The Thorium Paradigm – Mike Conley

Mike Conley is a writer from L.A., California. He is working on a novel. Has a book being published and working on a script for a documentary. He also attended the Blue Ribbon Commission hearing on May 13th the same week and same city that hosted the third Thorium Energy Alliance Conference. Washington, D.C.
They only give each person three minutes so he was only able to read the first page. He was one of five people who had a statement to support the Liquid Fluoride Thorium Reactor which was originally called a Thorium Molten Salt Breeder Reactor. Keep in mind that any details outlined about the actual design is purely a speculation and broadly based on the original designs from the 1960s by Alvin Weinberg's team at Oak Ridge National Laboratory. LFTR has flexibility of function and application.

The Thorium Paradigm

The problem is with the reactors we've been using to produce it. If the reactors at Fukushima had been Liquid Fluoride Thorium Reactors (LFTRs) they wouldn't have had a disaster on their hands.

1. Liquid-fuel reactor technology was successfully developed at Oak Ridge National Labs in the 1960s. Although the test reactor worked flawlessly, the project was shelved, a victim of Cold War strategy. But LFTRs have been gathering a lot of attention lately, particularly since the tragic events in Japan.
2. A LFTR is a completely different type of reactor. For one thing, it can't melt down. It's physically impossible. And since it's air-cooled, it doesn't have to be located near the shore. It can even be placed in an underground vault. A tsunami would roll right over it, like a truck over a manhole cover.
3. Imagine a kettle of lava that never boils. A LFTR uses liquid fuel. nuclear material dissolved in molten fluoride salt. Conventional reactors are atomic pressure cookers, using solid fuel rods to super-heat water. That means the constant danger of high-pressure ruptures and steam leaks. But liquid fuel can always expand and cool off.
4. LFTRs don't even use water. Instead, they heat a common gas like CO_2 to spin a turbine for generating power. So if a LFTR does leak, it's not a catastrophe. Just like lava, the molten salt immediately cools off, quickly becoming an inert lump of rock.
5. LFTRs burn Thorium, a mildly radioactive material as common as tin and found all over the world. We've already mined enough raw Thorium to power the country for 400 years. It's the waste at our Rare Earth Element mines.

6. LFTRs consume fuel so efficiently that they can even use the spent fuel from other reactors, while producing a miniscule amount of waste themselves. In fact, the waste from a LFTR is virtually harmless in just 300 years. (No, that’s not a typo.) Yucca Mountain is obsolete. So are Uranium reactors.
7. LFTR technology has been sitting on the shelf at Oak Ridge for over forty years. But now the manuals are dusted off, and a dedicated group of nuclear industry outsiders is ready to build another test reactor and give it a go. Will it work. If it doesn’t, we’ll have one more reactor to retire.
   But if it does work and there is every reason to believe that it will the LFTR will launch a new American paradigm of clean, cheap, safe and abundant energy.
   Let’s build one and see!

A Uranium reactor is an atomic pressure-cooker – it works just fine until it pops a gasket. Then you’ve got a mess on your hands. Even when it works properly, it wastes 95% of its fuel, making another mess. And the same procedure for making that fuel is used to make nuclear weapons. Is that any way to power a planet.

A Liquid Fluoride Thorium Reactor (LFTR, pronounced “lifter”) is a completely different approach to generating power, with none of the problems inherent in Uranium reactors and several unique advantages. If the reactors at Fukushima had been LFTRs, Fukushima would never have happened.

The Molten Salt Reactor was the precursor to the LFTR. Developed at Oak Ridge National Labs in the sixties, the MSR performed flawlessly for 20,000 hours. But in spite of its superior design and stellar performance, the program was cancelled – a victim of professional rivalry, personality conflicts, and Cold War strategy.

LFTR technology has literally been sitting on the shelf for over forty years, but it’s been gathering a lot of keen attention lately. Because if LFTRs perform as predicted (and there is a wealth of evidence to suggest that they will) they will go a long way toward resolving the four main problems that everyone has with nuclear energy – Waste, Safety, Proliferation, and Cost.

WASTE: Yucca Mountain is obsolete. Why. Because LFTRs will eat nuclear waste for lunch. They’re designed to burn fuel so efficiently, that they can also consume the spent fuel that’s wasted by Uranium reactors. LFTRs will also be able to consume the cores of dismantled nuclear weapons.

No reactor is waste-free, but a LFTR's waste will be miniscule. For a LFTR big enough to power a city of one million, the yearly long-term waste would be the size of a basketball, and becomes virtually harmless in just 300 years.

No, that's not a typo. That's how clean a LFTR will run. Its main fuel will be Thorium, a mildly radioactive element found all over the world. We have thousands of tons of it already dug up – it's in the slag piles at our Rare Earth Element mines. ("REEs" are typically found with thorium ore.)
A 1-gigawatt LFTR, big enough to power a city of one million, will run on one ton of pure Thorium a year. The current price for a ton is $107,000 (that's not a typo, either.) At the end of each year, 1,660 pounds of that ton will be "short-term" waste, meaning it's virtually harmless in one year. The other 340 lbs (the size of a basketball) will take while longer to mellow out.

SAFETY: Imagine a kettle of lava that simmers but never boils. It's super-hot, but it's not under pressure. A LFTR is essentially a kettle of atomic lava. The analogy is accurate – Thorium and Uranium reactions are what keep the earth's core molten. In a LFTR, Thorium is dissolved in molten (liquefied) fluoride salt. That's why the Molten Salt Reactor is now called a Liquid Fluoride Thorium Reactor.

If this "lava" ever leaks out (actually, it looks and flows just like green dish soap) there's no explosion, because there's nothing around the power plant for the molten salt to react with – LFTRs don't use water to keep cool, or make steam to spin a turbine. They heat a common gas like CO2 instead.

Since the liquid fuel is never under pressure, a leak would simply "pool and cool" just like lava, quickly forming a blob of solid rock on the reactor room floor. If it spilled into a flooded reactor room, it would behave like the lava flows in Hawaii. A bit of steam would billow off the cooling blob of salt, and that would be it.

Only two percent of the salt mixture is the actual radioactive fuel, and every atom of atomic fuel is chemically bonded to the salt. There are no radioactive particles floating around inside a LFTR, ready to escape. Every particle is bonded to the salt itself, and stays that way until it is burned as fuel. The big problem at Fukushima wasn't radioactive material such as Cesium leaking out of the reactors. The big problem was that it leaked out and spread into the environment. But if a LFTR leaked any Cesium at all, it would be trace amounts of Cesium Fluoride locked into the fluoride salt. Liquid fuel solves a crucial problem of environmental safety.

Once the salt has cooled, it's an inert radioactive blob with the consistency of cast iron, and dissolves in water very, very slowly. In fact, the minerals in both fresh and salt water would form a protective crust over the blob, enhancing its ability to withhold contaminants from the environment. So if the reactor room were flooded, by a tsunami or a hurricane or even sabotage, the amount of material transferred to the environment would be negligible.

Liquid fuel is stable stuff. Below 450°C (about 750°F) it's just a lump of rock, and can be broken up and collected by robots or other remote machinery. A year after the spill, it can be manually recovered by workers in radiation suits. Like any nuclear fuel, it's dangerous. But at least it'll stay put until you can clean it up.

A LFTR will naturally regulate its own temperature, but a Uranium reactor will naturally overheat, unless it's held back by a robust cooling system. Solid fuel rods get hot, and they also heat each other up, which is a good thing, but they can't expand or move away from each other to cool themselves off. For a lot of technical reasons, the coolant of choice is super-heated water, which stays liquid as long as it's kept under pressure. Hence the term "atomic pressure cooker."

In the partial meltdown at Three Mile Island in 1979, the cooling system failed for a mere ten seconds. That's all it took. At Fukushima, all the control rods dropped the moment the earthquake hit. Which was good; that stopped the fission process. But the fuel rods were still red hot, and they were still tightly packed together. And, there was no electric power to run the cooling system. So when the tsunami flooded the backup generators, everything went to hell in a hand basket.

Nuclear power is wonderful stuff, but after a series of spectacular near misses and disasters, a lot of people have written off Uranium reactors as accidents waiting to happen. The numbers on the dice are too big, they'll tell you. The risks are too great. They've had it up to here with nuclear power…

But nuclear power isn't the problem. The problem is with the reactors we've been using to produce it.

LFTRs are completely different. For one thing, they can't melt down. Ever. The reason is simple: How do you melt a liquid. Solid fluoride salt melts at 450°C. With a full load of atomic material, the temperature rises to about 700°C (1,300°F.) If the liquid fuel starts to overheat, it expands, which separates the radioactive particles and slows the fission process, cooling the molten salt back down again.

This completely eliminates the need for control rods and a cooling system, as well as all of the problems, costs, and risks associated with a pressurized light water reactor. It also entirely eliminates any possibility of a meltdown. Better yet, the fuel will be piped through a processing unit, where the contaminants that spoil solid fuel rods are easily removed. This increases the fuel-burning efficiency of a LFTR to 99%, which greatly reduces the volume and the radioactivity of its waste.

Liquid fuel changes everything.

A LFTR never operates under pressure because even with a full load of nuclear material, the molten salt is still more than 500°C below its boiling point. And if it ever does start to get too hot, a freeze plug of solid salt in a drainpipe below the reactor will melt away. The fuel will empty into a large holding tank and solidify.

On Friday afternoons at Oak Ridge, the research scientists would switch off a common household fan that cooled the freeze plug. The hot salt above the plug would melt it, and the fuel would drain out of the reactor by gravity. On Monday mornings, they would switch on the heating coils and re-melt the fuel, then pump it back into the reactor and turn on the freeze plug fan. Even Homer Simpson couldn’t screw that up. For five years, the reactor practically ran itself. They used to joke that the biggest problem they had was finding something to do.

Passive safety isn’t just built into the LFTR; it’s built into the actual fuel itself. The genius of liquid fuel is that the stuff won’t even work unless it’s held within the confined space of a reactor. In a Uranium reactor, the solid fuel rods keep radiating heat even when the control rods are dropped. The cooling system never rests. But when a LFTR shuts down, the fuel shuts down and sleeps like a rock.

Because of the constant and absolutely critical need for cooling, all Uranium reactors are located near a large body of water. It’s a tragedy that some were installed near the seashore, in the most earthquake-prone nation in the world, the very country that coined the word tsunami. But when you’re a small, crowded island nation hungry for carbon-free energy, you don’t have much of a choice…

Until now. Because LFTRs are air-cooled. That changes everything as well. Because that means they can be installed anywhere. They can even be placed in underground vaults to ward off an attack or a natural disaster. If a vault is near the ocean, a tsunami would roll right over it, like a truck over a manhole cover.

PROLIFERATION: Any rogue nation can build a 1940s-style graphite pile reactor and make the Plutonium for a bomb. That's what North Korea did. Or they can use centrifuges to purify Uranium for a bomb. That's probably what Iran is doing. Or, with a lot of expense and difficulty, they can convert a Uranium power reactor into a Plutonium breeder. The genie has been out of the bottle for over sixty years.

LFTRs convert Thorium into Uranium-233, an incredibly nasty substance. It's an efficient, hot-burning reactor fuel, but it's a very problematic weapons material. By contrast, U-235 and Pu-239 are very well behaved substances, and can be easily worked with in the lab or the factory. Out of the tens of thousands of nuclear weapons that were ever produced, the U.S. military built and tested only one U-233 " device." It was a partial fizzle, and we promptly abandoned the idea.

Even though LFTRs and LFTR fuel will be "denatured" to prevent weapons production, a rogue nation could possibly get around the fix and start a U-233 bomb program. But they'd have to start from scratch. There's a wealth of information about U-235 and U-239 weapon design, and several experienced scientists could probably be recruited. But making a U-233 bomb is a lost art.

So, yes, in theory, you could make a bomb with a LFTR. But the development of a workable device would be an expensive and painstaking affair. Even though LFTRs won't be "bomb-proof" per se, Uranium and Plutonium technology is very well known, thoroughly proven, and fully developed. So why reinvent The Bomb.

One last point: Nuclear weapons are not dependent on nuclear power. Even if every commercial power reactor in the world were taken out of service, that still wouldn't stop the bad guys from pursuing nuclear weapons. North Korea developed the bomb without generating a single watt of nuclear power.

COST: The cost of a nuclear power plant is largely determined by four elements: The reactor itself; the structure that contains it; the inspection process; and the lawsuits that are piled on the project.

This last element adds an enormous amount of time and money to the endeavor, which raises utility rates and turns off investors and insurance firms and voters. So a rational comparison can only be made with the first two elements – the cost of the reactor and the cost of the containment structure.

The inspection process varies, depending on which reactor technology is used, and a Uranium reactor's custom-made high-pressure systems require a bewildering thicket of inspections, tests, and reports. You'd think they were trying to go to the moon.

But LFTRs are an entirely different technology. In fact, it's a lot more like high-temperature plumbing than nuclear physics. And because molten salt sheds heat quite easily, an elaborate cooling system isn't even needed. A simple radiator will suffice.

Since LFTRs don't operate under pressure, high-strength valves and fittings and high-pressure pipes aren't needed, either. Off-the-shelf parts will do. Back-up generators, emergency cooling systems, control rod mechanisms, spent fuel storage pools, the crane for replacing fuel rods, the reactor pressure vessel, the airtight containment dome – all of these pricey items and more are eliminated.

For various reasons, every Uranium power reactor in America was designed and built from scratch, which significantly added to their build time as well as their cost. The plans alone would often exceed $100 Million in today's dollars.

But LFTRs will be small and standardized, allowing them to be mass-produced in factories and shipped by rail. Their low-pressure components will be much easier to assemble, allowing for faster and simplified inspection. LFTRs will be modular, so a power plant will be able to grow along with the city it serves. All these factors and more will combine to produce a trickle-down effect, greatly reducing the complexity, cost, size, and build time of each project.

The current estimate for 1-gigawatt Thorium power plant is somewhere in the neighborhood of $2 Billion. That makes Thorium competitive with coal.

CONCLUSION: Liquid fuel is the killer app of nuclear power. It's a whole new ball game. In fact, LFTRs could even replace the furnaces of our existing fossil fuel power plants, including coal. (Don't get me started about coal…) LFTRs will provide carbon-free power wherever it's needed, 24/7/365.

We've already mined enough fuel for over 400 years. They'll be mass-produced right here in America, providing plenty of good jobs, and they'll get us off of foreign oil and domestic natural gas, and even King Coal, by providing us with all the safe, clean energy we need.

Will they work as promised? Let's build one and see. Power to the Planet!

Mike Conley Los Angeles p.s.

One more thing: Last fall, a delegation from China visited Oak Ridge National Labs. When they returned home, they announced that they would be embarking on an aggressive Molten Salt Reactor program, and would be patenting everything they can think of along the way. The Chinese are eating our lunch again, and using our own damn recipe. If this isn't a Sputnik Moment, then I don't know what is.

[I recall he did improvise a few words at the end in regard to building.the LFTR: Let us build one even if we make total fools of our selves as if to say "What if we're right?"]

"THE THORIUM PARADIGM" soon to be a one-hour documentary
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