BEYOND NUCLEAR FACT SHEET
TEN MYTHS ABOUT THORIUM AS A NUCLEAR ENERGY SOLUTION

Summary
Thorium may be abundant and possess certain technical advantages, but it does not mean that it is economical. Compared to uranium, the thorium fuel cycle is likely to be even more costly. In a once-through mode, it will need both uranium enrichment (or plutonium separation) and thorium target rod production. In a breeder configuration, it will need reprocessing, which is costly. In addition, inhalation of thorium-232 produces a higher dose than the same amount of uranium-238 (either by radioactivity or by weight). Reprocessed thorium creates even more risks due to the highly radioactive U-232 created in the reactor. This makes worker protection more difficult and expensive for a given level of annual dose. Finally, the use of thorium also creates waste at the front end of the fuel cycle. The radioactivity associated with these is expected to be considerably less than that associated with a comparable amount of uranium milling. However, mine wastes will pose long-term hazards, as in the case of uranium mining. There are also often hazardous non-radioactive metals in both thorium and uranium mill tailings.

1. There is no "thorium reactor." There is a proposal to use thorium as a *fuel* in various reactor designs including light-water reactors – the most prevalent in the United States – as well as fast breeder reactors.

2. You still need uranium – or even plutonium – in a reactor using thorium. Thorium is not a fissile material and cannot either start or sustain a chain reaction. Therefore, a reactor using thorium would also need either enriched uranium or plutonium to initiate the chain reaction and sustain it until enough of the thorium has converted to fissile uranium (U-233) to sustain it.

3. Using plutonium sets up proliferation risks. To make a "thorium reactor" work, one must (a) mix the thorium with plutonium that has been stripped of the highly radioactive fission products; (b) use the mixed-oxide thorium-plutonium fuel in a reactor, whereby the plutonium atoms fission and produce power while the thorium atoms absorb neutrons and are turned into uranium-233 (a man-made isotope of uranium that has never existed in nature); (c) strip the fission products from the uranium-233 and mix *that* with thorium in order to continue the "cycle"; in this phase, the U-233 atoms fission and produce power while the thorium atoms absorb neutrons and generate *more* uranium-233. And so the cycle continues, generating more and more fission product wastes. (Gordon Edwards).

4. Uranium-233 is also excellent weapons-grade material. Unlike any other type of uranium fuel, uranium-233 is 100 percent enriched from the outset and thus is an excellent weapons-grade material and as effective as plutonium-239 for making nuclear bombs. This makes it very proliferation-prone and a tempting target for theft by criminal and terrorist organizations and for use by national governments in creating nuclear weapons.

5. Proliferation risks are not negated by thorium mixed with U-238. It has been claimed that thorium fuel cycles with reprocessing would be much less of a proliferation risk because the thorium can be mixed with uranium-238. In fact, fissile uranium-233 must first be mixed with non-fissile uranium-238. If the U-238 content is high enough, it is claimed that the mixture

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cannot be used to make bombs without uranium enrichment. However, while more U-238 does dilute the U-233, it also results in the production of more plutonium-239, so the proliferation problem remains.

6. Thorium would trigger a resumption of reprocessing in the US. In most proposed thorium fuel cycles, reprocessing is required to separate out the U-233 for use in fresh fuel. Reprocessing chemically separates plutonium and uranium and creates a large amount of so-called low-level but still highly radioactive liquid, gaseous and solid wastes.

7. Using thorium does not eliminate the problem of long-lived radioactive waste. Fission of thorium creates long-lived fission products including technetium-99 (half-life of over 200,000 years). Without reprocessing, thorium-232 is itself extremely long-lived (half-life of 14 billion years) and its decay products will build up over time in irradiated fuel. Therefore, in addition to all the fission products produced, the irradiated fuel is also quite radiotoxic. Wastes that pose long-term hazards are also produced at the "front end" of the thorium fuel cycle during mining, just as with the uranium fuel cycle.

8. Attempts to develop "thorium reactors" have failed for decades. No commercial "thorium reactor" exists anywhere in the world. India has been attempting, without success, to develop a thorium breeder fuel cycle for decades. Other countries including the US and Russia have researched the development of thorium fuel for more than half a century without overcoming technical complications.

9. Fabricating "thorium fuel" is dangerous to health. The process involves the production of U-232 which is extremely radioactive and very dangerous in small quantities. The inhalation of a unit of radioactivity of thorium-232 or thorium-228 produces a far higher dose than the inhalation of uranium containing the same amount of radioactivity. A single particle in the lung would exceed legal radiation standards for the general public.

10. Fabricating "thorium fuel" is expensive. The thorium fuel cycle would be more expensive than the uranium fuel cycle. Using a traditional light-water (once-through) reactor, thorium fuel would need both uranium enrichment (or plutonium separation) and thorium target rod production. Using a breeder reactor makes costly reprocessing necessary.

Conclusion

From Dr. Gordon Edwards, Thorium Reactors: Back to the Dream Factory, July 13, 2011.
"The bottom line is this. Thorium reactors still produce high-level radioactive waste. They still pose problems and opportunities for the proliferation of nuclear weapons. They still present opportunities for catastrophic accident scenarios -- as potential targets of terrorist or military attack, for example. Proponents of thorium reactors argue that all of these risks are somewhat reduced in comparison with the conventional plutonium breeder concept. Whether this is true or not, the fundamental problems associated with nuclear power have by no means been eliminated."

Materials above were drawn largely from: "Thorium Fuel: No Panacea for Nuclear Power", by Dr. Arjun Makhijani and Michele Boyd, Institute for Energy and Environmental Research, January 2009 and available at: www.ieer.org/fctsheet/thorium2009factsheet.pdf. Additional information was provided by Dr. Gordon Edwards, Ph.D., President, Canadian Coalition for Nuclear Responsibility.