MANTRA
TANZANIA
ROSATOM

URANIUM AND RADIOACTIVITY

FREQUENTLY ASKED QUESTIONS

URANI NA MIONZI

MASWALI MBALI MBALI YANAYOULIZWA MARA KWA MARA

MANTRA
TANZANIA
ROSATOM

URANIUM AND RADIOACTIVITY

What is Uranium?

Uranium is the most commonly found naturally occurring radioactive isotope in nature. When in natural form It is a slightly radioactive element, which has been around since the formation of the earth 4.5 billion years ago. It is found in the earth's crust, found in soil and rock, as well as in groundwater and seawater. One and a half square kilometre of earth, 30 cm deep, contains about 2 tons of uranium. It is found everywhere in varying concentrations.

Uranium is the heaviest metal that occurs in nature. It is an unstable material which gradually breaks apart or "decays" at the atomic level. Any such material is said to be "radioactive". As uranium slowly decays, it gives off invisible bursts of penetrating energy called "ionizing radiation". It also produces more than a dozen other radioactive substances as by-products. These unstable by-products, having little or no commercial value, are called "uranium decay products".

What is radioactivity?

Radioactivity is the term used to describe the natural process by which some atoms spontaneously disintegrate, emitting both particles and energy as they transform into different level, to become stable atoms. This process, also called radioactive decay, occurs because unstable isotopes tend to transform into a more stable state. Radioactivity is measured in terms of disintegrations, or decays, per unit time.

Common units of radioactivity are the Becquerel, equal to 1 decay per second, and the Curie, equal to 37 billion decays per second. Radiation refers to the particles or energy released during radioactive decay. The radiation emitted may be in the form of particles, such as neutrons, alpha particles, and beta particles, or waves of pure energy, such as gamma and X-rays.

Each radioactive element, or radionuclide, has a characteristic half-life. Half-life is a measure of the time it takes for one half of the atoms of a particular radionuclide to disintegrate (or decay) into another nuclear form. Half-lives vary from millionths of a second to billions of years.

What is natural background radiation?

Everyone in the world is exposed to radiation on a daily basis. This type of radiation is called Natural Background Radiation.

Mantra Tanzania Ltd
has successfully delineated Uranium ore resource of significant quantity to develop a Uranium Mine at Mkuju River Project. This will be the first Uranium Mine to be developed in Tanzania.

This new development while exciting has generated some questions particularly on radiation safety, desire for value add and use of nuclear energy for electricity. This booklet assists to providing answers to some of the questions

This radiation is found primarily from naturally occurring cosmic rays, radioactive elements in the soil, and radioactive elements incorporated in the bodyMan-made sources of radiation, such as medical X-rays or fallout from historical nuclear weapons testing, also contribute, but to a lesser extent. About 80% of background radiation originates from naturally occurring sources, with the remaining 20% resulting from man-made sources.

Is radioactivity dangerous?

Alpha particles, beta particles and gamma rays can harm a living cell by breaking its chemical bonds at random and disrupting the cell's genetic instructions.
Outside the body, alpha emitters are the least harmful, and gamma emitters are more dangerous than beta emitters.

Inside the body, however, alpha emitters are the most dangerous. They are about 20 times more damaging than beta emitters or gamma emitters. Thus, although alpha radiation cannot penetrate through a sheet of paper or a dead layer of skin, alpha emitters are extremely hazardous when taken into the body by inhalation or ingestion, or through a cut or open sore.
It should be noted, however, that exposure to low radioactivity will not necessarily lead to any radiation related illness.
Several possible health effects are associated with human exposure to radiation from uranium.

MANTRA
TANZANIA
ROSATOM

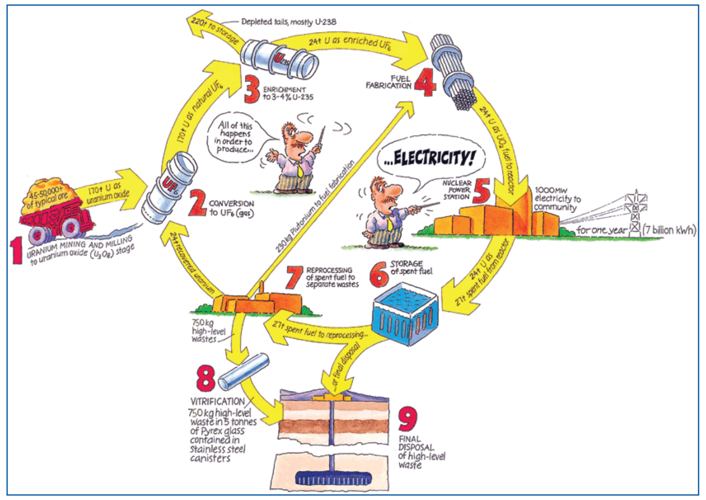
Because all uranium isotopes mainly emit alpha particles that have little penetrating ability, the main radiation hazard from uranium occurs when uranium compounds are ingested or inhaled. However, workers in the vicinity of large quantities of uranium in storage

or in a processing facility also may also be exposed to low levels of external radiation from uranium decay products. The probability of developing a radiation-induced cancer increases with increasing uranium intakes. However, it is important to note, that since uranium is a heavy metal like lead and mercury, the most important potential health impacts are due to its chemical properties, not because of its radiological properties or radiation.

The Nuclear Fuel Cycle

Uranium, just like coal, oil and natural gas, is an energy resource that requires processing through a series of steps in order to produce an efficient fuel for electricity generating purposes. The uranium fuel cycle is, however, more complex than the other natural energy sources.

The nuclear fuel cycle is presented in the diagram below.



Mining and milling of uranium

Uranium is usually mined by either surface mining (open pit) or underground mining techniques, depending on the location of the ore body.

Open Pit Uranium Mine

In Tanzania at the Mkuju River Uranium Mine Project the uranium is found near the surface and the open pit technique will be used. Once mined the ore will be transferred to a processing plant (mill) where the uranium ore can be processed by means of various techniques such as leaching the milled ore slurry with sulphuric acid to separate the uranium from the ore material and recovery of the uranium concentrate from the solution to produce uranium oxide (also called Yellow Cake).

Uranium Oxide (Yellow Cake)

The uranium oxide is the final form in which the uranium will leave the mine and processing plant.

African countries with significant uranium deposits include Algeria, Botswana, Central African Republic, Democratic Republic of Congo, Gabon, Guinea, Equatorial Guinea, Malawi, Mali, Mauritania, Morocco, Namibia, Niger, Nigeria, South Africa, Tanzania, Zambia and Zimbabwe. Not all of these countries, however, produce uranium at this stage.

URANIUM AND RADIOACTIVITY

Uranium conversion

Africa produces up to nearly 18% of global production. This production comes mainly from just three major producers: Namibia , Niger and South Africa. Uranium mining and processing in Africa started as long ago as 1952 (South Africa) and 1976 (Namibia).

Uranium conversion

Uranium needs to be in a gas form for it to be enriched. The uranium oxide is therefore further processed at a conversion plant and converted into uranium hexafluoride (UF6).

Uranium enrichment

Natural uranium consists mainly of 3 isotopes namely Uranium-238 (U-238), Uranium-235 (U-235) and Uranium-234 (U-234). The proportion of these 3 isotopes in natural uranium is 99.0%, 0.72% and 0.3% U-238, U-235 and U-234 respectively. Most of the nuclear reactors in operation and under construction in the world require “enriched” uranium in which the proportion of the U-235 isotope has been raised from the natural 0.72% to between 3.5 – 5%. The enrichment process removes about 85% of the U-238 by separating the gaseous uranium hexafluoride into two streams. The one stream is enriched to the required level and then passed on to the next stage in the fuel cycle. The other stream, called the tails, is depleted in U-235 and is called depleted uranium.
Various technologies exist for the enrichment process of which the centrifuge process is the most commonly used.

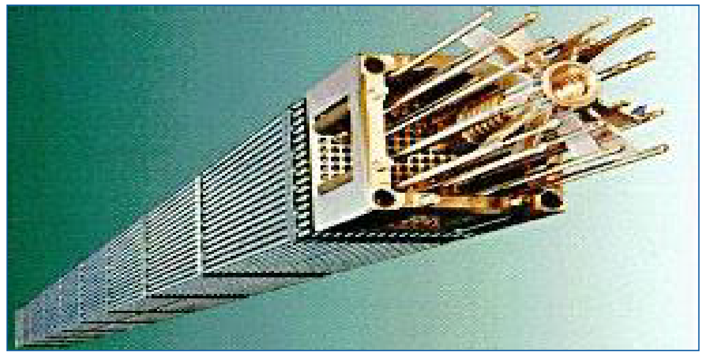
Fuel fabrication

Enriched UF6 is transferred to a fuel fabrication plant where it is converted into uranium dioxide (UO2) powder and pressed into small pellets. These pellets are then inserted into small zirconium alloy or stainless-steel tubes. These tubes are called fuel rods. They are sealed and clustered together to for a fuel assembly. These fuel assemblies are then used in the nuclear reactor to generate electricity. About 27 tonnes of fuel is required per annum for a 1000 Mwe nuclear reactor.

Uranium Oxide powder and Pellets

Nuclear Reactor

Several hundred fuel assemblies make up the core of a reactor. For a reactor with an output of 1000 megawatts (MWe), the core would contain about 75 tonnes of low-enriched uranium. In the reactor core the U-235 isotope fissions or splits, producing heat in a continuous process called a chain reaction. The process depends on the presence of a moderator such as water or graphite, and is fully controlled.

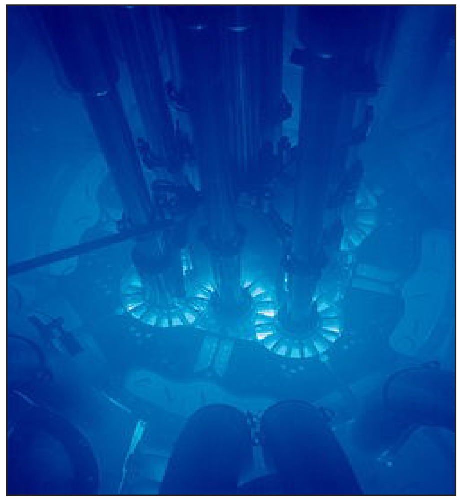


Fuel assembly

MANTRA
TANZANIA
ROSATOM

Nuclear Power Plant

Some of the U-238 in the reactor core is turned into plutonium and about half of this is also fissioned, providing about one third of the reactor's energy output.



Reactor Core

As in fossil-fuel burning electricity generating plants, the heat is used to produce steam to drive a turbine and an electric generator, in this case producing about 7 billion kilowatt hours of electricity in one year. To maintain efficient reactor performance, about one-third of the spent fuel is removed every year or 18 months, to be replaced with fresh fuel.
On a question whether the uranium produced at the Mkuju River Uranium Mine can be used in Tanzania for electricity generation the answer is that it can be done but then only once a nuclear power plant has been established in Tanzania. In order to use the uranium mined in Tanzania in a nuclear power plant it first has to be processed into nuclear fuel as described in the chapters above.

Facilities and technologies to perform this do not currently exist in Tanzania. Once a country decides to use nuclear energy as part of its total energy supply mix and has established a nuclear power plant, it could, however, procure its nuclear fuel from foreign fuel manufacturing plants if it does not have its own. Nuclear fuel manufacturing (conversion, enrichment and fuel assembly manufacturing) is very expensive and many countries opt to rather buy the nuclear fuel from countries having that capability to manufacture.

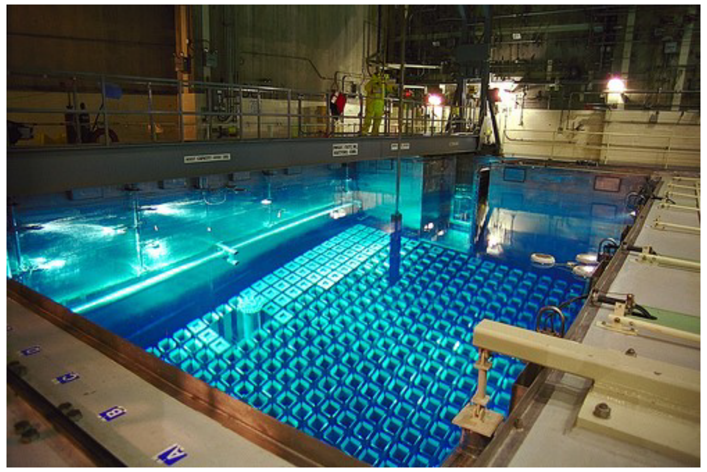
In Africa only South Africa currently uses nuclear energy for energy generation. The Koeberg Nuclear power plant has a capacity of 1830 Megawatt and a 5.2% share of the electricity production in South Africa.

If Tanzania wants to become a nuclear power user it would require firstly a government decision and commitment. This would be followed by developing suitable legislation. Technically the process involves siting exercises, environmental impact assessments, nuclear licensing, decision on the type of plant, appointment of construction contractors, construction and commissioning of the plant. This process can take from 10 to 15 years to complete.
Used Fuel Management

a. Used fuel storage

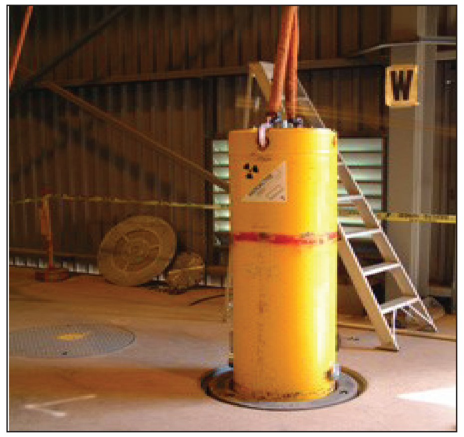
Used fuel assemblies taken from the reactor core are highly radioactive and still give off a lot of heat even though it is regarded as used fuel. Used fuel assemblies can be stored as follows:

In special ponds which are usually located at the reactor site, to allow both heat and radioactivity of the fuel assemblies to decrease. The water in the ponds serves the dual purpose of acting as a barrier against radiation and dispersing the heat from the spent fuel. Used fuel can be stored safely in these ponds for long periods.



Used Fuel Storage Ponds

Environmental impacts from uranium mining and processing



Both kinds of storage are, however, intended only as an interim step before the used fuel is either reprocessed or sent to final disposal. The longer it is stored, the easier it is to handle, due to decay of radioactivity.

b. Used fuel reprocessing

Used fuel still contains approximately 96% of its original uranium, of which the fissionable U-235 content has been reduced to less than 1%. About 3% of used fuel comprises waste products and the remaining 1% is plutonium (Pu) produced while the fuel was in the reactor and not "burned" then.
Reprocessing separates uranium and plutonium from waste products (and from the fuel assembly cladding) by chopping up the fuel rods and dissolving them in acid to separate the various materials. Recovered uranium can be returned to the conversion plant for conversion to uranium hexafluoride and subsequent re-enrichment. The reactor-grade plutonium can be blended with enriched uranium to produce a mixed oxide (MOX) fuel, in a fuel fabrication plant. The remaining high-level radioactive wastes can be stored in liquid form and subsequently solidified.

c. Final disposal

The waste forms envisaged for disposal are vitrified high-level wastes sealed into stainless steel canisters, or used fuel rods encapsulated in corrosion-resistant metals such as copper or stainless steel. All national policies intend either kind of canisters to be buried in stable rock structures deep underground. Many geological formations such as granite, volcanic tuff, salt or shale are suitable. The first permanent disposal is expected to occur about 2020.

Environmental impacts from uranium mining and processing

In many respects uranium mining is much the same as any other mining. Projects must have environmental approvals prior to commencing, and must comply with all environmental, safety and occupational health conditions applicable. Increasingly, these are governed by national and international regulatory authority with none negotiable condition.

Releases of radioactivity to the Environment

In most respects, conventional mining of uranium is the same as mining any other metalliferous ore, and well-established environmental constraints apply in order to avoid any off-site pollution.

Uranium minerals are always associated with more radioactive elements such as radium and radon in the ore which arise from the radioactive decay of uranium over hundreds of millions of years. Therefore, although uranium itself is not very radioactive, the ore which is mined, especially if it is high-grade, is handled with some care, for occupational health and safety reasons.

The releases of radioactivity from uranium mining are sourced from tailings, low-grade ore and, to a lesser extent water management.

The solid waste from the processing of uranium is found in the waste tailings. This is kept on-site normally in large waste tailings facilities (dams). These tailings facilities are engineered facilities which are well designed and operated under specific controls. They comprise most of the original ore and they contain most of the radioactivity in it. In particular they contain all the radium present in the original ore.

MANTRA TANZANIA ROSATOM

The main releases of radioactivity from these facilities are radon– a noble gas that is a radioactive decay product of uranium and radium. The radon generated from the tailings facilities does, however, not have any significant off-site impact as only the areas on top of the tailing's facilities and the near surrounding areas may be exposed to it.

Low grade ore is normally kept on site on a large stockpile. From open cut mining, there are substantial volumes of barren rock and overburden waste. These are placed near the pit and either used in rehabilitation or shaped and re-vegetated where they are. The only credible exposure pathway from these stockpiles is radon exposure and potentially some water run-off containing very low levels of radioactivity.

Release of water to the environment

Release of radioactively contaminated water from an uranium mining site is possible but is normally very strictly controlled. Run-off from the mine stockpiles and waste liquid from the milling operation are collected in secure retention ponds for isolation and recovery of any heavy metals or other contaminants.
The liquid portion is disposed of either by natural evaporation or recirculation to the milling operation. Process water discharged from the mill contains traces of radium and some other metals which would be undesirable in biological systems downstream. This water is evaporated and the contained metals are retained in secure storage. During the operational phase, such water may be used to cover the tailings while they are accumulating.

Protection of workers at uranium mines

While uranium itself is only slightly radioactive, radon, a radioactive inert gas, is released to the atmosphere in very small quantities when the ore is mined and crushed. Radon is one of the decay products of uranium and radium, and occurs naturally in most rocks - minute traces of it are present in the air which we all breathe.

Uranium mines have mostly been open cut and therefore naturally well ventilated. Underground mines are normally ventilated with powerful fans. Radon levels are kept at a very low and certainly safe level in uranium mines. (Radon in non-uranium mines also may need control by ventilation.)

Gamma radiation may also be a hazard to those working close to high-grade ores. It comes principally from radium in the ore, so exposure to this is regulated as required. In particular, dust is suppressed, since this represents the main potential exposure to alpha radiation as well as a gamma radiation hazard.

At the concentrations associated with uranium (and some mineral sands) mining, radon is a potential health hazard, as is dust. Precautions taken during the mining and milling of uranium ores to protect the health of the workers include:

- Good forced ventilation systems in underground mines
- Efficient dust control,
- Limiting the radiation exposure of workers in mine, mill and tailings areas
- The use of radiation detection equipment in all mines and plants.
- Imposition of strict personal hygiene standards for workers handling uranium oxide concentrate.

At any mine, designated employees (those likely to be exposed to radiation or radioactive materials) are normally regarded as Occupationally Exposed Workers. This means that they are controlled by means of a specific radiation protection programme designed for each specific mine and processing plant (based on the radiological hazard present). They are further monitored for alpha radiation contamination and personal dosimeters are worn to measure

Protection of the Public and the Environment

exposure to gamma radiation. Routine monitoring of air, dust and surface contamination is also undertaken as part of the radiation protection programme.

Protection of the Public and the Environment

Although, as indicated earlier on, the potential radiological risk to the public as a results of uranium mining and processing activities are low, it is normally required by the regulatory authorities that an environmental radiation protection programme be implemented. In order to do this a radiological public risk assessment is first performed to determine the possible exposures and exposure pathways to the public in the vicinity of the uranium mine.

The environmental radiation protection programme monitors on an on-going basis all the likely radiological exposure pathways to the public as determined by the radiological public risk assessment. This includes normally the inhalation pathway (radon and radioactively contaminated dust) and ingestion pathway (water and foodstuffs grown on the land in the vicinity of the uranium mine).

The Tanzania Atomic Energy Commission (TAEC) is the regulatory authority of Tanzania, operating under the mandate of the Ministry of Communications, Science and Technology. The TAEC has been mandated to:

- Provide atomic energy industry regulation and atomic radiation protection services.
- Co-ordinate or facilitate or advise on, the transfer and safe, peaceful utilization of nuclear technology and atomic energy.
- The control of the use of ionizing and non ionizing radiation sources, the promotion of safe, secure and peaceful use of nuclear technology and atomic energy.
- Advise the government of Tanzania on the implementation of international conventions related to nuclear technology and atomic energy.

MANTRA
TANZANIA
ROSATOM

2nd Floor, Masaki ikon, Bains Avenue, Masaki
P.O.BOX 23451
Dar es Salaam, Tanzania

Tel: +255 764 700 440
E-mail: info@rosatom.ru

www.uranium1.com

URANI NA MIONZI

Urani ni nini?

Urani ni metali ya asili yenye kawaida ya kutoa mionzi. Ni metali yenye mionzi ambayo imekuwapo ardhini tangu kuumbwa kwa dunia miaka bilioni 4 na nusu iliyopita. Urani hupatikana ndani ya udongo wa juu wa uso wa dunia, katika miamba, na ndani ya maji, ardhini na baharini. Eneo la kilometa moja na nusu la mraba na kina cha sentimita 30 hivi, kwa kawaida linakuwa na kiasi cha tani 2 za urani wenye mionzi na hupatikana katika maeneo mbali mbali kwa viwango tofauti.

Urani ina asili ya uzito kuliko madini yote, ni madini ambayo huweza kuoza kwa urahisi kwa kiwango cha atomiki na "kwa hiyo kitu chochote cha tabia ya namna hiyo kinaweza kuwa na mionzi". Kadri urani unavyooza hutoa nguvu ya mionzi inayoitwa"mionzi ya atomiki". Pia hutoa dazani ya vitu vingine ambavyo pia hutoa mionzi, hivi vitu ambavyo sio vigumu huwa havina thamani ya kibiashara huitwa "maozeo ya urani" wakati wa uchimbaji maozeo haya hutupwa kama takataka, na moja wapo huitwa radoni na pia mengine huwa vitu vigumu ambavyo pia vina mionzi.

Mionzi ni nini?

Mionzi/mnururisho ni neno linalotumika kuelezea njia ambayo ni ya asili ambayo atomiki humegeka na kutoa chenga chenga na nguvu na kubadilika kuwa kwenye atomiki ambayo ni ngumu zaidi. Njia hii pia huitwa uozo wa mionzi, hii hutoa wakati miamba laini hubadilika na kuwa katika hali ngumu. Mionzi hupimwa kwa kiwango cha umomonyokaji au uozaji unaopimwa kwa uniti ya muda. Unit za kawaida za mionzi ni kipimo cha Bekuere (Becquere) ambacho ni sawa na uozo mmoja kwa sekunde na cha Kurie (Curie) ambacho ni sawa bilioni 37 za uozo kwa sekunde.

Mionzi inaelezewa kuwa ni vipande vidogo vidogo ambavyo hutokea wakati wa uozo wa mionzi, mionzi ambayo hutokea inaweza kuwa katika hali chengachenga au nguvu ambayo hutokea wakati wa mgandamizo wa uozo. Miozo inayotolewa inaweza kuwa katika aina ya vipande kama vile nutroni, vipande vya alfa na vipande vya beta, au mawimbi ya nishati halisi kama vile gamma na eksirei.

Kila aina ya mionzi au redionuklidi ina tabia ya nusu maisha. Nusu maisha ni kipimo cha muda unaochukua nusu ya atomu ya redionuklidi husika kubomoka (au kuoza) na kuwa katika umbo lingine la nyuklia. Nusu maisha zinatofautiana kutoka milioni ya sekunde hadi mabilioni ya miaka.

Kampuni ya Mantra Tanzania imefanikiwa kufanya utafutaji na kupata mashapo ya kutosha kuendeleza Mgodi wa Urani katika Mradi wa Mto Mkuju. Huu utakuwa ni mgodi wa kwanza wa madini ya Urani kuanzishwa nchini Tanzania. Maendeleo haya mapya yamesababisha kuwepo kwa maswali mengi, hasa hasa juu ya mionzi, usalama na dhana ya uwezekano wa kuanzishwa kwa kinu cha nuklia kwa ajili ya kuzalisha umeme. Kijarida hiki kitasaidia kutoa majibu ya baadhi ya maswali hayo

Nini asili ya mionzi?

Nini asili ya mionzi?
Kila kitu duniani huishi na mionzi katika maisha ya kila siku. Aina hii ya mionzi huitwa mionzi ya asili. Kimsingi aina hii ya mionzi hupatikana katika mionzi ya kawaida ya asili yenye dalili za mionzi katika udongo na aina ya mionzi ambayo inapatikana katika mwili. Miozi ambayo imetengenezwa na binadamu ni pamoja na inayotokana na Eksirei ambazo hutumika wakati wa matibabu au iliyosababishwa na kushindwa kwa jaribio la nyuklia pia huchangia kupatikana kwa mionzi kwa kiasi fulani.Takribani asilimia 80 ya mionzi ya asili hutokea katika vyanzo mbalimbali vya asili na asilimia 20 inayobaki husababishwa na shughuli mbali mbali za binadamu.

Je mionzi ni hatari?

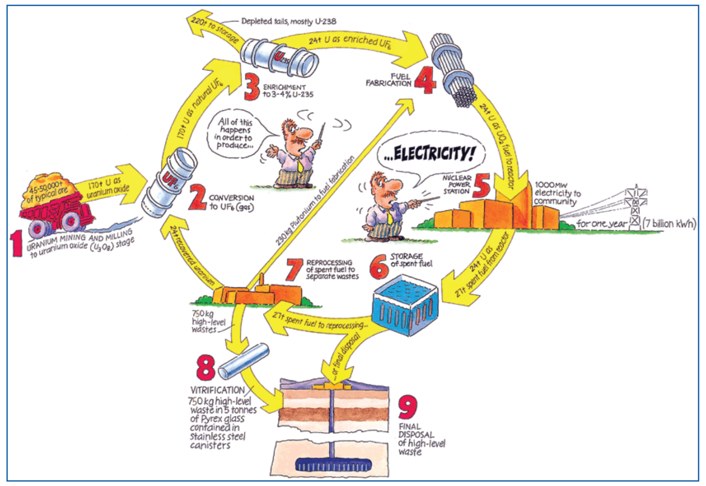
Chembechembe za Alfa, chembechembe za Beta na miozi aina ya gamma zinaweza kuathiri seli za kuishi kwa kuzivuruga na kuharibu mfumo wa ukuaji wa seli.
Nje ya mwili chembechembe za alfa hazina madhara kama ilivyo chembechembe za mionzi ya aina ya gamma ambazo zina madhara makubwa zaidi. Lakini ndani ya mwili mionzi ya aina ya Alfa ina madhara mara ishirini zaidi ya madhara ambayo huweza tolewa na mionzi ya aina ya Beta au gamma. Kwa hiyo pamoja na kwamba mionzi aina ya alfa haiwezi kupenyeza kwenye karatasi au juu ya ngozi, mionzi aina ya alfa ni hatari sana ikiingia katika mwili wa binadamu kwa njia ya kuvuta hewa, kumezwa au kwenye kidonda.
Ni lazima ieleweke kuwa katika mazingira yenye kiwango cha mionzi kidogo, haiwezi kusababisha magonjwa yatokanayo na mionzi.
Kuna madhara mbali mbali ya kiafya ambayo yanaweza kutokana na mionzi ya urani. Lakini kwa kuwa aina nyingi za mionzi ni chembechembe za aina ya alfa ambazo huwa na uwezekano mdogo wa kuingia mwilini madhara makubwa ya mionzi ya urani hutokea kama itaingia ndani ya mwili kwa njia ya hewa au kumezwa. Kwa hiyo wafanyakazi wafanyao kazi katika maeneo yenye madini ya urani mengi au katika mtambo wa uchenjuaji pia hupata madhara ya mionzi midogo ya nje kutokana na urani iliyoozeshwa.

Uwezekano wa kupata kansa inayosababishwa na mionzi inategemea zaidi na kuongezeka kwa kiasi cha Urani kiingiacho mwilini. Lakini pia ni vema kuelewa kuwa kwa kuwa urani ni madini ambayo ni mazito kama chuma na zebaki na madhara yake makubwa si kutokana na asili yake ya mionzi ila asili ya kemikali inazoendana nazo.

Matumizi ya nyuklia katika mzunguko wa nishati

Urani kama yalivyo makaa ya mawe, mafuta na gesi ni asili ya nishati ambayo huhitaji kuchakatuliwa katika hatua mbali mbali kwa madhumuni ya kuzalisha nguvu ya nishati. Mchakato wa kuzalisha umeme utakonao na urani ni mgumu sana ukilinganisha na vyanzo vingine vya asili vizalishavyo umeme.

Mchoro ufuatao hapa chini unaonyesha mzunguko wa uzalishaji wa nguvu ya umeme kutokana na nyuklia.



Uchimbaji na uchakatuaji wa urani

Urani unaweza kuchimbwa kwa njia mbili kutoka uso wa dunia (shimo lililowazi) au kwa njia ya ndani ya ardhi, na hii hutegemeana na uelekeo au sehemu mashapo yalipo.

Mgodi wa uchimbaji wa Urani kwa njia ya shimo lililo wazi

Katika nchi ya Tanzania katika eneo la Mto Mkuju madini ya urani yanapatikana karibu na uso wa dunia na uchimbaji wa njia ya shimo lililowazi ndio utakaotumika. Mara baada ya uchimbaji kukamilika udongo wenye urani utasafirishwa kwenda kwenye mtambo wa kuchakatua (kinu cha kusagia) hapo udongo wenye madini ya urani utachakatuliwa kwa kutumia njia mbali mbali kwa mfano kuchuja rojorojo ya udongo wenye urani kwa kuchanganya na tindikali nyepesi ili kutenga urani kutoka kwenye rojorojo ya tope na kutengeneza oksaidi ya urani (pia hujulikana kama Keki ya Njano).

Madini ya Urani yaliyochakatuliwa (Keki ya Njano)

Keki ya njano ni hatua ya mwisho ya madini ya Urani ambapo huondolewa katika mgodi na mtambo wa kuchakutulia.

URANI NA MIONZI

Ubadilishaji urani

Nchi za Afrika ambazo zina kiasi kikubwa cha madini ya urani ni pamoja na Algeria, Botswana, Jamhuri ya Afrika Kati, Jamhuri ya Demokrasia ya Congo, Gabon, Guinea, Equatorial Guinea, Malawi, Mali, Mauritania, Morocco, Namibia, Niger, Nigeria, Afrika Kusini, Tanzania, Zambia na Zimbabwe. Si nchi zote hizi kwa sasa zinazalisha urani.

Afrika huzalisha kiasi cha asilimia 18 ya urani duniani. Uchimbaji na uchakatuaji wa Urani barani Afrika ulianza miaka mingi iliyopita, 1952 (Afrika Kusini) na1976 (Namibia).

Ubadilishaji urani

Urani inatakiwa kuwa katika umbo la gesi ili iweze kurutubishwa. Kwa hiyo gesi ya urani hutengenezwa tena katika mtambo wa ubadilishaji na kuwa Heksafloraidi ya Urani (UF6).

Heksafloraidi ya Urani katika kichupa cha glasi

Urutubishaji Urani

Kwa asili, urani ina isotopesi kuu 3 nazo ni Urani-238 (U-238), Urani-235 (U-235) na Urani-234 (U-234). Uwiano wa hizi isotopesi 3 ni U-238 ina 99.9%, U-235 ina 0.72 % na U-234 ina 0.3%. Mitambo mingi ya urani inayofanyakazi na inayojengwa inahitaji urani "iliyorutubishwa" ambapo uwiano wa isotope wa U-235 umeongezwa kutoka ule wa asili wa 0.72% na kufikia kati ya asilimia 3.5 hadi 5. Mchakato wa urutubishaji unaondoa kama asilimia 85 ya U-238 kwa kutenganisha gesi za Heksafloraidi ya Urani katika mitiririko miwili. Mtiririko mmoja unarutubishwa kwa kiwango kinachotakiwa na halafu hupelekwa katika hatua nyingine ya mzunguko wa nishati. Mtiririko mwingine uitwao tails(uchafu unaobaki baada ya kusafisha urani), inapunguzwa katika U-235 na huitwa urani iliyopungua.

Teknolojia mbalimbali zipo zinazotumika katika mchakato wa kurutubisha urani ambapo njia ya sentrifuji ndio hutumika mara nyingi.

Utengenezaji fueli

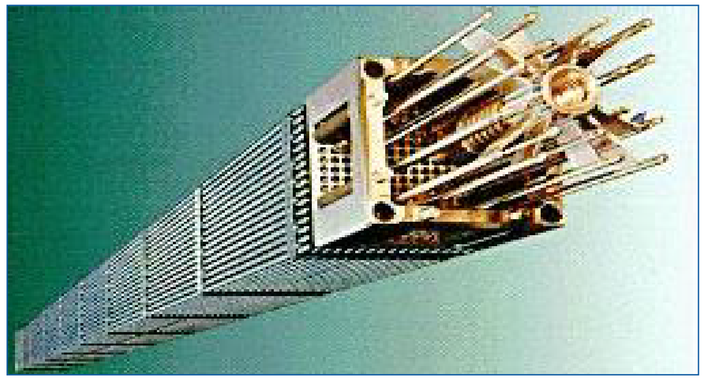
UF6 iliyorutubishwa inahamishiwa katika mtambo wa kutengeneza fueli ambapo inabadilishwa kuwa unga wa Urani Dayoksaidi (UO2) na kutengenezwa kuwa vitonge vidogo. Baada ya hapo vitonge hivi huingizwa katika aloi za zirkoniamu au matyubu yasiyoweka kutu. Matyubu haya pia huitwa rodi za fueli. Hufungwa madhubuti na kukusanywa pamoja kwa ajili ya mkusanyiko wa nishati. Mkusanyiko huu wa fueli baadae hutumika katika mtambo wa nuklia ili kuzalisha umeme. Takriban tani 27 za fueli huhitajika kwa mwaka kwa mtambo wa nuklia wenye Megawati (MWe) 1000.

Poda na vidonge vya Urani

Mtambo wa nyuklia

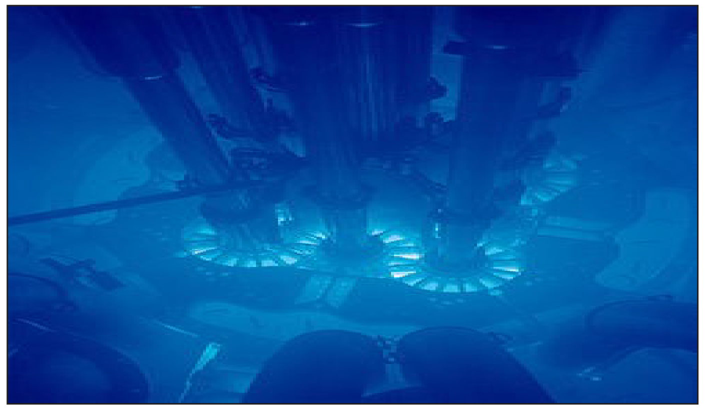
Mamia ya mikusanyiko ya fueli ndio hufanya kiini cha mtambo. Kwa mtambo wenye kutoa MWe 1000, kiini kitakuwa na tani 75 zenye urani iliyorutubishwa kidogo. Ndani ya mtambo isotope U-235 huvunjika au kugawanyika na kutoa joto mfululizo mchakato unaoitwa mtiririko wa matokeo (chain reaction). Mchakato huu unategemea na kuwepo kwa kipoozeo kama maji au graffiti na ina inathibitiwa kikamilifu.

MANTRA
TANZANIA
ROSATOM



Mkusanyo wa nishati

Mtambo wa nguvu za nyuklia



Kiini cha mtambo

Baadhi ya U-238 katika kiini cha mtambo hugeuzwa kuwa plutoniamu na karibu nusu ya hii pia hugawanyika na kutoa takriban moja ya tatu ya nishati inayotolewa na mtambo.

Kama ilivyo katika fueli za fosili zinazotoa nishati ya umeme, joto linatumika kuzalisha mvuke unaosukuma mtambo na genereta ya umeme ambapo hapa, hutoa wastani wa kilowatsi billion 7 za saa za umeme katika mwaka mmoja. Ili kuendelea kuwa na ufanisi wa jinsi mtambo unavyofanyakazi, takriban moja ya tatu ya fueli iliyotumika hutolewa baada ya mwaka au miezi kumi na nane na kuwekwa fueli mpya.

Swali la kwamba je Urani itakayozalishwa katika Mto Mkuju inaweza kutumika kuzalisha umeme Tanzania? jibu ni kwamba inaweza kufanyika hivyo isipokuwa tu lazima kuanzishwe mtambo wa kuzalisha nyuklia Tanzania.

Ili urani izalishwayo Tanzania iweze kuingizwa katika mtambo wa kuzalisha nyuklia ni lazima ichakatuliwe na kuwa katika aina ya kuzalisha nishati ya nyuklia kama ilivyoelezewa hapo juu. Mitambo na teknolojia ya kufanya hivyo kwa sasa haipo Tanzania.

Kwa hiyo nchi ikiamua kutumia mitambo ya nyuklia kuzalisha umeme kama chanzo cha umeme na ikaanzisha mtambo wa nyuklia huwa inawezekana, isipokuwa mpaka inunue vyanzo vya mitambo ya nguvu ya nyuklia kuzalisha umeme toka viwanda vya nje ambavyo huzalisha mitambo ya namna hiyo. Mitambo ya kuzalisha nguvu za nyuklia kwa ajili ya kufua umeme ni gharama sana na inawezekana nchi ikaamua kununua nishati ya aina hii toka nchi zenye uwezo wa kuzalisha nishati ya aina hii.

Katika bara la Afrika kwa sasa ni nchi ya Afrika Kusini pekee yake ndio inatumia nguvu ya nyuklia kuzalisha nishati. Mtambo wa nyuklia wa Koeberg huzalisha megawati 1830 na huchangia asilimia 5.2% ya umeme unaozalishwa nchini Afrika Kusini.

Kama nchi ya Tanzania itaamua kuanzisha nishati itokanayo na nyuklia ni lazima kwanza itahitaji maamuzi na kuwajibika kwa serikali, na hii itafuatiwa na kuunda sheria.

Kiitalaamu utaratibu huu hufuatiwa vikao, kukamilisha taarifa za athari za mazingira, kibali na leseni za nyuklia, aina ya mtambo, kuchagua wakandarasi wa kujenga mitambo ya nyuklia, ujenzi na uendeshaji wa mitambo ya nyuklia. Mchakato huu unawezekana kukamilika kati ya miaka 10 hadi 15.

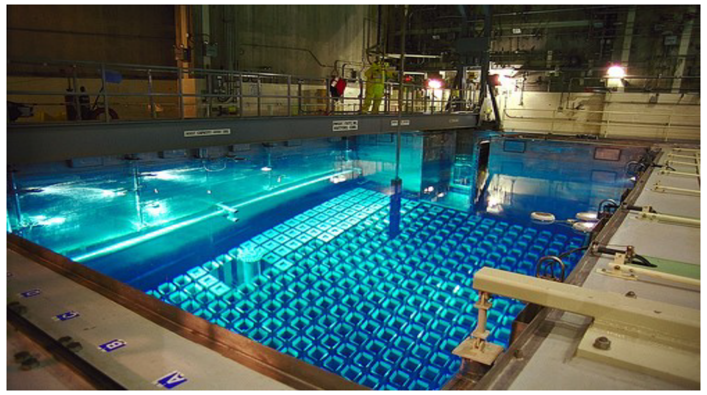
Usimamizi wa fueli iliyotumika

a. Utunzaji wa fueli iliyotumika

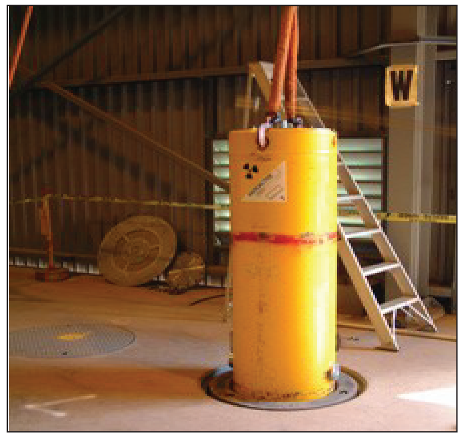
Fueli iliyotumika itolewapo katika mtambo huwa inakiasi kikubwa cha mionzi na hutoa joto jingi pamoja nakuwa huchukuliwa kuwa ni fueli iliyotumika. Fueli iliyotumika inaweza kutunzwa kama ifuatavyo;

- Katika madimbwi maalumu ambayo huwa karibu na mtambo wa kuzalisha nguvu za nyuklia, ili kuruhusu joto na hali ya umionzi kupungua.Maji katika mabwawa haya hutumika kama kinga ya mionzi na kupoza joto toka fueli iliyotumika. Fueli hii iliyotumika huweza kutunzwa katika mabwawa haya kwa muda mrefu.

Environmental impacts from uranium mining and processing



Mabwawa ya kutunza fueli iliyotumika



Utalaamu wa kiufundi wa kukausha (juu au ndani ya ardhi)

Aina zote hizo mbili za utunzaji ni njia mbadala ya aina ya utunzaji ambayo imelenga kutunza mabaki ya fueli kabla ya kurudishwa tena kutumika au kupelekwa kwa kwa ajili ya hatua ya mwisho ya kuteketezwa. Kadiri yanavyokaa muda mrefu ndivyo inakuwa ni rahisi kuyatunza kutokana na kuooza na kuisha kwa mionzi.

b. Utumiaji tena fueli iliyotumika

Fueli iliyotumika bado inakuwa na wastani wa asilia 96 ya urani ya awali na kati ya hiyo U-235 inayogawanyika inakuwa imepungua kwa chini ya asilimia 1. Wastani wa asilimia 3 ya fueli iliyotumika ni mabaki yasiyofaa na asilimia 1 iliyobaki ni plutonium (Pu) ambayo huzalishwa wakati fueli iko kwenye mtambo na haikuchomeka hapo. Mchakato wa kutumia tena hutenganisha urani na plutonium katika mabaki (na kutoka mkusanyiko wa fueli) kwa kukata kata rodi za fueli na kuziyeyusha kwenye asidi ili kutenganisha vitu mbalimbali.

Athari za mazingira zitokanazo na uchimbaji na uchakatuaji wa urani

Katika hali nyingi za uchimbaji urani unafanana na madini mengine. Miradi ni lazima ipate vibali vya mazingira kabla ya kuanza na lazima kukidhi masharti yote yanayohusu mazingira,
Usalama na Afya kazini. Hivi lazima vikidhi viwango vya kimataifa na ukaguzi wa nje.

Urani iliyopatikana inaweza kurudishwa kwenye mtambo ili ibadilishwe na kuwa heksafloraidi ya urani na baadae kurutubishwa. Plutoniam yenye kufaa kwenye mtambo inaweza kuchanganywa na urani iliyorutubishwa ili kutoa mchanganyiko wa oksaidi ya fueli, (MOX) katika mtambo wa kutengeneza fueli. Mabaki ya mionzi mikali yanayosalia yanaweza hifadhiwa katika muundo wa umaji maji na baadae kubalishwa kuwa umbo gumu

c. Uteketezaji wa mwisho

Mabaki hutupwa au huteketezwa kwa kufungwa kwenye vyombo vya vyuma vilivyozibwa bila kuachwa sehemu ya kutoa na kuingiza hewa na rodi za fueli zilizotumika huwekwa kwenye vyombo visivyo pata kutu kama shaba au feleji isiyopata kutu. Sheria zote za nchi zinataka aina yoyote ya vyombo hivi vizikwe chini kabisa ya ardhi ambako kuna muundo wa majabali imara. Miundo mingi ya kijiolojia kama granaiti, mawe ya volkano, chumvi au miamba hufaa. Mahala pa kwanza pa kudumu pa kuhifadhia taka pataanza kuwapo mwaka 2020.

Uchafuzi wa mazingira utokanano na mionzi

Katika hali ya kawaida sheria za uchimbaji wa urani ni wa sawa na madini mengine na utaratibu maalumu huanzishwa ili kuzuia uchafuzi wa mazingira.

Madini ya urani mara nyingi huendana na mionzi kama vile radium na radon katika udongo unaoendana na uozo wa urani zaidi ya mamilioni ya miaka. Kwa hiyo pamoja na kwamba urani yenyewe haina mionzi sana, udongo ambao huchimbwa pamoja nayo hasahasa ikiwa ya daraja la juu inapaswa kutunzwa au kufanyiwa kazi kwa umakini mkubwa kwa sababu za afya na usalama.

Utokaji wa mionzi katika migodi ya urani huanzia katika mabwawa ya kutunzia takataka za mabaki ya udongo, madini ya ngazi ya chini na kwa kiasi kidogo usimazi wa maji.

Takataka ngumu itokanayo na uchakatuaji wa urani hupatikana zaidi katika mabwawa ya kutunzia takataka za mabaki, hizi hutunzwa zaidi katika mabwawa makubwa ambayo huwa ndani ya eneo la mgodi. Mabwawa haya yametengenezwa kiutalaamu mkubwa wa kihandisi na huendeshwa kwa utaratibu maalum. Huwa na kiasi kikubwa cha madini ya awali na mionzi na hasa huwa na radiam yote iliyokuwemo kwenye madini ya awali.

Aina kubwa ya mionzi katika mabwawa haya ni ile aina ya radon ambayo ni gesi inayotokana na mionzi itokananyo ya uozo wa urani na radon. Radon ambayo hupatikana kwenye haya mabwawa haiwezi kuwa na uchafuzi nje ya eneo la mgodi kwa maana huu uko juu ya mabwawa haya na pia kwa kiasi fulani maeneo yanayozunguka mabwawa haya.

Udongo wenye kiwango kidogo cha urani kwa kawaida hurundikwa katika marundo makubwa ndani ya eneo la mgodi. Kutoka uchimbaji wa wazi kuna udongo mwingi sana na mwamba ambao hauna urani.

Marundo haya hurundikwa karibu na shimo hili la wazi kwa ajili ya kulinda kingo na kuweza kukarabatiwa mahali hapo utakaporundikwa. Kiasi kidogo cha uchafuzi kinaweza kutokana na gesi ya radon kutoka katika marundo haya ambayo pia huwa na kiasi kidogo sana cha mionzi.

Uranium mines have mostly been open cut and therefore naturally well ventilated. Underground mines are normally ventilated with powerful fans. Radon levels are kept at a very low and certainly safe level in uranium mines. (Radon in non-uranium mines also may need control by ventilation.)

Gamma radiation may also be a hazard to those working close to high-grade ores. It comes principally from radium in the ore, so exposure to this is regulated as required. In particular, dust is suppressed, since this represents the main potential exposure to alpha radiation as well as a gamma radiation hazard.

At the concentrations associated with uranium (and some mineral sands) mining, radon is a potential health hazard, as is dust. Precautions taken during the mining and milling of uranium ores to protect the health of the workers include:

- Good forced ventilation systems in underground mines
- Efficient dust control,
- Limiting the radiation exposure of workers in mine, mill and tailings areas
- The use of radiation detection equipment in all mines and plants.
- Imposition of strict personal hygiene standards for workers handling uranium oxide concentrate.

At any mine, designated employees (those likely to be exposed to radiation or radioactive materials) are normally regarded as Occupationally Exposed Workers. This means that they are controlled by means of a specific radiation protection programme designed for each specific mine and processing plant (based on the radiological hazard present). They are further monitored for alpha radiation contamination and personal dosimeters are worn to measure exposure to gamma radiation. Routine monitoring of air, dust and surface contamination is also undertaken as part of the radiation protection programme.

Protection of the Public and the Environment

Although, as indicated earlier on, the potential radiological risk to the public as a results of uranium mining and processing activities are low, it is normally required by the regulatory authorities that an environmental radiation protection programme be implemented. In order to do this a radiological public risk assessment is first performed to determine the possible exposures and exposure pathways to the public in the vicinity of the uranium mine.

The environmental radiation protection programme monitors on an on-going basis all the likely radiological exposure pathways to the public as determined by the radiological public risk assessment. This includes normally the inhalation pathway (radon and radioactively contaminated dust) and ingestion pathway (water and foodstuffs grown on the land in the vicinity of the uranium mine).

The Tanzania Atomic Energy Commission (TAEC) is the regulatory authority of Tanzania, operating under the mandate of the Ministry of Communications, Science and Technology. The TAEC has been mandated to:

- Provide atomic energy industry regulation and atomic radiation protection services.
- Co-ordinate or facilitate or advise on, the transfer and safe, peaceful utilization of nuclear technology and atomic energy.
- The control of the use of ionizing and non ionizing radiation sources, the promotion of safe, secure and peaceful use of nuclear technology and atomic energy.
- Advise the government of Tanzania on the implementation of international conventions related to nuclear technology and atomic energy.

MANTRA TANZANIA ROSATOM

2nd Floor, Masaki ikon, Bains Avenue, Masaki
P.O.BOX 23451
Dar es Salaam, Tanzania

Tel: +255 764 700 440
E-mail: info@rosatom.ru

www.uranium1.com