WASTE-TO-ENERGY PROPOSAL FOR YUCCA MOUNTAIN

Occupy Carson City asks that the Committee on High-Level Nuclear Waste learn about and give your support for the implementation of Liquid Fluoride Thorium Reactors (LFTRs) as a solution for our energy needs, a disposal method of conventional nuclear waste, a productive use for the Yucca Mountain site, and a source of much needed employment opportunities.

Long have the people of Nevada been opposed to nuclear energy, due to its potential for arms development and its hazardous waste. However, recently we have become aware of another alternative for safe, inexpensive and independent energy: thorium and Liquid Fluoride Thorium Reactor (LFTR) technology. The most important aspect of this new technology for Nevada is that certain configurations of LFTRs can consume the long lived radioactive elements in our present stockpiles of nuclear waste.

The US Federal government could build a Liquid Fluoride Thorium Reactor (LFTR) in Nevada at the Yucca Mountain site. The LFTR is a safer choice than storing the waste as it exists for ten-thousand years. California's nuclear waste would be fed to the Nevada reactor with minimal reprocessing. The reactor consumes the waste and converts it to carbon-free electricity, eliminating issues of long-term storage. The excess capacity could go to Las Vegas or sold to neighboring states. Moreover, this technology is scalable. Reactors could be miniaturized and made modular to be mass produced in factories. Units could then be shipped to existing Light Water Reactor (LWR) sites and consume the waste where it now rests, avoiding any future transportation issues. Nevada will be at the forefront of green energy technology with our vast expanses of sunlight, wind, geothermal energy, and now green nuclear technology.

This is not a new idea. In 2008, Senator Reid and Senator Hatch sponsored S-3060, a bill to amend the Atomic Energy Act of 1954 to provide for thorium fuel cycle nuclear power generation. The bill was not able to advance through the legislative process; nevertheless, this is an issue that is too important to ignore. With the disaster at Fukushima, the creeping threat of global climate change, and our precarious over-reliance on foreign energy, there is no better time than now to present a new direction for the state of Nevada and the United States of America.

Please become informed about thorium energy and LFTRs, and consider our proposal. Thank you for your time, consideration, and the hard work you have done for the people of Nevada.

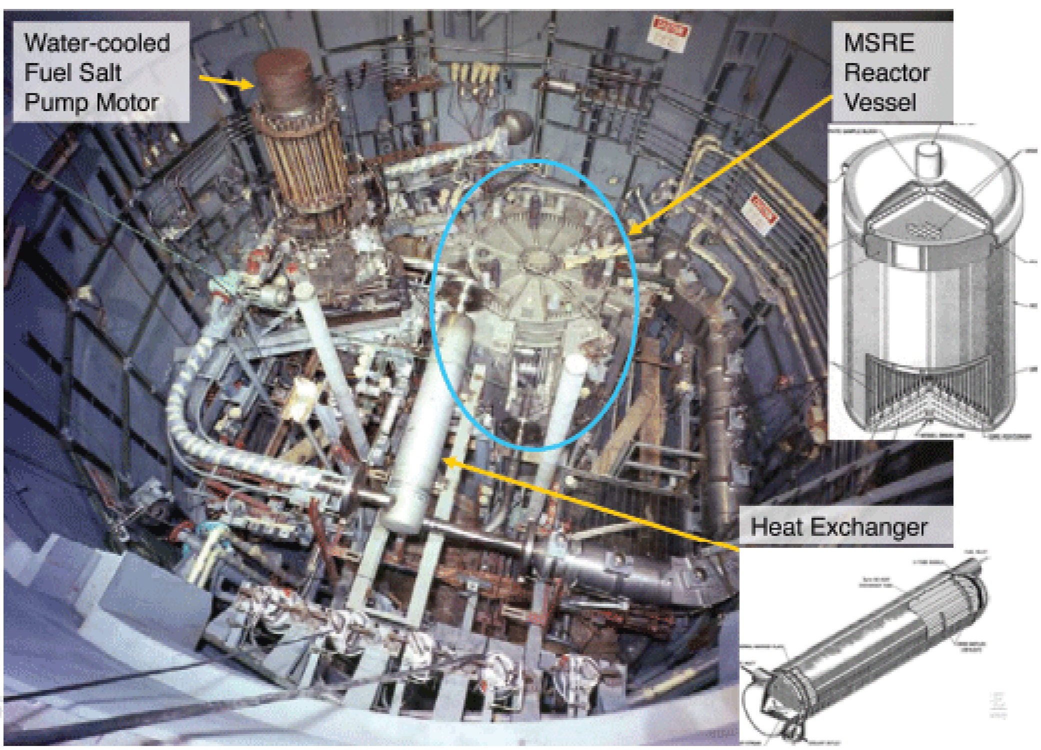
EXHIBIT D - HLRW
Document consists of 7 pages.
Entire document provided.
Meeting Date 08-21-12

A Worldwide Energy Solution America Can Supply

Dr. William H. Thesling, Ph.D. July 2012

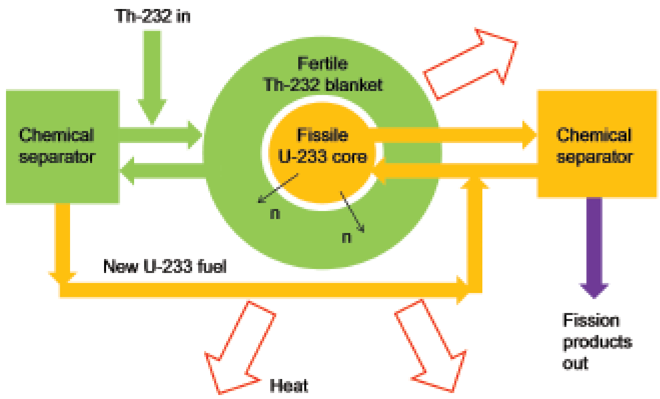
Stored solar energy is how one can think about all types of fossil fuels. Plants convert solar radiation (light) energy into chemical energy through photosynthesis. Layers of plant matter build up and, throughout millions of years, it converts into coal, oil, and natural gas.

It is noteworthy to point out that in 2011, 474 exaJoules of energy was used by the first world, or about 2 billion people – depending on how one defines the first world. This is equivalent to 449 quadrillion BTUs, representing all forms of energy combined (coal, oil, gas, nuclear, hydro, etc.). This is roughly equivalent to 15 billion tons of coal. If we wish to bring the other 5 billion people up to a first world standard of living, we would need to increase this energy production rate by three to five times, ignoring any advances in efficiency. If we wish to increase the standard of living beyond that of where the first world is today, bringing the energy per capita for everybody on the earth to twice that of the present level in the United States, we might need 10 times this rate of energy production. Achieving this with fossil fuels would be challenging to say the least. Even if one does not believe in climate change, consuming fossil fuels at 10 times the present rate should, at least, make one rethink that position.



Often considered the ultimate in renewable energy is solar energy. However, the world's energy requirements are huge. If we wanted to meet all of the world's energy needs with solar power alone, we would need a solar array that was a square, 280 miles on a side, an area approaching twice the size of the state of Ohio. Wind energy might help (wind is another form of solar energy), but it is doubtful solar energy will supply more than a small percentage of our energy needs for quite some time. Still, advances in solar cell technologies, and wind turbines, may result in solar energy being competitive with fossil fuels someday.

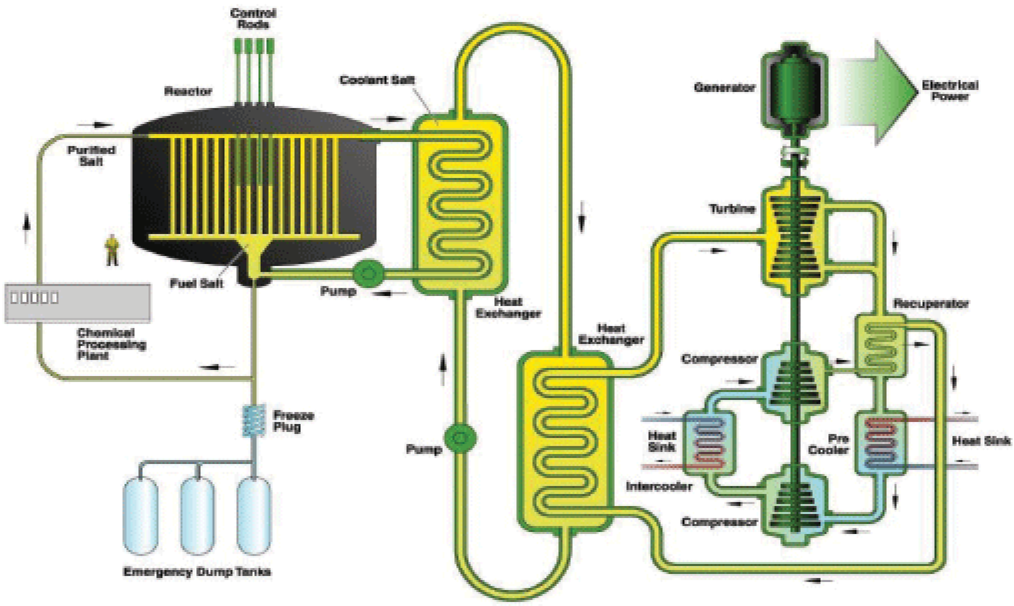
Let us aim high and ask: How can we raise the standard of living (more specifically, energy per capita) for everybody on planet Earth to U.S. levels, and increase that level by a factor of two? Also, let us achieve this without greenhouse gas emissions. To achieve this, we will almost certainly require a source that is very energy dense and available at a low cost.



Nuclear energy has one very significant advantage over all forms of fossil fuels (as well as all other forms of energy). Theoretically, nuclear energy has an energy density that exceeds that of fossil fuels by a factor of one million. The ramifications of this are enormous and cannot be overstated. If you want to have energy in abundance you need to give nuclear energy a serious look. Present day nuclear power plants consume (or burn) an isotope of Uranium, U-235. Only 0.7% of natural Uranium is U-235. The other 99.3% of Uranium is U-238. Conversion of U-238 to Plutonium-239 is through a process called breeding, where Plutonium-239 can then burn as fuel. There have been significant efforts during the past 60 years to build reactors that breed and burn Pu-239 (Liquid Metal Fast Breeder Reactors) but these have met with limited success. However, another element exists that can be bread into a consumable fuel. That element is Thorium, which can be bread into Uranium-233, also consumable nuclear fuel.

Back in the 1950s and 60s there was a significant effort to develop reactors to consume and breed U-233 from thorium. This occurred at Oak Ridge National Labs under the direction of the lab's director, Alvin Weinberg (en.wikipedia.org/wiki/Alvin_M._Weinberg). Interestingly, Weinberg is the patent holder of the light water reactor (LWR), the predominant type of nuclear power reactor used in the world today. At the dawn of the nuclear era, nearly all nuclear scientists and engineers, including Weinberg, considered nuclear power based on the consumption of U-235 as a stopgap measure. The real promise of nuclear power was to be with breeder reactors. Here, arguably, history took a wrong turn. Two methods of breeding nuclear fuel exist: Method 1 – The breeding of Pu-239 from U-238 and Method 2 – The breeding of U-233 from Th-232. Pursuit of Method 2 was not to the degree it merited. The reason's Method 1 was more vigorously pursued ahead of Method 2 were partially technical but mostly political (whitehousetapes.net/transcript/nixon/004-027). However, despite receiving only a tiny fraction of the funding of Method 1, the work done at Oak Ridge demonstrated the feasibility of breeding U-233 from Thorium as well as burning U-233 in Molten Salts. These molten salts serve as a carrier fluid for both Thorium and Uranium. The resulting design has been coined the Liquid Fluoride Thorium Reactor or LFTR. Below is a simplified LFTR diagram.

MSR lives on as a Gen-IV Concept with International Interest



In a LFTR, fission takes place in a liquid core. Fission generates heat that ultimately finds use to do some useful work (e.g. drive a turbine to make electricity). Surrounding the core is a blanket of liquid carrying Thorium. Neutrons from fission pass from the core to the blanket for absorption by the Thorium. This transforms the Thorium to Uranium-233. After chemical removal of the Uranium-233 from the blanket, it goes into the core as new fuel. Next is the chemical removal of the fission products from the core. The process is self-sustaining, requiring only Thorium as input.

A LFTR was never build at ORNL. However, they did build and operate the Molten Salt Reactor Experiment (MRSE) for four years (en.wikipedia.org/wiki/Molten-Salt_Reactor_Experiment) from 1965 through 1969. This reactor generated 7.5 Megawatts of heat, allowing the scientists to determine the design parameters and work through system issues to arrive at a design that allows for the burning nuclear fuel in molten salts. The MSRE worked out nearly all key issues needed to build a LFTR.

The MSRE demonstrated:

1. The burning of both U-235 as well as U-233 in a carrier salt of LiF-BeF2-ZrF4-UF4

2. Operation at high temperature (650°C) at full power for more than one year

3. Operation at atmospheric pressure

4. That carrier salts were impervious to radiation damage

5. The carrier salt chemistry and metals metallurgy to eliminate corrosion

6. An efficient method of on-line refueling

7. Largely validated predictions

The MSRE did not:

1. Have a blanket to breed U-233 from Thorium (therefore, it was not a complete LFTR)

2. Have the size of a utility class power plant, (this was the next step before funding ceased)

3. Have a power conversion system to generate electricity

Conventional Nuclear Power suffers from two key issues: spent nuclear fuel or nuclear waste and costs of plant construction. Significant mitigation of both of these issues is with a LFTR.

Owing to the LFTRs liquid core, fuel stays in the core until consumption. This increases the fuel efficiency enormously, by a factor of 30 or more. So, there is much less production of waste. Moreover, because there is U-233 and almost no U-238 in the core, a LFTR produces almost no transuranics, which are the reason for the long storage (300,000-year storage and Yucca Mountain). The result is that compared to conventional nuclear energy, a LFTR produces less than 1% of the waste, and that waste needs to be stored for a much shorter period (300 years).

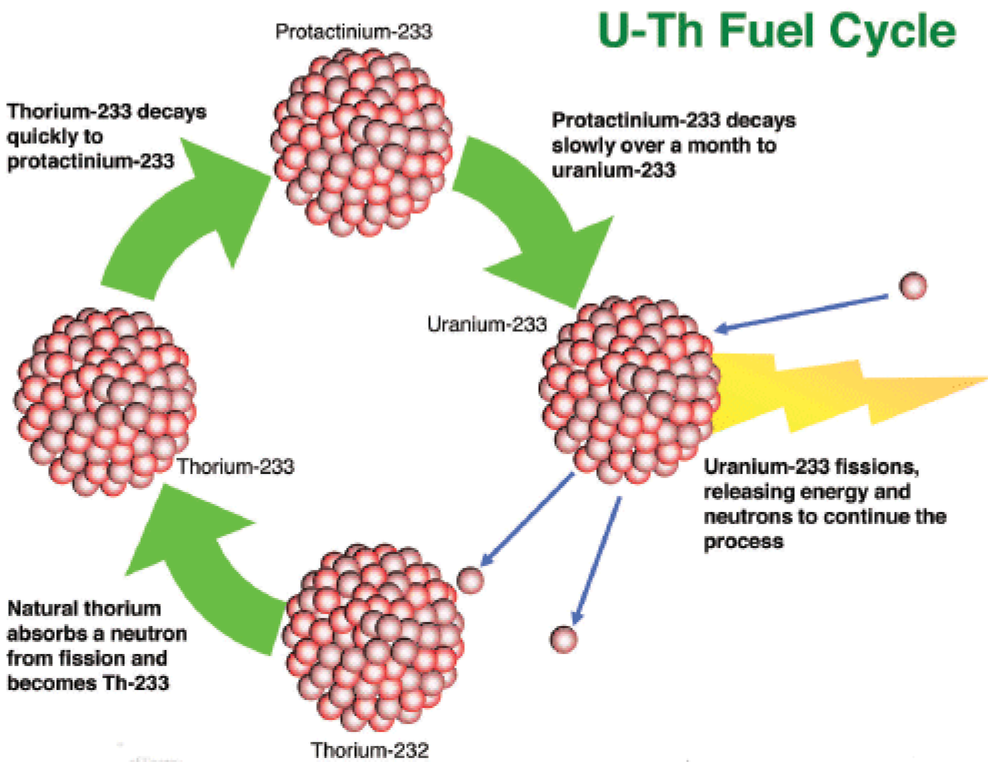
Conventional nuclear power plant costs are driven by safety issues along with the fact that water is used in the reactor to cool the core and transfer heat out to do useful work. For water to function efficiently as a medium to carry heat to a turbine, it needs to be much hotter than the 100°C where water normally boils. Accomplishment of this is by running the reactor under pressure – up to 140 atmospheres of pressure. This means the reactor is inside a pressure vessel at pressures up to 2,000psi. If for some reason pressure was lost, (e.g., a pipe break), the water would flash to steam and cooling of the reactor core would all but cease. Fission would stop, but the decay heat (heat generated from residual radioactivity from the fission products) would continue. If we do not get water on the core to cool it, the core will soon melt and release the fission products. This is what happened at Fukushima. Guarding against this event drives the design of the reactor and drives up the cost enormously. We have a thick steel walled pressure vessel, placed inside a thick walled reinforced concrete containment building with about 1,000 times the internal volume of the reactor pressure vessel (to contain the steam), and we have a variety of pumps and backup systems to get water on the core if things go wrong. All built to reactor grade specifications. Contrast this to a LFTR. Because LFTRs use molten salts that remain liquid at high temperatures and at atmospheric pressures, LFTRs have no need for a pressure vessel. LFTRs have no water that can flash to steam and thus no need for the large reinforced concrete containment building. If you need to shut down a LFTR, you drain the liquid core into a series of drain tanks underground, configured to dissipate the decay heat passively. There is no need for high-pressure backup pumping systems to keep the core cool in the event of an emergency. This significantly simplifies the total system design and lowers the capital cost. In fact, the liquid core of a LFTR allows for compact designs that can be built in a modular fashion in a factory, significantly driving down costs further.

LFTRs have some significant advantages compare to today's nuclear power. The most significant of these stem from the liquid core running at atmospheric pressure.

These advantages are:

1. No water under pressure, therefore no pressure vessel, reducing cost
2. No large reinforced concrete containment building is required, reducing cost
3. Can be built in a factory, reducing costs
4. Because the core can be drained, LFTRs exhibit an enormous level of passive safety
5. Can be refueled without shut down
6. Exhibit 100% fuel burn up and generates almost no long lived radioactive waste
7. Configurations of LFTRs can consume the long lived radioactive elements in our present stockpiles of nuclear waste
8. Allow for the extraction of molybdenum-99 for medical purposes. Eliminating a supply shortage issue (ncbi.nlm.nih.gov/pubmed/21512666)
9. Allows for the extraction (in large quantities) of other radioactive isotopes for medical purposes
10. Can operate at high temperature, allowing the use of waste heat to desalinate seawater; higher temperatures can make for economical generation of synthetic fuels, (could use CO_2 from the atmosphere, thus making synthetic fuels carbon neutral)

Thorium exists in high concentrations in a number of locations on earth, often found in high concentrations with rare earth elements (REEs). Because present policy requires treating thorium as low-level nuclear waste, very little REE mining occurs within the United States (thoriumenergyalliance.com/downloads/TEAC4%20presentations/Kennedy_TEAC4.pdf).



Since 100% of Thorium in the earth's crust is Th-232 you can use all natural Thorium as fuel. The earth's crust has nearly four times as much Thorium as Uranium. In fact, small amounts of thorium are present in all rocks, soil, water, plants, and animals. Soil contains an average of about six parts of thorium per million parts of soil. That may not sound like much, but recall that the energy density of Thorium is over 1 million times greater than that of any fossil fuel. That means there is roughly the energy of four barrels of oil (in the form of thorium) in a cubic foot of dirt, everywhere – including the dirt in your backyard. Therefore, if the population of the earth was to consume energy at 10 times our present rate, we could power the world for one year on 10 billion tons of dirt. The world presently consumes more than half this quantity of coal alone in a single year. Since we are talking about common dirt, we could supply the world with energy (at 10 times our present rate) for millions of years. Additionally, thorium exists in a number of locations around the world, including the United States, at much greater concentrations than six parts per million. To learn more visit energyfromthorium.com/lftradsrisks.html.

All images courtesy of U.S. Department of Energy and Oak Ridge National Laboratory, Advanced SMR Technology Symposium Small Modular Reactors, 2011