OFFICE OF THE SECRETARY
CORRESPONDENCE CONTROL TICKET

Date Printed: Sep 08, 2008 17:50

PAPER NUMBER: LTR-08-0465 **LOGGING DATE:** 09/08/2008

ACTION OFFICE: EDO

To: Sheron, RES

AUTHOR: John Weinbrecht

AFFILIATION: NM

ADDRESSEE: Dale Klein

SUBJECT: Concerns nuclear power and a hydrogen economy

cys: EDO
DEDMRT
DEDR
DEDCM
AO
NRR
NRO
FSME
NMSS
Adams, OEDO

ACTION: Appropriate

DISTRIBUTION: RF

LETTER DATE: 08/29/2008

ACKNOWLEDGED No

SPECIAL HANDLING: Made publicly available in ADAMS via EDO/DPC

NOTES:

FILE LOCATION: ADAMS

DATE DUE: **DATE SIGNED:**

John F. Weinbrecht, PE
Development Engineer
12405 Sierra Grande Ave. NE
Albuquerque, NM 87112
Phone: (505) 294-3692 **Fax: (505) 271-4141** **Email: refdens@msn.com**

August 29, 2008

Chairman Dale Klein
Nuclear Regulatory Commission
Mail Stop 016 G4
Washington, D.C. 20555-0001

Dear Chairman Klein:

I previously sent you a first-draft article I had written regarding conversion of our carbon-based energy economy over to a hydrogen based one. The article is now in final release form and a copy is enclosed for your information and study. It is self-explanatory and discloses how and why it is completely feasible to convert, and why I feel it is important that we must proceed to do so without unnecessary delay. The supporting technology is sound, and it represents the only way we can gain complete energy independence and eliminate man-made carbon dioxide air pollution.

To bring about a complete conversion to a hydrogen economy requires an inexhaustible source of clean energy to separate hydrogen from water and to generate electricity for the entire process. The present light water type nuclear reactor has a fuel cycle that does not produce clean energy. It only utilizes 5% of the total available fuel rod energy before the fuel must be changed out. The only possible source of inexhaustible clean energy can be provided by the fast neutron type. That type of reactor burns up 99% of the totally available fuel energy.

The Argonne National Laboratory has designed a liquid metal cooled, fast neutron reactor and already completed laboratory scale testing on it. General Electric is prepared to build and test a full scale version and a fuel reprocessing test facility when funding is made available, a matter that requires top priority to get the conversion process started. The fast neutron or breeder type of reactor lends itself very well to serve as the "workhorse" for the hydrogen conversion.

The magnitude of industrial effort required will provide employment from coast to coast during the construction period. A compete conversion will require about 100 nuclear reactor sites or parks, 750 to 800 one gigawatt fast neutron nuclear reactor units, and a few thousand ground-based vehicle refueling stations. The benefits to be gained are summed up in the last paragraph of the enclosed conversion article. Any other stop-gap solution will be short term and provide only partial results.

Of all the people involved with the development of nuclear reactors, I am the least likely person to be trying to get nuclear technology back on track and headed in the right direction. I was privileged to be there when this all happened and feel obligated to do so, as there aren't many of us from that era left. We desperately need what only nuclear technology can provide; an inexhaustible source of clean energy. Please take the time from your busy schedule to thoroughly consider what has been outlined in the enclosed article. It merits your full support.

Thank you for your consideration.

Sincerely,

John F. Weinbrecht

Enclosure (1): "Nuclear Power and a Hydrogen Economy".

Nuclear Power and a Hydrogen Economy

The Only Path to Complete Energy Independence

The Ultimate Air Pollution Solution

Foreword

Aside from Mid-Eastern conflicts and other world-wide security problems facing our nation at this time, we are troubled by major energy-related concerns destroying our economy. These include the increasing rate at which our carbon-based energy infrastructure is polluting the environment and contributing to global warming. The question is; how can we control it so that civilization on this planet as we now know it can survive? Without effective counter measures it will eventually reach a point of no return. A second concern is our continuing dependency on foreign oil to provide fuel for the transportation sector, and the ever-increasing damage to our economy that it causes. The question here is; how can we eliminate it and achieve full energy independence?

A hydrogen-based energy infrastructure has great appeal for removing the major sources of air pollution and for eliminating our energy dependence on imported oil. To date, converting from a carbon-based to a hydrogen-based economy may have been tentatively considered, but no definitive action has been initiated to cause it to happen. It will require a world-wide, disciplined conversion program to succeed. These writings intend to review the state of supporting technology needed to bring about such a conversion, and to identify those areas that may require additional research and development effort. The question to be answered here is; can the conversion be fully supported by the presently developed state of relevant technology?

Hydrogen Production

Hydrogen differs greatly from usual gases that we are most familiar with. As a gas, it contains about three times the energy by weight as that of methane or natural gas, but occupies eight times the volume. Sonic velocity is three times that of natural gas, and liquid temperature level is only a few degrees above absolute zero. As a fuel it must be used in gaseous form to avoid liquefaction problems. It is the most abundant element in the universe, but does not appear in nature in an uncombined form. It must be separated from water, preferably by electrolysis, using a clean source of energy. For the magnitude of hydrogen production required, the only source of clean energy is that of the nuclear power reactor.

Development History of Nuclear Power

In one way or another, my professional career as a development engineer has been closely associated with nuclear power reactors, a fall out of the atomic bomb technology that brought to a sudden halt the WWII conflict in the Pacific. In the mid 1950's I became part of a research group at the Los Alamos Scientific Laboratory assigned to develop a nuclear propulsion reactor for space travel applications. In the early 1970's I was placed on loan to the Nuclear Regulatory Commission to help review a backlog of nuclear power plant applications. I was in a position to observe and to learn when the following events took place.

After a strong beginning in the 1960's, nuclear power received bad publicity from horror movies, anti-nuclear activists, the Three-Mile accident, and the Russian Chernobyl disaster. Applications for new nuclear power plants peaked early in the 1970's and then fell to zero by 1980. The power industry and the public had lost confidence in the technology. During the time I was serving on the Nuclear Regulatory Commission assignment, the Atomic Energy Commission, the agency established to oversee and manage the complex research and development activity for atomic energy, was disbanded. Responsibility for nuclear energy was transferred to the newly formed U. S. Department of Energy, where it became just another source of energy along with coal, oil, and natural gas.

Probably because it was based on a heat transfer process and used a coolant that industry was familiar with, the light water reactor became the established standard for nuclear power production. This took place in spite of a fuel cycle that must change out fuel rods after only about 5% of the total contained nuclear energy had been consumed, and for which there was no viable method for reprocessing spent fuel. To date, some 438 light water reactors have been placed in service, 103 of them here in the United States. To put it bluntly, in the absence of a more thorough evaluation we blew it, and thereby set the development of viable clean energy nuclear power back by thirty or more years. The research and development for fast neutron reactors and spent fuel reprocessing that the AEC planned to carry out had fallen into a crack, and progress on further development of nuclear power came to an end.

While spent fuel from light water reactors is being reprocessed in other countries, it is not done here. Establishing a procedure for reprocessing was avoided by a government edict banning spent fuel reprocessing within these United States, but the basic problem was never resolved. Nuclear power has the potential when fully developed to provide clean energy for the hydrogen economy, and represents the only source capable of doing so in the amount required. Clean energy can only come from complete fuel burn-up, which requires a fast neutron or breeder reactor, and a complete spent fuel reprocessing and disposal procedure such as that described in the referenced Scientific American article.

In retrospect, it has been difficult to recall our major national concerns from that period. We came out of WWII with the strongest industrial base in the world, and had been scientifically and technically challenged by space age assignments. In the 1970's, the world had begun to change around us. Although we had 'Nam, Nixon, hippys and a gas shortage, the economy remained fairly stable, and there was little thought given to the level of environmental quality. Needless to say, those days are now long past. Our greatest concerns at this time are the air pollution levels and the economy. The measures proposed in this opinion essay are drastic, hard to accept, and difficult to carry out, but I believe them to be factual and to represent the only feasible solution for our air pollution problems. In addition we will then have obtained full energy independence.

Carbon to Hydrogen Energy Infrastructure Conversion

A complete energy conversion to hydrogen will require some 750 to 800 one gigawatt nuclear reactor units in this country alone, to provide electric power and to produce the hydrogen for ground-based vehicle fuel. The referenced NEI article entitled "The hydrogen Economy and Nuclear Energy" provides background information concerning the interdependence of the two technologies. The referenced article entitled "Smarter Use of Nuclear Waste" by Hannum, Marsh and Stanford is an excellent description of the research and development effort that must be completed to solve the problem of spent fuel reprocessing and disposal.

The Hannum, Marsh and Stanford article also discloses design of an Argonne liquid metal fast neutron reactor that appears to be capable of becoming the clean energy "work horse" for providing the source of power for the conversion. Neither the high temperature graphite reactor nor the pebble bed reactor designs are suitable. A laboratory scale unit based on the Argonne design was built and tested at EBR-II in Idaho, but a commercial scale unit has yet to be tested. One of the domestic nuclear power firms (GE) is prepared to do so, but has not been able to obtain funding. The conversion process cannot proceed until research and development testing of the spent fuel reprocessing and of a full scale fast neutron reactor have been carried out. This requires top priority and full funding ASAP. Some of the major considerations relevant to conversion are discussed in the following proposed mandates.

Mandate 1:

Establishment of an agency or commission that is apolitical and capable of monitoring and managing a wide variety of international research and development activity associated with the conversion process. This might be similar to the previous Atomic Energy Commission, with responsibilities expanded to include hydrogen production and distribution. Because of the research and development effort already carried out by the United States, (and in spite of the big delay in developing nuclear power to full potential), we are in the best position to take the lead in this conversion, but the entire planet earth civilization has a vested and vital interest in the success. We need the combined technological development of all industrialized nations to contribute in bringing it about.

Mandate 2:

Completion of the research and development program needed to establish a nuclear power reactor design of the fast neutron or breeder type, and having a fuel reprocessing cycle close to that described by Hannum, Marsh and Stanford. This will provide the design information for a new series of "clean" reactors that will consume nearly 99% of fuel rod energy. It will require close coordination and contribution between the Mandate 1 Commission, the U. S. Department of Energy, and the Nuclear Industry. Use of the fast neutron reactor minimizes the risk that spent fuel from reprocessing could be used for weapons production. The need for 10, 000 year storage to mitigate spent fuel radioactivity will thereby be reduced to about 500 years, and the need for further uranium prospecting and mining will be nearly eliminated.

Mandate 3:

Establishing a nationwide network of nuclear electric power generation reactor sites or parks, along with connecting grids of electric power. The conversion may require as many as 100 reactor parks As was done with the interstate highway construction program carried out after WWII, state participation under federal guidance may be the best way to distribute the work load. The reactor sites or parks would be geographically distributed throughout our 48 contiguous states according to projected demand loads. Each site would contain a number of fast neutron reactor units and have a reliable source of water supply for the electric power generating turbines. No water is required for safeguard and shut-down procedures. Each park would also include a spent fuel reprocessing facility, assuring full security for that activity.

Mandate 4:

Provision of enough on board vehicle fuel storage for 400 or more miles of cross-country travel between refueling points. Present state hydrogen fuel cell development has demonstrated improved efficiency and may meet the mileage criteria without excessive weight penalty. Another method of meeting the stored fuel requirement is to compress and cool the gaseous hydrogen down to liquid nitrogen temperature and maintain it at that temperature. Temperature of liquid nitrogen is about 80 Kelvin, where the gaseous hydrogen density is 0.307 kg/m3. It is readily available from industrial sources, and the boil-off is non-contaminating.

This concept for on-board hydrogen storage consists of a central storage vessel capable of containing gaseous hydrogen fuel at pressures up to 250 bar and at a temperature of 80 Kelvin, surrounded by an annular chamber containing liquid nitrogen in a quantity sufficient to maintain through boil-off the stored fuel temperature for periods up to six hours, and further surrounded by an annular Dewar chamber designed to reduce boil-off to a practicable level. Hydrogen equivalent energy for a 70 liter tank is about 30 % greater than that for CNG, which can offset the additional weight penalty associated with the external Dewar and LN2 chamber installation and operation.

Mandate 5:

For safety concerns, do not provide any hydrogen storage at vehicle refueling locations. An urban location serving limited mileage IC or fuel cell powered vehicles would consist of an electrolysis system for the production of hydrogen, a reliable supply of water, electrical power supply, heat exchanger, densifier, and dispenser. The refueling arrangement would densify directly from the electrolysis system, through the dispenser, and into non-refrigerated vehicle storage tanks. For cross-country travel and for serving higher mileage vehicles, commercial trucks or buses equipped with refrigerated fuel storage, a supply of LN2 would be required, and the dispenser would include an LN2 heat exchanger on the supply line between the dispenser and the vehicle tanks and a means of measuring the amount of liquid nitrogen refrigerant.

Mandate 6:

Concentrate all energy related government financing on the carbon to hydrogen conversion process. Avoid subsidizing large wind power and solar farms, and re-direct the industrial capacity used to produce and install them to the production and installation of fast neutron "work horse" reactors. Eliminate the ethanol subsidies. Gradually remove all government subsidies for alternative forms of energy production that are otherwise not economically viable and that that do not support the goal of energy infrastructure conversion. The greatest contributors to carbon dioxide air pollution are oil and coal. Usage of those as fuel will diminish as the supply is reduced and conversion to a hydrogen economy progresses. At the present rate of world-wide consumption, this could happen within a few decades.

Mandate 7:

As an aid in reducing air travel congestion, restore our railroads and rail transport to a point where they once more become a principle method of travel. Hydrogen may never fly aircraft, but nuclear power can provide electricity to power trains. Europe is leading the way in developing fast (200 mph) trains and road beds, and has developed passenger handling procedures that we can study. It is far more comfortable to be seated on a train than to be waiting in line to check in at an airport, and the saving in time for air travel is questionable.

In Closing

The conclusions expressed herein outline what I believe to be the only viable solution to our worsening air pollution problem, while at the same time, providing true national energy independence. The solution requires converting our present carbon-based economy over to a hydrogen-based economy. The question raised in paragraph 2 of this article was whether conversion from a carbon to hydrogen based economy is fully supported by the presently developed state of relevant technology. The conclusion is: "Well, almost, but we know how to fix it!" We need to bring development of the Nuclear Power Reactor up to full potential!

This article is the result of taking a hard look at and giving much consideration to what we must do as a nation to bring about a conversion from a carbon based to a hydrogen based economy, and why we must proceed without delay to do so. There are no technical obstacles in the way. For the sake of our economy and for the health and well-being of future generations, the sooner we can bring this about, the better. The cost to convert and the magnitude of effort required are quite high and may be difficult to accept at first. That is, until the benefits come into consideration. When conversion is nearly complete, deep sea, off-shore and arctic drilling will be eliminated, there will be no more foreign oil imports, no more huge oil tankers endangering our coasts, no more huge oil refineries, no landscape clutter from mile after mile of wind or solar farms, no more hazardous coal or uranium mining, no restriction on using natural gas as feedstock, global warming will be arrested, and our cities will have much cleaner air to breath.

References: Hannum, W.H., Marsh, G.E., and Stanford, G.S. "Smarter Use of Nuclear Waste" Scientific American, December, 2005, PP 84-91

Excerpts from Walters, Wade and Lewis "Transition to a Nuclear/Hydrogen System" Nuclear Energy Institute "The Hydrogen Economy and Nuclear Energy"

John F. Weinbrecht, PE
Development Engineer
August 22, 2008