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Fusion

The feature article in the June issue, "Fusion at the Crossroads," by T. C. Simonen, left me wanting a more balanced account. The article begins by stating that "the major fuel of fusion, deuterium, is abundant, inexhaustible." But, of course, deuterium is just half of the fuel for the D-T reaction. The other half, tritium, is made by bombarding lithium with neutrons. Simonen says that neutrons from fusion will be captured in a lithium blanket around the fusion machine, an unproven concept. For now, tritium is made in nuclear reactors. Regardless, for each deuterium atom consumed, one atom of lithium is also consumed. I didn't see any claim for the inexhaustibility of lithium.

The article also claims that "fusion could reduce nuclear waste and reduce public concern about accidents." This overlooks the large inventory of tritium, a radioactive gas. If released accidentally, tritium would pose a serious health hazard, since it is chemically the same as hydrogen. And tritium is the stuff of hydrogen bombs, raising national security problems.

Finally, the neutrons generated in the fusion reaction would cause radiation damage in the materials of the fusion machine, which, in addition to the damage from the plasma, would eventually cause the materials to fail. These materials would also be radioactive, posing a disposal problem.

Simonen states that fusion funding was

cut in 1996, largely to reduce the federal budget. Could the paucity of tangible results after a half-century of high-level funding have something to do with it? The article says that estimates put the cost of electricity from a tokamak at \$0.05/kW·h. This is a ludicrous claim, given that the basic concept of controlled fusion has yet to be fully demonstrated, much less an engineering prototype built that can produce electricity. That a biased paper was printed as a feature article raises serious questions about the ability of the editors of *The Industrial Physicist* to publish papers of professional quality.

Walter John

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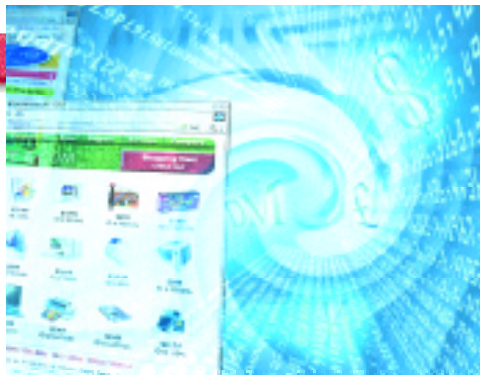
[*Author replies:* The challenges that Walter John points out are well known and can be addressed. As he points out, lithium needed to make tritium for the D-T reaction is indeed in shorter supply than deuterium. However, studies show that lithium availability is sufficient for thousands of years of a fusion power economy, allowing time to develop fusion systems using higher-temperature, pure deuterium fuel. John's concern about inner-wall radiation damage and waste is presently being addressed with research on innovative designs and low-activation materials.

The issue of tritium certainly must, and can, be managed with strict attention to health and safety guidelines. More to the



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point, when compared with fission power plants, fusion would pose a much smaller environmental risk. Like fission, fusion would not have the deleterious atmospheric effects of fossil fuel plants.

Obviously, the estimated costs of fusion energy must be based on certain assumptions. However, these estimates are based on very detailed studies performed in several countries and are valuable guides to research priorities.

Regarding his comment about results in the field, I recommend that he become aware of the tremendous progress in both scientific understanding and technical accomplishments reported in *APS/AIP* and other journals. It is worth pointing out here that most of the physics basis for fusion has been demonstrated, so the field is now at a crossroads. We must continue innovative physics research to improve and optimize fusion concepts, and we must build a burning plasma experiment and develop

fusion technology. While the challenge of developing fusion may seem daunting to some, there are few long-term options for satisfying the base-load energy demands of a world economy. To forgo vigorous development of fusion would be irresponsible.

Thomas C. Simonen]

Cryptography

I enjoyed the article “Cryptography and the New Economy” (August 2000, pp. 29–33). Cryptography is a relatively old concept that has been brought into the modern world via high-speed computers. It moved me to look for an article that I believe was published in the *IEEE Spectrum* and later forcibly withdrawn when the National Security Agency threatened to arrest all involved. That article, entitled “The Mathematics of

Public-Key Cryptography,” by Martin E. Hellman, described two approaches. One was by Hellman, Ralph Merkle, and Whitfield Diffie at Stanford University, and the other was the RSA approach, as mentioned in *The Industrial Physicist*.

In both approaches, an integral concept seemed to be how to include a “trapdoor” for monitoring by the U.S. intelligence community. Thus, although not mentioned in your article, I would assume that the systems used for current “encrypted” communications do, in fact, have a trapdoor

available to, at minimum, the CIA and NSA and, at worst, the Internal Revenue Service, Department of Justice, and oth-

ers. To publish an article emphasizing communications security without mentioning the possibility of the U.S. Government’s ability to view it, is to lead readers into a warm, fuzzy, but unreal feeling about the security of their Internet communications.

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[*Author replies:* The issue of trapdoors, or the ability of authorized bodies to decipher encrypted messages, is a heated one. Currently, the primary encryption vehicles used in e-commerce are not equipped with such facilities, although various agencies have strongly recommended legislation to that effect. Furthermore, the current prevailing wind in Washington is that of loosening the rigid view of encryption as a strategic technology and to allow wider usage in e-commerce contexts. Ironically, the one area where trapdoors—or, in some cases, “key-escrows”—are beginning to show up is in business organizations. Many companies see the need to access encrypted business information on-demand in circumstances brought on by departing employees or misuse of facilities by employees. So the technology is developing, but for different reasons than in the past.

Tom Lee]

Energy

I enjoyed your article “Where is Energy Going” [February 2000, pp. 16–19]. I agree strongly with many of your points and share your vision of a hydrogen economy. I have visited your Program for the Human Environment Web pages and was fascinated by many of the subjects I found there. Recently, I attended a lecture given here at Southwest Research Institute by a scientist working on advanced fusion. We agreed that it is just a matter of time and research before cheap

and abundant energy is available through fusion (there was a great deal of discussion on how long, but that is another story).

One of the questions I raised was, “What happens to the energy?” By this I mean that if we do indeed have cheap and abundant energy available, will we eventually drown ourselves in waste heat? Even if we learn to use energy more efficiently, all the energy is ultimately converted into heat. Cities are already 5 to 15 °F hotter than the countryside because of albedo [reflectivity of surfaces], energy use, and possibly, less transpiration cooling. Warmer cities cause us to expend more energy cooling our structures, thereby compounding the problem. Even if we learn to curb our generation of greenhouse gases, will we see global warming due to increased energy use? Or is radiative cooling able to keep up with our energy generation? After reading your article and perusing your Web pages, I thought your group would be an appropriate one to pose these questions to.

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[*Author replies:* Looking forward centuries, we must consider waste heat. Globally, human activities now release only about 1/10,000th of the solar energy absorbed by the Earth’s surface. But in perhaps 150–200 years, 20 billion people, each using an average of 20 kW·yr/yr, might release about 400 TW, or 1/200th of the solar input. In the 1970s, meteorologists calculated that this could lift the global surface temperature about 1 K. And as around today’s cities, the concentrated release of waste heat in certain areas could alter climate patterns, which appear to be quite nonlinear.

The possible climatic effects merit continuing attention, as do those due to changes in the reflectivity of the Earth’s surface that will attend large-scale darkening of the surface with solar panels or reforestation. Our millennial strategy should be to consume negative entropy and not heat. Ocean thermal systems might eventually

offer a way to dissociate the two. The essence of the ocean thermal system is floating stations churning the oceans and producing liquid air, carried by tankers and pipelines to final consumers.


Jesse Ausubel]

Gold standard

In the June 2000 issue, the New Products section has information about a NIST reflectance standard named LaserGold [p. 39]. The June 2000 issue of *Military & Aerospace Electronics* also had information about LaserGold, but it said nothing about it being a NIST standard. I went to the Epner Web site, and no information there indicates that it is a NIST standard. An article in the November 1997 issue of *Photonics Spectra*, “Gold Rules the World of Infrared,” also gives information about LaserGold and Epner; it states that Epner and Optical Data Associates of Tucson, Arizona, developed a standard for a band or range that NIST standards did not cover, but there was no mention of it being a NIST standard. The September 1997 issue of *Lasers & Optronics* talks about Epner and LaserGold, but there is no mention of it being a NIST standard. Has it become a standard since 1997?

Tom Davis
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[Epner Technology supplied NIST with mirrors that NIST then individually measured, certified, and now distributes as NIST standard reference materials. A more fitting statement might be: Epner Technology’s mirrors were used to produce NIST Standard Reference Material 2011, First Surface Gold Mirror.

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ERRATUM: In the August 2000 issue, page 12, third paragraph, the company name Siemens was misspelled as Siemans.