If you watch television or read repeated public statements of concern about nuclear power plants as terrorist targets, you would be justified in believing that spent nuclear fuel casks being shipped to Nevada for storage are each a nuclear catastrophe just waiting to be triggered. These casks have been called “mobile Chornobyls,” and we are told they are capable of causing “tens of thousands of deaths” (1). What are the facts about the safety of nuclear shipments and power plants?

Since 11 September 2001, the U.S. nuclear industry and its regulators have been reevaluating plant and fuel shipment safety. These studies are being kept secret. But it is no secret that basic engineering facts and laws of nature limit the damage that can result. Extensive analysis, backed by full-scale field tests, show that there is virtually nothing one could do to these shipping casks that would cause a significant public hazard (2, 3). Before shipment, the fuel elements have been cooled for several years, so the decay heat and the short-lived radioactivity have died down. They cannot explode, and there is no liquid radioactivity to leak out. They are nearly indestructible, having been tested against collisions, explosives, fire, and water. Only the latest antitank artillery could breach them, and then, the result would be to scatter a few chunks of spent fuel 1988 by flying an unmanned plane at 215 m/s (about 480 mph) into a test wall 3.6 m thick. The plane, including its fuel tanks, collapsed against the outside of the wall, penetrating a few centimeters. The engines were a better penetrator, but still dug in only 5 cm. Analy-ses show that larger planes fully offset their greater impact by absorbing more energy during their collapse. Higher speed increases the impact, but not enough to matter. And inside the containment wall are additional walls of concrete and steel protecting the reactor.

Is it possible to cause a nuclear reactor to melt down some other way? Yes, it happened at Three Mile Island (TMI) in 1979. Reactors are much improved since then, and the probability of such an accident is now much less. But suppose it happens, through terrorist action or other; what then? Well, the TMI meltdown caused no significant environmental degradation or increased injury to any person (7–10), not even to the plant operators who stayed on duty. It has been said that this lack of public impact was due primarily to the containment structure. But studies after the accident showed that nearly all of the harmful fission products dissolved in the water and condensed out on the inside containment surfaces. Even if containment had been severely breached, little radioactivity would have escaped. Few, if any, persons would have been harmed.

To test how far the 10 to 20 metric tons of molten reactor penetrates the 13-cm-thick bottom of the reactor vessel on which it rested, samples were machined out of the vessel and examined. The molten mass did not spread onto the ground. There seems to be no reason to expect harmful effects of the radiation any significant distance from the cask.

Similarly, we read that airplanes can fly through the reinforced, steel-lined 1.5-m-thick concrete walls surrounding a nuclear reactor and inevitably cause a meltdown resulting in “tens of thousands of deaths” and “make a huge area of the U.S. uninhabitable for centuries,” to quote some recent stories (4). However, there seems to be no credible way to achieve that result (5, 6). No airplane, regardless of size, can fly through such a wall. This has been calculated in detail and tested in detail in field tests by the Department of Energy at the Idaho National Engineering Laboratory.

**POLICY FORUM: NUCLEAR SAFETY**

**Nuclear Power Plants and Their Fuel as Terrorist Targets**


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Three Mile Island nuclear power plant.

SCPEAR-2000 (11) reported that there were 30 deaths to plant operators and firefighters, but no significant increase in mortality or cancer due to irradiation of the public have been observed (12, 13). A possible link between exposure and thyroid cancer is still under study (14). The terrible and widespread consequences of that accident—increased alcoholism, depression, unemployment (15), plus 100,000 unnecessary abortions (16)—were caused primarily by fear of radiation and by poor planning based on that fear. The evacuated lands are generally now no more radioactive than the natural background levels where many people have lived healthily for generations. It’s not surprising that some people overstate the concern about radiation, for whatever reason. But it is surprising that most nuclear advocates are reluctant to challenge such claims. They say they just want to be cautious. But striving for maximum caution leads to the assertion that we should act as if even the tiniest amount of radiation might be harmful, despite the large body of good scientific evidence that it is not (17–22). This policy has scared people away from mammograms and other life-saving treatments and has caused many Americans to die each year from pathogens that could have been killed by food irradiation (23). It has paled regulations on nuclear medicine facilities that caused many of them to shut down. And now, “permissible doses” have been pushed below those found in natural radiation backgrounds (24–26).

Such cautiousness has drawbacks when applied to design and operation of nuclear facilities. But it is particularly dangerous when applied to terrorism. To tell people that they and the Earth are in mortal danger from events that cannot cause significant public harm is to play into the hands of terrorists by making a minor event a cause for life-endangering panic. Now is the time to clear the air and speak a few simple scientific and engineering truths.

References and Notes
1. "[A] major fire is possible which could release 25 times more radioactive material than Chernobyl. Here’s how: such a fire could render 29,000 square miles uninhabitable...cause 28,000 cancer deaths and 559 billion in damage." C. Smith, The Fed, 1 May 2000. Available at: www-tech.mit.edu/V112/1122/col22bric22c.html.
4. You could have thousands of summers, hundreds of thousands of fatalities from cancer...the downwind path from these types of casualties could extend for hundreds of miles." D. Nelson, in One World UK, 2 November 2001 (www.one-worlduk.net.uk). To which the government reported: "Of course it would be a big mess. Would it lead to multiple tens of thousands of deaths? That’s much less certain." B. Henderson, Nuclear Regulatory Commission (NRC) representative, in K. David-Olson, "How safe is safe enough? A look at nuclear power plant safety," in OneWorld UK, 2 November 2001 (www.one-worlduk.net.uk). To which the government reported: "Of course it would be a big mess. Would it lead to multiple tens of thousands of deaths? That’s much less certain." B. Henderson, Nuclear Regulatory Commission (NRC) representative, in K. David-Olson, "How safe is safe enough? A look at nuclear power plant safety," in OneWorld UK, 2 November 2001 (www.one-worlduk.net.uk).
5. “A hijacked commercial airliner loaded with explosive jet fuel like the one that hit the Pentagon on September 11 could reach power reactor and release deadly radiation," from a Reuters report, 17 June 2002, of a National Press Foundation Seminar. The report, commissioned by the Nuclear Energy Institute, is being reviewed by industry experts and will be completed this fall. The study reports detailed computer modeling, confirmed by large-scale tests.
6. Videotapes of tests of an unmanned airplane impacting a mockup of a section of containment wall can be seen at www.sandia.gov/media/ffgamma00-03.htm.
12. This report (7) was reviewed and the conclusions on Chernobyl reaffirmed in the Chernobyl Seminar: Health Effects of the Chernobyl Accident: Results of 15 Years of Follow-Up Studies, Kiev, Ukraine, 4 to 8 June 2001, sponsored by UNSCEAR; the World Health Organization; other U.N. agencies; and Ukraine, Belarus, and Russia; available at www.unscear.org/chernobyl.htm. Z. Jaworowski, member and former chairman of UNSCEAR, described the significance of these findings in Phys. Today 52, 24 (1999).
20. The authors are all members of the National Academy of Engineering, but this statement does not constitute an official statement of the academy.