Lawrence Livermore National Laboratory

July 2010 -- Volume 2, Numbers 1 & 2

MARSHALL ISLANDS RADIOLOGICAL SURVEILLANCE GROUP

BIKINI • ENEWETAK • RONGELAP • UTROK

MARSHALL ISLANDS MONITOR

Inside this issue

Photo of newly constructed homes on Rongelap. "Rongelap by Night" taken by Terry Hamilton.

A note from the editor

This newsletter is sponsored by the U.S. Department of Energy and provides a forum for the rapid exchange of findings and information related to continuing environmental and medical programs in the Marshall Islands.

Each issued includes a feature article dealing with the broader aspects of the consequences of the nuclear test program that took place in the Marshall Islands from 1946 to 1958.

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 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

Questions and Answers:

Consequences of the Nuclear Weapons Testing Program in the Northern Marshall Islands

The following questions and answers were formulated in response to misinformation that has been circulated about radiological conditions in the Marshall Islands with a general focus on resettlement of Rongelap Atoll. In some instances we include answers to questions received from the media. We also provide responses to some outdated and potentially misleading information presented during formal hearings on the long-term consequences of the nuclear weapons testing program in the Marshall Islands. The science and language of radiation are difficult enough for the general public to understand yet alone to be confused by conflicting advice from different authorities, environmental groups and/or resident scientists.
The simple truth is that under the provisions of the resettlement program, radiological conditions on Rongelap Island will meet all reasonable and applicable national and international standards for public safety. There is simply no reason under a common system of radiological protection why Rongelap resettlement cannot occur. However, from an individual or societal perspective, a decision to resettle should always be based on a consensus opinion from stakeholders with due consideration for fulfillment of all possible domains whether that be based on health, environment, economic, social, psychological, cultural or political outcomes or, from a practical point of view, on some combination of all these outcomes. Under this scenario, a final decision to resettle should prescribe to producing 'more good than harm'.

Ultimately it will be up to the people of Rongelap and its leadership to make a decision about resettlement. However, when people of influence make false and misleading public statements it understandably adds element of confusion and distrust in the resettlement process. This type of information is often echoed by the local press and immediately takes on added truth or meaning. What is clear in this case is that much of the negative sentiment circulated on Rongelap resettlement comes from outdated sources or from people who either had a poor understanding of the science or present-day exposure conditions on Rongelap, were not properly informed about formal agreements between Rongelap Atoll Local Government (RALGov) and the DOE on the roles and responsibilities of each organization, and/or had an alternative or hidden agenda. The truth is that unless the full story is told and can be heard without bias then a grave injustice may be bestowed upon the people of Rongelap. Many of us who have worked closely with the Rongelap leadership and the community, and their scientist advisors, over the years would like to see progress in building a brighter future for this community. A well structured resettlement program may provide such an avenue and ultimately improve the general well-being of this small atoll population group. It should be said that misleading public statements on resettlement that are not supported by relevant data are confusing and could potentially lead to further delays or total disbandment of the resettlement program. Under these circumstances, more harm may be caused to the very people that we are all trying to help and protect.

What may appear as a surprise to many of our readers is that Rongelap resettlement may actually lead to real tangible and measureable health benefits to the community, especially where the local government can provide more spacious housing and a clean supply of fresh drinking water, and generally improve food security by establishing a replanting program.

Continued on next page

Continued from previous page
Q & A

Overcrowding and water-borne illnesses are two major health problems in the Marshall Islands. There are also very few breadfruit and papaya trees (as well as other fruiting plants such as banana) growing on Rongelap, and most of the existing coconut trees are overly tall and unproductive.

On the other hand, the health detriment caused by estimated levels of radiation exposure on Rongelap is purely speculative in nature where risks factors are derived from model assumptions and extrapolated to very low doses and low dose rates. The average avertable health risk from exposure to fallout contamination in the environment at Rongelap represents about 1.5 % of the lifetime fatal cancer rate caused by exposure to natural background radiation in the Marshall Islands, and will have no discernible or measureable consequence on human health. Also, the health risk posed by the sum of the natural background radiation and the nuclear test-related doses at Rongelap will on average almost certainly be much less than that experienced by people living in Europe and the United States from exposure to natural background radiation. The bottom-line is that people who resettle Rongelap will be exposed to less radiation than most people living in other parts of the world.

Note: To comply with international convention, the unit of dose used in the proceeding discussion is given in millisievert (mSv). Many of our readers are more familiar with the use of conventional dose units in millirem (mrem) as traditionally used by U.S. regulatory authorities. 1 mSv is equal to 100 mrem.

Terry Hamilton
Editor in Chief
Marshall Islands Monitor

Question: From your point of view, do you consider it safe to resettle Bikini and Rongelap at the moment? Under which circumstances would you consider resettlement safe? What is the current level of cesium-137 at Bikini, Rongelap, Enewetak and Utrōk Atolls?

Response: The main fallout radionuclide of concern in the Marshall Islands is radiocesium (cesium-137). Cesium-137 accounts for about 90-95% of the estimated radiation dose from exposure to residual fallout contamination in the environment. The main contribution comes from ingestion of cesium-137 contained in locally grown foods such as coconut, breadfruit and Pandanus, and from exposure to residual cesium-137 contamination in soil in areas that people occupy. Internally deposited radioactive material may cause an internal radiation dose to the whole body or other organ or tissue whereas radiation emitted from sources outside the body may irradiate the whole body, an extremity, or other organ or tissue resulting in an external radiation dose. Levels of cesium-137 contamination in soils and plants across Bikini, Enewetak and Rongelap Atolls are highly variable so questions about safety and resettlement are best answered on the basis of comparing predictive dose estimates under standardized living patterns on the main residence islands with national and international standards for radiological protection of the public.

The most widely used standards for radiological protection of the public come from the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). Both these agencies recommend restricting the annual effective dose above background to less than 1 mSv per year. Each agency allows for optimization of protection so that any criteria used to limit dose and minimize risks should be viewed more as guidance rather than a hard compliance standard. This approach is consistent with language now used by the ICRP in providing guidance on protection of the general public from radiation exposure. The Commission has come out with specific recommendations for protection of people living in long-term contaminated areas after a nuclear accident or a radiation emergency, and established a reference level for the optimization of protection 'in the lower part of the 1-20 mSv per year band' (ICRP Report 111, 2009). By comparison, the Government of the Marshall Islands has adopted a more restrictive cleanup standard of 0.15 mSv per year based on guidance from the U.S. Environmental Protection Agency (EPA) for cleanup of Superfund sites in the United States.

In general, Livermore scientists support the decision to resettle Bikini and Rongelap Atolls where local governments implement the Laboratory's recommendations on remediation, and establish a long-term radiological surveillance program to monitor the return of the population. The monitoring program is needed to provide added assurances to communities that radiological conditions remain at or below prescribed standards in health and safety. The recommended remediation program involves using the 'combined option' remedial strategy whereby potassium fertilizer is applied to agricultural areas to reduce the uptake of cesium-137 into locally grown foods, and thus to people consuming the produce. Secondly, for surface soil to be removed around housing and village areas and replaced with clean crushed coral fill to help reduce exposure to radiation coming from residual cesium-137 contaminatin in the surrounding soil.

Continued on next page

Continued from previous page
Q & A

These recommendations would also apply to Enjebi Island at Enewetak, a former residence island for the dri-Enjebi people of Enewetak Atoll.

One additional factor in helping establish a strong scientific basis for early resettlement of islands and atolls comes from our improved understanding of the behavior of cesium-137 in coral soils. Cesium-137 is effectively being washed out of the soil by the action of rainfall and is no longer available for uptake into plants. It has been clearly demonstrated that the environmental half-life (loss rate) of cesium-137 in locally grown tree-crops in the northern Marshall Islands is around 12 years. The effective half-life for cesium-137 (environmental loss + radiological decay) in coral soil is around 8.5 years so we can clearly state that conditions at Bikini, Rongelap and Enewetak are improving at an accelerated rate compared with early predictive dose estimates based on the radiological properties of cesium-137 alone.

Using the effective half-life of cesium-137, full implementation of the combined option remedial strategy and a diet of imported and local foods, the annual effective dose for resettlement of Rongelap Island at Rongelap Atoll, Bikini Island at Bikini Atoll, and Enjebi Island at Enewetak Atoll in 2012 will be 0.03, 0.17 and 0.08 mSv per year, respectively. In all cases, estimated doses fall well below the 1 mSv per year ICRP optimization level to protect people living in long-term contaminated areas. The estimated natural background dose plus the nuclear test-related dose (or total radiation dose) at Bikini, Rongelap and Enjebi Islands, is less for each of the islands than the average background radiation dose in the U.S. and Europe. These data should provide an important comparative measure for making decisions on resettlement.

Question: What is different about radiation doses to people living on Rongelap Island in 1985 versus living on Rongelap Island in 2011?

Response: The Rongelap community relocated from Rongelap Atoll in 1985 to an extended temporary residence on Mejatto Island at Kwajalein Atoll. The Rongelap Atoll Local Government (RALGov) are actively seeking assurances and assistance from U.S. government agencies such as the Department of Energy (DOE) to help structure a safe, sustainable and publically acceptable resettlement program so the community can finally return to their ancestral homeland and central place of residence on Rongelap Island. Scientific studies conducted at Rongelap over recent years have clearly shown that Rongelap resettlement is a safe and viable option, especially where cleanup measures are implemented to help minimize levels of radiation exposure. Estimated doses from exposure to residual fallout contamination in the environment under normal living conditions at Rongelap already fall far below the most widely accepted safety standard of 1 mSv per year used to protect members of the public from man-made sources of radiation. Any additional cleanup measures at Rongelap will serve to provide additional assurances for the overall safety and sustainability of resettlement.

What is important to first understand is that radiation exposure conditions at Rongelap have changed dramatically since the Bravo event, and are much lower now than in 1985 when the people of Rongelap entered into self-imposed exile. The emotional debate about levels of radiation exposure experienced by Bravo evacuees is often carried into present-day decisions on resettlement when in fact we are talking about very different circumstances, and very different sets of exposure pathways and radionuclides. The major nuclear test-related dose delivered to Bravo evacuees came in the form of an acute (all at once) dose to whole body and thyroid gland from internal (largely ingestion) and external exposure to fresh fallout debris containing short-lived radioactive elements such as radioiodine (e.g., Iodine-131). Short-lived radionuclides such as Iodine-131 have long since decayed away to harmless elements.

Following from discussion in the preceding section, over 90% of the estimated test-related dose at Rongelap is delivered by chronic (spread out over time) exposure to residual cesium-137 contained in the soil and locally grown foods. External exposure to cesium-137 gamma radiation (similar to X-rays) coming from the underlying soil accounts for about 10-15% of the dose, and ingestion of cesium-137 from consumption of locally grown tree-crop food products such as coconut, Pandanus, breadfruit, and papaya accounts for the other 80 to 85 % of the dose.

The estimated nuclear test-related dose for full time residency on Rongelap Island in 1985 was about 0.3 mSv per year based on a mixed diet containing imported and local foods. For perspective, the estimated annual background dose in the Marshall Islands from natural sources of radiation in the environment is about six times higher or about 1.9 mSv per year. Since 1985, radioecology experiments at the atolls have shown that rainfall slowly removes cesium-137 from the coral soil into the underlying ground water where it is then

Continued on next page

Continued from previous page
Q & A

dispersed into the ocean. As previously discussed, the effective half-life of cesium-137 (the combined loss rate by radioactive decay and by environmental processes) is about 8.5 years. This natural process is helping reduce levels of radiation exposure at Rongelap at a much faster pace than what scientists originally envisaged. In fact, levels of radiation exposure are now about 8 to 10 times lower that in 1985 when the community moved off Rongelap because of growing concerns about the possible long-term health impacts of radiation exposure. The simple fact that radiological exposure conditions at Rongelap are already much lower now than in the past will hopefully build renewed interest and confidence in the resettlement process.

Additionally, other experiments show that when 2000 kg of potassium per hectare is spread on the soil surface and subsequently dissolved by rainfall it is taken up by plant roots into the trees. It is estimated that the amount of cesium-137 in tree food crops such as coconut growing on Rongelap Island will be reduced to about 30% of their current concentration. The potassium addition also helps reduce soil-plant transfer of cesium-137 into locally grown garden vegetables and grain crops, and provides the added benefit of greatly improving the productivity of plants. Official testimony presented this past May references a statement that "a radiological expert for the people of Rongelap Atoll reported that a 1 mSv dose limit would be exceeded based on a local food only diet, if potassium fertilizer were not repeatedly applied". The long-term remediation experiments conducted on Bikini Island clearly show that the potassium treatment remains effective for at least a decade and possibly much longer. Thus, potassium does not have to be applied repeatedly to food crop trees at Rongelap, i.e., a one-time application of 2000 kg per hectare of potassium should provide adequate protection of human health through until such time that it will no longer be any measureable benefit (other than to improve the productivity of plants) to apply additional potassium to lower dietary intakes of cesium-137.

As previously discussed, by incorporating the combined effects of the effective loss rate of cesium-137 in the environment and after full implementation of proposed cleanup measures, we estimate that the dose to people living on Rongelap in 2012 who consume a mixed diet of local and imported foods will be around 0.03 mSv per year. These conditions satisfy national and international standards commonly used to protect the public from radiation exposure including the very restrictive cleanup dose criterion of 0.15 mSv per year adopted by the Republic of the Marshall Islands based on recommendations from the Marshall Islands Nuclear Claims Tribunal (NCT).

Scientists from LLNL have also implemented and maintained a radiological surveillance monitoring program on Rongelap Island since early 1999. The monitoring program is based on whole body counting of internally deposited cesium-137. Whole body counting of the workers (and future residents) provides an accurate and direct measure of how much cesium-137 (the main dose contributor) people have acquired in their bodies independent of any dietary assumptions that are typically used in predictive (modeled) dose assessments. These direct measurements and information also support the view that Rongelap is safe for resettlement. Moreover, LLNL scientists will continue to monitor the environment to assess and predict future change in radiological conditions, and ensure that Rongelap remains safe.

Question: Were the Rongelap people used as guinea pigs for studies of radiation induced genetic effects?

Response: Testimony presented at official hearings on the Marshall Islands this past May include references to a statement made in 1956 about the Bravo evacuees from Rongelap.

"This is an ideal situation to make your genetic study. It is far more significant than anything you could ever get out of Hiroshima and Nagasaki."

The U.S. Advisory Committee on Human Radiation Experiments issued a report in 1995 stating that the committee "found no evidence to support the claim that the exposures of the Marshallese, either initially or after resettlement, were motivated by research purposes". The basis behind these findings and much of our existing knowledge on the effects of radiation exposure (including genetic effects in humans) stems from studies conducted on Japanese bomb survivors. These studies date back to 1946 when President Harry Truman issued a directive for the United States to undertake a comprehensive study of exposed Japanese populations. The Atomic Bomb Casualty Commission (ABCC) was officially established in March of 1947. Prior to 1956, a wealth of data and information had already been developed on radiation effects based on observation of many thousands of Japanese bomb survivors who received instantaneous (or immediate) doses from a few mGy of prompt gamma radiation to doses in excess of that delivered to Bravo evacuees. In view of the existence of this very large, relevant and directed

Continued on next page

Continued from previous page
Q & A

study on radiation effects, to make claim that the Rongelap evacuees represented an 'ideal situation to make your genetic study' in 1956 yet alone today was then and still is totally unconscionable and, in many respects, somewhat irresponsible given the sensitivities of this subject to the people of the Marshall Islands. Publically accessible information like this is obviously counterproductive to helping the people of Rongelap make an informed decision on resettlement.

One only needs to look at this simple analogy. Even if all 67 Bravo evacuees from Rongelap were alive today, the maximum number of years of risk available for evaluation would be around 500 times less than what is presently available using data from the more than 76,000 people under the Hiroshima and Nagasaki cohort study.

Japanese radiation effects data shows that there is little or no evidence of heritiable genetic effects in humans from radiation exposure. It is therefore very difficult to understand the scientific value or logic behind attempting to use Rongelap Bravo evacuees for this type of study.

Official Comment: "As it now stands, if forced to return to their homeland the Rongelap people could receive radiation doses about 10 times greater than allowed for the public in the United States" (U.S. Congressional Testimony during May 2010, as quoted in the Marshall Islands Journal, July 9 2010).

Response: The current radiological protection standard for the public in the United States is 1.0 mSv per year as recommended by the International Commission on Radiological Protection (ICRP), the U.S. National Council on Radiation Protection and Measurement (NCRP), and the International Atomic Energy Agency (IAEA). This guidance has also been adopted by the U. S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), and Nuclear Regulatory Commission (NRC), most European countries as well as by many other countries around the world.

The population average dose estimated for resettlement of Rongelap Island in 2012 is 0.03 mSv per year or about 30 times less than that allowed for the public in the United States not 10 times greater.

Official Comment: "According to current risks derived by the National Research Council's Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR VII) the external dose received by the people of Rongelap would result in a 100 percent probability of contracting a radiogenic cancer" (U.S. Congressional Testimony during May 2010).

Response: This statement as written is very misleading because it can be inferred as saying there is a 100% chance that the entire population of Bravo evacuees from Rongelap will get cancer.

There were 64 people living on Rongelap Island on March 1, 1954 that received 1.7 Gy of radiation and 18 people on Ailinginae Island received an average of 1.1 Gy. Assuming that Rongelap Bravo evacuees were evenly divided between males and females, the number of cancers estimated using BIER VII data is "zero to 6.2 cases" for solid cancers for the 64 Rongelap Island residents (other than thyroid cancer). For the 18 people on Ailinginae Island the estimate is "zero to 1.0" cases (other than thyroid cancer). The total cases for solid cancers estimated for the Rongelap population is therefore "zero to 7.2 cases". The normal incidence of cancer would lead to 34 cases in this population. The estimate for leukemia for the Rongelap population is 0 to 0.73 cases for the Rongelap residents and 0 to 0.11 cases for the Ailinginae residents for a total estimate of "zero to 0.84" leukemia cases.

Reporter Question: In retrospective, do you consider Rongelap radiologically cleaned up in 1957, when people have been resettled there? Do you consider it as a mistake that the Rongelapese have been sent back?

Response: There was no radiological cleanup of Rongelap Island prior to people resettling in 1957. The United States annual dose standard in 1957 was 5.0 mSv per year. The mean external dose on Rongelap Island in 1958 was 0.057 mR per hour (range 0.047 to 0.067 mR per hour) that translates to a mean dose of around 3.5 mSv per year [range 2.9-4.2 mSv per year] (UWFL-91, Gamma dose rates at Rongelap Atoll, 1954-1963, Edward E. Held, May 1965). Depending on the composition of the diet at that time (that is, how much imported food was available versus consumption of local foods), the total dose could have slightly exceeded 5 mSv per year with a likely maximum around 6.6 mSv per year. For perspective, measureable increases in the incidence of cancer have only been observed in humans at chronic exposure levels above 200 mSv.

Reporter Question: How do you consider contamination of Enewetak, especially near the Cactus Dome?

Response: Cactus crater on Runit Island was used primarily for disposal of contaminated soil and equipment from islands in the northern half of Enewetak Atoll. The major focus for the cleanup program was on plutonium and americium-241 but the soil and debris also contained other fallout

Continued on next page

Continued from previous page
Q & A

radionuclides such as cesium-137 and strontium-90. The crater was capped with concrete, and has subsequently been known as Runit Dome.

Today, the people of Enewetak are mainly concerned about leakage of radioactive waste from beneath Runit Dome into the nearby lagoon water and sediment, and the impact this might have on fish and other marine foods and resources. Extensive environmental studies conducted over the past two decades continue to show that the radionuclide concentrations in lagoon water and sediment, and fish collected in close proximity to the Runit Dome are very similar in range to that observed in samples collected from other parts of the lagoon. Based on these data there appears to be no evidence that Runit Dome is significantly impacting the environment. Moreover, and perhaps most importantly, Livermore scientists have been closely monitoring the people of Enewetak for the past decade using whole body counting of cesium-137 and

Based on these data there appears to be no evidence that Runit Dome is significantly impacting the environment.

plutonium bioassay. There is no evidence of increasing levels of radiation exposure from cesium-137 or plutonium in the local population since construction of the Runit Dome in 1980. Under the individual radiological monitoring program, we estimate that the present-day population average nuclear test-related dose at Enewetak is less than 0.01 mSv per year and support the view of safe and sustainable resettlement of Enewetak Atoll under present-day exposure conditions.

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2009 Summary Results of the Marshall Islands Whole Body Counting Program

Under the auspices of the U.S. Department of Energy (DOE), scientists from the Lawrence Livermore National Laboratory (LLNL) in partnership with local atoll governments in the Marshall Islands along with the support of trained Marshallese technicians have been conducting radiological surveillance monitoring of population groups in the Marshall Islands for well over a decade. There are presently over 3500 registered volunteers contributing to this effort in what has become the largest per-capita public whole body counting program in the world.

The program operates permanent and/or semi-permanent radiological facilities on Enewetak, Majuro and Rongelap Atolls. Each of these facilities maintains a whole body counting system designed to test for the presence of cesium-137 inside peoples' bodies. These tests are performed free of charge. The measurement data developed are then used to compute a 'radiation doses' as a quantitative measure of the harmful effects of radiation exposure on human health. The most widely used standards for radiological protection of the public come from the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). Both these agencies recommend restricting the annual effective dose above background to less than 1 mSv per year [1 mSv is equal to 100 mrem]. The Government of the Republic of the Marshall Islands (GRMI) has adopted a more restrictive cleanup standard of 0.15 mSv per year based on guidance from the U.S. Environmental Protection Agency (EPA) for cleanup of Superfund sites in the United States.

A total of around 1600 individual counts or tests were conducted during 2009 in support of the Marshall Islands individual radiological protection monitoring program. All these results along with estimates of the annual effective dose from internally deposited cesium-137 are available on the LLNL Marshall Islands Program web site (https://marshallislands.llnl.gov/). The annual effective dose contribution from internally deposited cesium-137 for all our program volunteers easily satisfies the national and international annual dose criterion for protection of members of the general public including the more restrictive GRMI standard of 0.15 mSv as adopted by the Marshall Islands Nuclear Claims Tribunal (NCT) for cleanup of radioactively contaminated sites in the Marshall Islands. This is a significant finding because ingestion of cesium-137 is by far the most important pathway for human exposure to residual nuclear test-related fallout contamination in coral atoll ecosystems such as the Marshall Islands.

Continued on next page

Continued from previous page

Summary Results 2009

The average effective dose from internally deposited cesium-137 delivered to residents and workers living on Enewetak, Rongelap and Utrōk Atolls during 2009 was 0.003, 0.012 and 0.011 mSv per year, respectively (Figure 1). The full range in estimated doses varied from 0 to 0.064 mSv per year on Enewetak Atoll, 0 to 0.050 mSv per year on Rongelap Atoll and 0 to 0.051 mSv per year on Utrōk Atoll. As in previous years, we also observed that people living on other northern atolls (most notably on Ailuk, Lipiek, and Mejit Atolls) are more likely to acquire measurable quantities of cesium-137 in their bodies compared with volunteers from the southern atolls (including Majuro). Excluding those residents and workers living on Enewetak, Rongelap and Utrōk Atolls, the average dose from internally deposited cesium-137 delivered to volunteers from the northern and southern atolls was 0.0048 and 0.0009 mSv per year, respectively. As a reminder, the GRMI radiological cleanup standard for contaminated sites is 0.15 mSv per year.

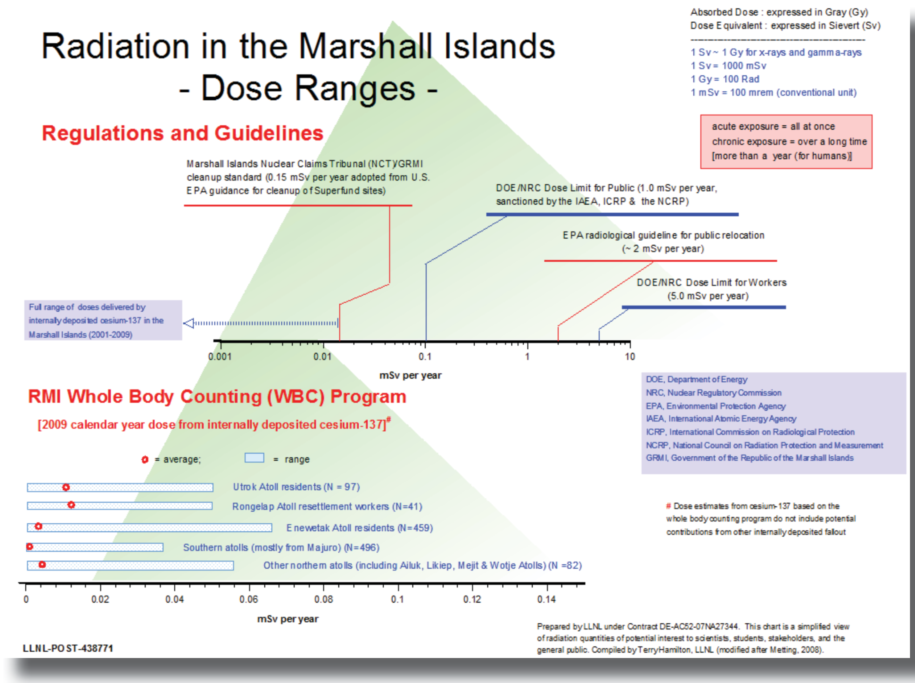


Figure 1. Dose Estimates Based on Measurements of Internally Deposited Cesium-137 in Atoll Populations from the Marshall Islands.

Did you know?

What is a CT scan? How is it used? Should I be concerned about radiation exposure from CT scans?

Computed tomography (CT) is a diagnostic procedure that uses specialized x-ray equipment to obtain cross-sectional pictures of the body. A CT scan can provide a detailed image of organs, bones, and other tissues. CT is used to detect or confirm the presence of a tumor, provide information about the size and location of the tumor, guide a biopsy to remove cells or tissues for examination under a microscope, help plan radiation therapy or surgery, and may be used to determine whether a cancer is responding to treatment.

CT scans are normally performed on an outpatient basis and do not cause any pain apart from the possible discomfort from lying still on a table for extended periods of time. Image times may range fifteen minutes to one hour depending on the size of the area being x-rayed. A contrast agent or "dye' is sometimes administered to the patient by either mouth, injected into a vein, or given by enema in order to help highlight specific areas inside the body.

A spiral (or helical) CT scan may be performed to obtain a 3–dimensional image of specific areas inside the body. During a spiral CT, the x-ray machine rotates continuously around the body, following a spiral path to make cross-sectional pictures of the body. Virtual endoscopy including CT colonography or virtual colonoscopy is a relatively new procedure that uses a type of spiral CT. It allows doctors to see inside organs and other structures without surgery or special instruments, and is under study as a screening technique for colon cancer. A total or whole body CT scan creates images of the entire body—from the chin to below the hips. Positron emission tomography (PET) creates a colored image of chemical changes (metabolic activity) in tissues and, at some specialized facilities, may be combined with CT imaging (PET/CT scan) to produce a better diagnosis of a tumor's location, growth and response to treatment than either test alone.

Radiation exposure from a CT scan can be considerably higher than from a regular x-ray. People should weigh the relative risks and benefits before having a CT scan. Often not having the procedure can be more risky than having it, especially where cancer is suspected. The medical profession is also responding to the need to ensure that CT x-ray machines are properly calibrated and maintained, and that radiologists receive appropriate levels of advanced training. The American College of Radiology does not recommend using total or whole body CT scans for screening purposes on the odd chance of finding signs of disease.

Information about CT scans is available from the American College of Radiology, the National Cancer Institute, and the Radiological Society of North America [http://www.acr.org; http://www.cancer.gov/; http://www.radiologyinfo.org].

Compliance Monitoring Under the Comprehensive Nuclear-Test Ban Treaty

Public concern over atmospheric nuclear weapons testing during the 1950s prompted the U.S. and the Former Soviet Union to enter into a bilateral nuclear test moratorium during 1958. Negotiations also began on a comprehensive ban on nuclear weapons testing in all environments, including the atmosphere, outer space, underwater, and underground. A worldwide network of seismic stations was established for detecting underground nuclear explosions and monitoring for compliance under the moratorium. The test moratorium ended after the Former Soviet Union resumed weapons testing in September 1961. Other countries engaged in nuclear weapons production and testing through this period included France, the United Kingdom, the United States, and the Former Soviet Union.

U.S. President Barack Obama (left) and Russian President Dmitry Medvedev signed the New Strategic Arms Reduction Treaty (New START) on April 8, 2010, in Prague, Czech Republic. (Courtesy of U.S. Department of State and White House; photographer: Chuck Kennedy.)

In the ensuing decades, arms-control negotiations on strategic force levels and nuclear testing led to a number of successful international treaties. The Limited Test Ban Treaty on detonation of nuclear devices in the atmosphere, oceans, and outer space was ratified in 1963. However, both the Former Soviet Union and the U.S. continued to develop extensive underground nuclear weapons test programs. The United Kingdom participated jointly with the U.S. on a number of these underground tests while China entered the nuclear arms race in October 1964 and continued to test atmospheric devices through October 1980. The underground test programs of China and France continued until 1996.

The Threshold Test Ban Treaty was signed by President Richard Nixon and Soviet Secretary Leonid Brezhnev in 1974 but was not ratified by the U.S. until 1990. This treaty called for limiting the yield of underground nuclear explosions to 150 kilotons. For perspective, the nuclear weapon dropped on Hiroshima (Japan) on 5 August, 1945, was 15 kilotons while the estimated yield for the Castle Bravo test conducted on Bikini Atoll in the Marshall Islands was 15,000 kilotons.

Following many years of negotiation, the Comprehensive Nuclear-Test-Ban Treaty (CTBT) was signed by President Bill Clinton and other heads of state on September 24, 1996, at the United Nations. The pact has since been ratified by 153 nations but will not come into force until all 44 nuclear-capable states have signed and ratified the agreement. Of these 44 states, three - India, Pakistan, and North Korea - have not signed the Treaty while six states - China, Egypt, Indonesia, Iran, Israel, and the United States -have signed but not ratified the Treaty. The CTBT is intended to prohibit all nuclear weapon test explosions. India, Pakistan, and North Korea have all conducted underground nuclear tests since the CTBT was signed. The U.S. stopped testing of nuclear weapons in 1992.

On a related subject, the Strategic Arms Reduction Treaty (START), a bilateral treaty between the U.S. and the Former Soviet Union, was signed in 1991. START entered into force in 1994 through negotiations with former Soviet republics after the Soviet Union dissolved. It succeeded the Strategic Arms Limitation Treaty I and II. START barred its signatories from deploying more than 6,000 nuclear warheads atop a total of 1,600 intercontinental ballistic missiles, submarine-launched ballistic missiles, and bombers. The START treaty expired in December 2009. U.S. President Barack Obama and Russian President Dmitry Medvedev signed a new START treaty during April 2010 which further reduces the number of strategic delivery vehicles by more than half and deployed warheads by three-quarters. This agreement will enter into force after the two countries' legislatures ratify it.

Science and scientists have played a critical role in supporting the development of agreements on international and bilateral treaties governing weapons of mass destruction, especially in relation to monitoring worldwide compliance, providing expertise for on-site inspections and related

Continued on next page

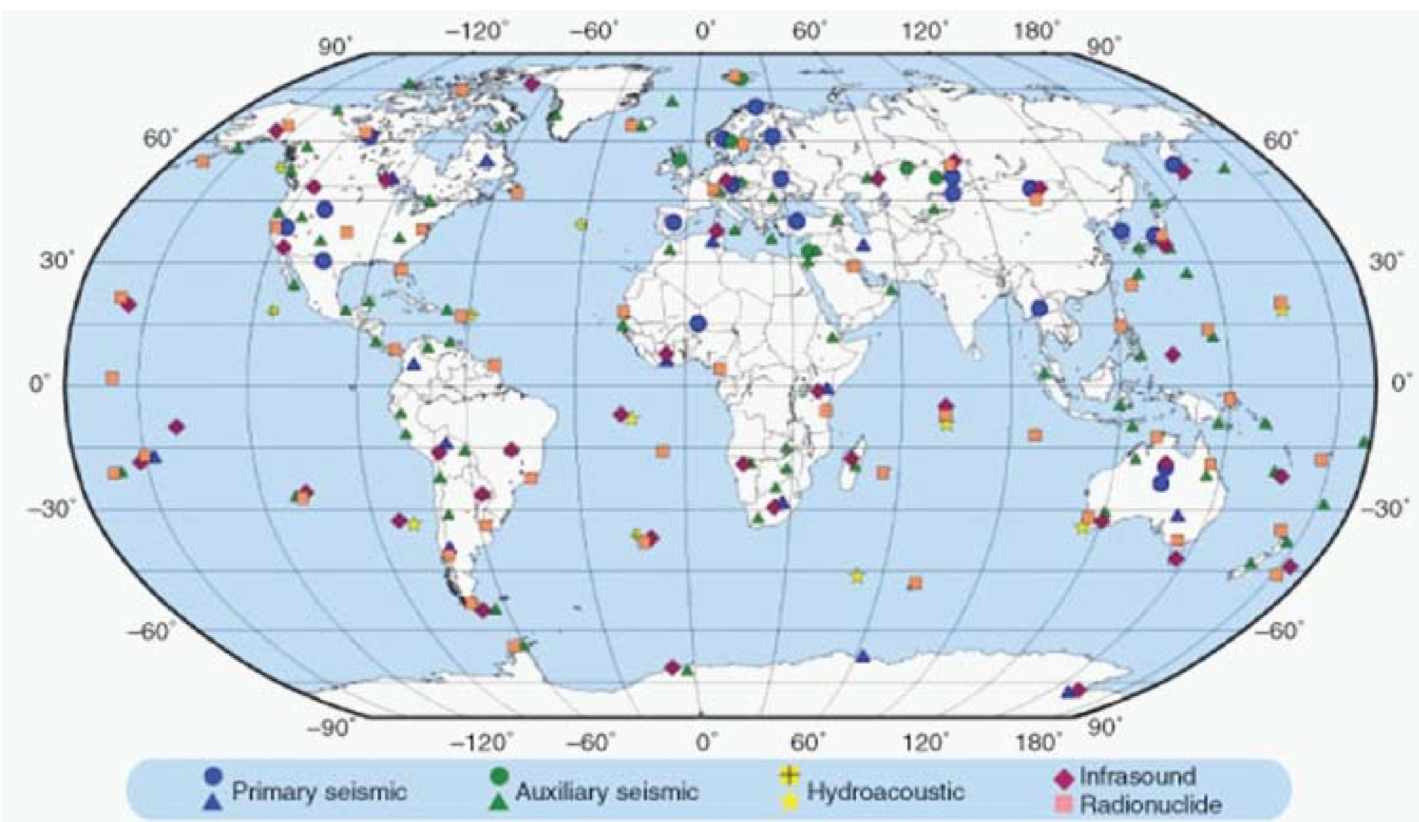
Continued from previous page
Comprehensive Nuclear Test Ban Treaty

technologies, and analyzing the possible effects of a treaty's provisions on national security.

"Indeed, the strength of treaties and arms reduction agreements rests, in large part, on the technical capabilities available for monitoring compliance" writes Arnie Heller in a recent issue of S&T Review [a publication featuring accomplishments of the Lawrence Livermore National Laboratory (LLNL)].

The International Monitoring System (IMS) network established under CTBT is designed to search for evidence of clandestine nuclear explosions, and consists of hundreds of monitoring stations strategically positioned at different locations around the world. The International Data Centre (IDC) in Vienna (Austria) receives several gigabytes of data from the IMS network on a daily basis. The primary monitoring stations register seismic events. More than 200,000 earthquakes are known to occur annually around the world having seismic signatures similar to that of small underground nuclear explosions. LLNL is working in partnership with other scientists from the States Signatories to develop techniques to accurately distinguish nuclear explosions from other natural phenomena such as earthquakes and volcanoes as well as from non-nuclear man-made phenomena (e.g., mining activities or other chemical explosions). When complete, the IMS will comprise of 321 stations across four global networks (seismic, hydroacoustic, infrasound, and radionuclide monitoring stations) and 16 laboratories capable of performing the functions of detection, location and identification of explosions in support of CTBT monitoring and verification goals. Hydroacoustic stations located in the oceans record very-low-frequency atmospheric sound waves. Radionuclide air sampling stations collect atmospheric debris and noble gas samples that may contain evidence traceable to atmospheric, underwater or underground nuclear explosions.

The IDC process and evaluate data from each of the recording stations on the IMS network. About 85 percent of the proposed 321 monitoring stations are now operational. At a time when the IMS was still incomplete and in a provisional operational status, more than 10 primary seismic stations around the globe picked up an unambiguous nuclear explosion on 25 May 2009 in the north-east of the Democratic People's Republic of Korea (North Korea). Reports to the States Signatories helped confirm reports that North Korea had conducted a second underground nuclear test. The data developed from this event permitted a more precise assessment of the location and magnitude of the test, and provides a clear example of the function of the IMS in supporting CTBT monitoring and verification goals.



The International Monitoring System for the Comprehensive Nuclear-Test-Ban Treaty searches for evidence of clandestine nuclear explosions. (Courtesy of Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization.)

RADIATION CORNER

News and highlights related to radiation risks and benefits

San Francisco Considering Cellphone Warnings

SAN FRANCISCO (Los Angeles Times) – San Francisco officials are debating whether to make this famously liberal city the first in the nation to require retailers to prominently post the amount of radiation emitted by cell phones. Although there is no scientific consensus that the ubiquitous devices cause health problems, Mayor Gavin Newsom plans to call for an ordinance next month that would require the conspicuous display of radiation levels wherever the phones are sold...

http://articles.latimes.com/2009/dec/23/local/la-me-sf-cell23-2009dec23

Related: Bill Calls for Cell Phone Radiation Disclosure (http://articles.sfgate.com/2010-02-19/bay-area/17946970_1_cell-phones-radiation-fcc-web).

Does Safer Flying Mean A Risk Of Radiation

(guardian.co.uk, reported by Denis Campbell) – So-called "naked" body-scanning machines at airports, the latest defense against would-be plane bombers, have already raised concern for breaching flyers' privacy and, potentially, feeding the voyeurism of security officials. But could being screened also pose a health risk? The question arises because one of the two types of new ¬scanner – those that deploy "back-scatter" x-ray technology – uses ionizing radiation to generate the images that indicate if someone is concealing something dangerous. The Department for Transport, which ordered the introduction of whole-body scanners at all UK airports after the plot to blow up an aeroplane over Detroit on Christmas Day, says that they are completely safe...

http://www.guardian.co.uk/uk/2010/feb/04/airport-security-scanners-radiation

Related: Airport scanners will soon use radiation to detect explosives and chemicals, The Washington Post (http://www.washingtonpost.com/wp-dyn/content/article/2010/02/01/AR2010020103210.html).

Biolabs' Radiation Drug On Fast Track

BUFFALO (NY News, Business First, reported by David Bertola) – A drug developed in Buffalo to treat Acute Radiation Syndrome has been granted Fast Track status by the U.S. Food and Drug Administration. CBLB502 was developed by Cleveland BioLabs Inc. It is injected into muscle tissue to treat Acute Radiation Syndrome or radiation poisoning from exposure to radiation such as that from a nuclear or radiological weapon, or from a nuclear accident...

http://www.bizjournals.com/buffalo/stories/2010/07/19/daily34.html

Kazakhstan, The Race For Uranium Goes Nuclear

AIKONUR, KAZAKHSTAN (Washington Post, reported by Philip P. Pan) – The dry steppe stretches to the horizon in all directions from this remote outpost in southern Kazakhstan. But peeking out of the sandy soil, amid the sagebrush and desert shrub, are thousands of wells arranged in geometric patterns, each extracting radioactive treasure. These desolate fields sit above one of the world's largest deposits of uranium, and with nuclear energy in a renaissance, a rough-and-tumble battle is underway for access to them…

http://www.washingtonpost.com/wp-dyn/content/article/2010/02/24/AR2010022403242.html

Chernobyl: Leaking Radiation And Sucking Up Candanian Money

KIEV (Canada-Globe and Mail, reported by Doug Sanders) – Almost a quarter-century after its explosion killed hundreds and shocked the world, the Chernobyl nuclear reactor still sits crumbling amid an uninhabitable wasteland in northern Ukraine, still emits surprising amounts of radiation, and still absorbs vast amounts of money. Much of that money, at least $71-million of it, has come from Canadian taxpayers, intended to pay for a project launched in 1997 under a pledge from leaders of the G-7 countries to enclose the reactor in a permanent, sealed sarcophagus. It was meant to be finished in eight years and cost $768-million (U.S.), a symbol of a resurgent Ukraine returning to democratic government and an open economy, putting the 1986 disaster permanently in the past.

But in a story of tragic disappointment that exemplifies the web of corruption and distrust that so often ensnares relations between Ukraine and the West, 13 years later the cost of the project has ballooned to almost $2-billion and construction has not even begun…

http://www.theglobeandmail.com/news/world/chernobyl-leaking-radiation-and-sucking-up-canadian-money/article1454040/

Higher Stroke, Heart Disease Risks For A-Bomb Survivors

HONG KONG (Reuters, reported by Tan Ee Lyn) – A study of atomic bomb survivors in Japan conducted over 53 years has found that they appear to suffer a far higher risk of heart disease and stroke because of their exposure to radiation. The study, published in the British Medical Journal, involved 86,611 survivors from the bombings of Hiroshima and Nagasaki in 1945, which forced Japan into surrendering to the Allied Powers and officially ending World War Two. Each person was exposed to an absorbed radiation dose of between 0 and 4 Gy (Gray) at the time of the bombings… "This study provides the strongest evidence available to date that radiation may increase the rates of stroke and heart disease at moderate dose levels (mainly 0.5-2 Gy), though the results below 0.5 Gy are not statistically significant," said the researchers in Japan. "Further studies should provide more precise estimates of the risk at low doses," they said…

http://www.reuters.com/article/2010/01/15/us-radiation-atomic-japan-idUSTRE60E02420100115

Recent Staff Publications

Hamilton T.F., J. Jernströem, S.R. Kehl, R.E. Martinelli, M. Eriksson, A. Rivers, M. Bielewski, R.W. Williams, T.A. Brown, S.J. Tumey, and M. Betti (2009). "Frequency distribution, isotopic composition and physical characterization of plutonium-bearing from the Fig-Quince zone on Runit Island, Enewetak Atoll, J. Radioanal." *Nucl. Chem.*, 282, 1019-1026.

Hamilton, T.F. (2009). *Site Visit to Utrōk Atoll*. Lawrence Livermore National Laboratory, Livermore, California, 94550, LLNL-MI-422849.

Hamilton, T.F., S.R. Kehl, R.E. Martinelli, F. Gouveia, E. Kaplan, S. Musolino, and W.L. Robison (2009). *Rongelap Island Resettlement Support: Status Report*. Lawrence Livermore National Laboratory, Livermore, LLNL-TR-421381.

Kehl, S.R., T.F. Hamilton, and D.P. Hickman (2010). *Performance evaluation of whole body counting facilities in the Marshall Islands (2006-2009)*. Lawrence Livermore National Laboratory, Livermore, California, 94550, LLNL-TR-446073.

Martinelli, R.E., T.F. Hamilton, R.W. Williams, and S.R. Kehl (2009). "Separation of uranium and plutonium isotopes for measurement by multi collector inductively coupled plasma mass spectrometry." *J. Radioanal. Nucl. Chem*., 282, 343-347.

Robison, W.L., and T.F. Hamilton (2010). "Radiation doses for Marshall Islands atolls affected by U.S. nuclear testing: All exposure pathways, remedial measures, and environmental loss of 137Cs." *Health Phys.*, 98, 1-11.

Tumey, S.J., T.A. Brown, T.F. Hamilton, and D.J. Hillegonds (2009). "Further development of accelerator mass spectrometry of 90Sr at the Lawrence Livermore National Laboratory." *J. Radioanal. Nucl. Chem.*, 282, 821-824.

Scientific Meetings

- Health Physics Society, Midyear Meeting, Radiation Risk Communication to the Public, Albuquerque, New Mexico, USA (24-27 January 2010).
- American Nuclear Society Annual Meeting ANS 2010, San Diego, CA, USA (13-17 June 2010).
- 55th Annual Meeting of the Health Physics Society, Salt Lake City, UT, USA (27 Jun-2 Jul 2010).
- 11th International Symposium on Environmental Radiochemical Analysis, Chester, UK (19-23 Sep 2010).
- Plutonium Futures – The Science 2010, Bloomfield, CO, USA (19-13 Sep 2010).
- 13th International Conference on Environmental Remediation and Radioactive Waste Management ICEM'10, Tsukuba, Ibaraki, Japan (3-7 October 2010).
- OEECD/NEA Workshop on Practices and Experiences in Stakeholder Involvement for Post Nuclear Emergency Management, OECD Nuclear Energy Agency Committee o Radiation Protection and Public Health (CRPPH), Bethesda, Maryland, USA (12-14 October 2010).

Program Activities

- Jan 2010 LLNL mission to Utrōk Atoll to conduct an initial survey of possible "hot-spot" locations, and support the implementation of a garden project.
- Apr-May 2010 LLNL mission sampling mission to Bikini, Enewetak, and Rongelap Atolls to perform pantry sampling of selected, collect bioassay samples, and establish agricultural projects to study the uptake of cesium-137 and strontium-90 in leafy vegetables, grains and root crops.

Proposed

- Jul 2010 RMI-DOE Annual Meeting, 14-15 July, Honolulu, Hawaii.
- Sep 2010 Travel to Hawaii to develop a platform for supporting a mobile *in-situ* gamma system, and then onto Kwajalein/Majuro to finalize preparations for missions to Utrōk and Rongelap Atolls during 2011.

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Acknowledgements

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. We wish to thank our partner, the Office of Health and Safety, U.S. Department of Energy for program support, and acknowledge the cooperative efforts of local atoll governments and the work of our Marshallese staff in helping implement this program.

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