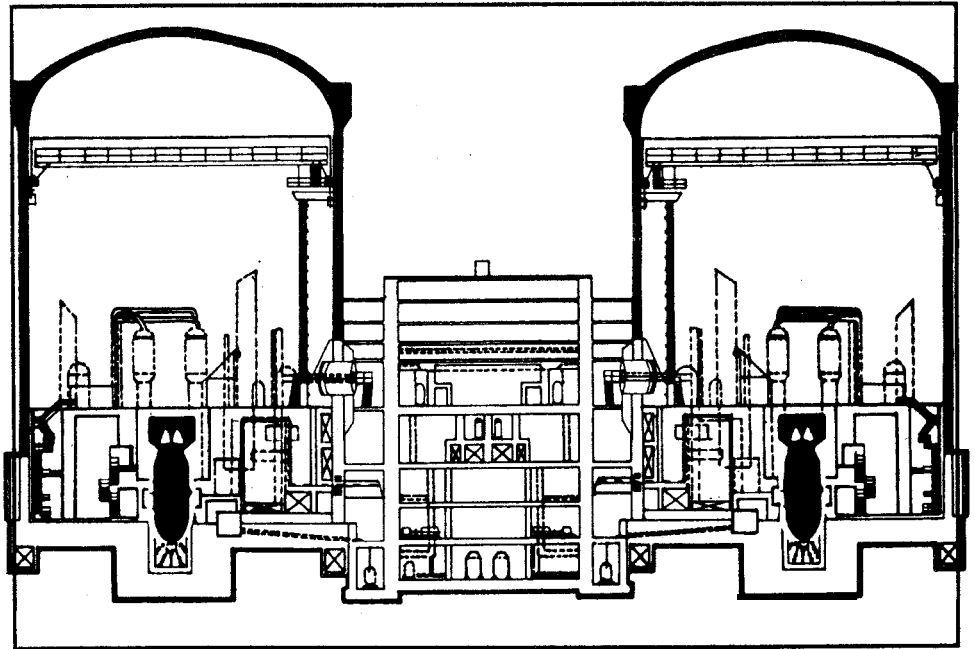


# GROUNDSWELL

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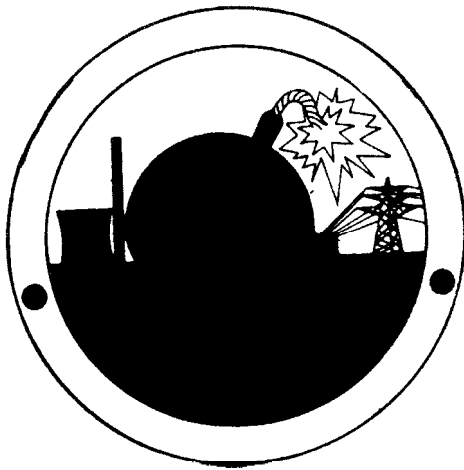


## When Reactors Become Weapons

By promoting the development of nuclear-generated electricity for domestic use and export, the United States and other industrialized nations unwittingly have turned all of their potential adversaries into nuclear powers. Nuclear reactors may have been designed for peaceful purposes, but in the end they still can be used as weapons by nations, groups, perhaps even individuals. Like a clown's rifle that only shoots backwards, a reactor is a weapon that normally can be used only against the nation that built it.

Nuclear reactors always have been vulnerable to the knowledgeable saboteur. Although modern reactors boast improved safety features and stronger containments, they nonetheless are becoming increasingly vulnerable to terrorists as weapons technology improves. And in wartime, most nations' conventional weapons have the capability to cause radiation release from a power reactor. Thus far, the primary defense against attacks on reactors may have been moral constraints—innocent civilians normally would be the most affected by an attack on a reactor. But recent events suggest that those moral constraints may be breaking down at the same time as the number of reactors increases and more and more nations enter the nuclear age.

Despite the potential magnitude of the problem, the concept of reactors as weapons has received, with a few notable exceptions, almost no attention, either officially or otherwise. The Nuclear Regulatory Commission (NRC) is prohibited from considering military implications of civilian power reactors. If the Department of Energy or the military have considered the issue in detail, they haven't told anyone. Other nations by and large ignore the issue as well, even though nuclear power programs can represent the single greatest capital asset of some countries.



Ignoring the problem may in fact be the only solution for nuclear power supporters. The potential of sabotage and terrorism gives the lie to research into accident hazards at nuclear plants: the probability of a successful act of terrorism simply cannot be calculated, while a knowledgeable saboteur could force the release of nearly the entire inventory of radioactivity.

#### Life During Wartime

A world-wide all-out nuclear war obviously would be a disaster of unspeakable proportions. Details of the possible effects of nuclear war, well-publicized elsewhere, need not be repeated here, except as necessary to examine the significance of the destruction of nuclear reactors in such a conflict. Would the additional radiation released by an attack on reactors in fact make any difference after such a conflagration? Some experts predict that such an event by itself would end human life on earth. Others suggest a "nuclear winter" would be created, at least in the Northern hemisphere, that would make survival difficult, if not impossible. If either of these scenarios is true, then there is little need to fear the added threat posed by civilian nuclear reactors.

However, if both of the theories are ex-

aggerated, then it would be wise to consider the additional impact of reactor destruction. Further, many experts believe that it might be possible to fight a "limited nuclear war." The effect of attacks on reactors might well determine how limited such a war really would be. It is, in fact, foolish to ignore the consequences of attacks on nuclear power plants—such attacks might alter the conduct or outcome of even a conventional war.

It is acknowledged that a nuclear exchange of even a significant fraction of the superpowers' arsenals would kill, in the U.S. alone, 100 to 150 million people. Millions more would die in the first weeks and months after the blast due to the intense radiation carried by the nuclear fallout. However, nuclear weapons radiation is short-lived. If there were survivors from the initial blasts and ensuing fallout, then, leaving aside possible psychological inertia caused by the trauma, it remains faintly possible that the nation could rebuild. After all, there would still be millions of survivors.

But with its 9,000 warheads, the Soviet Union could target every major city in the U.S. and Europe, every military installation, every oil refinery, and still have plenty of warheads left over to drop on nuclear power plants and their spent fuel pools, and waste dumps. Some critics argue that traditional restraints against attacks on civilian populations, international law, and/or the desire for conquest rather than destruction, would preclude the targeting of nuclear power installations. But given the insanity that would prompt the use of such weapons, this view seems naive.

Further, as Amory Lovins points out in his book *Brittle Power*, large-scale energy facilities of all kinds are likely to be targets in wartime because of their importance to a nation's economy and war effort. The Federal Emergency Management Agency (FEMA) agrees, noting in a 1980 study that officials of Nazi Germany were astound-

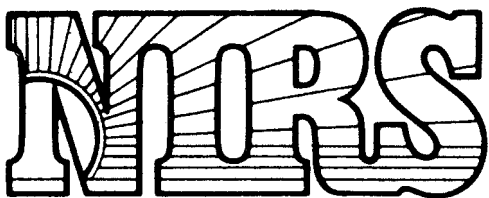
ed that there were not greater Allied attacks on their electricity-generating facilities during World War II. After the fighting had ended, some German officials said the war could have been over one or even two years earlier had the Allies attempted to disrupt German energy sources. "Since World War II," the FEMA study noted, "power plants and electrical facilities have become prime targets."

Some critics downplay the damage that could be caused by targeting reactors. In an Oak Ridge study, Conrad and Rowena Chester predicted the effects of a major attack on reactors and waste facilities would be limited to a few hundred thousand additional cancers per year, beginning a decade after an attack, which "would be difficult to detect" following the destruction caused by the weapons themselves.

This appears to understate the case. In fact, nearly all of the U.S. east of the Mississippi River would be uninhabitable even a year after the attack—solely due to the extra radiation caused by targeting nuclear reactors. As Jonathan Schell points out in *The Fate of the Earth*, "after a year an area of some seventeen hundred square miles downwind of a [single unit] power plant on which a one-megaton bomb had been ground-burst (again assuming a fifteen-mile-an-hour wind) would still be delivering more than fifty rems per year to anyone who tried to live there, and that is two hundred and fifty times the safe dose established by the Environmental Protection Agency. The bomb by itself would produce this effect over an area of only twenty-six square miles."

There are over fifty reactor sites east of the Mississippi (either operating or under construction); that's more than 85,000 square miles of severe contamination. In addition, as the accompanying chart shows, a nuclear weapon set off at a reactor produces radiation over a much larger area than either can alone. Even a year

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## GROUNDSWELL

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after an attack on one reactor, the dose rate would be above 2 rem per year in an area of over 25,000 square miles, still well above current permissible exposures.

Survivors of a nuclear attack, especially those in the East and California, would not long remain survivors. Add to the radiation caused by reactors and waste facilities the release of toxic chemicals from demolished plants and toxic waste dumps, and nuclear winter nearly ceases to be a relevant concept: man-made poisons might finish off the nation before more natural phenomena could get to work. The United States would indeed become, in Schell's words, "a republic of insects and grass."

The devastation in the Soviet Union would be comparable. Although that nation is larger than the U.S., and American weapons tend to be smaller which would cause fewer initial casualties, Soviet reactors are even less protected than those in the U.S. and are often located closer to populous areas.

One wartime unknown is the effect of Electromagnetic Pulse (EMP). A hydrogen bomb set off high above the Earth creates a sudden power surge that can disrupt or disable most solid-state electrical equipment such as that relied upon by nuclear power plants. It has been postulated that EMP conceivably could cause simultaneous meltdowns at nearly every reactor in the country by disabling their safety systems. A1983 NRC study disputed that notion and predicted that EMP would have virtually no effect on reactor operation. However, the study has been criticized by some experts. According to Dr. Conrad L. Longmire, a Los Alamos scientist who developed the first comprehensive theory of EMP, the methodology of the study rested on a "long chain of plausible but not provable assumptions that provide only a shaky foundation" for the report's conclusions. However, Longmire did not directly contradict the study's findings. Another critic was George H. Baker, a projects officer with the Defense Nuclear Agency's EMP Effects Division. According to Baker, false electrical signals created by EMP make it impossible "to completely rule out shutdown problems that may result from temporary loss of critical control equipment."

**Can Reactors Cause Nuclear War?**

The concept of a "limited" nuclear war is relatively new. Until the past decade or so, most military theorists believed that any use of nuclear weapons would lead to a global nuclear conflict. Now however, some Pentagon planners think

small tactical nuclear weapons could be used in much the same manner as more conventional arms are used. In this context, small can mean as large as the Hiroshima bomb. Miniaturization of nuclear weapons components has also led to smaller and less powerful nuclear devices; some U.S. soldiers in Germany are outfitted with nuclear bombs which fit into backpacks.

Scenarios for limited nuclear war usually involve a time of increasing tensions along the East and West German border and in Berlin, culminating in some kind of attack of conventional forces across the border- usually Soviet forces invading West Germany. Nuclear weapons could be used without spreading to global war, so the scenarios go, as long as both sides agreed-tacitly or explicitly-to use them only on military targets, such as advancing tank convoys, etc.

However, as Bennett Ramberg points out in his book *Nuclear Power Plants as Weapons for the Enemy* (the only comprehensive treatment of the subject), several nuclear power plants lie along the most likely Soviet invasion paths. A mis-targeted tactical nuclear weapon, or even one aimed correctly but in an area difficult to discern between military and civilian uses, could easily destroy a reactor, releasing its radiation on the civilian population. Retaliation and escalation likely would follow.

In fact, reactors add greatly to the risks that even a conventional conflict in Europe would lead to nuclear destruction. Some conventional weapons are capable of breaching reactor contain-

ments, and others can easily cause enough disruption at a plant to bring about a nuclear accident. Again, whether the reactor had been attacked deliberately or accidentally, the civilian population would have been affected, and an important threshold crossed: it would be easier to introduce nuclear weapons once any kind of radiation entered the conflict.

Dr. Ramberg offers an even more chilling scenario. If Western troops were being driven back, they might deliberately sabotage a reactor as a means of slowing down the Soviet advance. Or, they could sabotage a reactor along the East German border (winds generally flow toward the east) as a means of attacking the East without actually committing troops there. Either event could easily lead to an escalation of the battle and the use of nuclear weapons.

It would be ironic indeed if the "peaceful atom" were to cause the introduction of its deadlier brothers.

**Third World War**

It is in the Third World, however, where attacks on nuclear reactors already have occurred, and are most likely to happen again. In some countries, a nuclear reactor may well be the land's largest source of electricity and the single largest investment- both reasons for enemy attack. Further, Third World reactors are often inextricably tied to the country's military program. Small research reactors, not yet operational, have already been attacked in both Iran and Iraq. It seems only a matter of time before an

continued on the next page

**Area in Square Miles that Must Remain Uninhabited for a Given Time for Different Nuclear Energy Facilities Release Scenarios'**

Time Uninhabited	1 Megaton Reactor (7000 Mwe) Weapon	Weapon on Meltdown	Weapon on Reactor	Weapon on Waste Storage Facility
1 week	31,000	2,200	79,000	113,000
2 weeks	26,000	2,000	72,000	110,000
1 month	21,000	1,800	64,000	103,000
2 months	17,000	1,600	54,000	100,000
6 months	5,000	1,200	33,000	83,000
1 year	1,200	900	25,000	67,000
2 years	150	680	17,000	49,000
5 years	11	320	10,000	35,000
10 years	2	140	6,000	30,000
20 years	1	68	3,200	25,000
50 years		50	1,200	14,000
100 years		20	180	2,400

Source: Steve Fetter and Kosta Tsipis, "Catastrophic Nuclear Radiation Releases." (Program in Science and Technology for International Security, Department of Physics, Cambridge, Massachusetts, Report No. 5 September 1980), Tables 2, 3, 6, 8.

'Fetter and Tsipis assume that an area becomes uninhabitable for a given time assuming the maximum allowable dose is 2 REM per year.

operating reactor becomes a target for an enemy force.

Following are some very brief descriptions of areas where reactors might play a role in a potential conflict:

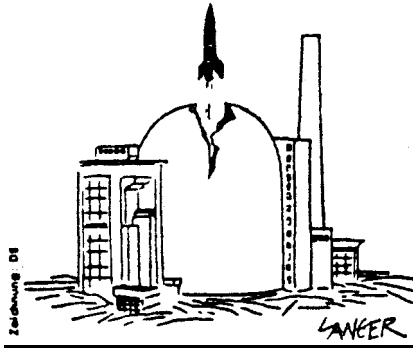
**Korea.** Neither North nor South Korea possesses nuclear weapons, however U.S. troops base tactical nuclear weapons on South Korean soil. North Korea has no nuclear power plants, and apparently none planned. South Korea has three plants in commercial operation and another six under construction. None of the nine are near the border and thus aren't immediately vulnerable to attack. However, North Korea may have an airborne capability to destroy one or more of the reactors. If this were to happen, South Korea's response would be constrained—there would be no similar action it could undertake against the North. In that case, the pressure on American troops to use nuclear weapons could become immense.

**India/Pakistan.** Tension has been a way of life between these two countries since the late 1940's, occasionally erupting into armed conflict. India has five reactors in operation and another three under construction. It has also tested atomic weapons, although it claims not to have any stockpiled. Pakistan has one small reactor. Most observers believe Pakistan is attempting to develop atomic weapons capability, and may already have done so. In any case, the country probably has the capacity to destroy at least one of India's reactors. However, because that would probably result in the destruction of its own reactor or even a nuclear weapons retaliation, the situation seems to end in a stalemate. But that could change in the event of another major conflict between the two nations.

**Mideast.** There are a few small research reactors in the mideast, but fortunately no power reactors have been introduced into that volatile region. Israel had planned to build a 900 MWe reactor, but apparently has scrapped those plans, perhaps because of the tiny country's extreme vulnerability to the effects of a reactor attack. Egypt has had two 900 MWe reactors on the drawing boards for a number of years, but has yet to begin construction on one. Such a facility would make a very tempting target for Israel in the event hostilities between those two countries recommenced, and perhaps even for other Arab nations or groups. No other mideast nation currently is contemplating a power reactor, nor does it seem likely that Israel would permit the construction of one. An Iraqi attempt to build a research reactor (which Israel

maintained was to produce materials for nuclear weapons) was bombed and destroyed in 1981 by Israeli warplanes shortly before fuel load was scheduled—the first major attack on a reactor anywhere in the world.

**South Africa.** South Africa has two small research reactors and two large power reactors. Many analysts believe the country's nuclear power program is aimed more at producing materials for nuclear weapons than at generating electricity. For that reason, the reactors are tempting targets for South Africa's opponents. However, the power reactors' location in the far southwestern part of the country, far from any border, means a potential adversary would have to travel hundreds of miles through South African territory—something no other African nation has the ability to do. In addition, prevailing winds in the region likely would carry radioactivity into sparsely populated areas, diminishing the impact of a strike on the reactors. Terrorism, or guerilla war, cannot be ruled out as possible actions in South Africa, although the reactor site is said to be heavily-guarded.



#### Sabotage and Terrorism

There may be an infinite number of ways to sabotage or otherwise damage a nuclear reactor sufficiently to cause a radiation release. The best defense society has against nuclear sabotage and terrorism is the fact that so few people want to attack them. And that will probably remain our best—some might say only—defense. Still, there already have been several cases of sabotage and other kinds of attack against nuclear facilities in the U.S., and even more abroad.

But the fact that there have not yet been any large-scale terrorist assaults on nuclear facilities in the U.S., nor any other acts which seem to have had as their purpose radiation release, does not mean that it can't, or won't happen. Some experts believe that the only reason that it hasn't happened yet is due to the constraints placed on terrorists by themselves, rather than on the strength of reactor defenses or the availability of appropriate weapons. That seems a rather

fragile thread upon which to hang one's beliefs that it can't happen, as the industry and the NRC are wont to do.

Many have long feared the ramifications of a terrorist group obtaining an atomic weapon, which could be used either for blackmail or destructive purposes. It seems no less appropriate to ponder the possible effects of a similar group using a reactor as a weapon, or even a combination of the two. If it can be believed that a terrorist group (quite possibly one funded and organized by a hostile government) could and would use an atomic weapon, then there is reason to believe that it could detonate the weapon near a reactor.

The "nuclear backpack" used by U.S. troops in Europe has the explosive power of 250 tons of TNT, although some experts say that easily could be raised to 7000 tons. And, as Dr. Thomas Amlie, former technical director of the Naval Weapons Center, recently told *Parade* magazine, "a hand-carried device should be accurate to within a foot, which is a lot better than any ICBM that I know of. Their main problem could be finding a space in the Pentagon car park." In fact, it may even be easier to get within 1000 feet or so of a reactor than to find a parking space at the Pentagon. Smuggling the device into the country (assuming the terrorists were foreign) would not necessarily be difficult—consider the millions of pounds of marijuana that reach our shores every year. The radiation that could be released by the detonation of such a device on a reactor or spent fuel pool could be much greater, and travel much further, than that caused by any conceivable accident sequence.

But reactors are vulnerable to more than atomic weapons. A recent Sandia National Laboratories report noted that a truck bomb detonated *outside* of a reactor's normal protected area could cause "unacceptable damage" to a reactor's vital systems. Similarly, at an Advisory Committee on Reactor Safeguards (ACRS) hearing in May, ACRS member Carlyle Michelson noted that nuclear plants have no defense against the use of railroad cars as bombs. "No handier design has ever been provided than a dead-ended railroad inside of a building used as a guided missile set off from outside the plant. It's guided right into the building. . . . There are some plants, you know, that the railroad even goes into the control room in the process of getting to the refueling area. . . ."

There are, of course, other ways of attacking a reactor. Helicopters and airplanes can deliver explosives from the

air; artillery with the proper shells can breach a containment from several miles away; commando teams could take over the plant and damage essential safety systems, still allowing enough time for them to escape.

Many terrorism experts, however, believe that it is unlikely that any existing terrorist group would purposely set out to damage a reactor sufficiently to cause radiation release-most such groups simply haven't shown the inclination to cause large numbers of civilian casualties. More likely than a direct attack on a reactor then, is the possibility that a terrorist organization would seek to hold a reactor hostage, threatening to cause damage unless certain demands were met. This would result in massive media interest and genuine fright among the nearby population-both conceivable goals of terrorist groups-without actually causing large-scale contamination.

Still, some recent actions, such as the sabotage of airliners instead of their sky-jacking, suggest that terrorist groups are becoming more willing to attack innocent civilians. In either case, security forces at most nuclear plants are not equipped to handle a well-planned armed assault. And though the ACRS has held some meetings on the subject, the NRC seems to have little interest in forcing the utilities to upgrade their security systems.

Current NRC security standards are weak indeed. Promulgated in 1976, during a period of low terrorist activity, the "design basis threat" calls for utilities to defend against sabotage by only one insider, no more than three attackers, all in one team, with only hand-carried weapons. Moreover, utilities are not required to defend a plant against "enemies" of the United States, which

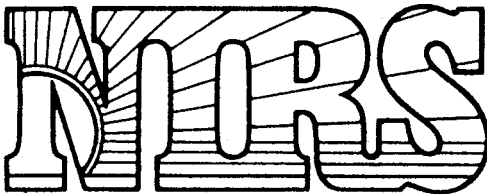
presumably could be defined as any foreign terrorist group. Some utilities, however, have security forces that exceed minimum NRC standards.

Historically, terrorist organizations have used the resources necessary to carry out their objectives. If such a group decided that it was essential to their aims to take over or attack a nuclear power plant, and it had sufficient resources to do so, it would use those resources. Changing the design basis threat might limit the number of terrorist groups with the capability to successfully attack the reactor, but it couldn't entirely eliminate the problem. The point is: short of turning the nation into a police state, nuclear power plants, like nearly every other building and city in the country, will remain indefensible against a major terrorist attack.

### **Solutions**

Because there is no real defense for nuclear reactors, either in wartime or against a determined band of terrorists, how can the population be protected from their use as weapons? Dr. Ramberg suggests that international treaties, prohibiting reactor destruction in wartime, be supported, although he recognizes that step has limited effectiveness.

Ramberg also calls for alternative reactor siting-underground and/or in very remote locations; improvements in containment effectiveness; and the possibility that an inherently safe reactor can be created. Lovins argues for an end to centralized energy facilities in general and nuclear power plants in particular. Ramberg notes this approach, but seems to question whether it is possible at present. In the long run, this may be the only way to provide security, because the mere existence of nuclear power plants makes us all potential nuclear hostages.



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