2013 HOUSE ENERGY AND NATURAL RESOURCES

HB 1190

2013 HOUSE STANDING COMMITTEE MINUTES

House Energy and Natural Resources

Pioneer Room, State Capital

HB 1190
February 7, 2013
18462

☐ Conference Committee

Relating to intrastate use of thorium

Minutes: *1-3 Attachments*

Rep. Porter: We will the hearing on HB 1190.

Rep. Maragos: I introduced this bill on behalf of 2 men who have an idea they would like to explain to you why this legislation is needed in pursuit of the goals to achieve their ideas. have also prepared some amendments that came about as a result of pre-hearing discussions that were held and some concerns were raised and these are being introduced to a lay those concerns.(Attachment 1)

Allen Kruse: Chief Executive Officer for Rare Earth Energy; N.D. is one of those states that we feel is leading the charge, and setting the charge, and setting an example to the rest of the nation, by making it possible to utilize the natural resources within its borders. We are here to discuss this bill in an element called thorium a type of nuclear reactor that is based molten fuel that can use thorium.

Dr. Brewer: Chief Technical Officer at Rare Earth Energy; I am here to express my support to HB 1190 (Attachment 2) N.D. has been an integral part in bringing this technology into the 21 century. However, with ever tightening Federal air quality regulations, one of the major concerns related to the use of this processes for the production for fuel liquids from coal and natural gas is the creation of emissions from the process itself: Either through the burning of feedstock to create the heat necessary to drive the reaction of from the liquid faction processes and emission of the intermediate CO2 or CO feedstock gas.

Rep. Anderson: Are these reactors self-regulated?

Dr. Brewer: Yes; during its operational period at Oakridge National Lab there was one occurrence during that time where the control rods were pulled out to see how the temperature of the salt changed and if it levelized or if it kept going up. At they were retracting the rods the rods failed and pulled the rods out where there was no control of the salt. The reactor which was sustained at 800 degrees through the use of the control rods

increased in temperature up to about 950 degrees Celsius and then leveled off and then dropped back down on its own without the reemployment the control rods.

Rep. Anderson: Is there a reason why they built part of the reactor under the ground. Is there a reason for that?

Dr. Brewer: One of the reasons why is what they are showing and what you see online is what they think is an idealized version of these reactors. As part of the NRCs current reaction on the light water reactors they went and designed implementing underground aspects of it.

Rep. Silbernagel: Have you had any conversations with the EERC on Grand Forks?

Dr. Brewer: Yes we have regarding the molten salt technology and as they have stated to us they are not nuclear experts, but what they are experts in is the use of process heat.

Rep. Keiser: Can you share your communications with the NRC and reactions you have had relative to this legislation?

Dr. Brewer: We have not talked to the NRC regarding this legislation. The discussions we have had with the NRC and the people associated with the NRC are scientists from Berkley, Madison, and MIT are in the process of helping China develop this technology for the DOE.

Rep. Hunskor: Why would you say "at the federal level" nothing has been done at that level for years?

Dr. Brewer: This goes into the speculation aspect. There has been much speculation and conversation to the fact that some believe that the NRC is protecting the solid fuel markets as well as the current light water fleet.

Rep. Anderson: This is an interesting concept to me. What effect would this have on you guys if this went into a legislative study?

Dr. Brewer: Not only would it affect us but what the state and the committee need to consider is what kind of outcome it would have on the state and the country.

David Glatt: Chief of the Environmental Health Section for the N.D. Dept. of Health; the environmental section is responsible for the implementation of many of the environmental protection programs in the state. (Attachment 3)

Rep. Keiser: Is it true that some government entities within the United States are working in China developing this technology? What was the comment other than they maintained they have regulatory authority; when do they plan on moving on this technology?

David Glatt: It is my understanding that countries such as China and India are looking at this; other countries have looked at this, some with mixed results some with stating that may be something good and others stating that the benefits are overstated.

Rep. Schmidt: You talk about bad implementation and rules that address the use, storage and handling and disposal of radioactive sources, but on the testimony I quote" less radio than bananas and radiation can't penetrate the skin".

David Glatt: We have heard that it will have a radioactive characteristic I don't know how high that would be.

Rep. Nathe; you suggested a possibility of a study. How do you see that study going?

David Glatt: The first thing I would have dialog with the NRC to see where the law is and what we could do or somebody could do to push this forward.

Rep. Porter: Do you see this as something to empower and along with your assistance throughout the interim come back with recommendations or at least the recommendations to give us the information to move forward.

David Glatt: I think that would be reasonable path.

Rep. Mock: If you had a chance to see the amendments at all? And is your position consistent with the amendments?

David Glatt: I still have some concerns.

Rep. Porter: We will close the hearing on HB 1190.

2013 HOUSE STANDING COMMITTEE MINUTES

House Energy and Natural Resources

Pioneer Room, State Capital

HB 1190
February 8, 2013
18601

☐ Conference Committee

To create and enact chapter 23 of the N.D. century Code relating to the intrastate use of thorium

Minutes:

Rep. Porter: In viewing the fiscal note if this go out as a do pass I would be very uncomfortable sending it to the floor without going to appropriations from the stand point of how the fiscal note reads. We have a motion for a do not pass for HB 1190 from Rep. Keiser and a second from Rep. Hofstad. Motion carried

Yes 12 No 0 Absent 1 Carrier: Rep. Silbernagel

FISCAL NOTE
Requested by Legislative Council
01/14/2013

Bill/Resolution No.: HB 1190

1 A. **State fiscal effect:** *Identify the state fiscal effect and the fiscal effect on agency appropriations compared to funding levels and appropriations anticipated under current law.*

	2011-2013 Biennium		2013-2015 Biennium		2015-2017 Biennium	
	General Fund	Other Funds	General Fund	Other Funds	General Fund	Other Funds
Revenues						
Expenditures						
Appropriations						

1 B. **County, city, school district and township fiscal effect:** *Identify the fiscal effect on the appropriate political subdivision.*

	2011-2013 Biennium	2013-2015 Biennium	2015-2017 Biennium
Counties			
Cities			
School Districts			
Townships			

2 A. **Bill and fiscal impact summary:** *Provide a brief summary of the measure, including description of the provisions having fiscal impact (limited to 300 characters).*

The Bill requires the Department to issue a permit to operate a refinery in the state producing thorium that is used commercially or privately in this state and to issue a permit to a facility which uses molten fluid fueled reactors commercially or privately within the borders of the state.

B. **Fiscal impact sections:** *Identify and provide a brief description of the sections of the measure which have fiscal impact. Include any assumptions and comments relevant to the analysis.*

Sufficient information is not available regarding the thorium mineral extraction process, the generation process and associated waste streams (i.e. air, water, waste) to determine a fiscal impact on the department and formulate a rational fiscal impact estimate. The Department does not currently have the authority to regulate reactors, which are the exclusive jurisdiction of the Nuclear Regulatory Commission (NRC). The refining of thorium meets the definition of a mill, which North Dakota is not authorized to regulate or administer rules. The Department would need to amend the current agreement with the NRC to allow state oversight, which is estimated to take several years to complete. This may require the addition of several staff to adequately monitor depending upon the complexity of the operation and rules. For the above referenced reasons we are unable to provide a reliable fiscal note. However, we are confident that a significant fiscal impact would occur.

3. **State fiscal effect detail:** *For information shown under state fiscal effect in 1A, please:*

A. **Revenues:** *Explain the revenue amounts. Provide detail, when appropriate, for each revenue type and fund affected and any amounts included in the executive budget.*

B. **Expenditures:** *Explain the expenditure amounts. Provide detail, when appropriate, for each agency, line item, and fund affected and the number of FTE positions affected.*

C. **Appropriations:** *Explain the appropriation amounts. Provide detail, when appropriate, for each agency and fund affected. Explain the relationship between the amounts shown for expenditures and appropriations. Indicate whether the appropriation is also included in the executive budget or relates to a continuing appropriation.*

Name: Brenda M. Weisz

Agency: Department of Health

Telephone: 328-4542

Date Prepared: 01/17/2013

Date: 2-8-2013
Roll Call Vote #: 1

2013 HOUSE STANDING COMMITTEE
ROLL CALL VOTES
BILL/RESOLUTION NO. 1190

House Natural Resources Committee

☐ Check here for Conference Committee

Legislative Council Amendment Number _____

Action Taken: ☐ Do Pass ☒ Do Not Pass ☐ Amended ☐ Adopt Amendment

☐ Rerefer to Appropriations ☐ Reconsider

Motion Made By Rep Keiser Seconded By Rep Hofstad

Representatives	Yes	No	Representatives	Yes	No
Chairman Todd Porter	✓		Rep. Bob Hunskor	✓	
Vice Chairman Chuck Damschen			Rep. Scot Kelsh	✓	
Rep. Jim Schmidt	✓		Rep. Corey Mock	✓	
Rep. Glen Froseth	✓				
Rep. Curt Hofstad	✓				
Rep. Dick Anderson	✓				
Rep. Peter Silbernagel	✓				
Rep. Mike Nathe	✓				
Rep. Roger Brabandt	✓				
Rep. George Keiser	✓				

Total (Yes) 12 No 0

Absent 1

Floor Assignment Rep Silbernagel

If the vote is on an amendment, briefly indicate intent:

REPORT OF STANDING COMMITTEE

HB 1190: Energy and Natural Resources Committee (Rep. Porter, Chairman) recommends **DO NOT PASS** (12 YEAS, 1 NAYS, 0 ABSENT AND NOT VOTING). HB 1190 was placed on the Eleventh order on the calendar.

2013 TESTIMONY

HB 1190

13.0253.02001
Title.

Prepared by the Legislative Council staff for
Representative Maragos
February 5, 2013

PROPOSED AMENDMENTS TO HOUSE BILL NO. 1190

Page 1, after line 14, insert:

"2. Within legislative appropriation and as a prerequisite to administering this chapter, the department must employ or contract for the necessary personnel and subject matter experts to comply with this chapter.

3. The department shall adopt rules for the permitting and regulation of thorium refineries and facilities."

Page 1, line 15, replace "2." with "4."

Page 1, line 22, replace "3." with "5."

Page 2, line 3, replace "4." with "6."

Page 2, line 7, replace "5." with "7."

Page 2, line 7, replace "limits" with "may be construed to limit"

Page 2, line 9, replace "6." with "8."

Page 2, line 15, replace "7." with:

"9. Regardless of the provisions in subsections 5 and 8 on intrastate law, the regulation of thorium facilities, or in particular to a commercial or private molten fluid fueled reactor, is primarily that of the state until there are federal regulations on the subject matter."

Page 2, line 15, replace "formulate" with "assist the"

Page 2, line 15, after "state" insert "in creating state regulations"

Page 2, line 16, after "or" insert "create"

Renumber accordingly

Statement of

Allen Kruse
Chief Executive Officer
Rare Earth Energy

&

Joseph Brewer, Ph.D.
Chief Technical Officer
Rare Earth Energy

Before the

Committee on Energy and Natural Resources
North Dakota State House of Representatives

February 7, 2013

INTRODUCTION

Chairman Porter and Members of the Committee, my name is Allen Kruse, and I am the Chief Executive Officer for Rare Earth Energy. Thank you for giving myself and my colleague Dr. Brewer the opportunity to be here today and for taking the time to hear testimony from us in support of House Bill 1190.

As this committee is well aware, the quest for energy independence is not just an endeavor that affects North Dakota and its citizens exclusively, but all Americans. Federal and State governments as well as private enterprise are working hard to try and address and find solutions for our nation's growing energy needs. North Dakota is one of those states that we feel is leading the charge, and setting an example to the rest of the Nation, by making it possible to utilize the natural resources within its borders for not only the benefit of the State and its people, but of the country as well. North Dakota understands very well that through the utilization of its assets that it can and has created economic possibilities that at one time may have seemed impossible. Putting the infrastructure in place that allows and encourages free enterprise and free markets to come to North Dakota and to flourish, is what has put North Dakota on the path to economic prosperity for generations to come.

It is this very forward looking, progressive thinking that led a North Dakota to come back home, for us to open our business here and has ultimately brought us before you today. We are here to discuss this bill, an element called thorium, a type of nuclear reactor that is based upon molten fluid fuel that can use thorium, and how we were the country that developed it over 40 years ago and are still not utilizing this technology today. At this time I would like to introduce my colleague, Dr. Joseph Brewer:

Chairman Porter and members of the Committee: Thank you for having us here today. My name is Dr. Joseph Brewer, Chief Technical Officer at Rare Earth Energy. I am here to express support of HB1190 not just as a scientist, but as a fellow North Dakotan.

I would first like to acknowledge the great strides North Dakota has made in economic diversification in recent years. After graduation from Velva High School (2000) and Minot State University (2004), I was left with very few options for where to find work as a scientist. Much like many of the graduates of the physical sciences from ND, I too found myself as part of the brain drain statistics that plagued the state for years. The State of North Dakota has done fantastic work in recent years in aggressively pursuing avenues to retain the youth and cease the brain drain that had so many North Dakotans worried for so long.

In 2004, as I left for my laboratory job in Denver and subsequent graduate schooling at the University of Nebraska, I was determined to find my way back: I wasn't going to be a permanent statistic. When coming back, I was determined to not just bring my wife and kids with me, but also an advanced degree, ideas and an entrepreneurial spirit to create jobs for the scientists and engineers of the state. I was not going to let what happened to me happen to another generation of North Dakotan college students. I was going to do my part to make sure that North Dakotans had options and to make sure that the state doesn't have to deal with brain drain ever again.

HB1190 would allow North Dakota to develop the technology necessary to cleanly utilize its God-given natural resources of coal and oil. In developing this technology, there would be hundreds of jobs for our states physicists, chemists and engineers for many years to come. Our power producers and oil refiners, such a Basin Electric and Tesoro, would have access to a technology that would allow them to generate the cleanest, most efficient energy on the planet.

Coal to synthetic liquid fuels, though relatively obscure, is also not a recent technological development and is not new to the state of North Dakota. The Bergius hydrogenation process and Fischer-Tropsch process were both developed and patented in Germany about 10 years before the outbreak of World War II.(Stokes 1985; Miller 2011) The development of synthetic fuel technologies came about as a response to an increasing demand for imported crude, which the National Socialist Party deemed to be a national security issue, and as a means of utilizing abundant coal reserves to meet the energy demands of the pre-war military build-up as production from German owned oil reserves began to decline.(Stokes 1985)

North Dakota has been an integral part in bringing this technology into the 21st century. However, with ever tightening Federal air quality regulations, one of the major concerns related to the use of these processes for the production of fuel liquids from coal and natural gas is the creation of emissions from the process itself: Either through the burning of feedstock to create the heat necessary to drive the reaction or from the liquefaction process and emission of the intermediate CO_2 or CO feedstock gas.

The combination of two old technologies, both of which were developed around events associated with WWII, could lead to the significant long-term economic diversity for the state of North Dakota for hundreds of years and reduce emissions associated with the utilization of our resources.

That technology is known as the Molten Salt Reactor (MSR). MSR technology was developed, along with current light water reactor technology, as a continuation of the Manhattan Project following WWII.(Uhlir 2005) The liquid fuel reactor technology was developed at Oak Ridge National Laboratory during the 50's and 60's and ran for almost 6 years incident free. The technology was lauded for the efficient use of nuclear fuel, high process heat (nearly 1,700ºF) and inherent safety. Of the two technologies, the molten salt technology was favored for civilian use as it was designed with passive safety systems, had a negative temperature coefficient and did not produce readily available weapons grade materials.

In 1968, Glenn Seaborg the Chairman of what was then the Atomic Energy Commission was quoted as saying that the reactor had a reputation of reliability, and he thought that someday the world will have commercial molten fluid reactors. These qualities make it an ideal instrument for a wide range of uses in the private sector. Ultimately, the country decided to go with a design of a light water reactor which is the type of design all 104 reactors in this country are based off of today. A decision ultimately made as it allowed for an easier transition towards producing weapons grade nuclear material. And in 1974, the last of the federal research towards the commercialization of this type of reactor was stopped. Before the research ended, the reactor design showed that it had many features that would make it superior to current nuclear technology, if only someone had the courage and ability to see the bigger picture and breathe new life into the possibility of a commercial molten fluid fueled reactor.

The MSR technology finds its strengths in the thorium fuel cycle and the use of liquid fuels instead of solid oxide fuel rods. Thorium is 4-10 times more abundant than uranium and there are enough known reserves to supply the world with energy for the next 5000 years. The thorium fuel cycle has inherent advantages over the uranium cycle as it does not need to be enriched, there is only one naturally occurring stable isotope, and its fuel cycle does not produce any readily available weapons grade materials.

The MSR reactors do not need cooling water, as temperature is regulated by the molten salt, and can be designed to be very compact. The reactors can be built so small that they can be built to fit on a flat be trailer. This allows current power plant structures with existing coal infrastructure to be retrofitted with the reactors with minimal changes to the plants. Because of this small size, oil-refineries which currently use coal-fired or natural gas-fired power plants can retrofit their sites with these highly efficient small scale reactors.

As a molten salt nuclear reactor is considerably more efficient at generating heat than burning coal or natural gas, the cost to produce the synthetic petroleum products or cracking oil is greatly reduced, both monetarily and environmentally. Furthermore, as feedstock for the liquefaction process is not being burned, all the potential feedstock material can be used to generate high value chemicals. These high value synthetic petroleum chemicals synthesized from the coal and other organic feed stock have market values of 30 to 1,000 times greater than materials from which they are generated.

The combination of the molten salt reactor technology with the very large natural gas and coal reserves of North Dakota can lead to a long term fine chemical generation ability that can cost effectively supplement the existing petroleum industry. Furthermore, the molten salt reactor technology will be able to provide a highly efficient zero-emission thermal source which can be used to significantly decrease the environmental impact of the coal and oil industries and enhance profitability and long term viability.

Imagine a cleaner more efficient nuclear technology, that is safe, reduces proliferation issues, could create process heat allowing for carbon neutral (zero emission) oil refineries or for the conversion of coal into a cleaner liquid fuel as a replacement for diesel.

This half-forgotten technology from the Cold War era could have the potential to resolve the country's energy independence issue, allow for a more economical, efficient and even environmentally friendly use for our coal and fossil fuel supply. It could create new education programs, bring new industry, and provide an even broader and longer lasting economic diversity for North Dakota than currently enjoyed. Now picture this technology, again a technology created here in the United States, being developed first by another country such as China. Under this scenario this technology will be sold back to us at a premium without the additional economic benefits that would come with doing it ourselves.

As the State of North Dakota continues its push forward to protect the industries that have provided its citizens with high paying jobs, they will need to find new aggressive ways to stay ahead of global competition. The opportunities provided by HB1190 are numerous and can lead to the much needed protection of North Dakotans vital industries.

The U.S. Nuclear Regulatory Commission (NRC) currently provides all regulatory framework for all current reactor types as well as various test reactor designs, but nowhere within federal regulations do they have the regulatory framework for a molten fluid fueled reactor. For various reasons that could be speculated, the NRC has never in over four decades provided the base guidelines for permitting a molten fluid fueled reactor design and then ultimately commercialization. There are various references and examples set that showcase the NRCs ability to create the regulation, and have the expertise and subject matter experts in order to do so in a timely manner. One comes to the conclusion that they don't feel a need to do so, and so here in lies the whole point of this legislation.

Primacy over matters regarding nuclear material and reactors has been almost exclusively on the federal level, but primacy over regulation can be claimed at the state level as long as those regulations are as strict as or more stringent than federal regulation on the subject matter. This bill would create enabling legislation that empowers the state to assemble its own subject matter experts under the Department of Health, Environmental Health Section to create regulatory framework in regards to the commercialization of a molten fluid fueled reactor. This bill and the state framework would only claim primacy up until such time that the NRC decides to write a framework on the federal level, upon which time the state would then follow the framework provided by the NRC. This bill is not meant to circumvent the NRC, and we would strongly suggest that the state as outlined within the proposed legislation, request that the NRC assist the state in the drafting of the legislation or to simply write the regulation at the federal level.

This framework would allow private industry and investment to finally be able to start finishing the last bit of research needed to be done for commercialization, without risk that their investment would be all for naught. This investment of not only money, but also intellectual currency, would be a massive boon for the state. This bill is not to enable nuclear reactors to be built overnight or for reckless regulation to be quickly or carelessly drafted: Neither of which we would ever endorse. The context of House Bill 1190 was always to enable the state to allow for the first steps to be made, in what will be a journey towards the commercialization of a molten fluid fueled reactor. All aspects are to be handled at the state level because federal regulation doesn't exist and this technology is too vital to our future, not only as North Dakotans, but also as Americans to not commercialize.

We hope the committee will agree with us on the vital importance of this technology and can see all the large and wide sweeping benefits that this technology could bring to North Dakota and therefore urge the committee to recommend passage of this legislation.

We thank you for your time today to testify on behalf of this bill, and are more than willing to answer any questions you may have.

The dependence of modern society on liquid fuels is one of the major geopolitical and economic factors of our day. By combining two historically proven technologies North Dakota can further supply these demands, and reduce dependence on foreign oil. Coal to liquids powered by molten salt reactors is an innovative new use of these proven technologies.

Coal to Liquids: Bergius and Fisher-Tropsch Processes

Coal to synthetic liquid fuels, though relatively obscure, is not a recent technological development. The Bergius hydrogenation process and Fischer-Tropsch process were both developed and patented in Germany about 10 years before the outbreak of World War II.(Stokes 1985; Miller 2011) The development of synthetic fuel technologies came about as a response to an increasing demand for imported crude, which the National Socialist Party deemed to be a national security issue, and as a means of utilizing abundant coal reserves to meet the energy demands of the pre-war military build-up as production from German owned oil reserves began to decline. Prior to tactical Allied bombing of German refineries in late 1944, the Nazi's were producing synthetic fuels at 4.3 million metric tons per year; up from only 90,000 metric tons in 1927.(Stokes 1985)

The two processes, though similar in feedstock materials of coal, water and hydrogen, are very different in implementation and liquid fuel chemicals produced.(Gordon 1947) The direct liquefaction of coal, called the Bergius process, consumes carbon based feedstock such as coal, and reacts it at 400-600°C and 200-700 atmospheres of hydrogen pressure.(Miller 2011) This is done in the presence of water and sulfide or oxide catalysts such as iron, tungsten or molybdenum.(Kaneko, Derbyshire et al. 2000) Overall, about 97% of the carbon feedstock is converted to naphthenes and aromatics in varying chain lengths which form the heavy and medium oils and gasoline fuel liquids and fuel gases such as methane. The liquid fuel product is typically passed to further processing such as cracking or reformation to generate useful fuel fractions.(Kaneko, Derbyshire et al. 2000)

The Fischer-Tropsch process, though not common in WWII era Germany, is the preferred commercial method used today and is known as indirect liquefaction.(Speight 2011) The carbon based feedstock is turned into CO and subsequently reacted with the hydrogen, but under much milder conditions: 150-300°C and several tens atmospheres of pressure in the presence of a transition metal catalyst such as iron or nickel.(Speight 2011) The products are typically long chain alkanes of varying lengths and methane.

This process is used on a commercial scale for the synthesis of low sulfur content high quality diesel fuel by several companies globally: Sasol and PetroSA in South Africa, Shell in Malaysia, Oryx GTL in Qatar, UPM in Finland and Rentech in Colorado.(Speight 2011) The carbonaceous feedstock for these plants are varied: Some synthetic fuels producers use natural gas or coal while others use wood pulp and other biomass. The use for carbonaceous feedstock goes well beyond basic automobile fuels too: The U.S. Air Force has recently approved Syntroleum's synthetic jet fuel blend for use in all its aircraft to reduce its need on imported petroleum.(Moses and Roets 2009)

Energy and Emission Concerns

One of the major concerns related to the use of these processes for the production of fuel liquids from coal, natural gas and biomass is the creation of emissions from the process itself: Either through the burning of feedstock to create the heat necessary to drive the reaction or from the liquefaction process and

emission of the intermediate CO_2 or CO feedstock gas. Combining the Fisher-Tropsch process with the Lurgi gasifier has greatly improved the overall efficiency of the overall process.(Minchener 2005) However, to significantly reduce the emissions associated with the creation of the synthetic fuels and make the process more environmentally sustainable and profitable, there is a need for a zero-emission thermal power source to drive the reaction.

Thorium Molten Salt Reactors

Liquid fueled molten salt reactors are an ideal candidate for the zero-emission thermal power source. Molten salt reactor technology was developed, along with current light water reactor technology, as a continuation of the Manhattan Project following WWII.(Uhlir 2005) Of the two technologies, the molten salt technology was favored for civilian use as it was designed with passive safety systems, had a negative temperature coefficient (as things heated up, it ran less efficiently and began cooling down) and didn't not produce readily available weapons grade materials.(Uhlir 2005) The final point, no weapons grade nuclear materials, is what ultimately lead to the end of the research program at Oak Ridge National Laboratory during the height of the cold war.

The process, which utilizes nuclear materials dissolved in a molten salt, was very efficient at using its fuel (greater than 90%), and generating significant amounts of waste heat.(Furukawa, Arakawa et al. 2008) That waste heat, in excess of 800°C, could be used to provide the necessary energy for the coal liquefaction processes without creating unwanted emissions, as indicated by the North Dakota EERC. Furthermore, process heat from the reactor could also be used to power the cracking and reformation processes in the oil industry; which currently are provided by coal or natural gas fired power plants.

As a molten salt nuclear reactor is considerably more efficient at generating heat than burning coal or natural gas, the cost to produce the synthetic petroleum products is greatly reduced. Furthermore, as feedstock for the liquefaction process is not being burned, all the potential feedstock material can be used to generate high value chemicals. These high value synthetic petroleum chemicals synthesized from the coal have market values of 30 to 1,000 times greater than coal from which they are generated.

The combination of the molten salt reactor technology with the very large natural gas and coal reserves of North Dakota can lead to a long term fine chemical generation ability that can cost effectively supplement the existing petroleum industry. Furthermore, the molten salt reactor technology will be able to provide a highly efficient zero-emission thermal source which can be used to significantly decrease the environmental impact of the coal and oil industries and enhance profitability and long term viability.

Furukawa, K., K. Arakawa, et al. (2008). "A road map for the realization of global-scale thorium breeding fuel cycle by single molten-fluoride flow." Energy Conversion and Management **49**(7): 1832-1848.

Gordon, K. (1947). Report on the petroleum and synthetic oil industry of Germany: Medium: X; Size: Pages: 140.

Kaneko, T., F. Derbyshire, et al. (2000). Coal Liquefaction. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA.

Miller, B. G. (2011). 5 - Introduction to Coal Utilization Technologies. Clean Coal Engineering Technology. Boston, Butterworth-Heinemann: 133-217.

Minchener, A. J. (2005). "Coal gasification for advanced power generation." Fuel **84**(17): 2222-2235.

Molten Salt Reactor Notes: Thorium

Dr. Joseph R. Brewer
Rare Earth Energy

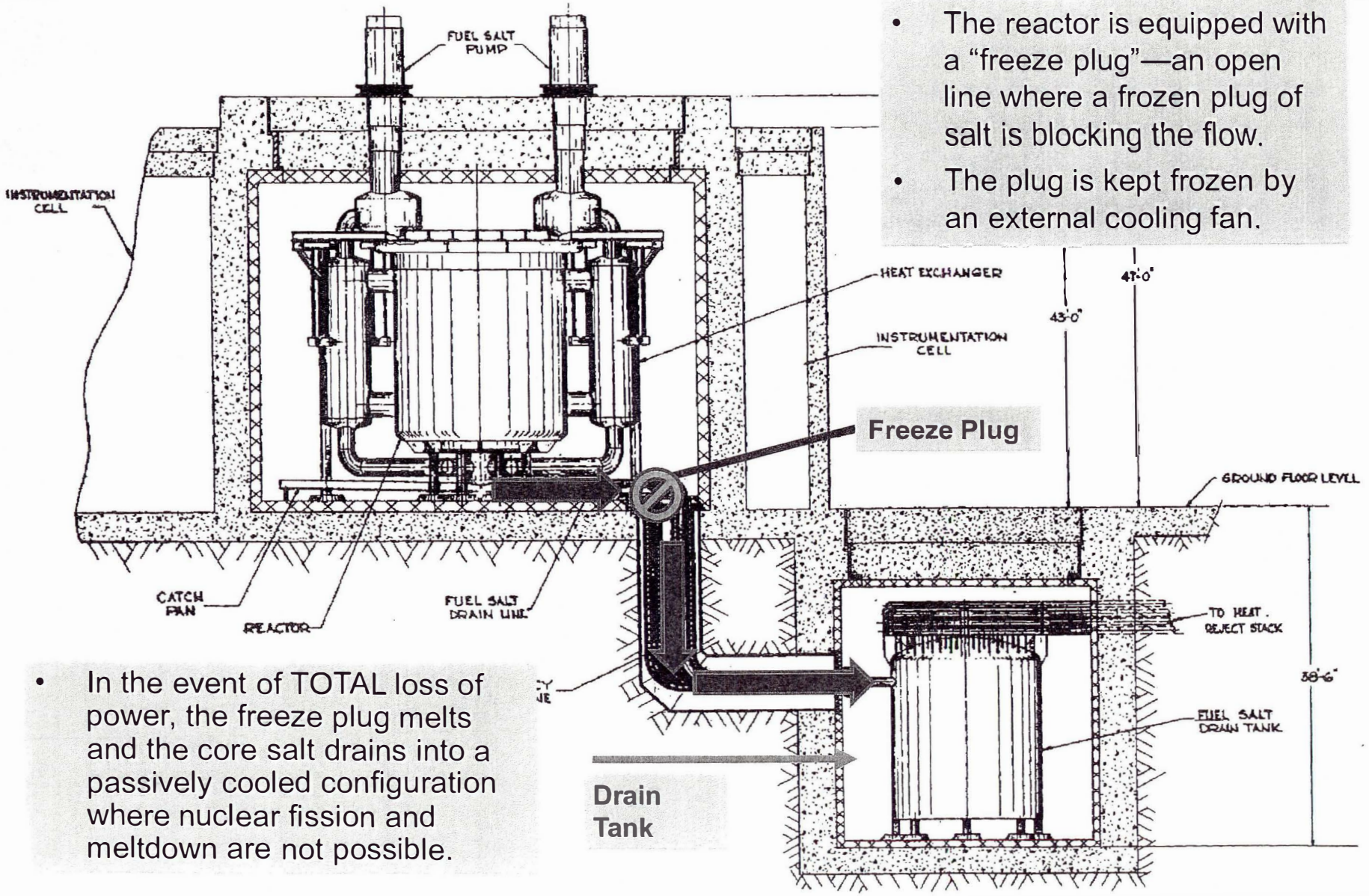
Molten Salt Reactor Energy: Thorium

- Mature Technology with over 20+ years of R&D: Ran for +22,000 hours in the 60's
- Walkaway Safe Nuclear Technology: Cannot melt down
- Can be used to destroy current waste reactor rods from current LWR's
- Over 5,000 years worth of energy
- Generates only 1% of total waste of light water reactors
  - By-products are inert in 200 years instead of 10,000 years
- 4 times more abundant than Uranium but with no proliferation concerns
- Less radioactive than bananas and radiation can't penetrate the skin

- Only major technical hurdle: Performing continuous fuel processing.
  - Rare Earth Energy has developed a patent pending method

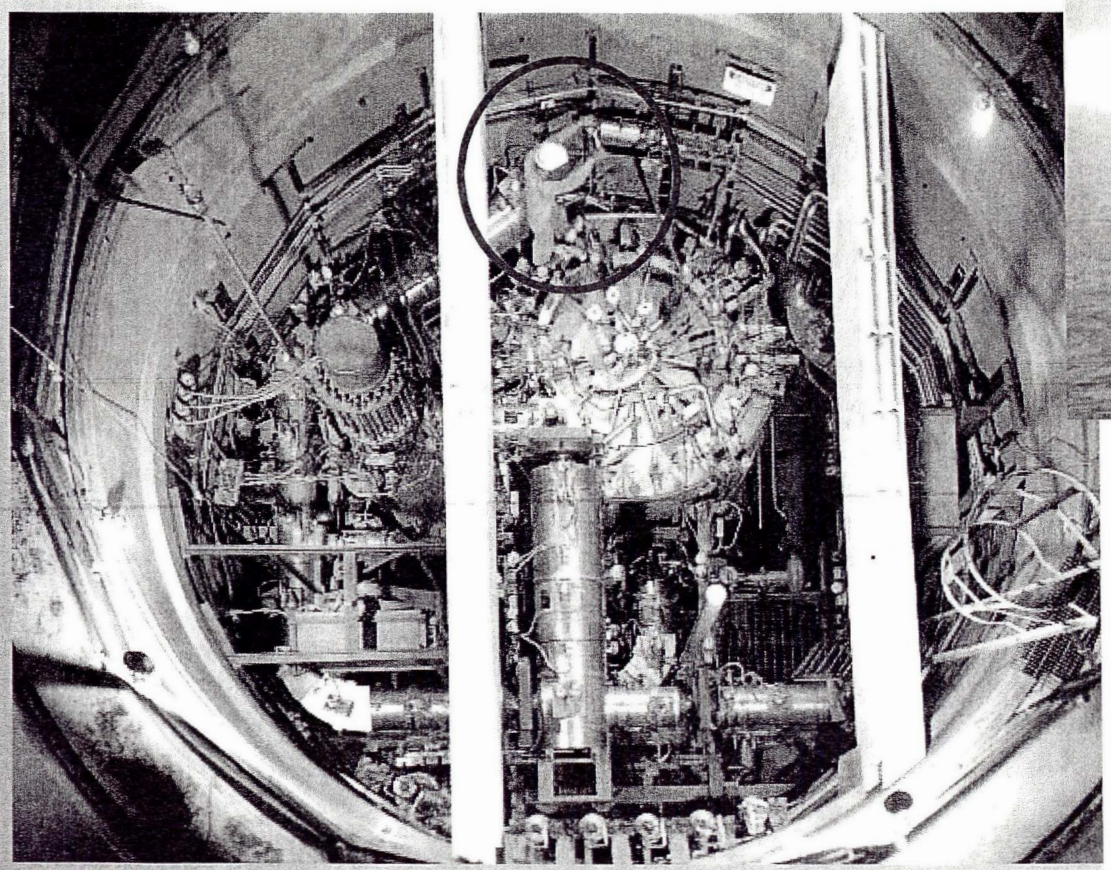
LFTR is passively safe in case of accident

- The reactor is equipped with a “freeze plug”—an open line where a frozen plug of salt is blocking the flow.
- The plug is kept frozen by an external cooling fan.

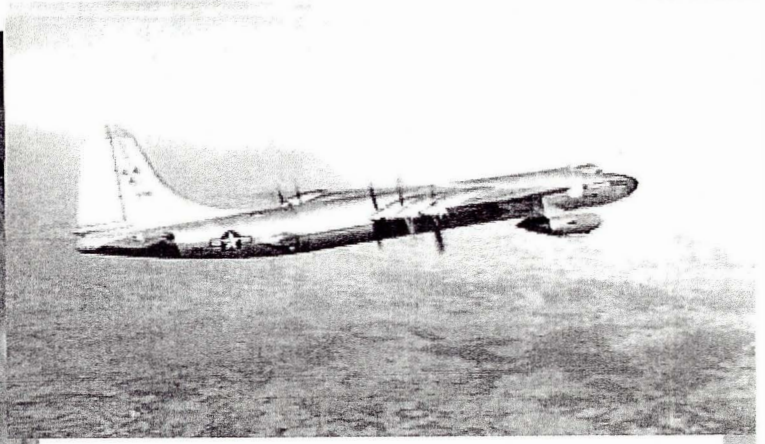


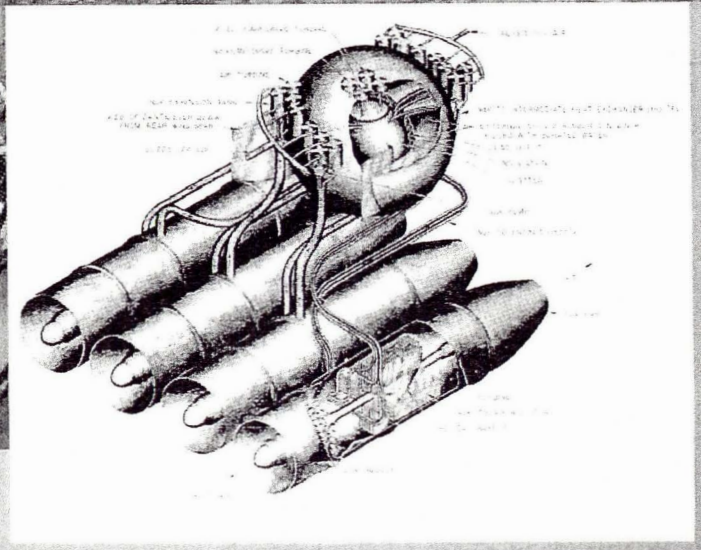
- In the event of TOTAL loss of power, the freeze plug melts and the core salt drains into a passively cooled configuration where nuclear fission and meltdown are not possible.

Molten Salt Reactors



8MW MSR Reactor





2.5MW Aircraft Reactor Experiment

Molten Salt Reactor Energy

- Top four industries that can be positively affected by the technology:
  - Petroleum
  - Coal
  - Steel
  - Energy

Molten Salt Reactor Energy

- Process heat from the molten salt can be used to:
  - Make petroleum refining more efficient, cost effective and environmentally friendly
  - Convert coal gasification facilities into more cost effective and environmentally friendly energy producers
  - Removes nearly all CO_2 and particulate emissions from gasification and refining
  - Can be used to create cleaner and more cost effective steel from iron ore, and help revive the US steel industry

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Testimony
House Bill 1190
House Energy and Natural Resources
February 7, 2013
North Dakota Department of Health

Good morning Chairman Porter and members of the House Energy and Natural Resources Committee. My name is David Glatt, Chief of the Environmental Health Section for the North Dakota Department of Health. The Environmental Health Section (EHS) is responsible for the implementation of many of the environmental protection programs in the state. The EHS currently operates a Radiation Program, which through an agreement with the Nuclear Regulatory Commission (NRC) allows the implementation of rules that address the use, storage, handling and disposal of radioactive sources. I am here today to testify in opposition to House Bill 1190.

House Bill 1190 would direct the Department of Health to issue a permit for the operation of a thorium refinery and molten fluid fueled reactors. It also declares that the U.S. Environmental Protection Agency, as well as the Nuclear Regulatory Commission (NRC), lacks the authority to deny regulatory permits because the products of these refineries and facilities have not traveled in interstate commerce. The Department of Health is in opposition to HB 1190 for the following reasons:

- The Department of Health lacks the regulatory authority to permit thorium refinery operations or molten fluid fueled reactors. It is our understanding after reviewing the federal law and discussing the issue with the NRC that the authority to permit nuclear reactors is the exclusive jurisdiction of the federal government. NRC regulatory authority is provided pursuant to federal laws, which rely on Congress's power over the common defense and security, interstate and foreign commerce, and promotion of the general welfare.

- The refining of thorium meets the definition of a mill, which North Dakota is not authorized to regulate under our current agreement with the NRC. The department would be required to amend the current NRC/State agreement to allow state program implementation with federal oversite. The process to receive authorization to regulate a mill at the state level is estimated to take several years to complete. This action would require the

state to gain regulatory and monitoring expertise not currently with the department.

- Mining thorium may come under the jurisdiction of the Department of Mineral Resources, requiring the establishment of rules to address the mining activities and issuing a permit. This process is estimated to take over a year to complete with a potential fiscal impact.

- Mining of potentially radioactive material in the past, such as uranium, without knowing all potential environmental ramifications has resulted in extensive and expensive remediation. For example, remediation of uranium mining activities that occurred over 50 years ago in western North Dakota has cost the state and federal government in excess of $15 million dollars with environmental impacts still being observed today.

- The department does not have sufficient information available regarding the thorium mineral extraction process, energy generation process or the potential quantity and quality of air, water and solid waste streams to formulate a rational regulatory process or know the overall fiscal impact.

- It is not clear how the generation of radioactive material produced by the Molten Fluid Reactors would be handled or accepted through the state's low level radiation disposal agreements currently held with other states.

Based upon the information presented, the confusing nature of the existing bill and lack of knowledge regarding waste generation or regulatory authority, we would suggest that the thorium issue be studied thoroughly before moving forward with any development or regulatory action.

This concludes my testimony and I am available to answer any questions you have regarding this matter.