# THORIUM

**Anti-Nuclear & Clean Energy Campaign**
**Friends of the Earth, Australia**
**www.foe.org.au/anti-nuclear**

*Thor-bores and uro-sceptics: thorium's friendly fire*
*Jim Green, Nuclear Monitor #801, 9 April 2015, www.wiseinternational.org/nuclear-monitor*

Many readers will be familiar with the tiresome rhetoric of thorium enthusiasts − let's call them thor-bores. Here's one in full flight − a science journalist who should know better: *"Thorium is a superior nuclear fuel to uranium in almost every conceivable way ... For one, a thorium-powered nuclear reactor can never undergo a meltdown. ... Thorium is also thoroughly useless for making nuclear weapons. ... But wait, there's more. Thorium doesn't only produce less waste, it can be used to <u>consume</u> existing waste."* Thankfully, there is a healthy degree of scepticism about thorium, even among nuclear industry insiders, experts and enthusiasts (other than the thor-bores themselves, of course). Some of that 'friendly fire' is noted here.

**Readiness**

The World Nuclear Association notes that the commercialisation of thorium fuels faces some *"significant hurdles in terms of building an economic case to undertake the necessary development work."*

A 2012 report by the UK National Nuclear Laboratory states: *"NNL has assessed the Technology Readiness Levels (TRLs) of the thorium fuel cycle. For all of the system options more work is needed at the fundamental level to establish the basic knowledge and understanding. Thorium reprocessing and waste management are poorly understood. The thorium fuel cycle cannot be considered to be mature in any area."*

**Thorium is no 'silver bullet'**

Do thorium reactors potentially offer significant advantages compared to conventional uranium reactors?

Nuclear physicist George Dracoulis states: *"Some of the rhetoric associated with thorium gives the impression that thorium is, somehow, magical. In reality it isn't."*

The UK National Nuclear Laboratory report argues that thorium has *"theoretical advantages regarding sustainability, reducing radiotoxicity and reducing proliferation risk"* but that *"while there is some justification for these benefits, they are often over stated."*

The UK National Nuclear Laboratory report is sceptical about safety claims: *"Thorium fuelled reactors have already been advocated as being inherently safer than LWRs [light water reactors], but the basis of these claims is not sufficiently substantiated and will not be for many years, if at all."*

**False distinction**

Thor-bores posit a sharp distinction between thorium and uranium. But there is little to distinguish the two. A much more important distinction is between conventional reactor technology and some 'Generation IV' concepts − in particular, those based on repeated (or continuous) fuel recycling and the 'breeding' of fissile isotopes from fertile isotopes (thorium-232 > uranium-233 or uranium-238 > plutonium-239).

A report by the Idaho National Laboratory states: *"For fuel type, either uranium-based or thorium-based, it is only in the case of continuous recycle where these two fuel types exhibit different characteristics, and it is important to emphasize that this difference only exists for a fissile breeder strategy."*

So should we be enthusiastic about these Generation IV designs, whether fuelled by thorium or uranium? Some of these concepts promise major advantages, such as the potential to use long-lived nuclear waste and weapons-usable material (esp. plutonium) as reactor fuel.

However, Generation IV concepts are generally those that face the greatest technical challenges and are the furthest away from commercial deployment; and they will gobble up a great deal of R&D funding before they gobble up any waste or weapons material.

Moreover, uranium/plutonium fast reactor technology might more accurately be described as failed Generation I technology. The first reactor to produce electricity − the EBR-I fast reactor in the US, a.k.a. Zinn's Infernal Pile − suffered a partial fuel meltdown in 1955. The subsequent history of fast reactors has largely been one of extremely expensive, underperforming and accident-prone reactors which have contributed more to WMD proliferation problems than to the resolution of those problems.

Most importantly, whether Generation IV concepts deliver on their potential depends on a myriad of factors − not just the resolution of technical challenges. India's fast reactor / thorium program illustrates how badly things can go wrong, and it illustrates problems that can't be solved with technical innovation.

John Carlson, a nuclear advocate and former Director-General of the Australian Safeguards and Non-Proliferation Office, writes: *"India has a plan to produce [weapons-grade] plutonium in fast breeder reactors for use as driver fuel in thorium reactors. This is problematic on non-proliferation and nuclear security grounds. Pakistan believes the real purpose of the fast breeder program is to produce plutonium for weapons (so this plan raises tensions between the two countries); and transport and use of weapons-grade plutonium in civil reactors presents a serious terrorism risk (weapons-grade material would be a priority target for seizure by terrorists)."*

Generation IV thorium concepts such as molten salt reactors (MSR) have a lengthy, uncertain R&D road ahead of them − notwithstanding the fact that there is some previous R&D to build upon.

**Weapons proliferation**

Claims that thorium reactors would be proliferation-resistant or proliferation-proof do not stand up to scrutiny. Irradiation of thorium-232 produces uranium-233, which can be and has been used in nuclear weapons.

The World Nuclear Association notes that in 1955 the US detonated a plutonium / uranium-233 composite weapon, and that in 1998 India detonated a very small device based on uranium-233. According to Assoc. Prof. Nigel Marks, both the US and the USSR tested uranium-233 weapons in 1955.

Carlson discusses other proliferation risks associated with thorium. A thorium reactor must be driven by fissile material − enriched uranium or plutonium − until such time as it is producing sufficient uranium-233 (another fissile material) to sustain a chain reaction. Those fissile materials pose proliferation risks, as do the enrichment plants used to produce enriched uranium and the reprocessing plants used to separate plutonium. Another risk noted by Carlson is that a thorium reactor (as with uranium reactors) could be used for plutonium production through irradiation of uranium targets.