

MARSHALL ISLANDS RADIOLOGICAL SURVEILLANCE GROUP



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A note from the editor

Welcome to the *Marshall Islands Monitor*, a quarterly newsletter featuring work performed under the Marshall Islands Dose Assessment and Radioecology Program at the Lawrence Livermore National Laboratory.

Each issue of this newsletter will include a feature article dealing with the broader aspects of the consequences of the nuclear test program that took place from 1946 to 1958 in the Marshall Islands as well as updates on specific program activities and findings.

The newsletter is available through a free e-mail subscription and is also accessible on the Web at <https://marshallislands.llnl.gov/>. You can subscribe to future e-mail issues by sending an e-mail message to freitas21@llnl.gov and include the words "subscribe MIMonitor" in the subject box.

Terry Hamilton, PhD
Editor in Chief

Feature Article

Plutonium bioassay monitoring in the Marshall Islands

Whole body counting (WBC) and plutonium urinalysis (bioassay) are very sensitive measurement techniques used to determine the amount of radioactivity that people have incorporated into their bodies. In general, these techniques provide us with a very accurate way to estimate the radiation dose from internally deposited radionuclides such as those contained in residual nuclear fallout contamination in the environment.

Experience shows that monitoring of individuals within a general population group is seldom required to reliably assess doses delivered to people from chronic (long-term) exposure to residual fallout contamination in the environment. However, the United States Department of Energy (DOE) has agreed to conduct whole body counting and bioassay testing under the Marshall Islands Program as an added precaution to ensure that radiation doses remain at or below applicable safety standards for radiological protection,

and that it can be deemed safe for people to live in the Marshall Islands without fear from radiation exposure. These individual radiological protection monitoring programs are used to estimate and document present-day doses from exposure to residual fallout contamination in the environment, and allow us to assess trends in exposure conditions and identify those people most at risk. Our working philosophy is to understand the present, anticipate change, and predict the future. Such actions are critically important to help sustain resettlement of the northern Marshall Islands and provide pro-active interventions (if required) commensurate with changes in living patterns, land-use and/or the behavior of fallout contamination in the environment.

What is plutonium? Plutonium is an important radioactive element produced in nuclear explosions. Plutonium emits alpha particles (or alpha rays). Alpha particles have

a short range in tissue (~40 μm or about the thickness of a cigarette paper) and cannot be measured directly by whole-body detectors external to the body. However, as heavy, slow moving, charged particles they have a high relative effectiveness to disrupt or cause harm to biological cells. As a consequence, in-vitro bioassay techniques have been developed to test for the presence of plutonium in the human body based on measured urinary excretion patterns and the behavior of plutonium in the human body.

How do we measure plutonium? Under the Marshall Islands Radiological Protection Monitoring Program, LLNL scientists have developed a new state-of-the-art technology for measuring the amount of plutonium in bioassay (urine) samples using Accelerator Mass Spectrometry (AMS). Urine samples are collected over a 24-h period. The test turns a urine sample into a powder which scientists analyze by counting the number of plutonium atoms contained in the sample.

How does plutonium get into our bodies? Everybody has a small amount of plutonium in their bodies. Plutonium occurs in nature at very low concentrations but human exposure to plutonium increased dramatically through the 1950s as a result of global fallout from atmospheric nuclear weapons testing. Marshall Islanders are potentially exposed to higher levels of plutonium in the environment as a result of exposure to close-in and

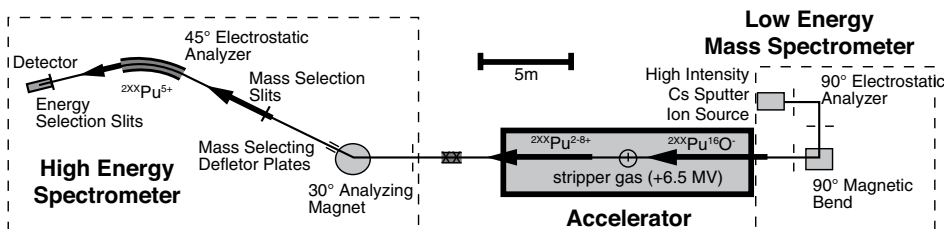


Figure 1. A schematic diagram of the Accelerator Mass Spectrometry (AMS) system at LLNL used for the detection and measurement of long-lived radionuclides such as plutonium. AMS is about 200 to 400 times more sensitive than standard techniques commonly employed in routine bioassay programs, and far exceeds the standard requirements established under the latest United States Department of Energy regulation 10CFR 835 for in vitro bioassay monitoring of alpha-emitting radionuclides such as plutonium-239.

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Bioassay monitoring

regional fallout contamination. The main pathway for human exposure to plutonium is through inhalation of contaminated dust particles in the air that people breathe. Inhaled (or ingested) plutonium eventually ends up in various organs—especially the lung, liver, and bone—resulting in continuous exposure of these tissues to alpha-particle radiation. Plutonium remains in the body for a long time although the systemic uptake of plutonium in people living in the northern Marshall Islands is still expected to be very low.

Inhalation exposure can be estimated from the product of the concentration of plutonium in soil, resuspension enhancement factors, and inhalation dose conversion factors for radionuclides of interest. These estimates show that the projected dose contribution from exposure to plutonium in the Marshall Islands is less than 0.3% of the total lifetime dose from exposure to residual fallout contamination in the environment. However, plutonium is a concern to people living in the northern Marshall Islands because of its long half-life (half-life = 24,000 year), and persistence in the human body (biological half-life = 20 to 50 years) and the environment. Moreover, radioactive debris deposited in lagoon sediments of coral atolls formed a reservoir and potential long-term source for remobilization and transfer of plutonium through the marine food chain and potentially to man. Elevated levels of plutonium in the terrestrial environment also represent potential inhalation and/or ingestion hazards. Moreover, early characterization of the terrestrial environment revealed the presence of hotspots containing milligram-sized pieces of plutonium. Consequently, atoll rehabilitation programs in the Marshall Islands have historically given special consideration to monitoring plutonium uptake into potentially exposed population groups.

The LLNL plutonium bioassay program in the Marshall Islands aims to address the following performance measures:

1. To provide more reliable and accurate

data to assess baseline and potentially significant incremental uptakes of plutonium within resettled and/or resettling populations in the Marshall Islands.

2. To monitor plutonium exposure in critical populations groups, such as field workers engaged in soil remediation or agriculture.
3. To demonstrate and document that occupational and/or public exposures to plutonium in the Marshall Islands are below levels that will impact on human health.
4. To ensure that the LLNL Marshall Islands Plutonium Bioassay Program meets all applicable quality requirements through the use of standardized procedures and performance testing.
5. To document and test the reliability of using environmental data to assess human exposure (and uptake) to plutonium in coral atoll ecosystems, and predict future change in conditions.

What do the LLNL results show? We have performed several hundred analyses of plutonium in bioassay samples collected from

the Marshall Islands. The low-level detection sensitivity of the AMS measurement system coupled with the demonstrated quality and reliability of the data (Hamilton et al., 2004) allows us to make several definitive statements about the exposure and uptake of plutonium in the Marshall Islands. This work has very important implications because historical efforts to characterize urinary excretion rates of plutonium in the Marshall Islands were not consistent with predictive dose assessments based on environmental data and was suggestive some islanders had acquired elevated levels of plutonium in their bodies.

By comparison, our studies based on AMS measurements show consistently low-levels of urinary excretion of plutonium from residents and workers from different atolls, and across different age groups. The amount of plutonium estimated in the body of Marshall Islanders was found to be no different to what we might expect to find in the general population living in the Northern Hemisphere. If anything, the urinary excretion of plutonium (mean rate ~0.1 μBq Plutonium-239 per 24-h void) is actually lower than what some health physicists predict to be present

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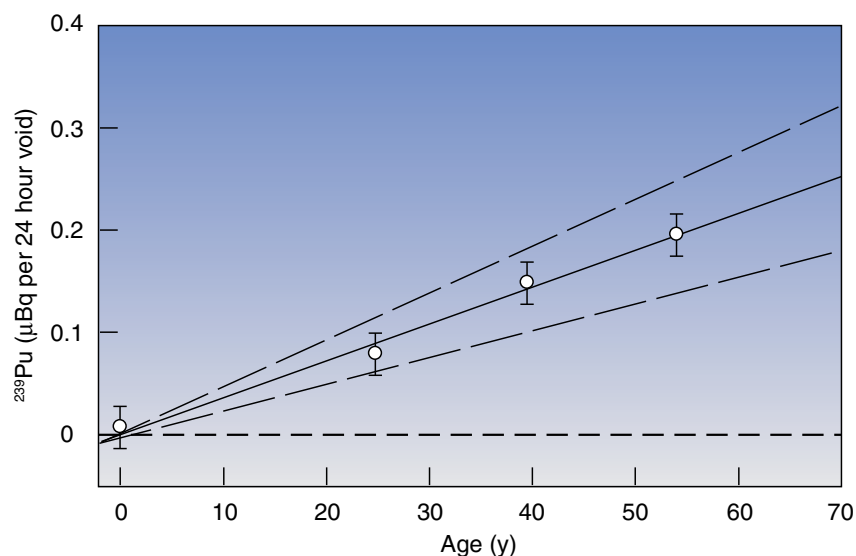


Figure 2. Urinary excretion of plutonium-239 on Enewetak Atoll. Urinary excretion of plutonium has a significant positive association with age as assessed by weighted linear regression using inverse-square measurement errors as weights, with data binned into three age groups: <35, 35 to 44 and ≥ 45 years old compared to pooled field blank ($n = 62$). Plot shows estimated linear fit (solid line) and corresponding 95% confidence limits (long-dashed lines), conditional on intercepts = 0; short dashed line = 0 μBq per 24-h void.

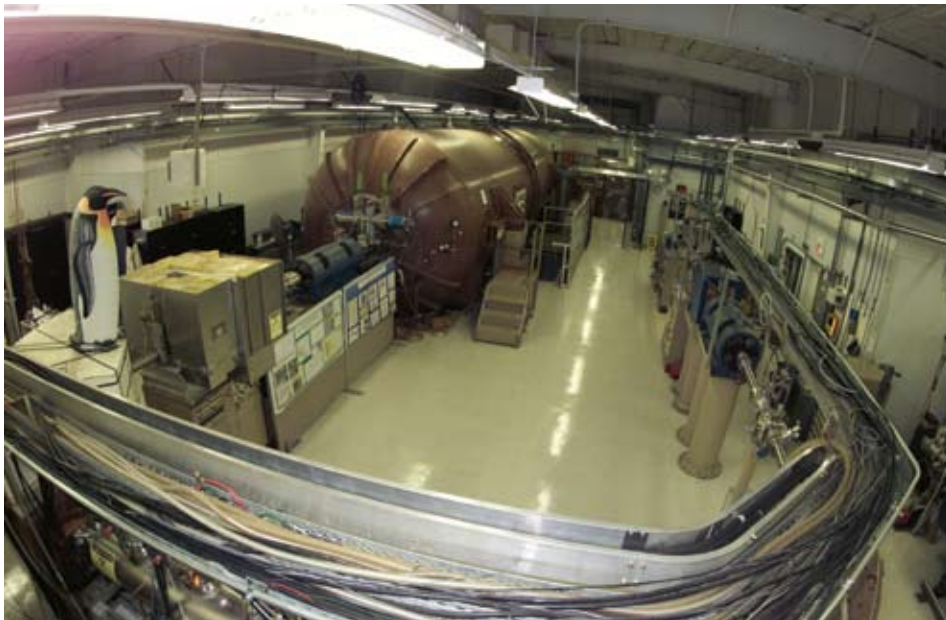


Figure 3. The HVEC Model FN Tandem Van de Graaff accelerator operated by the Center for Accelerator Mass Spectrometry (CAMS) at the Lawrence Livermore National Laboratory (LLNL). The CAMS facility at LLNL is one of the most versatile and productive AMS systems in the world.

as a normal background concentration from exposure to worldwide global fallout deposition. The associated average annual dose contribution from Plutonium-239 + Plutonium-240 is 50 μrem (or 0.05 mrem) or less than 0.03% of the natural background dose in the Marshall Islands. Plutonium has a relatively long biological half-life of 20 to 50 years whereby the systemic plutonium acquired from previous exposures will be very slowly removed from the body with a long-term excretion coefficient of about 2×10^{-5} of the systemic burden per day. The improved sensitivity of plutonium bioassay based on AMS provides a *reachback* capability where we can now review and potentially reconstruct doses from previous exposures to plutonium. Such measurements provide a basis for assessing the quality and reliability of historical plutonium bioassay data from the Marshall Islands, and could be used to evaluate claims that some Marshallese population groups were inadvertently exposed to high levels of plutonium as part of early resettlement of the northern Marshall Islands.

Interestingly, our recent studies of plutonium urinary excretion from selected Marshallese

population groups show a statistically significant positive association with the age of the volunteers (Bogen et al., 2006) (Figure 2). While the doses remain inconsequential to human health, these findings suggest that there is a very slow chronic buildup of internally deposited plutonium in the body of our program participants. A manuscript describing the details of the plutonium bioassay program on Enewetak Atoll is being prepared for publication in the peer review scientific literature.

*Dr. Terry Hamilton,
Lawrence Livermore National Laboratory*

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About the Authors



Terry F. Hamilton, PhD

Dr. Hamilton received his doctorate from the University of Melbourne, Australia, in 1987 and earned undergraduate degrees in chemistry and applied science. He served as a postdoctoral researcher at Flinders University of South Australia before joining the United Nations (1988-95) as a Group Leader in the International Atomic Energy Agency's Monaco Laboratory (IAEA-MEL).

In 1996, Dr. Hamilton joined the Lawrence Livermore National Laboratory under the UC Berkeley Scholar Program and has held positions as the Deputy Director of the Marshall Islands Program, as Group Leader of Environmental Measurements and Characterization Group—Health and Ecological Assessments Division, and as Deputy Division Leader of the Environmental Science Division. Dr. Hamilton has over 20 years of international experience solving problems related to the health and ecological impacts of radionuclide releases to the environment. He has been involved in studies in the Russian Arctic, Mediterranean Sea, Adriatic Sea, Sea of Japan, and at test sites in the Aleutian Islands, in French Polynesia and at the Maralinga test site in South Australia. Dr. Hamilton has multidisciplinary expertise in the fields of marine and terrestrial radioecology, health physics, radiochemistry and in studies on the fate and transport of radionuclides using advanced analytical techniques.

Dr. Hamilton is currently serving as the Scientific Director of the Marshall Islands Dose Assessment and Radioecology Program at the Lawrence Livermore National Laboratory.



Local News

Total eclipse of the sun

Marshall Islands experienced a total eclipse of the sun around 3:30 pm on July 22, 2009. Enewetak Atoll fell into darkness as the moon eclipsed the sun. The event lasted about six-and-a-half minutes. The eclipse continued in a southeast direction and tracked over Namu, Ailinglaplap, Namdrik and Jaluit Atolls. Majuro and Kwajalein were on the fringe of the eclipse. Several scientific teams including the University of Hawaii's Institute for Astronomy took up a front seat row and observed the event from Enewetak. For more information, visit http://www.space.com/scienceastronomy/solarsystem/solar_eclipse_view.html.

DOE to relocate office on Majuro

Effective November 1, 2009, the Department of Energy (DOE) will relocate its logistics support office (staffed by Pacific Operations International, Inc.) and Whole Body Counting Facility from Delap to the Robert Reimers Complex at Uliga. The DOE is also exploring, in consultation with the Government of the Republic of the Marshall Islands (GRMI) and the Ministry of Health (MOH), the feasibility of temporarily relocating its Majuro medical clinic to the downtown site until permanent space is found at the Delap hospital complex.

NB: There is general agreement between the DOE and the MOH that ultimately, DOE's Marshall Islands' Special Medical Care Program (SMCP), will be assigned an area for its Majuro clinic within either the next phase of the hospital's construction or the current hospital.

Update from the DOE Special Medical Care Program

Since January 1, 2009, the medical management of the DOE's Marshall Islands' Special Medical Care Program (SMCP), an activity originally mandated by the U.S. Congress, is being implemented by Comprehensive Health Services, Inc (CHS). CHS, founded in 1975, is a leading provider of employee health care in the U.S and abroad, and is fortified by a strong, base of best, health practices, with over thirty years of experience. CHS is considered to be the only major, health care company with a three-fold, service delivery capability: one, to implement programs of a sizable scale and time; two, to meet an employer's unique health needs; and three, to call upon a national network of medical clinics composed of highly qualified, health professionals and "readiness teams" that can be deployed almost anywhere in the world, on an as-needed basis. These capabilities make CHS uniquely-qualified to reach out DOE's widely scattered, eligible patient population of the Marshall Islands, now found throughout the RMI, Hawaii, and seven, other, very dispersed states within the continental United States (i.e., CONUS).

Earlier this year, CHS encountered a major setback when its long time and well-renowned Medical Director, Dr. Bud Ferguson, suddenly passed away. Dr. Ferguson had been instrumental in establishing and administering the CONUS portion of the SMCP under a sub-contract with PHRI, a predecessor, medical program, management group. Hence, in May of this year, Dr. Fatima Phillips, an Occupational Health Specialist M.D. hired by CHS to develop program policies, procedures, and services' modules for its U.S. and world-wide contracts within the 'Occ-Med' arena, was assigned, in addition to her other duties, as interim director of the SMCP. Recently, these duties have devolved to Dr. Michael Laughery, CHS' present Physician-in-Charge (PIC) of the SMCP.

Dr. Laughery, a graduate of the United States Air Force Academy, and licensed in both the fields of Aerospace Medicine and of Occupational Medicine, has more than fifteen-years of medical and related, management experience. He also has additional medical training

and a background in Surgery, Public Health, Tropical Medicine, and Emergency Medical Service (EMS). He has administered government-type, medical and health contracts for CHS in the past and is a published author on the subject of RADIO FREQUENCY RADATION EXPOSURE IN AIR CREW MEMBERS. His primary functions for the SMCP will be to provide medical oversight of the program, support the doctors located in the Marshall Islands, monitor the annual examination and patient referral/treatment processes, and conduct the on-going, quality-assurance aspects of the program. He also will oversee the exam and treatment activities provided to the Marshall-ese patients residing in the U.S.

The goal of the SMCP remains the same, which is to efficiently and effectively implement a medical program that provides annual Comprehensive Medical Screenings to detect and treat tumors for people of the Republic of Marshall Islands (RMI), more specifically those from the atolls of Rongelap and Utrok who were exposed to the nuclear weapons test that was code-named Bravo on March 1, 1954.

The program has two main clinics in the Marshall Islands. One is in Majuro with Dr. Gael Lavina as its Chief Medical Officer and Hemiko Bingham as the nurse. The other clinic is at Kwajalein with Dr. Tom Jack, Chief of Staff, Ebeye Hospital, as the SMCP physician and Bonnita Patrick as the program nurse. CHS also provides specialized consultants as part of the program to provide specialized care in the area of Endocrinology (Thyroid, Diabetes, etc).

CHS also has a nurse case manager in Hawaii, Amanda Opoku-Boachie, who works closely with the CHS team and the program physicians so that patient referrals are closely managed. As the new Chief Medical Officer, Dr. Lavina, is committed to the best possible care for the patients in the program and in order to accomplish this goal the following has been initiated. The entire medical program is being re-evaluated by CHS and CHRISTUS-Sphon in terms of timeliness of examinations and follow-ups, completeness of care, home visits for patient not just those that are homebound, but also those that are not, so that we can learn more about the individual environments of our patient which will help us provide better care. CHS and CHRISTUS-Sphon will also focus on the overall effectiveness and efficiency of the program.

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Medical Care Program

A commitment was made at the Annual DOE/RMI Meeting during June 2009, that with the new contract, a New Beginning was dawning, with the main emphasis being placed upon

improved services to the patients, wherever they are located, to the greatest extent possible under the DOE's existing law governing the program. It is also important to note that logistical support to the SMCVP is facilitated and arranged for CHS through a CHRISTUS-Spohn sub-contract with Pacific Operations

International, Inc. (POII) of Honolulu and the Marshall Islands.

*Mr. William Jackson
Program Manager
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H1N1 vaccine update

H1N1 influenza is a new virus in humans. To date, it has mainly caused mild illness. But because it is a new virus, health officials are closely monitoring the severity of illness. Even though the H1N1 virus has not produced severe illness in most people, it is

still important that people take steps to help slow the spread of the disease.

The novel H1N1 vaccine is expected to be available in the fall. The seasonal flu vaccine is not expected to protect against the novel H1N1 flu. It is anticipated that seasonal flu and novel H1N1 vaccines may be administered on the same day. For protective

immunity to H1N1, a series of two shots, given 2 – 3 weeks apart will be required with full immunity coming about a week after the second shot.

CDC has recommended that certain high risk groups receive the novel H1N1 vaccine when it first becomes available. They include pregnant women, people who live with or care for children younger than 6 months of age, healthcare and emergency medical services personnel, persons between the ages of 6 months and 24 years old, and people ages of 25 through 64 years of age who are at higher risk for novel H1N1 because of chronic health disorders or compromised immune systems.

Because a H1N1 vaccine is not yet available, health officials continue to emphasize the importance of preventive measures, such as frequent hand washing with hand sanitizer and staying away from the workplace when experiencing flu symptoms.

For CDC updates on the H1N1 vaccine: http://www.cdc.gov/h1n1flu/vaccination/public/vaccination_qa_pub.htm

Marshall Islands hosts DOE-RMI Annual Program Meeting in Majuro

MAJURO (June 2009) – The U.S. Department of Energy formally introduced its new team as part of the DOE-RMI annual program meeting held in Majuro on 17-18 June. The welcoming address was conducted by the newly appointed Foreign Minister for the Republic of the Marshall Islands, Mr. John Silk. The U.S. Department of Energy was represented by Dr. Patricia Worthington, Director-Office of Health and Safety, and Marshall Islands Program Manager, Mr. William (Bill) Jackson. Other participants included Senators, Mayors and representatives from each of the affected atolls along with Dr. Terry Hamilton from the Lawrence Livermore National Laboratory, Mr. Paul Gaden, Program Director/Prime Contract Manager from CHRISTUS-Spohn Health System Foundation (CSHSF), Mr. Gary Palmer, Executive Vice President, Comprehensive Health Services (CHS) and his team including interim Physician-in-Charge, Dr. Fatima Phillips, Chief Medical Officer, Dr. Gael Lavina, and Dr. Tom Jack, Chief of Staff at Ebeye Hospital and Medical Officer/Kwajalein for the SMCP. The Pacific Operations International Inc. logistics group was represented by its Business Manager, Ms. Michelle Yamaguchi and its Operations Manager, Mr. Lance Yamaguchi. This meeting laid the foundation for a more integrated approach to providing quality health care and environmental programs under the DOE Marshall Islands Program.



Bring Star Power to Earth

A new video recently posted on YouTube features the National Ignition Facility (NIF) located at the Lawrence Livermore National Laboratory in Livermore, California. This newly constructed facility contains the world's largest and highest energy laser system. Containing 192 laser beams and occupying a space around the size of 3 football fields, NIF will attempt to harness the same power found in the stars and sun, and explore the use of controlled nuclear fusion to help ensure global security, enable sustainable clean energy, and advance our understanding of the universe. View video at <http://www.youtube.com/watch?v=yixhyPN0r3g>

Did you know?

Pakistan reportedly enhancing its atomic weapon capabilities

WASHINGTON (Press Trust of India). Pakistan is enhancing its atomic weapon capabilities across the board by developing and deploying new nuclear-capable missiles and expanding its capacity to produce fissile material, two U.S. experts have said, estimating Islamabad has an arsenal of 70-90 warheads. In an article published in the latest issue of "Bulletin of the Atomic Scientist," Robert S. Norris and Hans Kristensen estimate that Pakistan's nuclear stockpile has jumped to an estimated 70-90 warheads from a previous figure of 60.

"A new nuclear-capable ballistic missile is being readied for deployment, and two nuclear capable cruise missiles are under development. Two new plutonium production reactors and a second chemical separation facility also are under construction," Norris and Kristensen wrote. However they agree that it is exceedingly difficult to estimate precisely how many nuclear weapons Pakistan has produced, how many are deployed, and of what types.

Obese get higher doses of radiation for x rays

(HealthDay News) – People who are overweight and obese are usually given higher-than-normal doses of radiation in order to obtain usable X-ray images, even though the long-term effects are unknown, new research contends.

"You need to get a certain amount of X-rays to go through the body in order to get an informative image, and excess weight impedes that," explained the study's lead author, Jacquelyn C. Yanch, a professor at the Massachusetts Institute of Technology in Boston. "And there are very few ways around that problem, other than increasing an overweight patient's exposure to radiation to improve the image quality." The findings from this study will appear in the July issue of Radiology.

Death Rays From Space: How Bad Are They

(softpedia.com) Cosmic radiations permeate everything around us at all times of the day.

Some of them are generated near us, on a radius of a few thousand light-years, while some only reach our planet after a ten-to 11-billion-year journey. They are unnoticeable to humans, but some researchers believe they may have played a crucial role in the development of life on Earth, and maybe even in some extinction events. "Some of the mass extinctions identified in the fossil record can be linked to an asteroid impact or increased volcanism, but many of the causes of those ancient die-offs are still open for debate", writes Michael Schirber, Astrobiology Magazine. However, astronomers almost unanimously agree that, if a supernova was to explode within a few light-years from our solar system, then the amount of emitted radiation would be enough to wipe out, directly or indirectly, a significant number of species.

Confused by SPF? Take a number

(New York Times) -- A sunscreen's SPF measures how much the product shields the sun's shorter-wave ultraviolet B rays, known as UVB radiation, which can cause sunburn. These days, a race is on among sunscreen makers to create the highest SPF that R&D can buy. A sunscreen's SPF number is calculated by comparing the time needed for a person to burn unprotected with how long it takes for that person to burn wearing sunscreen. So a person who turns red after 20 minutes of unprotected sun exposure is theoretically protected 15 times longer if they adequately apply SPF 15. If adequately applied, sunscreens with sky-high SPFs offer slightly better protection against lobster-red burns than an SPF 30. But they don't necessarily offer stellar protection against the more deeply penetrating ultraviolet A radiation, or so-called aging rays. What's more, both UVA and UVB radiation can lead to skin cancer, which is why dermatologists now advise using sunscreens with an SPF of at least 15 and look for UVA-fighting ingredients like Mexoryl SX, titanium dioxide or an avobenzene that doesn't degrade in light.

Wine may help cancer therapy patients

ROME (Reuters Life!) – A glass of wine a day may help breast cancer patients better tolerate radiation therapy and reduce its adverse effects, according to a new study by an Italian medical university. The study said polyphenols found in wine may help protect healthy tissues from the effects of radiation while combating cancerous cells. The full study is due to be published online in the International Journal of Radiation Oncology Biology Physics (<http://www.redjournal.org/>).

Are cell phones safe? Experts debate risks

(chicagotribune.com) – Cells phones release a small amount of microwave radiation when they are in use. Some researchers believe this form of radiation exposure may be harmful to human health.

Others aren't concerned about any risk. "There is more smoke than fire here," said Dr. Michael Thun, vice president emeritus of epidemiology and surveillance research for the American Cancer Institute. "The radio frequency that comes from a cell phone is half-way between a microwave oven and an FM radio. It's non-ionizing radiation, which doesn't change DNA and lead to cancer, and there has been no increase in brain cancer."

Recently, the topic has received much more attention in the United States and internationally through the World Health Organization. About 4 billion people in the world use cell phones, including more than 250 million Americans. There's evidence to support both sides of the argument. The United Kingdom, Sweden, France, Israel, Germany and Finland have issued warnings to citizens about a potential link between cell phone radiation and brain tumors, and damage to the blood-brain barrier. Earlier this year, Swedish researchers found the highest risk of brain tumors among people who started using cell phones during adolescence. And multiple studies reported young children's brains absorb more radiation than adults, making them more susceptible to brain tumors (<http://www.chicagotribune.com/topic/sfl-cell-phone-risks-091609,0,2199485.story/>).

Calendar of Events



MARSHALL ISLANDS PROGRAM

July-August 2009

Lawrence Livermore National Laboratory to conduct a mission to Rongelap Atoll to develop updated radiological data on pantry islands, and develop an experimental garden project to assess the uptake of fission products (Cesium-137 and Strontium-90) in leafy vegetables and other root crops.

October-November 2009

Lawrence Livermore National Laboratory to conduct an exploratory mission to Utrok Atoll to assess the condition of tree-crop products for sampling and analysis, and develop plans to establish an experimental garden plot to assess the uptake of fission products (Cesium-137 and Strontium-90) in leafy vegetables and other root crops.

RECENT STAFF PUBLICATIONS

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