For production of the radiopharmaceuticals, kits, and radioactive tracers we normally supply our essential materials from some European countries. Unfortunately, in most cases “end user statement” is needed. Though it is very time consuming, we prepare and send them the statements since the European suppliers are required to ask for such a thing according to their “Export license”. Our orders are mostly chemical, biochemical, biological materials for synthesis, and some formulation for the production of radiopharmaceuticals and kits which will be used for diagnostics and prognostic purposes in patients who are suffering from a disease. In this respect the North-South relation seems too weak and we believe that the IAEA can co-operate in some cases by fund in-trust procedure and supply the necessary materials for the projects. In some cases our centres are obliged to supply and purchase the materials they need from a free market twice as much as the actual price, or more, which is economically reasonable neither for the hospitals nor for the patients.
Since the above materials should be spec-pure and reliable to be synthesised for injection to the patients, the South-South collaboration in this particular case cannot be practical and efficient. However, in transferring the technology, expertise, and training of personnel is currently very effective in south-south collaboration and co-operation. We believe and we are sure, that the IAEA can and would play an important role to implement the projects.

**IAEA role**

The technical co-operation of IAEA has potential economic advantages for implementation of any project. The IAEA attempts to answer the needs by delivering the necessary materials, spare parts, equipment, and in particular expert missions for duration of one to three months. The essential mission tasks would be to install the equipment, carry out teaching and training programs on the theory and practice of the project. In this regard the IAEA plays an important role for the implementation of any project related to the development and practical applications of the Atomic energy for peaceful uses throughout the world.

**Other issues considered relevant**

We would like to thank the IAEA for its assistance and collaboration in arranging expert missions, training our personnel, and providing the necessary equipment and instruments. We hope this co-operation will be continued until the objectives or the “TC Projects” are accomplished. Today, we are deeply indebted to the technical co-operation department for their collaboration that has considerably helped our national development in nuclear medicine and industries. We are mostly benefited by bye IAEA’s expert training of our personnel and supply and delivery of some of the up to date equipment.