The Truth About 'Nuclear Power Plant Terrorism'

Various hypothetical scenarios for acts of sabotage against a nuclear power plant or some part of the nuclear fuel reprocessing cycle have been conduited through the media with an increasing frequency and intensity over the past few months. The objective, presumably, is to convince the public that such an act, which most people correctly believe to be impossible, could actually happen. The scenario usually ends with the saboteur(s) getting their hands on some plutonium (the scenario-spinners seem to have given up on the highly enriched uranium route, since they apparently can't convince anyone of that one anymore) and turning it into a nuclear bomb.

These fantasies have been the vehicles for some major attacks against the commercial nuclear power industry — which is absolutely the last place anyone who is really serious about making a bomb would go. Plutonium from commercial nuclear reactors is very poor bomb material, since it is diluted with non-fissionable plutonium. This fact, combined with the near-zero probability that anyone could actually get their hands on plutonium in a useable form from commercial reactors or their fuel cycle, exposes these scenarios for what they really are — hoaxes meant to scare the public into accepting some alternative energy program.

In fact, the frequency of such proposed nuclear terrorism scenarios hitting the front pages appears to be increasing at a rate about equal to the escalation of outstanding bad loans now being held by the Chase Manhattan Bank, the IMF and other Wall Street-based

What Would Really Happen If Terrorists Really Seized A Nuke Plant

By now, every civic-minded American is supposed to know that the main reason why America must give up nuclear energy and "conserve" itself back to the Stone Age is because of the danger of nuclear terrorism. President Carter says so, James Schlesinger says so, a lot of the press says so.

Consider this:

A terrorist team, after years of preparation finally attacks a nuclear power station in the Northeast U.S. Intricate alarm systems are neutralized by terrorists infiltrated into the plant's staff, and the plant's security forces are taken unawares; after several gun battles with guards through the plant, the terrorists make their way to the control room. The plant is theirs! The terrorists broadcast their demands to the world.

They threaten to overload the reactor and blow it up. Right? They threaten to steal deadly plutonium and poison the atmosphere, killing thousands. Right? Well, not exactly....

Suppose our terrorists try to make good on their threats. They start the reactor into a rapid power increase, but, alas, only to find that the safety system automatically shuts down the reactor completely. Subsequent trys to start it up again fail, also because of other fail-safe systems. They finally give up when the reactor operators convince them it would take hours to re-start the reactor, and that there is no way to bypass the safety systems and cause an overload.

The terrorists then decide that they will move to their fall-back threat: they will break open the reactor and steal the deadly plutonium. (We beg the reader's pardon at this point and ask him or her to ignore the fact that you can't really steal reactor plutonium: reactor plutonium comes in one-ton rods which are so radioactive that they have to sit around for six months before they are moved — with the help of enormous, remotely controlled machinery.)

Just for this purpose, the terrorist team has brought with them satchels of powerful plastique explosive. Their first task is to blast their way into the reactor building from the control room: The reactor building is automatically sealed during operation, with no human entry possible, and is even more stringently sealed after the safety system is activated.

Finally, after blasting their way into the reactor building, the terrorists are faced with a several-foot thick concrete wall and a 12-inch thick steel vessel. Little did they know that reactors are designed to withstand huge operating pressures and even greater blast pressures without failure. Needless to say, the terrorists' explosives only chipped away some concrete before they ran out of explosives and gave up.

The terrorists are demoralized; nothing seems to work. Finally, the terrorist leader hits upon an idea: what they need to break open the reactor is a small nuclear device. Now, all they have to do is steal an A-bomb...

Jon Gilbertson, a member of the U.S. Labor Party's Research and Development Staff, is a nuclear engineer and has helped design safety systems for nuclear plants.

financial institutions. There also appears to be a direct correlation with the increased push to get the Carter Administration's no-growth energy program past mounting national opposition.

Plant Sabotage — Fact or Fancy?

Certainly the most ridiculous of the terrorism scenarios is the "armed band" attack on a nuclear power plant followed by absconding with the plutonium. The box on page one indicates the likely results of such an operation and little more need be said. However, despite the impossibility of stealing plutonium from a nuclear power plant, the Nuclear Regulatory Commission has recently been pressured into imposing severe security regulations on all installations. All nuclear power plant security systems must now be capable of resisting an armed attack of six terrorists, one being an insider — quite a security system for a plant in which the most any saboteur would be able to accomplish is to shut down the electrical power generation.

The actual layout and construction details of a nuclear power plant (assume a Light Water Reactor (LWR) for our example) properly dispose of the scenario writers' fantasies. It is important to understand that plutonium does not exist in this reactor in any way, shape or form that can be used in a bomb. To obtain a bomb highly radioactive plutonium-bearing fuel in oxide compound form would have to be transfered from the reactor site, put through a costly remote reprocessing operation, separated, changed into metal or some other shapeable form, and finally fabricated in special remote facilities. This series of processes and operations may sound vaguely possible to the uninformed. It isn't, and here is why.

Plutonium does not now exist naturally in the earth and thus has to be produced by man through transmutation of uranium (U-238) via neutron bombardment. This occurs in LWR fuel during its three-year operating cycle, from the excess neutrons released in the fissioning of Uranium (U-235). Current LWR "fresh" fuel is enriched uranium oxide (UO_2) which is a mixture of 5 percent U-235 and 95 percent U-238 — no plutonium is present. During the three years that the fuel bundle remains in the reactor, most of the U-235 is "burned up," but with a significant amount of plutonium generated within the UO_2 mixture. (Enough plutonium is generated and enough unburned U-235 remains to more than economically justify its removal from the burned-up fuel via reprocessing, and eventually refabricating it into new fuel.)

Since plutonium in currently operating LWRs exists only in the burned-up fuel, getting it out represents a tremendous problem, not only for the would-be terrorist, but for the reactor plant operators as well. The fuel bundles which are now highly radioactive must be handled remotely through at least seven feet of concrete in order to protect the workers. The bundles also weigh over one ton each and are approximately 15 feet long. Removing these elements from the reactor vessel is a several day operation which involves many hours of preparation just to open up the reactor — of course all being done remotely behind thick walls. Once it is removed and sitting behind walls in a water pool storage area, there is no way to get at the plutonium unless the terrorist would like to try instantaneous death in a radioactive swimming pool. Because of these facts alone, it is safe to say that any kind of diversion of this fuel is impossible and that "burned" reactor fuel is inherently safe from theft.

Therefore all the scenarios about "intelligent terrorists or insiders" being able to pull off such a theft is simply an outright lie.

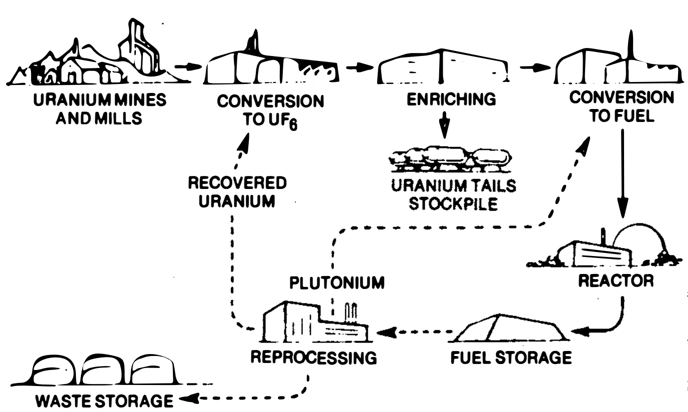
The Rest of the Fuel Cycle

Of course, the scenario writers don't give up that easily and do have their backups for the failure to sabotage the nuclear plant itself. They say: if that won't work, we'll sabotage the fuel reprocessing plant or some other part of the fuel cycle and get at the plutonium that way. Well, the only fuel reprocessing plants in existence today are government-owned facilities; most are used primarily by the various national defense establishments. Security at such facilities would make the breaking into Fort Knox look like a pushover by comparison.

Considering normal security precautions, it is difficult to see how any terrorist organization could obtain plutonium from an attack on the fuel cycle. The Light Water Reactor fuel cycle is shown in Figure 1: it consists of several processing and fabrication steps. The uranium fuel manufacturing processes resulting in "fresh" fuel for the LWR (5 percent U-235, 95 percent U-238) starts with the mining and milling of uranium ore into yellow-cake (U_3O_8). The yellow-cake is then converted to gaseous uranium hexafloride (UF_6) which is fed into a gaseous diffusion enrichment plant. The uranium is enriched to 5 percent U-235 in this facility, sent on to be converted into uranium oxide (UO_2), fabricated into fresh LWR fuel bundles, and finally shipped to the reactor site. These processes all deal with low-enriched material that cannot be used for producing bombs.

Figure 1

The Light Water Reactor Nuclear Fuel Cycle



After the burned-up fuel comes out of the reactor, it is highly radioactive and therefore also thermally very hot, requiring continuous cooling. All handling, shipping and storage must be done remotely in shielded and cooled cells and shipping casks. Several one-ton fuel bundles are transported in 70 to 100 ton casks on flatbed trucks or railcars to the storage and reprocessing area. The radioactivity, weight, bulk and the requirement for specialized handling equipment eliminate the possiblity of theft or sabotage during these steps. Furthermore the shipping casks are designed to be blast and crash proof! How long could our terrorists hide this radioactive flatbed in their garage following a "hijacking" before the geiger counters pinpointed their location? A few hours at most. Extending the scenarios beyond this gets even more ridiculous.

In the fuel reprocessing plant the radioactive fuel bundles are finally dismembered by cutting them up into small segments and dissolving in a strong nitric acid solution. The uranium (including U-238 and unused U-235) and the plutonium are chemically separated from the fission product wastes in this acid base mixture. The fission product waste solution is neutralized, concentrated, and stored in leak-proof tanks while the uranium and plutonium is prepared for recycling back into fresh fuel. This entire process must be done remotely under extremely adverse conditions of radioactivity and chemical reactivity (acids), hardly a place where a terrorist could intervene.

The only potentially vulnerable portion of the fuel cycle is after the recovery of plutonium from the burned fuel. At this point, it is converted to plutonium oxide (PuO_2) and readied for shipment to the fuel fabrication plant. Since the fission products have been removed, it no longer contains much radioactivity and therefore loses a certain amount of that inherent protection. Under former regulations, this material would be shipped in large shipping casks, under top security precautions, to the fuel fabrication plant. The uranium which now contains only one-and-a-half percent U-235 is shipped to the gaseous diffusion plant for re-use; again, the low enrichment makes it impossible for use as bomb material.

If additional security precautions are deemed necessary for the fresh plutonium part of the cycle (and I'm not suggesting that they are), there are several surefire ways to guarantee "terrorism proof" procedures. One of these and probably the easiest is to co-precipitate the uranium and plutonium out of the reprocessing slurry together as oxides (mixed UO_2-PuO_2), thus diluting the plutonium far below anything that is useful for nuclear weapons. It can then be shipped to the fuel fabrication plant as before. Another method is to "spike" either the plutonium oxide fuel material or the shipping cask with highly radioactive material, thus adding that inherent protective measure back again. A third way is to fabricate the plutonium into fuel bundles at the reprocessing plant, pre-irradiate these bundles in a special on-site reactor and then ship them to the reactor as highly radioactive fuel bundles, essentially duplicating the "burned" fuel bundles procedures.

The "Plutonium-240" Problem

Now that we've made liars (or, rather, conspirators) out of this select group of "scenarists," there is even more fuel to be added to the fire under them, so to speak. Plutonium that is produced in commercial nuclear power plants (commercial grade plutonium) is the last material anyone would use to make nuclear weapons — even if you had the know-how and the capabilities of the U.S. government. Nuclear experts have identified seven sources, besides nuclear power plants, from which bomb materials or bombs themselves could be obtained. In order of most probable source, stealing an atomic bomb from the Defense Department is near the top of the list along with other clandestine methods of obtaining such weapons from a foreign government, etc. Building a small research-type, plutonium production reactor (as India did) falls somewhere mid-way down the list with commercial power plants coming in last place — i.e., the most difficult source to use!

A large part of the reason for this is that the plutonium produced in such reactors is diluted with 25 percent Pu-240, a non-fissionable isotope, and therefore makes the construction of a nuclear explosive much more difficult. Plutonium-239 is the material wanted for weapons production, and plutonium production reactors are designed specifically to produce this stuff as pure as possible. Commercial reactors, on the other hand, produce Pu-239 initially, but as this material remains in the reactor for 3 or more years, a portion of it absorbs another neutron and becomes Pu-240. So when the burned-up fuel is removed from the reactor, the plutonium includes about 65 percent Pu-239, 25 percent Pu-240 and 10 percent higher plutonium isotopes. Plutonium-240 creates another problem for the amateur or professional bomb-maker, because it decays by neutron emission. To trigger an atomic bomb, precisely machined plutonium sections must be simultaneously brought together at the same time that an external neutron source is inserted to initiate the chain reaction. The neutrons, from Pu-240 decay, in a mixed plutonium bomb will cause a premature chain reaction most likely resulting in a dud. Even the Defense Department would have a difficult time producing a nuclear explosion from this material — obviously a band of terrorists cannot! So it seems quite evident that our "intelligent terrorist" would not consider going the commercial grade plutonium route for his bomb.

The "Johnny Appleseed" Syndrome

"A scenario for all circumstances" is this group's motto, and even they can come up with a last ditch effort. "Alright, so we can't make a bomb out of this stuff," they admit, "but we're going to spread plutonium hither and yon and terrorize the hell out of everyone." The thinking behind this version is that plutonium can be spread over the countryside with ease, much like Johnny Appleseed, affecting every nook and cranny with this dangerous poison. Some anti-nuclear groups have fed this syndrome by labeling plutonium "the most toxic substance known to man" in order to push their goals.

In actuality, plutonium is nowhere near the most toxic substance known to man, and is far down the list compared to other toxins that would be far easier to obtain. When swallowed or absorbed in the blood stream, it is ten times less toxic than lead arsenate, and hundreds of thousands of times less toxic than some biological substances, such as diptheria or botulism toxin, the list can go on. The point is that plutonium is radio-toxic and not very chemical-toxic, which means it causes death by radioactivity-induced cancer, if at all. Although there are *no* proven cases of plutonium-induced cancer even though about 1,200 people in the United States alone have ingested plutonium in the past 30 years, it still remains possible that cancer might result anywhere from *15 to 45* years after exposure! It seems unlikely that any terrorist group (even a dumb one) would want to wait that long to get results from their hard work.

The idea of being able to easily disperse plutonium is another farce. Assuming the terrorists did get their hands on some (which realistically can't be assumed), it would be in the oxide (PuO_2) form, either in hard sintered fresh fuel pellets or powder-like material. In pellet form, they would hardly be dangerous to anyone except the terrorist handling them.

In the powdered form, it is still a solid particulate material — not a gas such as poisonous chlorine — and is also insoluble in water. After adding it to the drinking water it would simply settle out at the bottom of the reservoir; trying to disperse it in the wind would result in it settling to the ground.

Ralph Nader has proposed putting it into a large building ventilation system as a blackmail threat. The custodian told him that he would shut off the fans if he did. At any rate the possible minimal dispersion of plutonium is not going to kill anyone in a short period of time (except perhaps the terrorist) and therefore its effectiveness for a terrorist is minimal!

— Jon Gilbertson

Oil Exploration Breakthrough

The United States Geological Survey (USGS) has announced a major breakthrough in lowering the cost of oil exploration. Oil formation occurs in a very narrow range of conditions, and the resulting deposits are decomposed or lost at only slightly more extreme conditions. Determining the history of a given geological formation can be extremely expensive and can make the cost of physical exploration too expensive for a given locality. If the geological history is well known, the success of an exploratory well becomes probable enough to entice the driller and the result is more available petroleum. A novel, inexpensive system of determining the maximum temperature of a great number and variety of strata has been described by the USGS, which should greatly decrease the probability of unsuccessful exploratory wells.

The method consists of isolating a fossil called conodont, and noting its color. With carefully prepared control samples, drawn from formations in which the history is known, and from laboratory-treated specimens, a very inexpensive and accurate determination of the maximum temperature of the sampled formation is possible.

The system is described in a USGS paper by Anita Epstein Harris, Jack Epstein, and Leonard Harris. The test is certain to lower the cost of oil exploration and greatly increase the availability of petroleum deposits.' The system is being tested in the United States, Australia, Canada, and the Soviet Union. Dr. Harris estimates that with a very small group of workers, an accurate map on a scale of 1 to 2,500,000 could be prepared for all of the United States in three or four years. Conodent color determination should increase the systematic scientific determination of geology for oil and gas exploration enormously. Genuninely scientific oil and gas exploration is only a few decades old, at most, and the conodont color determination test immediately opens large areas for oil and gas exploration. The Applachian Region is a prime example, with an inevitable increase in the availability of oil and natural gas.

Conodonts are tiny fossils with some trapped carbon containing substances, similar to those found in petroleum deposits. As the fossil is heated the carboniferous material breaks down, with a resulting change in color. The fossil can be viewed and photographed to compare it to the well established control sample to determine its heat history, simply by placing the sample in an ordinary light microscope. The ease of determination and the low cost of laboratory equipment involved make the system a very powerful tool ir geology and paleontology. The conodont color system is another example of basic research in one field being directly useful in a different scientific area, and an example of the economic value of scientific progress.

New Energy Beam Has Great Industrial Potential

A new energy concentrating device developed by Energystics Inc. of Toledo, Ohio now has the benefit of a rigorous scientific explanation by David Fenneman of the U.S. Navy weapons center. Energystics "energy beam" device is a plasma transferred radio frequency energy source. Fenneman's study shows apparent limitations to the amount of energy that can be transferred by the device, damping hopes that it is a high-focused energy source with a higher efficiency than that of a laser. In a soon-to-be released report, Mr. Fenneman shows that a plasma "conductor" is created by the high-frequency beam and higher energy throughput destroys the conductor, limiting the effective size. But the new explanation should aid in promoting uses of the device, as well as giving new insights into ordered plasma behavior.

The device's designer, Thomas E. Fairbairn, developed the system after observing that high-frequency radio beams collimated when forced off the end of an antenna. In an attempt to protect the antenna with an inert gas, a low cost, high energy, power source was made available. A single, 10-kilowatt unit costs $36,000 to produce. Its Thermal efficiency, in spite of the fact that half of the energy is used to create the plasma, is higher than considerably more expensive laser devices.

Several units have been sold for industrial welding, cleaning, and cutting, and for coating steel blades with a hard tungsten carbide surface. The 35,000 degree temperature achieved by the beam has resulted in some exciting results in initial tests. Other possibilities are in specific chemical reactions and analysis, or focusing several units on a small area for high-temperature plasma applications. As many as twelve beams have been directed at a point in the tests.