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The FISSION

A Publication of the Nuclear Power and Energy Agency

INIR FOLLOW UP MISSION

OUR VISION, MISSION STATEMENT

VISION

01

A premier hub for nuclear power development and sustainable energy solutions

To develop nuclear power, and undertake research and capacity building in the energy and petroleum sectors for socio-economic prosperity

02

MISSION

Contents

Let us Reset! Let me take this opportunity to introduce you to our 19th edition of the Fission Magazine. It has been a tumultuous period worldwide due to the COVID-19 pandemic that had many people working from home and the reset button highlighted the important role of having a reliable source of electricity.

The Agency continues to be involved in nuclear conversations around the world, representing the country at events throughout the year. In this edition, NuPEA's continuous organizational capacity development saw members of the Site Selection Team undertake a Scientific Visit to the Kingdom of Jordan. It will also highlight lessons learned from operating nuclear countries during a training course on Radioactive Waste Management and the Nuclear Fuel Cycle. We will then move to Vienna, Austria where staff attended a technical meeting to discuss radiological environmental impact assessment for nuclear installations.

This edition covers the launch of the Agency's Nuclear Student Ambassadors Programme held at Pwani University, in Kilifi County. This event engaged students and teachers on the nuclear power programme and future roles with emphasis on Science Technology, Engineering and Mathematics (STEM) in collaboration with our international partners such as the International Framework for Nuclear Energy Co-operation (IFNEC), USA. This Students Programme shall also be undertaken in various counties as we continue to build and strengthen collaborations nationwide.

The importance of international cooperation and developing best practices is heavily highlighted in the magazine, as Kenya cannot operate as a singular unit. Our ability to extend our reach to new audiences and new channels, despite difficult conditions, demonstrates the strength of our industry.

BASETT BUYUKAH
EDITORIAL DIRECTOR

INTERREGIONAL TRAINING COURSE ON INDUSTRIAL INVOLVEMENT FOR THE NUCLEAR POWER PROGRAMME IN RUSSIA

Saint Petersburg, Russia

Peter Mutembei
Mechanical Engineer, Nuclear Energy Infrastructure Development Directorate
Team Leader, Industrial Involvement Technical Working Group

National industrial involvement in launching nuclear power for a newcomer country is one of the major areas of concern when developing a nuclear power programme. 'Industrial Involvement' is defined as the sum of the entire industrial capability required to support a safe and reliable nuclear power programme, of which a subset is 'local industrial involvement' (Localization). Localization is the optimum participation (contribution) of local and national industries to the nuclear power programme. A range of goods and services are required to construct a Nuclear Power Plant (NPP) and to support its operation. The participating companies must comply with strict codes and standards and rigorous quality programmes associated with these goods and services.

In the last five years, the Nuclear Power and Energy Agency (NuPEA) has embarked on implementing Industrial Involvement as one of the key infrastructure issues. The International Atomic Energy Agency (IAEA) has offered assistance through a wide range of resources and services. One of the mechanisms to deliver assistance has been through the Integrated Nuclear Infrastructure Training (INIT) Programme. The objective of the programme is to enhance and harmonize capabilities on nuclear power introduction in newcomer countries, and assist in establishing a global network and forum for information exchange to new and expanding nuclear power programmes. Through this programme, the IAEA organized a one-week Interregional Training Course on Industrial Involvement for Nuclear Power Programme, held on 13th-17th September 2021, cohosted by IAEA and Rosatom, and held at Rosatom Technical Academy, St. Petersburg, Russia.

The course was attended by thirteen representatives from nine countries, including Kenya, Jordan, Nigeria, Kazakhstan, Morocco, Pakistan, Uzbekistan, Ethiopia, Senegal, and Zambia.
The one-week training program aimed at:

- Developing a broader understanding of the IAEA Milestones Approach and support provided by the IAEA
- Improved knowledge and understanding in specific areas of industrial involvement with technical tours to 'industry'
- Enhanced networking opportunities with participants from Member States

During the training the International and Russian experts presented various aspects of industrial involvement. The training consisted of theoretical sessions so as to build knowledge on fundamental aspects of Industrial Involvement, focusing on:

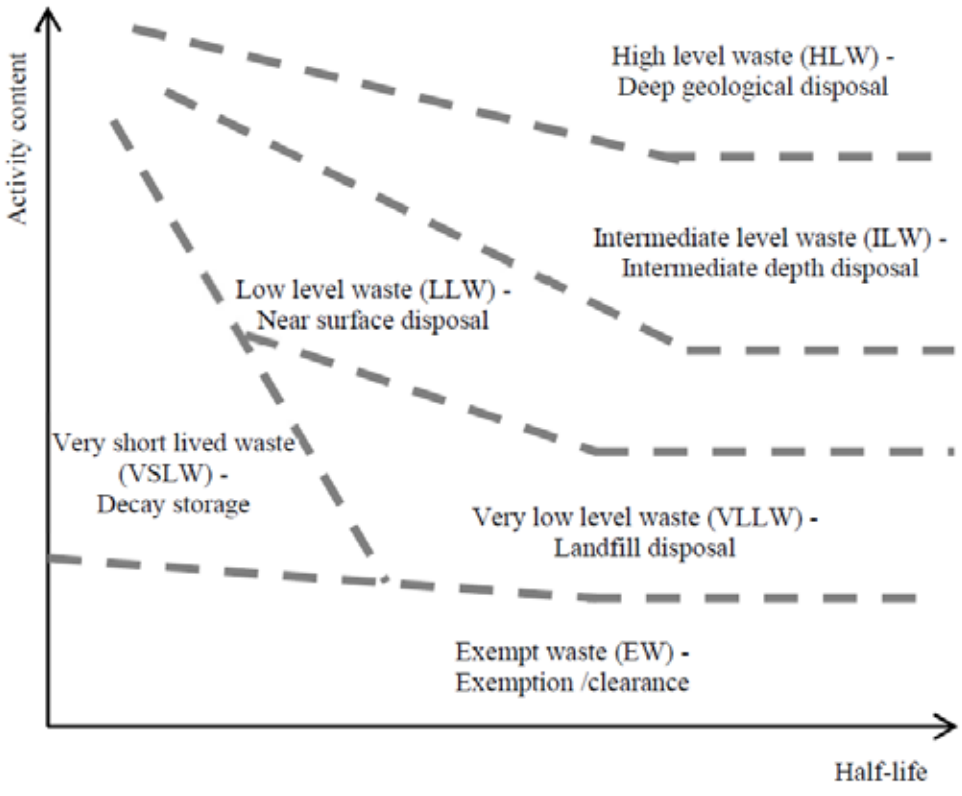
- An overview of Industrial Involvement;
- Core issues and the Human Resource Development programme; and
- Localization and Key Risk Factors.

Also practical sessions were incorporated through visits to a nuclear power plant (in a virtual manner) and parts & components companies (The LLC Turbine Technology AAEM - turbine-generator manufacturer and The JSC 'Central Design Bureau of Machine Building' - reactor coolant pump manufacturer).

Additionally, IAEA member states (Kenya, Jordan, Nigeria, Kazakhstan, Pakistan, and Uzbekistan) implementing/considering nuclear power had an opportunity to share on their experiences.

Attendees following closely during an industrial tour at the JSC 'Central Design Bureau of Machine Building' plant

Presentation session on the Kenyan experience



Waste Classification (IAEA)

28TH IEK ANNUAL INTERNATIONAL CONFERENCE

NuPEA Chief Executive Officer - Eng. Collins Juma speaking at the 28th Institution of Engineers of Kenya Annual International Conference

Mombasa, Kenya

By Faith Kosgei

NuPEA participated in the 28th Institution of Engineers of Kenya Annual International Conference held on 9th- 12th November 2021 at Pride Inn Paradise – Mombasa alongside the 4th IEK Women Engineers Summit.

The Conference whose theme was "Engineers Accelerating Sustainable Economic Recovery" presented a great opportunity for delegates to reflect on current and future challenges facing humanity and discuss strategies for sustainable economic recovery. It also aimed to; celebrate Kenyan engineers and key engineering activities in various sectors that have impacted the lives of Kenyans, showcase the role of engineers in contemporary socio-economic development; to explain the importance of engaging professional engineers in projects at national and county levels; to highlight the role of women in engineering and to emphasize the importance of engineers in helping Kenya achieve its Vision 2030 goals.

NuPEA sponsored the event in the Bronze category and exhibited, to interact with participants by addressing their concerns on matters Nuclear Safety, Nuclear Financing, Radioactive Waste Management, Human resource and Capacity Building and Industrial Involvement among others while familiarizing them with the progress and milestones achieved to-date in Kenya's nuclear power programme.

While delivering his address, NuPEA Chief Executive Officer Eng. Collins Juma mentioned that as countries slowly begin to emerge from the devastating health and economic impacts of the Covid-19

pandemic, the conference presents a countless opportunity to the delegates to reflect on engineering innovations to rebuild a more resilient and sustainable economy in the wake of 'New Normal'. He further stated that, the conference will provide a platform for sharing and exchanging best practices in the various engineering disciplines in response to pandemics and the contribution of the engineering fraternity to the economic and social pathways to recovery.
NuPEA is committed to promoting and supporting other corporate citizens that advocate strategies for sustainable economic recovery.

"Engineers are at the forefront in every facet of the society and are key drivers of innovation, thus we need to be at the table for policy formulation both at the national and county Government levels. We have a responsibility to create employment through manufacturing and industrialization, provide affordable and decent housing and enhance food security as outlined in the Big 4 Agenda. As engineers, we must have the natural environment in mind, the ravaging effects of pollution and climate change can no longer be ignored and we need to be intentional in our processes to ensure that there is no undue burden passed to our future generation. It is upon us to ensure the development in country and the region as we involve the women and youth." Said Eng. Collins Juma.

Participants were drawn from various spheres of influence. International community, Kenyan engineers, departments and agencies related to engineering work and government ministries. The four-day physical and virtual event featured paper and poster presentations around the main theme from participants.
Paper and poster presentations Presented by NuPEA Engineers included;
Workforce Development for Kenya's Nuclear Power Programme
A Systematic approach to siting of Energy projects: ACase study of Nuclear Power Plant Siting in Kenya
Evaluation of the Effectiveness of Power Plans in Kenya
Role of localization capacity, Assessment in Determining Optimum Inclusion of Local Industries in Kenya's Nuclear Power Program
Evaluation of Utilization of, Nuclear Technology Beyond Electricity Generation in Kenya

Engineers visit the NuPEA stand at the Annual International Engineers Conference

PITCHING NUCLEAR ENERGY AT THE 7TH CLEAN ENERGY EXPO AND EMA AWARDS.

Energy CS, Amb. Monica Juma (middle) visits NuPEA exhibition booth during the Clean Energy Expo accompanied by EPRA DG, Mr. Daniel Kiptoo (left), Kenya Power Ag. MD, Eng. Rosemary Oduor (second left), and KAM CEO, Ms. Phylis Wakiaga.

Nairobi, Kenya

By Esther Musyoka

The Nuclear Power and Energy Agency (NuPEA) took part in the 7th Clean Energy Conference & Expo held from 24th to 28th November, 2021 at Kasarani Stadium, Nairobi and in the annual Energy Management Awards (EMA) held on 27th August 2021 at the Safari Park Hotel & Casino, Nairobi. The hybrid event is organized and hosted by the Kenya Association of Manufacturers (KAM), a key stakeholder in the quest for nuclear power development in Kenya. The main objective of the Expo was to provide a common platform for participants to showcase their products and services to their key stakeholders.

The EMA is an award ceremony aimed to recognize and celebrate small, medium and large enterprises for their demonstrated excellence in energy management to achieve significant energy cost reductions.

At the event, NuPEA sought to boost its brand visibility while also tapping on the target audience to enhance stakeholder engagement on nuclear power development in Kenya. On the sidelines of the Expo and building up to the Conference was a CEOs' forum whose agenda was to hold candid discussions focused on clean energy and where the CEO of NuPEA - Eng. Collins Juma, MBS represented the Agency.

NuPEA participated in the Expo through corporate sponsorship in the category of a Bronze sponsor and by way of pitching an exhibition booth to interface with the event participants on matters around the nuclear power programme for Kenya. Enhancing public understanding and knowledge of nuclear energy

will ultimately add to the needed public and stakeholder support for nuclear electricity generation in Kenya as the country moves towards producing 1,000MW in 2036.

A vast manufacturing industry will thrive in the existence of a stable electric grid which nuclear power can offer comfortably. Subsequently, a high and growing demand for electricity translates to its continual consumption and therefore Kenya will need to speed up the planned flagship projects to increase the demand for this African rare gold. Kenya envisages the first generation of 1,000MW of nuclear electricity in 2030. As the State journeys towards this projected timeline to generate safe, reliable and affordable electricity for all citizens, it is treading with diligence and the assistance of the International Atomic Energy Agency (IAEA). This is a prerequisite for putting in place a robust nuclear infrastructure in accordance with international best practices in the industry.

"Organizations that have policies for energy efficiency experience benefits such as reduced peak power demand, saved energy costs and, importantly, improved industry competitiveness. Industry could be a big part of the solution for sustainable development in line with the Sustainable Development Goals," said the CS.

In a speech read on his behalf by Energy Chief Administrative Secretary (CAS) Mr. Zachary Ayieko, Keter said that the government has great at support for energy management awards and would continue to invest in efficiency and conservation. "We need to embrace energy efficiency as a nation in order to save on energy costs and achieve Vision 2030. KAM has played a key role in steering this course to ensure that industries and domestic users take up energy efficiency measures," he noted.

> **Organizations that have policies for energy efficiency experience benefits such as reduced peak power demand, saved energy costs and, importantly, improved industry competitiveness. Industry could be a big part of the solution for sustainable development in line with the Sustainable Development Goals**

The CS further observed that as a ministry, they were committed to improvement of energy infrastructure coupled with clean energy positions to make Kenya a choice destination for investment in manufacturing, CT and other sectors that required stable and quality electricity. "We intend to maintain our policy on cost reflective tariffs and focus more on additional renewable sources and growing demand to keep the prices under control," Keter said.

KAM CEO Phyllis Wakiaga on her part stated that the manufacturing sector consumed about 60 per cent of electricity in the country positioning it as energy intensive and a key consumer, adding that the need for stable energy supply has been discussed and milestones have been made. "Industrialization is driving Kenya's economy. In spite of relatively high manufacturing costs taking cognizance of the contribution by energy costs, manufacturers have a vital role in driving industrialization and GDP expansion. We encourage organizations to create an energy savings culture and integrate energy efficiency functions in their corporate and operational strategies," said Wakiaga.

British American Tobacco (BAT) Ltd Nairobi emerged as the most energy efficient company after winning the coveted 2021 Energy Management Awards (EMA) during a ceremony held at Safari park hotel in Nairobi.

NuPEA Director for Publicity & Advocacy, Basett Buyukah presents the Best Innovation Award to the winner of the category during the Energy Management Awards, 2021 ceremony at the Safari Park Hotel.

IAEA REVIEWS PROGRESS OF KENYA'S NUCLEAR INFRASTRUCTURE DEVELOPMENT

Nairobi, Kenya

By Lilian Matu

The follow-up Integrated Nuclear Infrastructure Review (INIR) mission took place from 8 to 11 June 2021 at the Emara Hotel, Ole Sereni. It assessed the country's progress on recommendations made from the Phase 1 INIR mission, which was conducted from 24th to 31st August 2015 in Nairobi. Various Government ministries and institutions involved in the nuclear power programme and corresponding infrastructure participated in the mission.

The 2015 review had made 15 recommendations and 8 suggestions to assist Kenya in making further progress in its infrastructure development. It reviewed the status of nuclear infrastructure development using the Phase 1 criteria of the IAEA's Milestones Approach, which provides detailed guidance across three phases of development (consider, prepare, construct). Phase 1 evaluates the readiness of a country to make a knowledgeable commitment to a nuclear power programme.

The 2021 follow-up mission was organized in a hybrid format with two Agency experts travelling to Kenya and two international experts from Ireland and Spain participating virtually.

The follow-up INIR team said that Kenya had made progress in the implementation of most recommendations

and suggestions from the 2015 review, completing ten and four, respectively.
The follow-up INIR team noted progress in areas including:
Kenya developed the National Nuclear Policy and the National Policy and Strategy for Safety to enable the Government to make an informed decision on whether to introduce nuclear power.
The country enacted a national nuclear law and established a regulatory body with clear responsibilities for safety, security and safeguards.
The Government completed an assessment of the national legal framework and identified other laws needing review.
The Government enhanced the coordination among its key stakeholders in the development of its nuclear power program
The team highlighted that further work was needed in areas such as the development of a nuclear leadership programme and the ratification of international conventions in the area of nuclear safety.
"Kenya made considerable efforts to address all the recommendations and suggestions made by the INIR team in 2015. The preparatory work needed to inform the Government's decision has progressed," said team leader Eric Mathet, Operational Lead of the IAEA's Nuclear Infrastructure Development Section.

"The Follow-up INIR Mission has given a big impetus to the Nuclear Power Programme for the country and therefore sets a new phase in the Milestone Approach," said Collins G. Juma, Chief Executive Officer and National Liaison Officer of NuPEA. "The next steps call for greater efforts by all stakeholders in ensuring that Kenya becomes a knowledgeable customer and ready to invite bids for the first nuclear power plant."
About INIR Missions
Integrated Nuclear Infrastructure Review missions enable IAEA Member State representatives to have in-depth discussions with international experts about experiences and best practices in different countries. Implementation of any of the INIR team's recommendations is at the discretion of the Member State requesting the mission. The results of the INIR mission are expected to help the Member State to develop an action plan to fill any gaps, which in turn will help the development of the national nuclear infrastructure.

NUCLEAR FUEL CYCLE AND RADIOACTIVE WASTE MANAGEMENT

Mr. Joe Mwangi being awarded a certification of participation of the workshop by Christoph Gastl (IAEA) & Anastasia Pavlovna (Rosatom) Workshop Coordinators

Saint Petersburg, Russia

By Joe Mwangi

I attended an Interregional Training Course on Strategies Related to the Nuclear Fuel Cycle and Radioactive Waste Management, Rosatom at Saint Petersburg, Russia on 8-12 November, 2021. The objective was to learn about the infrastructure and framework required by a country to have in place for an efficient nuclear fuel cycle program and radioactive waste management. The training had participants from many countries, from Jordan, Armenia, Ghana, Senegal, Kenya, Ethiopia and Russia with each country at different stages and progress in their nuclear energy applications (research and power generation).

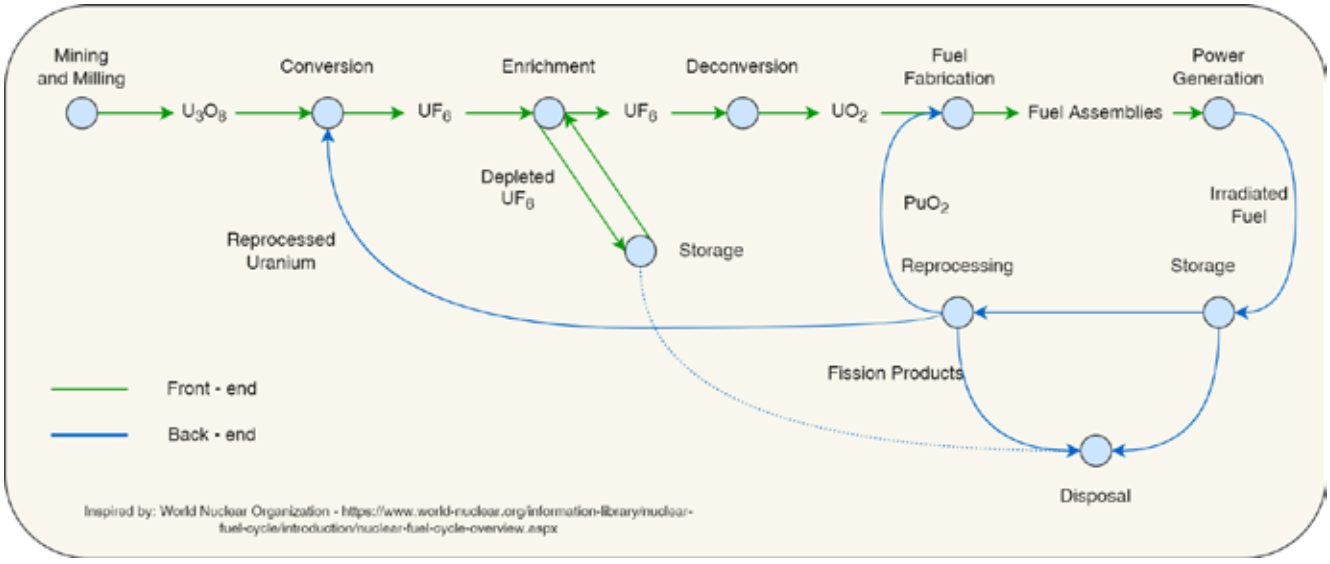
Nuclear fuel cycle (NFC) entails all activities involving nuclear material (uranium & thorium with their

transmuted fissile isotopes) for energy production, covering from mining until disposal. Radioactive waste management (RWM) is the quality management of radioactive material that has been identified by national authority as waste, awaiting storage and eventual disposal. The wide range of topics covered are as shown:

Radioactive Waste Management	**Nuclear Fuel Cycle**
Treaties and conventions	Treaties and conventions
Transportation	Transportation
Regulations	Regulations
Financial Implications (generator needs to have a strategy on waste management - a requirement in Kenya's nuclear regulatory act, and the government need to provide a national sustainable solution financing and funding)	Financial Implications (funding mechanism through electricity tariff and fund managed by government or owner/operator)
National Policy (quite diverse since it entails industry, agriculture, energy, education & training, medical applications)	National Policy (priority on disposal and storage)
Classification of radioactive waste	Research & Development
Pre-disposal (pre-treatment, treatment, conditioning, storage), Disposal	Mining, Milling, Conversion, Enrichment, Deconversion, Fabrication, Core Fuel Management, Storage, Reprocessing, Recycling, Disposal
Waste Management Organisation	Deep Geological Disposal (even if we undertake recycling & reprocessing, high level waste needs to be disposed)

The table above shows the activities and topics covered during the entire workshop, and also an indicator on the similarities of activities of both NFC & RWM. My takeaway was that Kenya needs to:

1. Develop comprehensive regulations for RWM & NFC,
2. Expand & develop detail classification of waste to include waste generated from nuclear facilities (research reactor, nuclear power plant),
3. Ratify key conventions such as the Joint Convention on Spent Fuel Management and Radioactive Waste Management
4. Establish a national radioactive waste management organisation for coordinated waste management activities by the government
5. Ensure in having a national policy on RWM & NFC as Kenya progresses with its nuclear power programme and research reactor project.



Nuclear Fuel Cycle Stages (WNO)

FOR THE WASTE CLASSIFICATION SEE PAGE XX

INTERNET REACTOR LABORATORY

Technical Group, Hilda Mpakany, Joe Mwangi both from NuPEA, Dr. Hashim and Mr. Joseph Wataka from Kenyatta University with Members from CNESTEN & IAEA.

Rabat, Morocco

By Joe Mwangi

NuPEA and Kenyatta University attended an "Orientation Workshop to Launch the Internet Reactor Laboratory" with other Africa nations in Rabat, Morocco, from 22 to 26 November 2021. The host facility is at the Centre National De L'Energie, Des Sciences Et Techniques Nucleaires (CNESTEN). Other nations present were Senegal, Nigeria.

The idea behind the Internet Reactor Laboratory (IRL) is to create "virtual research reactor" in a university classroom. Data acquisition hardware and display software is installed in the control room of a "Host" research reactor (in this case at CNESTEN), and the reactor's live signal output is captured and sent over the internet to the "guest institution" (university classroom), where students are able to see the live signal display so they can see the reactor's conditions changing in real time. Then, using video conference equipment, students and an instructor at the guest institution can interact with operators in the reactor control room to "conduct experiments" by asking the reactor operators to change reactor settings and seeing the real-time displays change accordingly. In essence it becomes a real-time virtual classroom.

The purpose of this event was to bring together participants from host and guest institutions of IRL focusing Africa region, to offer access to experiments as part of academic courses to share information on existing academic programmes at the guest institutions, and share experiences and lessons learned with regard to integrating these experiments; and to train the participants in the technical, pedagogical and

logistic aspects of the transmission of experiments from CNESTEN. This provides an opportunity for ideas in enhancing Kenya's training programs in nuclear science & technology, such requirements for introducing and expanding existing core curriculum courses in reactor physics and hands-on training on experimental research on core-fuel management.

Kenyatta University (KU) has signed an agreement with IAEA for facilitation of IRL, with the University being the recipient host for Kenya and has plans to coordinate the training with local universities. The agreement was signed in IAEA 's 63rd General Conference at Vienna, Austria, 2019.

Kenyatta University IRL Project Room

KU has already setup a project room equipped with 2 high-definition TV donated by IAEA and a room with a siting capacity of 25 people with each sit equipped with a computer for learning, data collection and analysis. This project shall enhance education & training program in Kenya on nuclear science & technology by building human capacity on matters of reactor safety, radiation physics, safety standard requirements, thermal-hydraulics and neutron transport experiments. 7 institutions and universities have written a letter of intent in partnership with KU to participate in the training program. Other stakeholders are the Kenya Young Generation in Nuclear & NACOSTI. The program commences from 2022.

NuPEA has played a great role in ensuring the program from its day of conception as an idea, fast-track its implementation towards its realisation, by coordination with local institutions, selection of local host institution and assisting with progress in implementation between IAEA & KU.

Kenyatta University & IAEA agreement signing at 19th GC, at Vienna Austria, 2019

CNESTEN hot cells for radiopharmaceuticals production

CNESTEN research reactor control room, on the left window is the research reactor (2MWth) room

COAST REGION ENVIRONMENTAL DATA FACT-FINDING AND STAKEHOLDER ENGAGEMENT

NuPEA Environmental protection Working Group team leader Ms. Diana Musyoka (middle background) and her team during the visit to Kenya Marine & Fisheries Research Institute in Mombasa.

Mombasa, Kenya

By: Emmanuel Mulehane

The Nuclear Power and Energy Agency (NuPEA) established by the Energy Act (2019), is required to undertake environmental protection activities, such as the Environmental Impact Assessment (EIA) for nuclear power plant sites.

NuPEA has identified two Preferred sites for a nuclear power plant through a rigorous site selection process. A dedicated Environmental Protection Working Group has so far collected preliminary environmental baseline data at the Preferred Sites. This data was used to develop the Kenya Nuclear Power Plant Project Description Report in the FY 2020/21, which is to be used to develop the EIA Project Report.

NuPEA Environmental protection Working Group during the visit to the Coast Development Authority offices in Mombasa.

The key objective of the field visits was to collect baseline data from expert institutions such as Kenya Wildlife Service (KWS), Kenya Marine and Fisheries Research Institute (KMFRI), Coast Development Authority (CDA) and Pwani University. This field study focused on two categories of baseline data: site region ecological characteristics and socioeconomics.

The NuPEA Team made presentations to KWS, KMFRI and CDA, which was followed by detailed discussions centered on NuPEA's data needs and the available data at the institutions. Informant interviews were conducted with marine experts from KWS, KMFRI and CDA and secondary data collected in the form of reports developed by the institution as well as by other key state agencies.

the coral cliffs at the site are undergoing undercutting by sea waves, especially during high tide

A consultative engagement session was held at the Pwani University School of Environmental Studies. The NuPEA team made presentations to the audience based on an overview of the Kenya nuclear power programme and an overview of the nuclear power plant, site selection process. The audience raised concerns that were consequently addressed by the team of experts from the Agency.

The NuPEA Environmental protection Team at the Preferred NPP Site.

The NuPEA Team visited the Preferred Site in Kilifi County and made key observations. One such observation was that the coral cliffs at the site are undergoing undercutting by sea waves, especially during high tide. The Team proposed remediation actions such as a Coastal Stabilization Plan to counteract the situation.

Way Forward

The NuPEA Team noted the following salient issues to be addressed by NuPEA:

1. Analyze the socio-economic impacts of the proposed KNPP to the residents of the site vicinity and the site region.
2. Develop a Relocation and Compensation Plan for the local farmers and quarry owners whose land may be annexed for the KNPP.
3. Design a Coastal Stabilization Engineering Plan to counter the on-going wave undercutting, for the safety of the proposed KNPP.
4. Draft a MoU with KMFRI to tap into the vast experience in Marine Science at KMFRI during the upcoming EIA studies at the Preferred Site.

NPP SITE SELECTION TEAM SCIENTIFIC VISIT TO THE KINGDOM OF JORDAN

NuPEA Site Selection Team delegation at the Jordan Atomic Energy Commission Headquarters in Amman, Jordan. [Left to right: Emmanuel Mulehane, Queenter Osoro, Elvis Kimani, Eng Taher Abualsamen and Mr Willis Ochieng]

Jordan

By: Emmanuel Mulehane

NuPEA was established by the Energy Act (2019) and is mandated to promote and expedite the development of nuclear electricity generation in Kenya and to coordinate research, development and dissemination activities in the energy and petroleum sectors. One of its core mandates is "To identify appropriate sites for construction of Kenya's nuclear power plant."

NuPEA established a multidisciplinary national Site Selection Team (SST) to finalize site selection for nuclear installations in Kenya in line with international safety standards. The SST undertook regional

surveys, identified and screened potential sites, ranked the candidate sites, and identified a Preferred and Alternate Site for Kenya's NPP. The International Atomic Energy Agency reviewed the site studies, provided recommendations, and advised Kenya on the next stage of Site Characterization.

In view of the considerable technical expertise required for NPP Site Characterization, NuPEA concluded a Technical Cooperation Project with the International Atomic Energy Agency (IAEA) to build the capacity of the SST. This involved a Scientific Visit to the Hashemite Kingdom of Jordan, from 7th to 11th November 2021. The scientific visit activities consisted of detailed interactive presentations by the Jordan Atomic Energy Commission (JAEC) and site visits to the Jordan Research and Training Reactor (JRTR) and the Amra Preferred NPP Site Meteorological station.

The technical presentations covered Jordan's experience in NPP development, Licensing of the NPP project, Requirements and Regulatory Framework for Site Evaluation, Jordan's NPP Site Selection, Assessment of Site Acceptability for an NPP, Offsite Infrastructure for an NPP, Site Technical Requirements for Reactor Vendors, QAP for NPP Site Characterization, Public Acceptance in Jordan for the NPP, Small Modular Reactor technology assessment in Jordan and Non-Electric Applications for the Jordan NPP.
The NuPEA SST had a lot to learn from the JAEC counterparts, including the following:

1. For embarking countries like Kenya, there is a likelihood that detailed regulations may not be ready just before site characterization. In this case, IAEA Safety Standards and Guides can be adopted/ adapted to ensure conformance with international safety standards. Afterward, Kenya's nuclear regulator should develop regulations on Site Licensing to support Part VII of the Nuclear Regulatory

NuPEA Site Selection Team delegation participating in a technical presentation by the Head of NPP Siting Eng. Taher Abualsamen (Presenting) at Jordan Atomic Energy Commission Headquarters in Amman, Jordan.

Act (2019), followed by Guides to elaborate how an Applicant can satisfy the nuclear regulations, and Standards to assure Quality. Furthermore, provisions should be made for the adoption/adoption of missing regulations, guides, or standards from the Reactor Vendor's country of origin regulations.

2. Kenya's nuclear regulator (KNRA) should agree with the environmental regulator (NEMA) on which institution will approve the Environmental Impact Assessment (EIA) Report prepared for an NPP Site. This can be achieved through a bilateral memorandum of understanding (MoU).
3. Kenya should prepare to establish an NPP Owner/Operator company to take over site characterization and the application for an NPP Site License, in line with the IAEA Milestone Approach. The Kenyan NPP Owner/Operator company may consist of technical staff from NuPEA and public electricity utility companies.
4. Kenya should procure a competent Contractor, with proven experience in successful NPP Site Characterization to undertake preliminary (site verification) and detailed (full scope) site characterization at the Preferred NPP Site in Kenya. The national SST should get hands-on experience in Site Characterization through a knowledge/technology-transfer program with the Contractor.
5. Kenya should consider adopting the ASME NQA Standards for its NPP Site Characterization project, in addition to the current ISO 9001:2015 Standards.
6. As Kenya prepares to initiate Site Characterization, a meteorological tower and seismic station should be installed at the Preferred NPP Site to begin collecting site-specific data.
7. Kenya should utilize the NPP site-specific engineering parameters (site parameter envelope) obtained from site characterization to develop detailed Bid Invitation Specifications (BIS) from international Reactor Vendors. Kenya should develop memoranda of understanding (MoUs) or non-disclosure agreements (NDAs) with selected Reactor Vendors, to allow the exchange of reactor technical specifications and design of the Kenya NPP.
8. Kenya should consider non-electrical applications of NPPs (e.g desalination, hydrogen production, process heat) in order to extract maximum value for money from the NPP, and to offer the local community near the NPP maximum socio-economic benefit.
9. Kenya's Research Reactor site should be subjected to detailed site characterization & EIA. Site Assessment at Kenya's Research Reactor site should follow a Graded Approach as per IAEA Guides, and consider among others, seismic hazards, geological and geotechnical hazards, hydrological hazards, extreme/rare meteorological events, and external human-induced hazards.

Front view of the Jordan Research & Training Reactor (JRTR) located outside the Jordan University of Science & Technology in Irbid Town north of the capital City of Amman.

The NuPEA SST delegation at the Amra NPP Site, located in central Jordan about 50 km from the capital City of Amman.

The NuPEA SST delegation at the Amra NPP Site meteorological station offices, located in central Jordan about 50 km from the capital City of Amman.

INVESTIGATION OF SITE CHARACTERISTICS AND ASSESSMENTS OF RADIOLOGICAL ENVIRONMENTAL IMPACT FOR NUCLEAR INSTALLATIONS

Vienna, Austria

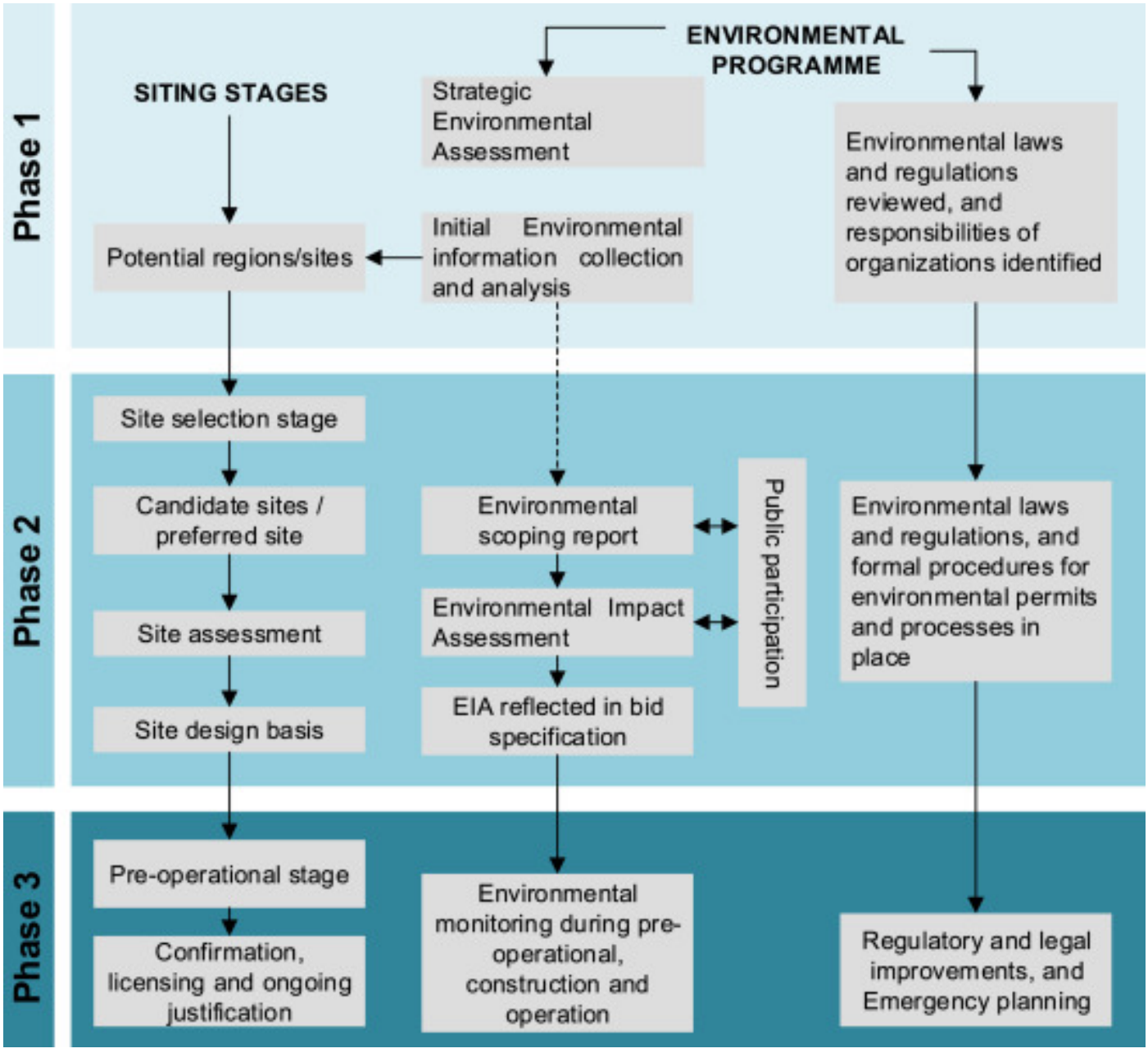
By: Diana Musyoka & Kenneth Anakoli

On 8 to 12 November 2021, Mr. Kenneth Anakoli and Ms. Diana Musyoka attended a technical meeting on radiological environmental impact assessment for nuclear installations at the International Atomic Energy Agency (IAEA) in Vienna, Austria. At the Agency Mr. Anakoli and Ms. Diana are in charge of the safety evaluation (characterisation) and environmental assessment of the NPP sites respectively.

A key requirement in siting of nuclear power plant is that the site and vicinity be investigated with regard to the characteristics that could affect the safety of the nuclear installation and the potential radiological

impact of the nuclear installation on people and the environment. The purpose of the event is to collect information on national practices of IAEA Member States and to identify the needs and issues to be covered in the revision of the IAEA Safety Standards Series No. NS-G-3.2 titled Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants. This Safety Standard concerns the investigation of site characteristics and assessments of radiological environmental impact for nuclear installations.

In this meeting the participants from Kenya shared their practice of site evaluation and radiological environmental impact assessment which is planned as part of environmental and social impact assessment of the Kenya NPP. They also received insight on recommendations and guidance outlined in the NS-G-3.2, on studies and investigations necessary for assessing the impact of a nuclear power plant on people and the environment. Upon the completion of the technical meeting the team took home best practices outlined by the IAEA experts, participant countries namely Turkey, Egypt, Ghana, Jordan, Saudi Arabia, Bangladesh, Morocco amongst others. Immediate actions upon return are application of the guidance from the NS-G-3.2 in updating the terms of reference for atmospheric dispersion modelling in site characterization and radiological impact assessment in environmental and social impact assessment.



Nuclear power & reactors worldwide

Location	Nuclear electricity generation, 2018 (billion kWh)	Share of total electricity production, 2018 (%)	Number of operable reactors	Nuclear generating capacity (MWe)
Argentina	6.5	4.73		1667
Armenia	1.9	25.61		376
Belgium	27.3	39.0	75	943
Brazil	14.8	2.72		1896
Bulgaria	15.4	34.7	21	926
Canada	94.5	14.9	19	13,553
China	277.1	4.2	43	50,900
Czech Rep	28.33	4.56		3932
Finland	21.93	2.5	42	764
France	395.97	1.7	58	63,130
Germany	71.9	11.7	79	444
Hungary	14.9	50.6	41	889
India	35.4	3.1	22	6219
Iran	6.3	2.1	19	15
Japan	49.3	6.2	37	36,147
Mexico	13.2	5.3	21	600
Netherlands	3.3	3.1	14	85
Pakistan	9.3	6.8	5	1355
Romania	1 0.51	7.22		1310
Russia	191.31	7.93	6	29,139
Slovakia	13.8	55.0	41	816
Slovenia	5.53	5.9	16	96
South Africa	10.6	4.72		1830
South Korea	1 27.1	23.7	24	23,231
Spain	53.4	20.4	77	121
Sweden	6 5.94	0.38		8376
Switzerland	24.5	33.7	53	333
Ukraine	79.5	53.0	15	13,107
UK	59.1	17.7	15	8883
USA	808.0	19.3	97	98,699
Total **	2563.0	10.3	446	397,529

*as of 07.06.2019 *Sources: World Nuclear Association, IAEA*

**The world total includes six reactors on Taiwan with a combined capacity of 3719 MWe, which generated a total of 26.7 billion kWh in 2018, accounting for 11.4% of its electricity generation.

INTERESTING FACTS ABOUT NUCLEAR REACTORS

Just one uranium fuel pellet - roughly the size of the tip of an adult's little finger – contains the same amount of energy as 17,000 cubic feet of natural gas, 1,780 pounds of coal or 149 gallons of oil

Nuclear energy is being used in more than 30 countries around the world, and even powers Mars rovers

A typical nuclear plant can generate enough electricity to power 690,000 houses without creating air emissions

13 percent of the world's electricity comes from nuclear power plants that emit little to no greenhouse gases

A typical nuclear reactor works 24/7 at a 90% average capacity factor

A typical nuclear reactor on an average refules 1/3rd of fuel every 18th month

THE LARGEST PRODUCERS OF NUCLEAR POWER ARE THE US, FRANCE AND JAPAN.

Crossword Puzzle Answers

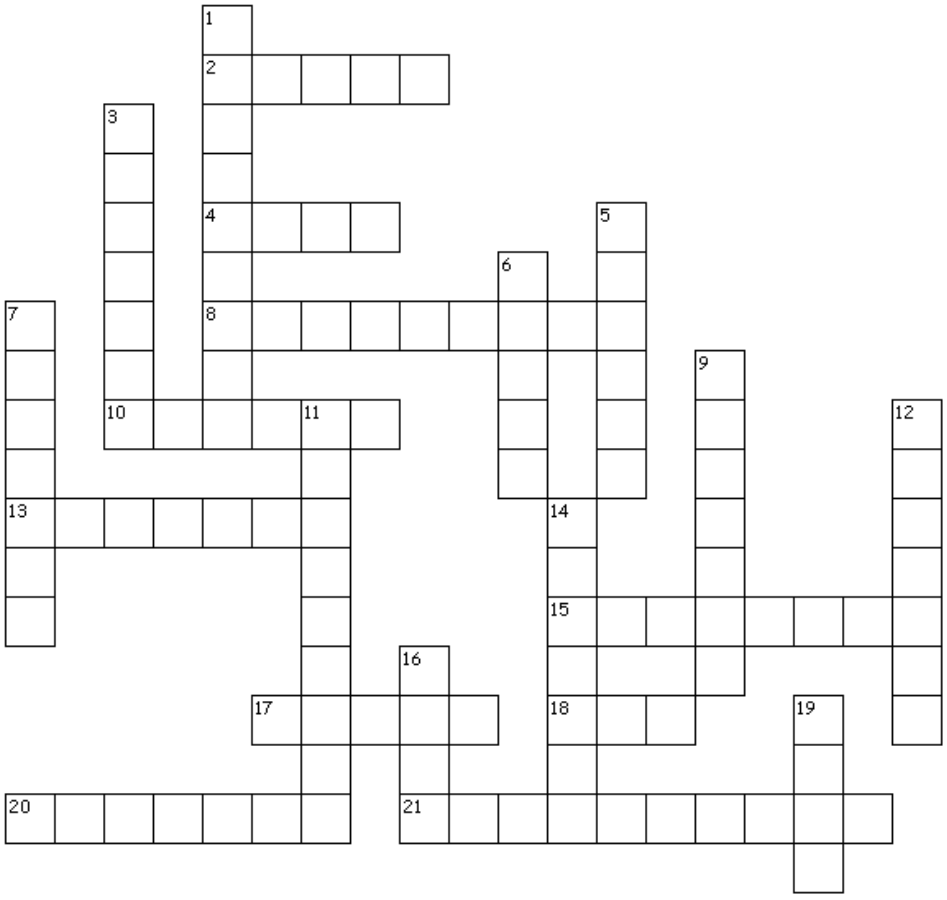
ACROSS
2. Alpha
4. Atom
8. Irradiate
10 .Cancer
13. Isotope
15. Absorber
17. Power
18. Ion
20. Nucleus
21. Atomic mass

Down
1. Radiation
3. Kinetic
5. Energy
6. Gamma
7. Thorium
9. Fission
11. Electrons
12. Austria
14. Uranium
16. Beta
19. Dose

Country Nuclear Profile in Africa

	Country	Status
1.	Egypt	Site preparation for first four NPP with a total of 4800 MWe is underway.
2.	South Africa	Two reactors currently in operation at Koeberg with total installed capacity of 1,800MWe
3.	Nigeria	30kW research reactor in operation. Nigeria Nuclear Regulatory Authority (NNRA) was set up for regulatory oversight on all uses of ionizing radiation. Nigeria Atomic Energy Commission (NAEC) announced selection of four sites for further evaluation. Signed a cooperation agreement with Russia including provision for uranium exploration and mining in the country.
4.	Ghana	30kW research reactor in operation. Nuclear Regulatory Power Act to establish an independent regulator – Ghana Nuclear Regulatory Authority (NRA) - was passed by Parliament in 2015.
5.	Kenya	Plans to realize NPP by 2027. Agreements of assistance in Nuclear Power Development with Russia, China and Korea have been signed. Nuclear energy policy to set up the national nuclear regulator is pending presidential ascent. Site selection is underway.
6.	Uganda	Government signed an agreement with IAEA to initiate the provision of a framework to develop nuclear power generation.
7.	Tanzania	Government has expressed an intention to investigate the use of nuclear power
8.	Zambia	Agreement between Rosatom and Ministry of Education for the construction of the center for Nuclear Science and technology in Zambia, with a 10 MWe research reactor.
9.	Namibia	The government has committed to a policy position of supplying its own electricity from nuclear power given that the country holds about 7% of the world's uranium reserves.
10.	Tunisia	Evaluation of possible construction of a 600 - 1000 MWe NPP by the government is underway.
11.	Libya	10MW research reactor present. Development of Institutional infrastructure for setting up a NPP currently underway. A site for both power generation and desalination has been selected.
12.	Algeria	Two research reactors currently operating. Signed agreements with Rosatom and China for design, construction and operation of NPPs and nuclear research respectively.
13.	Morocco	2MW Triga research reactor under construction. Pre-project study for desalination is complete. Government has approved setting up of a Nuclear Safety Agency
14.	Sudan	Government set up the Nuclear Energy Generation Department. Plans to have an NPP with four 300-600 MWe or 4400 MWe operating by 2030

Nuclear Science & Technology
CROSSWORD PUZZLE



Across

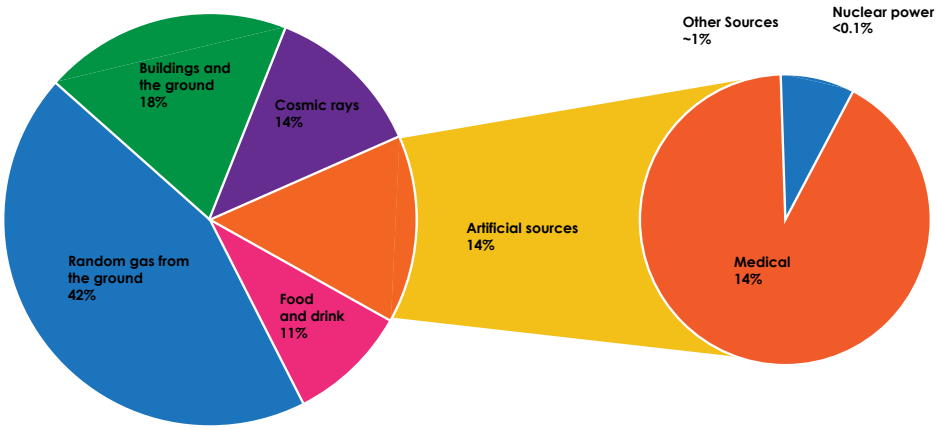
2. is the least penetrating radiation and can be stopped (or absorbed) by a sheet of paper.
4. Basic unit of a chemical element
8. To expose to some form of radiation
10. Too much ionization of body tissues may cause
13. Element that contain equal numbers of protons but different numbers of neutrons in their nuclei
15. A material that stops ionizing radiation
17. Rate at which energy is transformed?
18. An atomic particle that is electrically charged, either negative or positive
20. Core of an atom
21. Total no of protons and neutrons

Down

1. Transfer of heat through space
3. Energy at motion
5. Ability to do work
6. Electromagnetic radiation of the shortest wavelength and highest energy
7. Chemical element with symbol Th
9. Splitting of a heavy nucleus into two roughly equal parts
11. Negatively charged particles of atom
12. Headquarters of International Atomic Energy Agency
14. Fuel most widely used to produce nuclear energy
16. Radiation that can be stopped by a thin sheet of aluminum.
19. Term denoting the quantity of radiation or energy absorbed in a specific mass

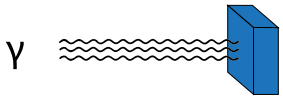
RADIATION SOURCES AND FACTS

Sources of background radiation



alpha: fast-moving helium nucleus, stopped by air, skin or paper

beta: high energy electron, stopped by aluminium plate or glass



gamma: high energy photons, stopped by, dense material, such as concrete or water

What is radiation?

Radiation is energy being transmitted through space. Visible light, ultra-violet light transmission signals from TV and radio communications are all forms of radiation that are common in our daily lives. These are all referred to as 'non-ionizing' radiation. Radiation particularly associated with nuclear medicine and the use of nuclear energy, along with X-rays, is 'ionizing' radiation.

Protection from radiation

Time: Dose is reducing by limiting exposure time.
Distance: The intensity of radiation decreases with distance from its source.
Shielding: Barriers of lead, concrete or water give good protection from penetrating radiation such as gamma rays.
Containment: Radioactive materials are confined to keep them isolated from the environment.
The international commission for radiological protection (ICRP) has developed a system for protection with three basic principles:
Justification: No practice involving exposure to radiation should be adopted unless it produces a net benefit to those exposed or to society generally.
Optimization: Radiation doses and risks should be kept "as low as reasonably achievable" (ALARA), economic and social factors being taken into account.
Limitation: The exposure of individual should be subject to dose or risk limits, above which the radiation risk would be deemed unacceptable.

Key points

- Radiation is easy to detect, even at extremely low levels.
- Radiation exists naturally everywhere at widely varying levels. Places exist where people live with 100 times higher than average background from the ground. A few areas even have levels 1000 times the average.
- Mankind has evolved in a world with strongly differing background radiation without developing a sense to detect it.
- Radiation has always been around and is now well understood. It has been used and studied for more than 100 years.

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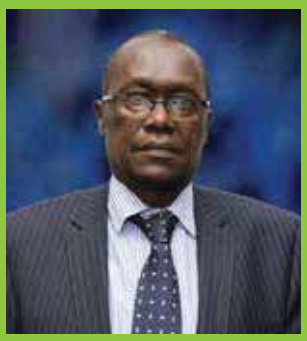

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