Thinking About Thorium

by Gordon Edwards, Ph.D., President
Canadian Coalition for Nuclear Responsibility
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On CBC's "Quirks and Quarks" radio program aired on Saturday, September 15, 2012, there was an enthusiastic endorsement of "thorium reactors" as a nearly miraculous form of nuclear energy that will avoid all of the major problems now associated with uranium-based nuclear power.

I have been asked by several people to give my own personal opinion of this prospect, and accordingly have written the following:

Background:

When nuclear power was first introduced by nuclear scientists to a credulous public, who were already strongly conditioned to respect science and trust scientists, people were quick to believe that nuclear power was safe, clean, cheap and inexhaustible -- just because scientists said so. It was also said, and widely believed, that "peaceful" nuclear power had nothing whatsoever to do with atomic bombs and the proliferation of nuclear weapons.

It took decades for people to realize that these assertions are all lies. In 1974 India exploded its first atomic bomb using plutonium produced in a “peaceful” research reactor given as a gift to the Indian government by Canada. In 1979 the Three Mile Island reactor in Pennsylvania underwent a series of hydrogen gas explosions and a partial meltdown, echoing the same steps that took place during the self-destruction of the NRX reactor core at Chalk River, Ontario, in 1952, and presaging the catastrophic meltdowns at Chernobyl, Ukraine, in 1986 and in Fukushima Prefecture, Japan, in 2011. In the meantime, tens of billions of dollars have been spent trying to find a still-elusive permanently safe method for keeping incredibly toxic radioactive wastes out of the environment of living things for millions of years.

Clean? Safe? Peaceful? Hmm.

Perhaps people should not be so eager to swallow all the hype about thorium reactors. There are over-the-top claims of thorium-based reactors being safe, clean, cheap, inexhaustible, and unrelated to nuclear weapons. Thorium-based reactors are even sold as a miraculous way of solving the nuclear waste problem created by the previous generation of – what was it? – oh yes, the previous generation of uranium-based nuclear reactors, which were also presented (back in the day) as safe, clean, cheap, inexhaustible, unrelated to nuclear weapons, and without toxic waste. So: thorium reactors are to solve the problems created by a previously problem-free technology?

As baseball great Yogi Berra once said, “It’s déjà vu all over again.” Or, as the old proverb goes, "once burned, twice shy". Or even more plainly, "Fool me once, shame on ***you***. Fool me twice, shame on ***me***."

If thorium is such a good idea then its promoters should be more willing to tell the whole truth about it rather than to spin fairy tales around it. Here are a few of them:

Fairy Tale #1. "Thorium is a nuclear fuel."

False. Thorium is NOT a nuclear fuel.

Fill the interior of ANY nuclear reactor with fuel assemblies made of thorium, turn it on, and voilà: absolutely nothing will happen. That’s because thorium is not a "fissile" material – it simply cannot sustain a nuclear chain reaction, no matter what.

However, if thorium is left in the core of a nuclear reactor that is fuelled with another material – a fissile material – then a fraction of that thorium will be converted into a new variety of uranium that does not occur in nature, called uranium-233.

Uranium-233 is a fissile material. It can be used either as fuel for a nuclear reactor or as the explosive material in a nuclear weapon. The USA exploded an atomic bomb made from uranium-233 more than half a century ago, in 1955.

But uranium-233 can only be created by bombarding thorium-232 with neutrons. When a thorium-232 atom absorbs a neutron it becomes transmuted into a uranium-233 atom.

So the bottom line is that thorium (meaning thorium-232) is not a nuclear fuel nor is it a nuclear explosive, but it can be used as a raw material to produce uranium- 233, which is both a nuclear fuel and a nuclear explosive.

It seems to me that if thorium proponents want to be believed, they should explain these simple facts to people right away instead of "preying on their ignorance" by telling them untruths.

Fairy Tale #2. "The use of thorium as a "nuclear fuel" [sic] has nothing to do with nuclear weapons or nuclear explosive materials."

This is wrong in several ways.

As already mentioned, thorium has to be converted into uranium-233 before "it" can be used as a nuclear fuel -- so already we have a link with nuclear weapons. An Atomic Bomb using U-233 as explosive was detonated by the USA military in the mid-1950s.

While uranium-233 does have some disadvantages as a nuclear explosive material (mainly due to the presence of a gamma radiation contaminant) it also has some terrific advantages for the would-be bomb-maker.

The main advantage is that uranium-233 is 100% enriched from the get-go, whereas naturally-occurring uranium-235 NEVER becomes 100% enriched. The higher the degree of enrichment, the more powerful the nuclear explosive.

And, by the way, with just a little extra effort the gamma-radiation contaminant in U-233 can be eliminated, making this artificial uranium isotope just as easy to handle as weapons-grade uranium-235, and even more powerful than U-235 as a nuclear explosive. See *https://phys.org/news/2012-12-thorium-proliferation-nuclear-wonder-fuel.html*

So the end product of thorium irradiation is a nuclear explosive material. Other nuclear explosive materials are also needed at the very outset, even before a thorium reactor starts operating. You cannot get the reactor going without mixing thorium with some nuclear-weapons-usable material as fuel – either plutonium or highly enriched uranium.

That means that you cannot even start using thorium for energy unless you first either

(1) separate plutonium from irradiated nuclear fuel using reprocessing technology, as North Korea has done for example (and used the plutonium in nuclear weapons), or

(2) produce highly enriched uranium in a uranium enrichment facility as Iran has done, (much to the consternation of the rest of the world).

Highly enriched uranium and plutonium are the two primary nuclear explosive materials used in all existing nuclear weapons. You need to have a stash of one of them, or both of them, just to start thorium reactors up. In short you need to spread nuclear weapons explosive materials around if you want the world to start using thorium-based reactors.

Yeah! Let's hear it for "peaceful" thorium reactors!

Fairy Tales #3, #4, #5,... A thorium reactor cannot undergo a catastrophic accident, it will not produce much nuclear waste, it will reduce the "storage time" from millions of years to hundreds of years, et cetera.

These are all profoundly misleading exaggerations, although each of these claims has a small germ of truth.

Any sufficiently powerful bomb dropped on a thorium reactor will result in a catastrophic spread of radioactive poisons over large land areas, not much different from what would happen if that same bomb were dropped on any other kind of operating nuclear reactor.

Thorium reactors produce high-level radioactive waste just like today's reactors, and while the proportions of various radionuclides may be substantially different, there is no

way that a thorium reactor will eliminate all radioactive waste elements having half- lives measured in the tens or hundreds of thousands of years (or greater).

Thorium is actually an old idea that has been promoted many times in the past. In 1977, for example, Atomic Energy of Canada Limited (AECL) urged the Canadian government to invest billions of dollars in plutonium and thorium reprocessing technology, in order to prepare the way for “the thorium cycle” – a scheme to use plutonium and thorium to create a new much longer-lasting epoch of nuclear power supremacy.

This particular plan is thoroughly documented on the CCNR web site --
see http://www.ccnr.org/AECL_plute.html [my account]
and http://www.ccnr.org/aecl_plute_seminar.html [the industry's plan]

The moral of this story is: don't be too eager to buy a nuclear pig in a poke, especially when you have heard this kind of exuberant nuclear sales pitch before. From the beginning, nuclear power was touted as absolutely clean, absolutely safe, and absolutely cheap. Not knowing any better, people took these promises literally – and you know how ***that*** turned out!

Gordon Edwards.

P.S. Here's what I wrote on this subject a year ago....
“Thorium Reactors: Back to the Dream Factory”
http://ccnr.org/Thorium_Reactors.html