The following is a critique by David Lochbaum from the Union of Concerned Scientists of Tom Blees's new book, Prescription for the Planet. *Mr. Blees's responses are in blue.*

June, 2008
Review of:
Tom Blees' book: Prescription for the Planet
The painless remedy for our energy & environmental crises

On a political level, the book blames anti-nuclear zealots and luddites (perhaps with some overlap here) as being the primary obstacle for wide deployment of integral fast reactors (IFRs) in the US.
Actually I blame Congress and Clinton. The public, Luddites or not, never really even confronted the issue. Once the advantages of IFRs are known to the public, I expect they would be far more amenable to seeing IFR deployment than more LWRs. That has certainly been the reaction I've gotten from some zealous anti-nuclear activists who've read my book.

The nuclear industry's role as an obstacle is alluded to, at most. The book claims that IFRs are cheaper to build and operate than existing reactors, safer to operate than existing reactors, and with onsite pyroprocessing facilities solve the spent fuel disposal problem. Why then is the nuclear industry today pursuing more expense, less safe, more irksome reactors? The bird-in-the-hand worth two-in-the-bush dynamic likely explains their decisions.

Last week I attended the Asia-Pacific Forum on Integration of Sustainability, Safety and Security of Nuclear Technology at U.C. Berkeley. Nuclear physicists and engineers from India, China, Japan, and South Korea presented updates on their nuclear programs, and timelines on where they're headed. All of them are intending to close their fuel cycles and end up with breeder reactors, some more quickly than others. Their presentations were in stark contrast to a representative of a consulting firm in the USA that advises private utilities here that hope to revive nuclear power. He maintained that people shouldn't be told about fast reactors because they'll be unfamiliar with them, and that we should just continue to build LWRs and stick the waste in Yucca Mountain. Exactly as you suggested, the bird in the hand scenario, don't rock the boat. I took exception to his view during the ensuing discussion phase and argued that the number one issue on people's minds when you talk to them about nuclear power is waste. If you don't even tell them that the technology exists to eliminate the waste, even some time in the future, how can people be expected to acquiesce to nuclear power unless out of sheer desperation in the face of global warming?

I am not a fan of the private utility companies that own and operate nuclear power plants in the USA. I believe that is more than alluded to in my book, since I'm advocating their dissolution.

When they developed business cases en route to selecting the EPR or AP1000 or other non-IFR designs, they likely at least considered the IFR design. Uncertainties about the

IFR's purported benefits steered them towards selections possessing fewer benefits and higher costs, if the arguments in the book are close to correct. If the nuclear industry does not believe the IFR's potential, it is unlikely that the American public can end-run that mis-belief and force a recalcitrant nuclear industry to build IFRs against their will.

What's steered them away from IFRs is the continuing gag order by the DOE on even *discussing* breeder reactors. At the conference last week I spoke with a researcher from Livermore National Lab who's working on lead-bismuth reactors (essentially a variation on the IFRs described in my book, with a different type of coolant and thus many ensuing ramifications that need more development to see if they can get them to work). Periodically his research team has to report to the DOE, a review that is happening this week. He told me that every reference they've ever made in their reports to fuel breeding has been struck from those reports before they move out of the DOE office. The politicians and policy makers don't even see that option, and most of them are completely unaware of the IFR option. There has simply not been a comparison made between LWRs and IFRs in the political arena since the travesty in 1994 that I document extensively in my book. It's not anything inherently inferior about the IFR system. Quite the contrary. They're simply not on the radar of anyone except the people in the nuclear research community. That's not so much the case in some other countries, but it certainly applies in the USA.

On a historical level, the IFR background is presented in partial context. As detailed in the specific comments that follow, the fuller context surrounding events such as the 1994 decision to shut down the EBR-II protect and candidate Bill Clinton's decision during the 1992 presidential campaign in New Hampshire to characterize his opponent as being "pro-nuclear" can explain what happened.

Your comments on those sections below explain the political environment of the time, but just because it was politically inexpedient at the time to pursue the technology doesn't mean it was a wise decision. It was, in retrospect, incredibly short-sighted.

On a technical level, the IFR is presented as a thornless rose. That portrayal is unrealistic. Few things are pure good or pure evil, and IFR is not among this minority. The IFR design is characterized as having no genuine proliferation, safety, security, or economic concerns.

I maintain that those concerns are minimal compared to other technologies and that they are entirely manageable, not that they don't exist. As for issues of good and evil, such considerations are more germane to philosophy and not really applicable to matters of science and technology.

As indicated in the specific comments that follow, each of these characterizations is tenuous. This is not to imply that IFR is a roseless thorn either. The book points out IFR's attractive features. It is the IFR's unattractive features, which are essentially summarily dismissed in the book, that explain why it received so little regard by the nuclear industry and became such an easy target during budget-cutting exercises.

See my previous comments about the nuclear industry's myopia and the foolishness of terminating the IFR project in 1994. I assume that the IFR's unattractive features that you refer to here are those you specifically mention in your later comments. As you'll see below, they are easily dealt with. If it seems I was too breezy about summarily dismissing them in the book, it is only because they are of a too technical nature for the book's target audience, not because I was trying to cover anything up. I'll be happy to discuss the technicalities with you or anyone else who understands them, and in fact at last week's meeting I took the opportunity to compare the relative merits and demerits of several reactor systems with a number of physicists and engineers. The IFR is clearly the superior technology on virtually every level, as was readily admitted to in candid conversation even by those who are working on alternative systems, both foreign and American.

On an implementation level, the IFR framework of an international owner and operator of all IFR facilities worldwide seems impractical for reasons cited in the specific comments that follow.

Overall, I am not persuaded by the arguments that the IFR will play or should play a key role in our or the world's energy future.

Whether the IFR *will* play a key role in our world's energy future is hardly a question if you pay attention to what is being done in India, China, Japan, Russia, Korea, and France. So whether it *should* or not is academic. The question is whether we'll continue to ignore it in the USA for a couple more decades (as the MIT study suggests) or get involved with the other developed nations to attempt to steer the development into the safest possible political and technological framework.

If you're not persuaded that IFRs will play a role in our world's energy future, please answer me this: By mid-century we expect to have about 3 billion more people in the world. Where will we get the energy they'll demand? More to the point, where will we get the freshwater they need to drink, to wash, and to grow the crops needed to feed them? Without death and destruction—by pandemic, famine or war—on a hitherto undreamed-of scale, our planet is going to be home to nearly ten billion people by the middle of this century. Already we're fighting over water supplies. Without massive increases in energy production enabling us to deploy hundreds or even thousands of desalination plants to augment major new canal projects (where they're feasible), the oil wars of recent times are going to look like schoolyard scraps. Are we ready for our world to be thrown into chaos? (Don't forget, our energy wars will get more extensive too.) Do you have any realistic idea where we'll get three times the energy the world is using now to fill these needs? And I'm not talking about just electricity, I'm talking about vehicle fuel, heating, cooking, the whole bit. Where is that energy going to come from if not, to a great degree, from nuclear power? And if nuclear is going to play a major role, do you prefer more nuclear waste to deployment of IFRs?

Review by Dave Lochbaum, Director of the Nuclear Safety Project, UCS

June 2008

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127	Statement is made that "*There were certainly no technical or economic reasons to do so*" with regard to the decision in 1994 to shut down the EBR-II. I was working my 15th year in the nuclear power industry at the time of this decision. The consensus feeling at that time was that of a nuclear industry fading out. Several reactors had recently closed due to unfavorable economics (e.g., San Onofre Unit 1 in California, Fort St. Vrain in Colorado, Trojan in Oregon, and Yankee Rowe in Massachusetts) and others were known or strongly suspected to be closing in the near future (e.g, Big Rock Point in Michigan, Zion in Illinois, Maine Yankee in Maine). When I attended industry conferences, like the annual meeting of the American Nuclear Society, the sessions on decommissioning and dismantling permanently closed nuclear power plants were standing room only while sessions on new reactor designs and fuel cycle alternatives only drew the speakers and their immediate families. A review of the conference proceedings and a Nexus search of trade press articles in the 1994 timeframe will show little optimism for an expansion of nuclear power in the US. Consequently, there was little interest even within the nuclear industry for fast reactor and breeder reactor technology. The scant industry support for continued research at EBR-II translated into "no technical reasons" for sustaining the effort and "economic reasons" to apply those funds elsewhere. You're conflating my statement about technical and economic reasons with political reasons. It would have been cheaper to finish the project (because of the money the Japanese had offered to contribute to its completion) than to kill it. I'm not denying there were political considerations. I'm saying that those were foolish reasons to kill the project.
132	Statement is made that fission products from spent fuel reprocessed at an IFR site "*can be stabilized by vitrification* … [and] *stored for thousands of years without fear of significant air or groundwater contamination*." The last part of this statement is overly optimistic. The first step of spent fuel reprocessing involves separating the spent fuel from the metal rods (cladding) containing it. As Tadashi Inoue of Japan's Central Research Institute of Electric Power Industry (CRIEPI) and Lothar Koch formerly with the Institute for Transuranium Elements at Germany's Joint Research Centre illustrated (upper left portion) in a paper co-authored for the April 2008 issue of *Nuclear Engineering and Technology*, this first step releases 100 percent

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of the radioactive xenon (Xe) and krypton (Kr) and 95 percent of the radioactive iodine (I) fission product gases. These radioactive gases are vented to the atmosphere at some reprocessing facilities while plans for new reprocessing facilities call for these radioactive gases to be compressed and stored in tanks and cylinders. The point being that these radioactive gases are not stored in vitrified form and thus are or may be released to the air.

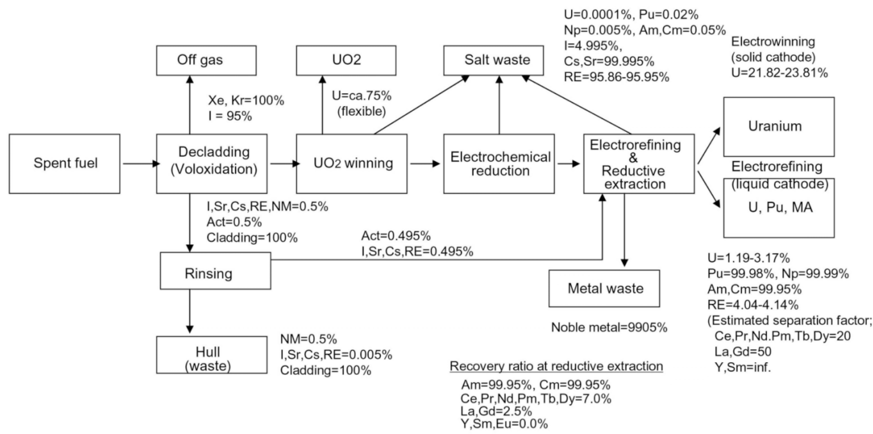

Fig. 5. Estimated Material Flow for the Treatment of Oxide Fuel

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The Inoue/Koch paper refers to LWR spent fuel processing and the voloxidation step for decladding is not a necessary step. The only implication is that iodine in the IFR processing for metal fuel would stay in the salt rather than being released as gas. That salt could be incorporated into the vitrified waste. Nevertheless, Xe and Kr will get released into the hotcell. In a conventional reprocessing plant, the Xe and Kr released into the cell would have to be released through a stack. However, in pyroprocessing, the cell volume is small and filled with inert argon gas, and hence Xe and Kr can be collected cryogenically as part of the argon purification system. The collected gases can be compressed and stored until they decay away: Xe with a very short halflife of 12 days or less and Kr with about 10 years. You are correct in saying gases are not vitrified. However, being able to collect and compress for storage provides an alternative management option to simply releasing them through a stack. Xenon is no problem whatsoever with such a short half-life. It can be compressed and just stored for a few months until it decays. Krypton is a bit more problematic because of its longer half-life, but still very manageable. Rather than storing it compressed for decades while it decays, however, it could more practically be disposed of in the vitrified waste by combining it in a salt with fluorine (krypton difluoride) and a common industrial acid like ferric chloride.
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<tr><td>133</td><td>Statement is made that with IFRs, “we have a prodigious supply of free fuel that is actually event better than free, for it is material that we are quite desperate to get rid of.”</td></tr>
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	At risk of invoking the perspective invoked later in the book (pages 166-169) regarding the 2003 MIT study being biased and close-minded, the overwhelming consensus of the studies I reviewed for my 1996 book *The Nuclear Waste Disposal Crisis*, specifically chapter 2 on the nuclear fuel cycle and chapter 5 on spent fuel reprocessing, concluded that reprocessing in the US increased the cost of nuclear fuel by approximately 25 percent. These studies relied on two assumptions that might not apply here: (1) that the nuclear fuel cycle was closed (i.e., spent fuel was reprocessed) with a mix of light water reactors and fast breeder reactors, and (2) that the cost of disposing of spent fuel in a closed-cycle (i.e., the alternative option to reprocessing) was entirely covered by the funds collected under the 1983 Nuclear Waste Fund, as amended. I have not seen analysis that would appreciably alter the fundamental conclusions from these studies. I haven't seen your book so I'm not qualified to compare, but what's quite certain is that the cost of fuel for IFRs will be such a miniscule amount compared to the energy they'll produce as to be inconsequential. Our stores of depleted uranium worldwide, not to mention spent fuel, are sufficient to our planet's needs for many hundreds of years if we switch to IFRs and a closed fuel cycle. Until LWRs reach the end of their service lives we will still be reprocessing their fuel, of course. My point is to transition away from them sooner rather than later, for a multitude of reasons.
136	Statement is made that plutonium is produced by today's existing nuclear reactors and in proposed fast reactors and that it "*can be done as easily with irradiated fuel from an ordinary thermal reactor as it can from the breeder blanket of a fast reactor*" such that "*the hue and cry about the proliferation dangers of breeder reactors is actually much ado about nothing special*." It is certainly true that thermal and fast reactors produce plutonium and that reprocessing spent fuel is comparable for both. But it is also true that fast reactors make most sense when operated in a closed nuclear fuel cycle where spent fuel is reprocessed. Thus, the construction and operation of fast reactors is more likely to also entail plutonium reprocessing. It is for this reality that many persons are concerned that development of fast reactors carries the inherent risk from expanded plutonium reprocessing. Granted, construction and operation of fast reactors will entail reprocessing of spent LWR fuel, but only until LWRs are all made obsolete by IFR deployment. This LWR to IFR fuel reprocessing could all be carried out at a few large reprocessing plant that are designed to fabricate fuel assemblies for IFRs, however, so even if plutonium separation took place in this process (which it wouldn't) it would not be a security issue since it would take place

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	in nuclear club countries. In pyroprocessing, a pure plutonium stream is not possible and Pu is always co-deposited with all minor actinides, some uranium, and rare earth fission products contamination. Yes, there will be more (unseparated) Pu involved in the entire process but once inside the door of the IFR it will never leave. With the sort of security and operational framework I propose in my book, it would be far easier to obtain Pu from another source such as a small research reactor.
137	Statement is made that during pyroprocessing, "*the plutonium is always in combination with elements that make it impossible to use for weapons without further PUREX-type processing, and is so radioactive that the entire operation is done remotely behind heavy shielding*." Dr. Edwin Lyman, my colleague here at UCS, addressed these issues in a variety of venues such as this online posting http://www.ucsusa.org/global_security/nuclear_terrorism/US_Nuclear_Fuel_Reprocessing_Initiative.html Ed cites the work of Dr. Bruce Goodwin regarding the possibility of making nuclear weapons from plutonium combined with other materials. Ed cited the work of DOE's Dr. E. Collins about the radioactive levels being about 100 times less than the standard established for self-protection. Thus, pyroprocessing does not equate to immunity from proliferation. Without undertaking a major evisceration of Lyman's polemic, I'll just make a few points in response to it. For starters, the isotopic quality of the plutonium that could be isolated from spent LWR fuel using PUREX is very poor for making nuclear weapons, even for state-sized weapons labs. But PUREX wouldn't be used anyway, thus making weapons manufacture even more improbable. Keep in mind that nobody is proposing that reprocessing of spent LWR fuel into metal IFR fuel assemblies be done anywhere but in nuclear club countries (as mentioned previously), so unless these countries are ludicrously negligent the point of terrorists getting their hands on anything dangerous is moot. If they ARE that negligent, then presumably their weapons-grade material would likely be available anyway. As for being able to safely handle and spirit away the reprocessed fuel, which would have been formed into fuel assemblies destined for IFRs, the plan is to spike them with cesium 137 or some other hot isotope, enough to make them untouchable but not enough to compromise their effectiveness as fuel. Thus IFR fuel assemblies destined for new plants would be terrorist-proofed. There is little doubt that some sort of radioactive material can make its way into the hands of people determined to cause trouble, but barring the actual purchase or theft of weapons (which has no bearing on my topic) it's all but certain that the worst a terrorist would come up with would be a dirty bomb,

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	sufficient to cause a panic but relatively harmless unless you happen to be within the blast range of whatever conventional explosive is used to disperse the material. I find it ironic that Lyman advocates simple burial of spent fuel in lieu of reprocessing, though he studiously avoids any mention of the sort of reprocessing I advocate in my book. I would have thought that the lingering legacy of simply burying spent fuel would have been anathema to UCS, as it is with nearly everyone. Lyman seems to neglect the fact that as time goes by such a repository would become in effect a plutonium mine. It is entirely unreasonable, in my view, for the U.S. to avoid reprocessing as if that avoidance will cause every other nation to do likewise, a naïve and outdated notion left over from the Seventies. Nearly every nation with a nuclear power program is headed to breeder reactors and a closed fuel cycle. By denying this and refusing to head in that (arguably inevitable) direction, we simply are foreclosing our opportunity to influence this development in a safe and sane manner. Nobody can guarantee immunity from proliferation, but the political and technological framework proposed in *Prescription for the Planet* would go farther than any current system to preclude proliferation and at the same time allow humanity to benefit from the limitless energy available through nuclear power systems like the IFR. If one is worried about terrorists getting their hands on weapons-grade material, spent fuel concerns are the least likely path for that to happen. Far more likely is the use of a small research reactor somewhere being used to create plutonium of a suitable isotopic quality.
143	Statement is made about the IFR "*During the lifetime of a plant it is unlikely that anything would have to be replaced.*" History suggests this outlook is optimistic. Several of the US nuclear power reactors discovered that metal material used in the tubes of the condensers adversely affected the chemistry of the water which in turn adversely affected the corrosion rate of large components. Consequently, several plant owners replaced the condenser tubes, which were expected to last for the plant's lifetime. In pressurized water reactors (about 2/3 of the US fleet), the steam generator tubes were expected to last the entire 40-year lifetime of the plants but had to be replaced beginning as early as within 10 years. Also in pressurized water reactors, the metal lids on the reactor vessels deteriorated faster than expected, requiring replacements before the end of plant lifetimes. In boiling water reactors (the remaining 1/3 of the US fleet), the piping connected to the reactor vessel cracked faster than anticipated and required replacement even though it had been expected to last the plants' lifetimes.

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	Nuclear reactors are licensed for 40 years and can seek 20-year extensions. It seems naïve to assume that engineers and scientists are knowledgeable enough today as to avoid all material reliability issues over the next 4 to 6 decades. History has repeatedly shown that it is wiser to do one's best to avoid problems, but provide capabilities in the designs to deal with the unexpected. For example, pressurized water reactors were designed assuming that their steam generators and reactor vessel heads would never need replacement. Consequently, the equipment hatches installed in containment walls to allow pumps, motors, valves, and other small components to be replaced are too small to get steam generators and reactor vessel heads in/out. Owners have had to cut holes through the reinforced concrete containment walls and then patch these holes. These are high costs for bad assumptions in the original designs. That's a good point, and one which I've mulled over a lot. My assumption would be that any reasonable plant design would allow for such replacement, but your example certainly would lead one to avoid such assumptions. I've amended my text accordingly, thanks for the suggestion: During the lifetime of a plant it is unlikely that anything would have to be replaced. *Based on past experience with nuclear plants (and other industrial facilities), however, the wisest course of action will be to make sure that the plant design will allow for replacement of any components that might become compromised, even if the chances of such contingencies are slim.*
145	Statement is made that the "*safety factors that would be built into the IFR plants as a matter of course will most certainly provide a level of safety that will be a vast improvement*." The best way to assure such an outcome would be to eliminate federal liability protection for nuclear power reactors. The 2005 Energy Policy Act extended federal liability protection originally established by the Price-Anderson Act. With my homeowners insurance policy, I get a premium reduction by having fire detectors on all floors (code now, but my older house pre-dates this requirement), by having a dry chemical fire extinguisher, and by having dead-bolt locks on all exterior doors. The amount of the reduction is such that adding these safety features was paid for within 2 or 3 years. With federal liability protection, a reactor designer who thinks up some new safety widget is perversely dissuaded from incorporating it. After all, this new safety feature drives up the price tag for the reactor without a

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	corresponding reduction in annual insurance premiums to offset the initial investment. Unless public ownership of energy facilities happens, the surest way to safer reactor designs is to provide financial incentives, not disincentives, for safety improvements. My statement is only about the inherent relative safety of IFRs. Your ideas here, while they may be valid, are about policy. And yes, I do advocate public ownership, for these as well as other reasons.
174	Statement is made "*Putting on rose-colored glasses and dreaming of a happy world of spinning windmills and vast seas of solar panels*" isn't going resolve our energy and environmental problems. True, but it would equally apply to the rose-colored glasses and dreams of free electricity from near-perfectly safe IFRs expertly managed by an international team of nice persons. Well, it wouldn't be free, just inexpensive. And they would be near-perfectly safe if they're designed properly. And yes, I do propose they be expertly managed by an international team. Hopefully those people would be nice. We could always employ psychological profiling in order to increase the odds of that.
214	The IFR is portrayed as better than the proposed EPR pressurized water reactor design because "*the physics of the IFR's materials and the reactor design itself ensure the plant against coolant emergencies*." Here, and elsewhere, only half of the safety threats are addressed. There are two types of safety threats faced by nuclear power reactor. One involves removal of the heat produced by the nuclear fuel. The accident at Three Mile Island (TMI) resulted from failure to meet this safety threat. The TMI reactor automatically shut down due to a fairly benign component failure. The operators relied on a false water level indication and shut off the cooling systems. Over the next two hours, the water covering the reactor boiled away. As the water level dropped below the top of the reactor core, the exposed nuclear fuel overheated and partially melted. The testing conducted of an IFR-like reactor (EBR-II) indicated that this design is far more tolerant when cooling systems are turned off. But that's only half of the risk. The other safety threat involves control of the nuclear chain reaction. As the book explains, neutrons released when uranium and plutonium atoms split interact with other atoms to induce them to split. When sufficient neutrons

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	and atoms are present, a nuclear chain reaction occurs. The 1961 accident at the SL-1 reactor in Idaho and the 1986 accident at Chernobyl happened when control of the nuclear chain reaction was lost. At SL-1, workers removed a control rod too far. The reactor core went from being shut down (i.e., no nuclear chain reaction) to operating at over 1,000 percent power in fractions of a second. The massive heat created by this power excursion vaporized the water surrounding the reactor core. The steam explosion lifted the entire reactor vessel about nine feet into the air and killed every worker at the plant. At Chernobyl, workers conducting a test of an emergency backup safety system also lost control of the nuclear chain reaction. The reactor core went from about 7 percent power to over 1,000 percent power in less than 4 seconds. The steam explosion blew the reactor and its containment apart. As a fast reactor, the IFR has less margin against losing control of the nuclear chain reactor. As the book points out, today's reactors produce plutonium atoms as they burn uranium atoms. At some point in the fueling cycle, more energy is being produced by plutonium atoms than from uranium atoms. This shift from uranium to plutonium atom power affects control of the reactor through what is termed the "delayed neutron effect." Neutrons interact with plutonium and uranium atoms making them unstable. The atoms fission seeking to restore stability. Energy and more neutrons are released from fissioning atoms. On average, neutrons are emitted sooner when plutonium atoms than from uranium atoms. This delayed feedback is similar to the delay experienced when one depresses the gas pedal in a moving car. The car ramps up to a higher speed. If the higher speed were achieved instantaneously rather than gradually, there would be more collisions with cars being passed. The ramp time allows the driver to make necessary adjustments to avoid mishaps. I personally experienced the "delayed neutron effect" when working at the Browns Ferry nuclear plant in the early 1980s. The Unit 1 reactor core consisted of about 100 tons of nuclear fuel. We were restarting the reactor towards the end of its fueling cycle. Plutonium atoms were providing far more of the fissioning than uranium atoms. The operator had just achieved a nuclear chain reaction when one of the control rods malfunctioned. The control rod was supposed to be withdrawn six inches at a time but it moved out one foot (each control rod was 12 feet long, matching the reactor core's height). The reactor core's power level started doubling every 5 seconds. A 100-ton reactor core doubling its output every 5 seconds gets your attention. Before the operator could respond, a protection system sensed the runaway reactor and automatically inserted all of the control rods, including the malfunctioning one, within seconds. As a fast reactor, IFR has less margin to reactivity excursion events involving loss of control of the nuclear chain reaction. This book does not

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	explain how the increased risk from this safety threat is managed. LWRs require a large excess reactivity at the beginning of their fuel cycle, which requires control by burnable poisons or control rods. IFRs can be designed with only a small excess reactivity due to their superior neutron economy and hence the reactivity insertion due to an accidental rod withdrawal is limited to well below runaway transient overpower. So the overpower transient will stabilize at a reasonable power to maintain safe operation.
265	Reference is made to our 2003 report on NRC's handling of the containment sump safety issue. Appreciate the citation. The NRC drew a line in the sand and required all plants to correct the containment sump problem by December 31, 2007. Update: 62 of the 69 nuclear power reactors in the US with the containment sump problem DID NOT resolve it by December 31, 2007. Apparently, the NRC drew a line in the sand with either side of the line being perfectly fine with them.
268 276	The concept for the Global Rescue Energy Alliance Trust (GREAT) is introduced. GREAT is essentially an entity that would own and operate all the nuclear power reactors and reprocessing facilities in the world. On page 276, the concept is described as providing energy embassies within nations' borders, with GREAT solely responsible for the activities within these sovereign embassies. Given the track record of a smaller scale, less intrusive, yet equally noble trust attempt in the past decade, this concept seems unlikely to get traction. Within the past decade, there was a proposal to form an international trust to resolve the spent fuel disposal problem. A geological repository would be opened in Russia for spent fuel from countries willing to pay the trust for its disposal. The trust would select the repository site, construct it, operate it, and even manage the transportation of spent fuel from customer countries to the repositories. The trust included a significant allocation (I believe around 25 percent of the incoming revenue) to be applied correcting environmental problems in Russia and preventing future problems. The trust, in theory, would solve the spent fuel disposal problems for many countries. In addition, it would hasten the recovery from past environmental problems in Russia. Who could oppose such a wonderful thing?

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	Turns out, just about everyone. Russia did not want to lose it's right to stop taking spent fuel from a country falling from grace. Other countries liked the idea of getting rid of their spent fuel, but didn't want to pay an undue surcharge to fix Russia's environmental excesses. I'm not saying it would be easy to create such an international organization, but I'm saying that it would be preferable to the sort of go-it-alone disjointed development of nuclear technology that I saw so clearly in evidence at last week's forum. If we expect to keep control of fissile material in a world where nuclear power is spreading far and wide (and it is, whether we choose to recognize it or not), we have to decouple nuclear power from nationalism. Whether you think that sounds naïve or not isn't really my concern. There comes a point where grave threats force people and countries to act in unprecedented ways. I'm banking on the nature of the threats we face (climate change, resource wars, especially water wars) being sufficient to spur the world to make such groundbreaking efforts at cooperation, all the more likely if the benefits are so obvious. I may be wrong. I hope I'm not.
281	Statement is made "*The cost of IFRs will be nothing to sneeze at, even taking mass production into account. We don't want those plants sitting idle or running at half power*." This point is well understood. But it's not understood why this point doesn't equally apply to the reprocessing facilities advocated for each and every IFR site. Unless there are sufficient IFRs at each site as to keep the reprocessing facility busy year-round, it will operate sporadically (i.e., not economically). Given the small quantities of reprocessing that would have to be done and the fact that the IFR plant-sited reprocessing units would be small, modular, and uniform in design, any added cost could be considered the price we pay for never having to move actinides out of the plant once they're in.
326	Statement is made "*The most accident-proof design for a pool-type reactor such as those being proposed for the IFR complexes involves, as mentioned earlier, a below-grade installation for the reactor vessels*." Such a criterion would eliminate certain sites. For example, a company proposes to build additional nuclear power reactors at the Turkey Point nuclear plant in southern Florida. This location near Miami could not easily accommodate a below-grade nuclear facility because the water table is close to the ground surface. To meet all potential sites, above-ground and below-grade IFR designs might be necessary.

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	But multiple designs invokes the dilemma that McDonalds faced about a decade ago as the company examined food irradiation as protection against *e coli* and other illnesses. McDonalds determined that food irradiation could successfully protect against the contamination without compromising quality, shelf-life, cost, and other factors. But there were insufficient food irradiators to allow McDonalds to deploy this treatment nationwide. McDonalds needed to do it everywhere or do it no where. The company felt that people might refrain from going to stores not receiving irradiated meat, concerned that they were not getting protection afforded others. Conversely, the company felt that people might refrain from going to stores receiving irradiated meat, concerned that McDonalds was conducting some kind of experiment. If the IFR reactor vessel must be installed below-grade, many sites are eliminated. If non-below-grade sites are deemed acceptable, people will likely balk at paying a higher cost for a below-grade plant when its not necessary for safety. This is a point well taken, and one that I'll address and change in the book. I was considering it from a standpoint of ease of security, but I've frankly felt a bit uncomfortable with the concept for the very reasons you mention. Thanks for the suggestions.
328	Statement is made "*Housing for the GREAT employees would logically be located in a compound near the plants that would be an integral part of the energy parks*." This invokes the unflattering images of the coal mining towns of the early 20th century where company housing and company stores turned miners into essentially slave workers. When the Grand Gulf nuclear plant was built near Port Gibson, Mississippi in the late 1970s, its owner had a company policy that workers must live in the counties in which they worked. The intent was good community relations. But the company found it difficult to recruit engineers and technicians to live in such a small town. The company was forced to revise its policies from requiring to encouraging workers to live in the same counties. Well, there wouldn't be all that many employees like there were in the coal mining and other company towns. If GREAT were organized along the lines I propose, potential employees would know in advance what would be expected of them. The reason for having housing near the site would be for standardized design to allow for the sort of movement you address in your next point, below.

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328	Statement is made that GREAT's employees "*would be expected to relocate to different counties at random times as a condition of their employment*." In 1980, the NRC required that the inspectors it assigned full-time to nuclear power plant sites be relocated at least every two years. The intent was to prevent inspectors from becoming too cozy with the companies being regulated and too accustomed to conditions to provide objective assessments. But people don't like being forced to move when children have a year to go in high school or want to attend a college without paying out-of-state tuition rates. The NRC has revised its policy to something like 7 years now, with plenty of exceptions granted even at this duration. In the early 1990s, the owner of the Susquehanna nuclear plant decided to consolidate its site and corporate offices. It transferred a group of about 30 design engineers from its corporate offices in Allentown, Pennsylvania to the plant site in Berwick. Or, it tried to do so. Only a small handful actually relocated. The rest quit the company or transferred to non-nuclear portions of the company to stay in Allentown. In short order, Susquehanna's performance dropped, caused in part by the loss of talent and knowledge from the departed engineers. Susquehanna had for years earned INPO's top rating of "1." It soon dropped to "3" on the five-point scale. Suborning people's interests to those of the company seldom yields the desired objectives. Perhaps it's due partly to my own natural curiosity about the world that I can easily imagine people inclined to international travel to be drawn to the sort of lifestyle that would be required of such mobile employees. There's a big difference between people being moved around within the USA and people moving between countries. As you point out in your examples, there could be ample room for exceptions without undermining the point of such mobility.
332	Statement is made that presidential candidate Bill Clinton during a 1992 debate "*eagerly labeled a rival as 'pro-nuclear' as if it was a patently absurd position*." New Hampshire has one operating nuclear power reactor, Seabrook. A second reactor was partially constructed at Seabrook. But it was canceled in 1988 as part of the recovery plans by the company to emerge from Chapter 11 bankruptcy proceedings. Massive cost over-runs forced the company to suspend its dividend payments and default on loan payments. When Seabrook went into operation in August 1990, electricity bills skyrocketed as the company tried to pay down its debts. People were not enchanted with nuclear power in New Hampshire. Forget about the anti-nukes, people on main streets hated paying 40 percent more for electricity than they paid last

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	year. So, being pro-nuclear in New Hampshire in 1992 was as close to a patently absurd position as any presidential candidate hopes his opponent to take. Whatever the situation in New Hampshire at the time, my point was to illustrate how Clinton used nuclear power as a political cudgel. In point of fact, two long-time antinuclear activists from New Hampshire have read my manuscript and are looking forward to the advent of the IFR era.

David, let me just say in closing that I've read much of your writing and concur wholeheartedly that the operation of nuclear plants in the USA has repeatedly been slipshod and even unconscionably careless. You have spent considerable time and effort to bring such irresponsible behavior to light, for which I commend you wholeheartedly. One could hardly blame you for developing a jaundiced eye toward nuclear power in general after being exposed to such a litany of screwups, many of them potentially dangerous. It was exposés such as those you specialize in that contributed to my own conviction that keeping nuclear power plants in the hands of private for-profit companies is a terrible idea.

That being said, it seems to me that the attitude in evidence at UCS toward nuclear power seems to have been unduly and unfairly influenced by its watchdog efforts. I suppose it's easier for me to consider the issue from a strictly technical standpoint since I haven't been steeped in such a milieu of stories of incompetence and negligence. I believe that superior reactor design can be combined with a culture of responsibility grounded in public ownership and international control to allow humanity to safely benefit from the promise of nuclear power.

I would have never considered myself to be pro-nuclear before I learned about IFRs. Quite the contrary. Like Patrick Moore, Stewart Brand, and James Lovelock, I see no alternative to a massive deployment of nuclear power to augment renewable energy systems that simply will not be able to meet the inevitable energy demands of the future. And if we must turn to nuclear power—as it seems we must—I want to make sure we use the best possible systems in a political framework that benefits all people to the utmost degree possible.

Thank you for taking the time to so assiduously examine my book and offer your perspectives and suggestions. I'll be happy to discuss these issues with you anytime.

Best regards,
Tom