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And so we have now discovered yet a third category of documented and scientifically accepted harmful effects of radiation and that is mental retardation in children who were irradiated while still in the womb. . . .

When we extract uranium from the ground, we dig up the rock, we crush it and we leave behind this finely pulverized material -- it's like flour. In Canada we have 200 million tons of this radioactive waste, called uranium tailings. As Marie Curie observed, 85 percent of the radioactivity in the ore remains behind in that crushed rock. How long will it be there? . . . . Well, it turns out that the effective half-life of this radioactivity is 80,000 years. That means in 80,000 years there will be half as much radioactivity in these tailings as there is today.

You know, that dwarfs the entire prehistory of the Salzburg region which goes way back to ancient, ancient times. Even archaeological remains date back no further than 80,000 years. We don't have any records of human existence going back that far. That's the half-life of this material.

And as these tailings are left on the surface of the earth, they are blown by the wind, they are washed by the rain into the water systems, and they inevitably spread. Once the mining companies close down, who is going to look after this material forever? How does anyone, in fact, guard 200 million tons of radioactive sand safely forever, and keep it out of the environment?

In addition, as the tailings are sitting there on the surface, they are continually generating radon gas. Radon is about eight times heavier than air, so it stays close to the ground. It'll travel 1,000 miles in just a few days in a light breeze. And as it drifts along, it deposits on the vegetation below the radon daughters, which are the radioactive byproducts that I told you about, including polonium. So that you actually get radon daughters in animals, fish and plants thousands of miles away from where the uranium mining is done. It's a mechanism for pumping radioactivity into the environment for millennia to come, and this is one of the hidden dangers.

All uranium ends up as either nuclear weapons or highly radioactive waste from nuclear reactors. That's the destiny of all the uranium that's mined. And in the process of mining the uranium we liberate these naturally occurring radioactive substances, which are among the most harmful materials known to science.

SEE ALSO: Canadian Coalition for Nuclear Responsibility (Dr. Edwards is CCNR's President)
There is a ***VAST WEALTH*** of information here. ***Hightly Recommended!!!***
See a subset of link pointers at Recommended Reading

NOTE: the following is Dr. Edwards corrections to the transcript of his talk
(forwarded to the ratitor), which never made it into print.

URANIUM:
Known Facts and Hidden Dangers

invited address by Dr. Gordon Edwards
September 14, 1992

Dr. Gordon Edwards, Quebec, Canada. Mathematician.

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Uranium

What do we know about uranium? Well, uranium is the heaviest naturally occurring element on earth. It is a metal, like all other metals, except that it had no commercial value before the mid-twentieth century. Until the last fifty years it was produced only as a byproduct. Thus the entire history of the mining of uranium has taken place during my lifetime. Moreover, a great deal of it has occurred in my homeland, Canada, which was the first country to produce and process uranium as such.

The first uranium processed by Canada was used to produce nuclear explosives for the atomic bombs dropped at Hiroshima and Nagasaki in 1945. Indeed, the beginning of the nuclear weapons program marked the beginning of the uranium industry. By 1956, uranium had become the fourth most important export from Canada, after pulp, lumber and wheat; and every ounce of it was used to produce A-bombs and H-bombs for the American -- and, to a lesser extent, the British -- nuclear weapons programs. It was the only use uranium had at that time.

Today, Canada remains the world's largest producer and exporter of uranium, ostensibly for peaceful purposes; that is, as fuel for civilian nuclear reactors. Canada is also one of the very few countries in the world in which uranium mining is currently expanding. In the province of Saskatchewan, there are environmental assessment hearings going on now, this year, having to do with the potential opening of five new uranium mines. This, despite the fact that the price of uranium is lower today than it has ever been. The price has been falling steadily for more than fifteen years, and is now at an all-time low.

I hope that those attending this conference will write to the Prime Minister of Canada (c/o House of Commons, Ottawa, Ontario, Canada, K1A 0A6) and to the Premier of Saskatchewan (c/o Saskatchewan Legislature, Regina, Saskatchewan, Canada) asking them not to continue the expansion of this industry. Why? Because uranium is the deadliest metal on earth. As you will see, the scientific evidence fully bears out this conclusion. I would now like to explain why.

Both the commercial value and the dangers of uranium are based on two extra-ordinary characteristics which it possesses. First of all, uranium is radioactive. Secondly, uranium is fissionable. These are two quite different properties, however, and they should not be confused.

Radioactivity

The phenomenon of radioactivity was accidentally discovered in 1896 when Henri Becquerel put a rock in a drawer. The rock contained uranium, and the drawer contained a photographic plate, which was well-wrapped and shielded from the light. Some weeks later, when Becquerel unwrapped and developed the plate, he found rays of light on the photograph emanating exactly from the point of contact where the rock had been resting on it. Being a scientist, he was astounded. He could think of no possible way in which an inert rock could spontaneously be releasing energy -- especially such a penetrating form of energy. Moreover, the energy release had taken place in total darkness, in the absence of any external stimulation -- there was no chemical reaction, no exposure to sunlight, nor anything else. Becquerel had discovered radioactivity.

Marie Curie decided to pursue the mystery further. She got some uranium ore from the Erz mountains, not very far from here. She chemically separated the uranium from the rest of the crushed rock (she had to crush the rock and dissolve it in acid to get the uranium out, which is what we still do today in mining uranium) and she found that even after the uranium had been removed, the crushed rock remained very radioactive -- much more so than the uranium itself. Here was a mystery indeed. Why is it that eighty-five percent of the radioactivity stays behind in the crushed rock?

Starting with many tons of rock, Madame Curie proceeded to separate out all the chemical elements she knew. It was painstaking work. Finally she was left with a small beaker of concentrated, highly radioactive liquid. By evaporating the water, she felt sure she would discover whatever was causing this intense radioactivity. But when the liquid was evaporated, the beaker was, apparently, completely empty. She was deeply disappointed. She couldn't fathom what had gone wrong. But when she returned to the laboratory late at night, she found the beaker glowing brightly in the dark, and she realized that it wasn't empty after all. In this way, Marie Curie discovered two new elements: radium and polonium. We now know these are inevitable byproducts of uranium.

By 1906, all the basic facts of radioactivity were known, except for the central mystery as to "why"; this we do not understand. Indeed, science doesn't really understand why anything is the way it is. All science can do is describe how things behave. Science tells us, for example, that all material things are made up of tiny atoms. The atoms found in most substances are remarkably stable, but in the case of radioactive materials, the atoms are unstable.

Consider the water in this glass. It is made up of stable atoms. Pure water is made up of hydrogen and oxygen atoms, and these atoms are, as far as science can determine, eternal and unchangeable. The very same atoms of hydrogen and oxygen that are in this glass of water were around, in some other combinations, in the days of the dinosaurs.

But radioactive substances have unstable atoms which can and will explode microscopically, and when they do, they give off a burst of energy. This process is called "radioactive disintegration" or "radioactive decay". When radioactive atoms explode, they give off highly energetic charged particles of two types: alpha and beta. These are particles, they're not invisible rays. They are like pieces of shrapnel from an explosion. And this

microscopic shrapnel does great damage because of the high energy of the particles which are given off.

Decay Products

When a radioactive atom explodes, that atom is changed permanently into a new substance. And radium turns out to be one of the results of exploding uranium atoms. So wherever you find uranium on the earth, you will always find radium with it because it is one of about a dozen so-called "decay products" of uranium.

To be more precise, when uranium disintegrates it turns into a substance called protactinium, which is also radioactive. And when that disintegrates it turns into a substance named thorium, which is likewise radioactive. When thorium disintegrates it turns into radium; when radium disintegrates it turns into radon gas. And when radon gas atoms disintegrate, they turn into what are called the "radon daughters", or "radon progeny", of which there are about half a dozen radioactive materials, including polonium.

Finally, in this progression, you end up with a stable substance, which in itself is highly toxic: lead. But because the radioactivity of the other materials is so much more dangerous than this toxic heavy metal, people don't even talk about the lead at the end of the chain. They think that once all the radioactivity is gone, what's left is perfectly safe. It isn't -- but the lead that remains is just a whole lot less dangerous than the radioactive materials that produced it.

So all the radioactive decay products of uranium remain in the crushed rock when uranium is separated from the ore. That's why Marie Curie found most of the radioactivity left behind in the residues, including all the radium and all the polonium.

Radium

Well, how did the story of uranium progress? Because uranium was less radioactive than its daughter products, it was not valued commercially. But radium was. And radium began to be used principally for two purposes. One was to burn cancerous growths. I should tell you that both Henri Becquerel and Marie Curie suffered grievous burns which were very difficult to heal and which left permanent scars just as a result of handling radium. Other scientists got the idea that if they embedded a needle containing radium inside a cancerous tumor, it would burn the cancer -- and indeed it did. That was the beginning of cancer therapy using radiation, wherein the harmful effects of atomic radiation are directed against cancerous cells instead of healthy cells. Of course, atomic radiation does similar damage to healthy cells.

Now, the other main use for radium was as a luminous paint, because of the glow-in-the-dark phenomenon that Marie Curie had observed. Believe it or not, the price of uranium in the 1920s was $100,000 a gram -- and this is using dollars of the twenties! It was a very expensive commodity, but only very little was needed for any given purpose. Some of it was used to make luminous paint, with which they would paint dials so they

could be read even in the dark.

Now the young women who painted these things began to get sick. This was first reported by an American dentist called Blum, who said that he had some very young women -- 19 years old, 18 years old, 20 years old -- coming into his dentistry office. Their teeth were falling out, their gums were badly infected and bleeding profusely, they were anemic, their bones were soft, and in some cases their jawbones had spontaneously fractured. Some of them died of severe anemia.

The only thing these women had in common was that they worked in a radium dial painting factory in New Jersey. Blum called this phenomenon "radium jaw". A few years later, the women who had recovered from these symptoms started developing problems in the rest of their skeleton. They suffered weakening of the bone, spontaneous fractures of the hip and of other bones, and growths -- tumors, some of which were cancerous -- in the bones themselves. Now, bone cancer is such an exceedingly rare disease, that there was little doubt that this cancer was caused by exposure to radium.

It was discovered that simply by wetting the tip of the brush in order to get a nice clean figure on the dials, these women were ingesting minute quantities of radium. And that was sufficient to cause all these symptoms. When autopsies were performed on the corpses of these women, doctors discovered that in their entire skeleton there were only a few micrograms of radium. This quantity was so small, that no conventional chemical analysis could detect it. Nevertheless, this tiny amount of radium had distributed itself so thoroughly through their skeleton, that you could take a picture of any one of their bones just by laying it on a photographic plate in a dark room, It is called an auto-radiograph -- that is, an x-ray picture with no x-ray machine.

So this was our first introduction to the harmful effects of even minute quantities of such substances. By the way, many of the women who survived this phase of the assault later on developed cancers of the head -- cancer of the sinuses, cancer of the soft palate, and other types of head cancers. We now know how these were caused. Remember, radium is radioactive -- even inside the body. As I told you earlier, when radium atoms disintegrate, they turn into radon gas. So radon gas was being produced inside the bodies of these women. In fact, one test for radium contamination is to check a person's exhaled breath and see if it has radon gas in it; if it does, that person must have radium in his or her body. In the case of the radium dial painters, the radon gas was being produced in the bones, dissolved in the blood, and pumped by the heart up to the head where it collected in the sinus and other cavities. And there it was irradiating the delicate living tissues and causing head cancers.

Radon

Now, it so happens that for hundreds of years, going back to the 15th century, there had been reports that miners working in the Erz mountains had been dying at a tremendous rate from some unknown lung diseases. We're talking here about 75 percent mortality in some cases. It wasn't until the late 19th century that the principal disease was diagnosed and found to be lung cancer. At that time, lung cancer was virtually unknown among the surrounding population; yet these miners were experiencing in some cases up to 50 percent lung cancer mortality. The other lung ailments were not lung cancer, but other types of

debilitating lung damage.

By the 1930s it had been established that this epidemic of lung cancer and other lung diseases was caused by breathing radioactive materials in the atmosphere of the mine. In animal experiments, radon gas was identified as the main killer.

Uranium finally acquired commercial value in 1942, when we discovered that we could make atomic bombs with it. Only then did we start mining uranium for itself and not as a byproduct of something else. A few years earlier, in 1938, it was discovered that uranium is not only radioactive, it is also fissionable, which makes it unique among all naturally occurring radioactive materials. When uranium atoms undergo the fission process, large amounts of energy are released. Unlike the process of radioactive decay, which cannot be turned on and off, nuclear fission can be controlled. The energy release caused by fission can be speeded up, slowed down, started or stopped. It can be used to destroy cities in the form of nuclear weapons, or to boil water inside a nuclear reactor.

Suddenly, uranium was in demand. We sent miners into the mines in North America at a permissible level of radiation exposure which was comparable to the levels that those miners in the Erz mountains had been getting back in the 19th century. And of course, the results were entirely predictable: an epidemic of lung cancer and other lung diseases. One has to ask therefore: Why were these consequences not predicted and prevented?

Radon Daughters

The answer is, in part, that the scientists refused to believe that such a small amount of radon gas could cause such a huge increase in cancer. As it turns out, the scientists were wrong. One of the basic things they overlooked, is that if you take a sample of radon gas -- right now, if I filled a tube with radon gas in front of your eyes, and measured the radiation in that tube -- within three hours, the level of radioactivity would increase by a factor of about five. Why?

As the radon atoms disintegrate, they produce other radioactive substances. And so, in fact, you have a multiplication of new radioactive materials which weren't there to begin with. This is one of the things the scientists overlooked. So that when the miners go into a mine where the radon has been collecting for several hours, it's five times as radioactive as radon in the laboratory. And those other substances -- the radon daughters -- are extremely dangerous. The worst of the radon daughters, by the way, is a substance called polonium -- the same polonium that Marie Curie discovered so many years ago. Recent scientific evidence shows that polonium is, in many circumstances, at least as toxic as plutonium, and in some cases more toxic.

Nuclear Fission

Now, what is that property that made uranium commercially valuable? It's called fissionability. More precisely, uranium is called a "fissile" material. Let me explain what

that means.

Yes, uranium atoms are radioactive, and so they will disintegrate if you just leave them alone; but what happens if you poke them? What happens if you bombard uranium atoms with tiny particles called neutrons? It turns out that in that case, you can force a much more violent disintegration of the atom, which is called fission. When fission occurs, the uranium atom doesn't just disintegrate, it actually breaks apart into two or three large chunks. In the process it gives off some extra neutrons, and it also gives off about 400 times as much energy as is produced by a radioactive disintegration event.

Now, the fact that fission is triggered by a neutron makes it quite different from normal radioactivity. Radioactivity is not triggered, and therefore science does not know how to control it. We have no mechanism for speeding up, slowing down, starting or stopping radioactivity. That's why radioactive wastes are such a problem. But with fission, we can start it, stop it, and control it, just by maintaining control over the extra neutrons that are produced at each stage. Starting with just one neutron, we can split one uranium atom, and the extra neutrons can go on to split two more uranium atoms, giving even more neutrons which can then split four atoms, which can then split eight atoms, and so on. In this way, forty quintillion uranium atoms can be split with only sixty generations of splittings, all triggered by a single neutron. [A quintillion is a billion billion, or a million million million.] This whole "chain reaction", as it is called, takes place in less than a thousandth of a second. That is really what constitutes the atomic bomb.

Fission Products

You may now realize that all of the radioactive materials which escape from an atomic bomb when it explodes, are basically the broken bits of uranium atoms. These are new radioactive materials, called "fission products", which are created by the splitting of uranium atoms. There are hundreds of them. They all have different names, and different chemical and biologically properties. Most of them did not exist in nature before the advent of nuclear technology.

You see, uranium travels in many disguises. In every sample of uranium ore, one finds radium -- but radium is, in a certain sense, just a transformation of uranium. Speaking loosely, one could say that it is a disguised form of uranium. It is just one of the many elements in the chain of decay. Similarly with polonium. Similarly with radon gas. These are all just different manifestations of uranium, so to speak, resulting from radioactive decay.

And similarly with the fallout from atomic bombs; all those radioactive materials which are released by nuclear explosions -- such as iodine-131, strontium-90, cesium-137, krypton-85, and all the rest -- they are all broken bits of uranium atoms. They are additional disguises for uranium, resulting from nuclear fission.

The radioactive poisons that were released from the Chernobyl reactor are also broken bits of uranium atoms. Incidentally, 80 percent of the total radiation dose delivered by the Chernobyl accident worldwide was caused by the escape of just a couple of kilograms of radioactive materials from the damaged nuclear plant. It doesn't take much.... To this day, the sheep in Wales are unsuitable for human consumption because of

contamination by one particular by-product of the Chernobyl accident called cesium-137. But every atom of cesium-137 from Chernobyl started out as an atom of uranium.

These radioactive materials, which are called fission products -- the ones in the bomb fallout and which in nuclear reactors -- should not be confused with the other radioactive materials I told you about earlier, which are the decay products of uranium. The decay products of uranium are due to radioactive disintegration. They are about two dozen in number, and they occur in nature because uranium does. When you talk about fission products, however, you are dealing with completely different substances. They are created only inside nuclear weapons or nuclear reactors. They are the leftover pieces of uranium atoms which have been violently broken apart by the fission process. There are over 300 of them altogether, when you consider that -- being radioactive -- each of the fission products also has its own decay products!

Health Effects of Radioactive Materials

And so this one material, uranium, is responsible for introducing into the human environment a tremendously large range of radioactive materials which are all very inimical to biological organisms. These are not invisible rays, they are materials. They get into our water, our food, and the air we breathe. They're exactly like other materials except for the fact that they're radioactive.

Take, for instance, radioactive iodine. It behaves just like ordinary iodine, which is not radioactive. Why is there iodine in our table salt? Well, it's one of the few examples of preventative medicine we have. The iodine, when it's eaten in the table salt, goes to the thyroid gland, and there it helps to prevent a disease of the thyroid gland called "goiter". Radioactive iodine does exactly the same thing. If a child or an adult gets radioactive iodine in the diet, the radioactive iodine goes to the thyroid too, and it also helps to prevent goiter. But while it's there, the atoms explode, and the shrapnel rips through the cells of the body, and in the process breaks thousands of chemical bonds randomly.

It's like throwing a grenade into a computer. The probability of getting an improvement in a computer by throwing a grenade into it is very small, and similarly with radiation events and human cells. Now, the cells that die are really no problem, as long as not too many of them die. They can be replaced. The ones that are particularly dangerous are the ones that survive. Those damaged cells can develop into cancers. You can also have damage to germ cells -- eggs and sperm -- leading to genetically damaged children, grandchildren, or great-grandchildren.

As Alice Stewart mentioned in her talk, there are two categories of human illness that everyone agrees can be caused by exposure to atomic radiation even at very low levels. They are **(1)** cancers of all kinds, and also **(2)** genetic mutations -- which can be caused right down to the lowest levels of radiation exposure. Most scientists believe that these harmful effects are linearly related to the dose, so that if the dose is doubled, the number of cancers and genetic defects will also be doubled, and if the dose is cut in half, only half as many cancers and genetic defects will be seen. It is important to realize that if a damaging dose is spread out among a very large population, so that each individual receives only a very small portion of the total dose, the number of cancers and genetic defects is in no way diminished. Thus, in the case of radioactive pollution, dilution is no solution at all.

However, there is one other effect of radiation at low levels which wasn't mentioned in the previous talk, and I would like to just mention it here. It has now been confirmed by the scientific community -- only in recent years, by the way -- that mental retardation is caused by radiation exposure in the womb. This type of biological damage also seems to be linear, that is, proportional to dose, right down to the lowest levels of exposure. There doesn't seem to be any cut-off point. And so we have now discovered yet a third category of documented and scientifically accepted harmful effects of radiation and that is mental retardation in children who were irradiated while still in the womb.

Uranium Tailings

Now, if I could just wrap up, I have to tell you something extremely important. The title of my talk was "Known facts and hidden dangers". I've told you a bit about the known facts. Now for at least one of the hidden dangers.

When we extract uranium from the ground, we dig up the rock, we crush it and we leave behind this finely pulverized material -- it's like flour. In Canada we have 200 million tons of this radioactive waste, called uranium tailings. As Marie Curie observed, 85 percent of the radioactivity in the ore remains behind in that crushed rock. How long will it be there? Well, it turns out that the effective half-life of this radioactivity is 80,000 years. That means in 80,000 years there will be half as much radioactivity in these tailings as there is today.

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In addition, as the tailings are sitting there on the surface, they are continually generating radon gas. Radon is about eight times heavier than air, so it stays close to the ground. It'll travel 1,000 miles in just a few days in a light breeze. And as it drifts along, it deposits on the vegetation below the radon daughters, which are the radioactive byproducts that I told you about, including polonium. So that you actually get radon daughters in animals, fish and plants thousands of miles away from where the uranium mining is done. It's a mechanism for pumping radioactivity into the environment for millennia to come, and this is one of the hidden dangers.

Conclusion

All uranium ends up as either nuclear weapons or highly radioactive waste from nuclear

reactors. That's the destiny of all the uranium that's mined. And in the process of mining the uranium we liberate these naturally occurring radioactive substances, which are among the most harmful materials known to science. Couple this with the thought that nuclear technology never was a solution to any human problem. Nuclear weapons do not bring about a sane world, and nuclear power is not a viable answer to our energy problems. We don't even need it for electricity. All you need for conventional electricity generation is to spin a wheel, and there's many ways of doing it: water power, wind power, geothermal power, etc. In addition, there are other methods for producing electricity directly: solar photovoltaics, fuel cells, and so on. What we have here, in the case of nuclear power, from the very beginning, is a technology in search of an application.

So, I think that we as a human community have to come to grips with this problem and say to ourselves and to others that enough is enough. We do not want to permanently increase our radiation levels on this planet. We have enough problems already.

Thank you.

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Freda Meissner-Blau (Moderator)

Thank you very, very much, Gordon Edwards. I think those two lectures gave a perfect background to the next step of our endeavors. Our objective of the meeting is really to give the voice to the victims of what we just have heard. And I should ask now to come up here, please, Mr. Vladimir Chernousenko, if he's here. And then, Mr. Guy White Thunder, Mr. James Garrett and the family Yazzie of Arizona -- that's Esther, Robert and their daughter Darnell.

Now we are going to hear for the next hour the testimonies. Now, you may know, may have heard about Vladimir Chernousenko. He was the coordinator of the clean-up in Chernobyl. He is himself a physicist, and he definitely is a victim. He isn't feeling very well, and he has a lot to say to us. He has lived through the whole nightmare, so we want to give him as much time as he needs.

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