TESTIMONY OF
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Good morning, Mr. Chairmen, ranking Members, and Members of the Subcommittee. I am pleased to discuss the possible health implications of radiation from the Fukushima Daiichi nuclear power plant accident in Japan. Just a few days before the natural disasters struck on March 11, 2011, I was in Hiroshima, Japan as a member of the Radiation Effects Research Foundation's Science Council, reviewing the study of atomic bomb survivors. I would like to begin by expressing my heartfelt sympathy for the families of the tens of thousands who lost their lives as a result of the tsunami and earthquake and for the hundreds of thousands who have been displaced from their homes and livelihoods. The health consequences associated with the radiation exposures emanating from the Fukushima Daiichi plant pale in comparison.

As background, I am a radiation epidemiologist and Professor in the Department of Medicine at Vanderbilt University and Scientific Director of the International Epidemiology Institute. I have spent my career studying human populations exposed to radiation, including Chernobyl clean-up workers, patients receiving diagnostic and therapeutic radiation, underground miners exposed to radon, nuclear energy workers, atomic veterans, persons living in areas of high background radiation and U.S. populations living near nuclear power plants and other facilities. I am also a commissioner of the International Commission on Radiological Protection, an emeritus member of the National Council on Radiation Protection and Measurements, a U.S. delegate to the United Nations Scientific Committee on the Effects of Atomic Radiation, and a member of the Congressionally-mandated Veterans Advisory Board on Dose Reconstruction.

My remarks will cover five areas:

- Fukushima is not Chernobyl.
- The health consequences for Japanese workers and public appear to be minor.
- The health consequences for United States citizens are negligible to nonexistent.
- We live in a radioactive world.
- There is a pressing need to learn more about the health consequences of radiation in humans when exposures are spread over time at low levels and not received briefly at high doses such as in atomic bomb survivors.

Fukushima is not Chernobyl [Slide 1]

The Chernobyl accident on April 26, 1986, resulted in massive radiation exposures, both to the emergency workers putting out the ensuing fire and to the environment. There was no containment vessel and after the explosion a fire burned for ten days and spewed radioactive particles continuously into the environment. The emergency workers, the first responders and fire fighters, received so much radiation that 28 of them died of acute radiation sickness within a few months of exposure. Those who survived developed cataracts at a high rate and several subsequently died of myelodysplastic disorders. Radioactive iodines were deposited on large areas throughout the Ukraine, Belarus and Russian Federation and were ingested by cows who gave milk that was drunk by children, and an epidemic of thyroid cancer ensued beginning about five years after the accident. Over 520,000 recovery workers were sent to clean up the environment and build the so-called sarcophagus to contain the damaged nuclear reactor. To date there is little conclusive evidence for adverse health effects associated with radiation received during these clean-up operations. There have, however, been indications of severe psychological stress and increased rates of suicide.

In contrast, while the radiation releases from Fukushima [Slide 2] are estimated to be up to 10% of that from Chernobyl, there appears to be substantially less worker and public

exposure. The Japanese authorities relaxed the allowable annual limit of worker exposure from 2 to 25 rem for this emergency situation, but only about 21 workers received more than 10 rem and only two workers received between 20 and 25 rem. These levels are far below the hundreds of rem needed to cause acute radiation sickness. Those workers who experienced levels over 10 rem to their entire body, however, have an increased lifetime risk of developing cancer of about 1-2% over the expected normal lifetime rate of about 42%. There were reports of high radiation fields in the vicinity of the damaged reactors and spent fuel storage ponds and with the contaminated water, but apparently the Japanese authorities rotated workers in such a way that cumulative exposures to individuals were minimized. Three workers received beta particle exposures to their legs from an estimated 200-300 rem to the skin, but the health consequences of these localized exposures were minimal and resulted in only a reddening of the skin.

Exposure to the public was minimal in large part because of the prevailing winds and the quick action taken by the Japanese authorities. The prevailing winds were generally to the east and over the ocean and thus did not result in meaningful radiation exposures to the Japanese public. In contrast to the circumstances around Chernobyl where the authorities failed to alert or evacuate the surrounding populations until several days had passed, the Japanese government quickly evacuated persons living within 20 km of the Fukushima Daiichi plant and recommended that those living within 30 km stay indoors to minimize any possible exposure to radioactive releases. In addition, they immediately monitored the food and water supplies and banned the shipment of foodstuffs and milk where the radiation levels exceeded allowable standards.

These protective action measures, including the distribution of stable iodine pills (or syrup for children), minimized public doses and suggest that there will be minimal health consequences associated with any radiation exposures to the Japanese public. This is borne out in one survey of over 1,000 children who had their thyroids measured for possible uptakes of radioactive iodine. Not one child had a measurement above detectable limits. This is in

contrast to children living near Chernobyl for whom large numbers had extremely high levels of radioactive iodine detected in their thyroids from drinking contaminated milk shortly after the accident.

Nonetheless, some of the prevailing winds did blow toward populated areas shortly after the accident and during the hydrogen explosions, and to the north-west in particular. Rain, snow and hail deposited radioactive particles in certain regions, including some beyond 20 km, and these areas will be a concern for remediation before allowing public access or return. The Japanese authorities are considering regular medical examinations for workers and inhabitants who received more than 10 rem. To reduce anxiety, they are considering medical check-ups for those who may have received between 2 to 10 rem. They are also grappling with important issues as to when and how to allow evacuated inhabitants to return to their homes. Childhood exposures are of particular concern and topsoil is already being removed from some school playgrounds.

Thus, while Fukushima is clearly a major reactor accident, the potential health consequences associated with radiation exposures in terms of loss of life and future cancer risk are small, particularly in contrast with those resulting from the Chernobyl accident some 25 years ago.

For completeness, the 1979 reactor accident at Three Mile Island did not release appreciable amounts of radioactive substances into the environment, and public and even worker exposures were minimal. The average dose to people in the area was only about 1 millirem, or about what would be received in three days from sources of natural background radiation to the surrounding population.

The health consequences for United States citizens are negligible to nonexistent [Slide 3]

Fukushima is 5,000 miles away from the United States and the radiation that has been detected was substantially diluted after traveling such a long distance. The detection of trace

amounts of radiation speaks more about the extreme sensitivity of our radiation detectors than about the potential health consequences from the radiation itself. In addition to EPA's RadNet system that monitors water, milk and the atmosphere, the Department of Energy has radiation monitoring equipment that can detect minute quantities of radioactive particles from the other side of the world as part of the Comprehensive Nuclear Test Ban Treaty. The tiny amounts of detected radioactive materials from Fukushima pose no threat to human health. They represent, at most, only a tiny fraction of what we receive each day from natural sources, such as the sun, the food we eat, the air we breathe and the houses we live in.

It is impressive that radiation monitors can detect levels of radioactive iodine-131 as low as 0.03 Bq/L (0.8 pCi/L) in milk in Washington State; this is the decay of one radioactive atom per second in about 33 gallons of milk. Such a level is 5,000 of times below the Derived Intervention Level set by the Food and Drug Administration to trigger concern over radionuclides in food. An infant would have to drink hundreds of gallons of milk to receive a radiation dose equivalent to a day's worth of natural background radiation exposure. Such tiny levels of radiation are inconsequential compared with the levels we experience in daily life.

Interestingly, the radiation monitoring stations in Washington State had to detect radionuclides other than iodine-131 in order to distinguish radiation from Fukushima from that at any local hospital in the area. Most nuclear medicine departments use radioactive iodine for imaging the thyroid and to treat thyroid diseases, and patients are discharged shortly after intake and remain radioactive for several months, releasing small but detectable levels of radioactive iodine into the environment.

The trivial levels of radiation from Japan, while detectable, should not be of a concern and Americans should not take stable iodine (potassium iodide pills, KI) as a preventive measure to block the thyroid's uptake of radioactive iodine. There are potential adverse health effects from taking KI pills and these risks have to be balanced against a nonexistent benefit.

We live in a radioactive world [Slide 4]

To place the radiation levels from Fukushima in brief perspective, it is important to recognize that we live in a radioactive world. A banana, for example, has 10 Bq of activity, that is, 10 radioactive potassium atoms decay every second. All the foodstuffs we eat that contain potassium also contain a small amount of radioactive potassium, a primordial element with a billion year half-life. There are no concerns and no health consequences from such exposures.

We breathe radioactive radon which contributes over the year to about 210 millirem of natural background radiation. Bricks and granite contain radioactive materials that result in radiation exposures to the public (20 millirem). The Capitol Building was constructed with granite and is frequently cited as having some of the highest radiation levels in all of the United States, about 85 millirem per year. Water contains small amounts of radioactive radium, thorium and uranium, all within allowable limits.

Not only do we live in a radioactive world, our bodies are radioactive (30 millirem per year). Each second over 7,000 radioactive atoms in our bodies decay and can irradiate those sitting next to us. The atoms are largely radioactive potassium in our muscles and carbon-14 in our tissues. The amount of radiation we receive each year from medical sources (300 millirem), such as CT and medical imaging, equals the amount received from natural sources (300 millirem). International travel increases our exposure to cosmic rays and space radiation. A roundtrip from Dulles to Tokyo would result in 20 millirem. Living in Denver for a year results in 450 millirem of radiation dose, or 35% more than the U.S. average of 310 millirem from natural sources. About 2.5 million Americans (0.8% of the population) receive more than 2,000 millirem per year from natural sources.

These examples are not to minimize the health consequences of high-level exposures which are clearly demonstrable in human populations and include acute radiation sickness at very high doses in excess of 200 rem and an increase in cancer at moderate doses above about 10 rem (10,000 millirem). The examples do indicate, however, that we live in a world of

low-level radiation for which the possible health consequences are of little concern. The exposures to the U.S. population from Fukushima are tiny and thousands of times below U.S. standards or guidelines where remedial action would be triggered.

What research is needed? [Slide 5]

Although we know much about the health effects of high levels of radiation when received briefly, as was the case for atomic bomb survivors, the risk following exposures experienced gradually over time is uncertain and remains the major unanswered question in radiation epidemiology.

One untapped opportunity is to study our own U.S. radiation workers and veterans. The Low Dose Radiation Program within the Department of Energy had the foresight to initiate pilot investigations of over one million such workers and this comprehensive work should continue. Cooperating agencies include the National Cancer Institute, the Department of Defense, the Department of Veterans Affairs, the Nuclear Regulatory Commission and others. The study populations include early DOE and Manhattan Project workers, atomic veterans who participated in nuclear weapons testing in the 1940s and 1950s, nuclear utility workers, medical workers and others involved in the development of radiation technologies, as well as nuclear navy personnel.

Such a large study in the United States is critically important to understand scientifically the health consequences of low-dose radiation experienced over time and is directly relevant to the setting of protection standards for workers and the public; the assessment of possible risks from enhanced medical technologies such as CT and nuclear medicine imaging; the expansion of nuclear power; the handling of nuclear waste; the compensation of workers with prior exposures to radiation; and even the possible consequences of the radiation released from reactor accidents such as at Fukushima. To date, no direct study of these issues has been

large enough to provide convincing answers and extrapolations from the atomic bomb exposures in 1945 have to be relied upon.

Summary [Slide 6]

Fortunately, the health consequences from the radiation releases from the Fukushima Daiichi power plant appear to be minimal and are of little importance with regard to the U.S. public. The Japanese authorities acted quickly to evacuate over 200,000 inhabitants living near the damaged reactors; they monitored food and water and took rapid action to ban foodstuffs with increased radiation levels; they distributed stable iodine pills and syrup; and they made measurements on over 175,000 persons. The lasting effects upon the Japanese population will most likely be psychological with increased occurrence of stress-related mental disorders and depression associated not necessarily with the concern about reactor radiation, but with the horrific loss of life and disruption caused by the tsunami and earthquake. There is a need for better public understanding and better communications on the health effects of radiation exposures. Finally, there is now the opportunity in the United States to learn directly about low-dose, long-term radiation health effects by studying our workers and veterans.

Thank you for this opportunity to testify. I welcome any questions that you may have.

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