4420 York Ave. S.
Minneapolis, MN 55410

July 26, 2012

Sierra Club Board of Directors
cc: Michael Brune, Executive Director

Dear Director:

I am a lifetime member of the Sierra Club and the Sierra Club is the only organization of which I am a lifetime member. I am committed to the Sierra Club's primary goal, the preservation of wilderness, but hope to convince you that the Sierra Club's current policy with regard to nuclear power is outdated at best, and severely biased at worst. Let me quote from page 5 of the Sierra Club's current Energy Resources Policy:

There is no time to lose.

I need not emphasize to you the grave issues of global warming, acidification of the oceans, the albedo effect, CO2 & methane release from melting permafrost, or any of the many studies indicating that there is indeed "no time to lose." (The ocean pH now is lower than at any time in 300 million years.)

Please turn to the attached table now and quickly review the Club's nuclear power policy and realize, as I do, that it is narrowly tailored to cover only a single type of nuclear reactor (a light water reactor) and does not apply to other types of nuclear reactors, including the molten salt reactor (MSR), nor to a specific type of MSR—a liquid fluoride thorium reactor (LFTR).

What I am urging that you do at the NEXT board meeting (not next year) is to pass a resolution modifying your various policies related to nuclear power, specifically limiting them to light water reactors only. While I believe that a new Sierra Club nuclear power policy which embraces and encourages research and development into MSRs would be our best policy (as the only realistic way to offset global warming), let's start small and simply make clear the limitations of the Club's current nuclear power policy. You can't argue with being accurate.

You may be wondering, as many are, if the molten salt reactor is so revolutionary, why aren't we using it instead of light water reactors? The answer is complex but can be simplified to be: Adm. Hyman Rickover and nuclear submarines in the 1950s, fuel for nuclear weapons, blind faith in the failed fast breeder reactor, and the politics and money associated with a huge, locked-in industrial base. I recommend that you read the books *Super Fuel: Thorium, the Green Energy Source for the Future*, by Richard Martin, and *The First Nuclear Era* (memoirs of the light water reactor co-inventor, Alvin Weinberg) if you are interested in the history of how thorium and the molten salt reactor lost out to uranium and light water reactors.

As the attached table shows, molten salt reactors (and liquid fluoride thorium reactors in particular) directly address the concerns of the Sierra Club's policies. They have been used, and can be used again! If you are thinking that a revamped nuclear-power policy may be divisive for the Club, or will require too much time and effort, then I would also like to remind you of the first sentence of the Sierra Club's Energy Resources Policy:

Our society now faces a fundamental challenge greater than any in history.

There has been no new Sierra Club nuclear power policy since 1986. Isn't it time for an updated policy that acknowledges that most all of the problems associated with nuclear power stem from uranium and water reactors, that if there is to be any hope of slowing global warming nuclear power must be considered, and in particular, shouldn't an inherently safe molten salt reactor run on thorium be considered?

Clean energy resources are sufficient to address climate change . . .

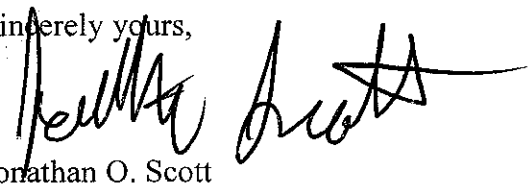
says the Energy Resources Policy on p. 21. Is this true? Certainly the Sierra Club's energy policies that focus on renewables and efficiency are laudable, and may have had some effect in slowing global warming. But have these policies resulted in the end of global warming? Certainly not. A disinterested observer must conclude that after 40 years of an anti-nuclear policy that the planet is in trouble. In short, the Sierra Club energy polices have not worked and have even encouraged dominance of combustion power (combustion companies invest in wind and solar, but not in nuclear, because they know wind and solar power cannot threaten their interests as nuclear power can).

I urge you to think long term, and realize that while renewables and efficiency are important, they will never be enough to satisfy the planet's energy needs. You will not be going it alone by accepting nuclear power: Patrick Moore, co-founder of Greenpeace, endorses nuclear power as the only way of slowing global warming. And, I remind you that the Clarification of Conservation Initiatives adopted by the Board on March 4-5 2006 states:

The club's highest priority for the next decade as an institution is to build capacity and focus on smart energy solutions.

I hope you will take the "smart" approach, show new wisdom in supporting a true competitor to combustion interests, and raise and act upon this issue at the NEXT board meeting.

Sincerely yours,



Jonathan O. Scott

To Which Nuclear Reactors do Sierra Club Policies Apply?

Sierra Club Nuclear Power Policy, Energy Resources Policy and Nuclear Fact Sheet	Policy applies to: a **Light Water Reactor**?	Policy applies to: a **Molten Salt Reactor** (MSR)?
There are . . . "significant safety problems inherent in reactor operation." (*Nuclear Power Policy, 1974.*) "Nuclear power can cause catastrophic damage . . ." (*Fact Sheet* citing the light water reactors of Chernobyl, Three Mile Island and Fukushima).	Yes. A light water reactor is *pressurized*, meaning that if anything goes wrong it can explode. (Pressurized reactor plumbing and structure exploded at Fukushima; there was both a steam explosion and graphite moderator fire at Chernobyl; and, Three Mile Island released some radioactive gas, with no ill effects. Chernobyl was a distinct type of reactor not used outside the former Soviet Union.)	**No**. An MSR is not pressurized because it uses a stable liquid salt fuel. Its temperature is inherently self-regulating. An MSR is <u>inherently</u> safe due to natural processes like thermal expansion and gravity drain.
	Yes. Loss of electrical power can be catastrophic because pumps are needed to circulate cooling water even after shutdown of fission, to remove decay heat. A tsunami wiped out generators at Fukushima. Further, the solid fuel of a light water reactor cannot be quickly moved if there is a problem.	**No**. In the event of electrical power loss fail-safe valves melt or lose magnetic sealing and gravity drains all fuel salt into underground holding tanks. Inherently, a liquid fuel can be moved using good ol' gravity (gravity is guaranteed not to stop working).
"The Sierra Club is concerned that the safety margins in some water-cooled reactors . . . are not sufficient to avoid accidental release of radioactive material." (*Nuclear Power Policy, 1972.*)	Obviously.	**Obviously not.** Molten salt reactors are not water cooled. In comparison to water's 100C range (330C if pressurized), molten salts have over 1000C range of safe operation, with no pressurization needed.

Sierra Club Nuclear Power Policy, Energy Resources Policy and Nuclear Fact Sheet	Policy applies to: a **Light Water Reactor**?	Policy applies to: a **Molten Salt Reactor** (MSR)?
There are . . . "significant safety problems inherent in disposal of spent fuels." (*Nuclear Power Policy, 1974.*) "Nuclear waste lasts for thousands of years." (*Fact Sheet.*) "Nuclear waste transportation, storage, and disposal problems remain unsolved." (*Energy Resources Policy, p. 20.*)	Again, yes. A light water reactor generates about 600 lbs/GW-Year of transuranic waste, plus shorter-lived fission products, whose decay heat accounts for the spent-fuel cooling requirement of 3 years or so. Fundamentally, spent fuel in a light water reactor is a problem because it is *solid fuel*. The fission products and transuranic waste are trapped in the spent fuel, which must be removed, transported and stored before all usable fuel (e.g., U235) has been used. Some trapped isotopes are gasses and cause voids or inhibit fission, meaning that more fuel than needed must be used initially, thus adding to fuel cost and creating more spent fuel.	**No**. A liquid fluoride thorium reactor (LFTR, a type of MSR) generates only 3 lbs/GW-Year of transuranic waste. Fission products may be kept in the reactor salt because their decay heat is valuable (~7% of peak power). Some products are valuable in medical, industrial and scientific applications (*e.g.*, technetium has medical uses, Pu238 is essential for NASA flights to Mars). An MSR can generate $100 million in isotope revenue per year. **Fundamentally**, fuel is handled more easily in a molten salt reactor because the reactor uses a *liquid fuel*. The undesirable fission products bubble out and can be extracted for sale or waste storage. Most can often be simply left in the salt, because they are stable salt compounds yielding valuable heat. Transuranics produced in a liquid fluoride thorium reactor are in very small amounts because thorium 232 is 7 neutron captures away from plutonium 239, while uranium 238 (in a light water reactor) is only 1 neutron capture away. This is why a light water reactor can be used to make weapons material. A LFTR produces orders of magnitude less ultimate waste in a 30-year operating cycle. A liquid fluoride thorium reactor can actually burn spent fuel from light water reactors!
"Radioactive fuel rods are stored in pools around reactors across the country." *Fact Sheet.*	Yes.	**No**. There are no fuel rods; the fuel is liquid and never outside the reactor. The wastes may remain in solution or be extracted. If extracted, there is far less of it and valuable isotopes are immediately ready for sale.

Sierra Club Nuclear Power Policy, Energy Resources Policy and Nuclear Fact Sheet	Policy applies to: a **Light Water Reactor**?	Policy applies to: a **Molten Salt Reactor** (MSR)?
There exists . . . "possible diversion of nuclear materials capable of use in weapons manufacture." (*Nuclear Power Policy, 1974.*) "Governments must maintain costly security programs to protect nuclear plants;" "nuclear reactors are targets for terrorists;" and "reprocessed nuclear fuel can be used to make nuclear weapons." (*Fact Sheet.*) "The nuclear fuel cycle increases weapons proliferation." (*Energy Resources Policy, p. 21.*)	Yes. A light water reactor produces solid plutonium in its fuel rods. Because used fuel is stored on site or transported, there must be security. Light water reactor fuel contains about 95% U238 meaning that it is "easier" for neutron absorption to make solid plutonium (a mixture of 239, 240 and 241 isotopes) because fewer neutrons need be absorbed. Reprocessed spent fuel can be used for nuclear weapons only if an expensive isotopic-separation facility is available to get rid of almost all Pu240 (which spontaneously fissions and ruins a bomb being assembled). This makes spent fuel much less attractive to unprofessional weapons makers. Less expensive alternatives, such as laser separation, are becoming available. In other words, even this Sierra Club policy with respect to light water reactors is not quite accurate.	**No**. A liquid fluoride thorium reactor (LFTR, a type of MSR) does not produce much plutonium at all. And, the plutonium can remain in the reactor as a salt, until it fissions, or is removed for other purposes. A LFTR breeds and uses U233 for its fuel, which, because there is far less needed to begin with, and because it is more "difficult" for U233 to absorb enough neutrons to become a transuranic, means that production of plutonium is rare and in small quantities in the salt. If desired, the transuranics can be left in the liquid fuel. So, what about the U233 and plutonium left in the liquid fuel? Good luck trying to spend 20 hours inside of a reactor trying to siphon enough of it off without being discovered (let alone being burned to a crisp). Besides, it would be easier for a terrorist to enrich their own U238. And, U233 makes a poor bomb. Security on the scale of a light water reactor would not be required for an MSR for the above reasons, and since the entire reactor and fuel-handling chemistry are enclosed in a sealed, underground hot cell, using remote/robotic manipulations. **And finally, did you know that MSRs can actually burn plutonium, etc. from light water reactors?!**

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"Transporting nuclear waste to a centralized site poses a risk to nearby people and it would be a potential target for terrorists." (*Fact Sheet.*)	Yes.	**No**. Because there are far fewer fission products and transuranics, transportation would be minimal; even after decades, the small amounts of waste could be vitrified and disposed of in a small, on-site borehole. As mentioned above, terrorists would not find it useful to target an MSR. And, there would be no fuel or other radioactive materials above ground.
"Uranium miners are at risk of exposure to radioactivity." (*Fact Sheet.*) "Uranium ore mining leaves behind tons of rock in the form of radioactive tailings. Hundreds of millions of tons of long-lived mining and milling wastes have been generated in the U.S." (*Fact Sheet.*) "Uranium miners and nearby populations are exposed to radon gases." (*Fact Sheet.*)	Yes.	**No**. A LFTR uses thorium which is far less radioactive than uranium (thorium has a 14 billion-year half life—the age of the universe we can see). Thorium is already being mined as a by-product of producing rare-earth metals. 5,000 tons are typically produced each year in a rare-earth mine. In fact, thorium need not be mined: there is 3,200 tons of thorium buried and available in Nevada. Less mining means less radon gas. Thorium is 10ppm of the earth's crust, so many thousands of years are easily available, if needed. No refining or enrichment is required because thorium has only one common isotope and need not be processed in any expensive way—it simply needs standard chemical conversion to a chloride or fluoride salt. Thorium is also a dense energy source. One ton will power a large city for a year. There is little environmental impact from thorium production or use. Its primary uses have been in welding rods, glass lenses, gas-lantern mantles and even toothpaste.

Sierra Club Nuclear Power Policy, Energy Resources Policy and Nuclear Fact Sheet	Policy applies to: a **Light Water Reactor**?	Policy applies to: a **Molten Salt Reactor** (MSR)?
"Nuclear power is the largest water consumer among all energy technologies." (*Fact Sheet.*)	Yes.	**No.** An MSR does not use water for cooling or heat transfer. It uses a liquid salt that self regulates its temperature and that can be used to transfer heat to any generation cycle, preferably an inert-gas, high-temperature cycle such as the Brayton Cycle.
"Nuclear power is not as cost-effective as it seems because of subsidies." (*Fact Sheet.*)	Yes.	**Perhaps**. Fuel cost is almost zero. Construction costs are low because no vast containment or emergency systems are needed. Security and spent fuel storage costs are far less. An MSR or LFTR also produces valuable isotope income as it runs. And, siting is water independent. But, if a LFTR can replace a dozen coal-fired plants, wouldn't it be worth it?
"The huge investment to bring additional nuclear facilities online would siphon capital . . . . ." (*Energy Resources Policy, p. 21.*)		**Perhaps not**. Private investment is poised to invest in a molten salt reactor. See Flibe Energy, the Waste Annihilating Molten Salt Reactor from MIT, the Denatured Molten Salt Reactor from Ottawa Valley Research Associates, and the many foreign countries, like China, that are pursuing MSRs.
A molten salt reactor (or, specifically, a liquid fluoride thorium reactor) has never been tried and would be extremely risky and costly to develop. (Not part of a Club policy, but the issue may be raised.)		**No**. The U.S. successfully built and ran a molten salt reactor at Oak Ridge National Laboratory in the 1960s, the largest operating from 1965 to 1969. Only mistaken funding choices by the Nixon administration prevented full MSR implementation. China announced in February 2011 that it will develop a thorium-fueled molten salt reactor by 2020.
It would take too long to develop a new type of nuclear reactor. (Not part of a Club policy, but the issue may be raised.)		**No**. The Sierra Club MUST plan for the long term. Besides, we already know that a molten salt reactor works! And, it is one of DoE's Generation-IV designs designated for development.