CHERNOBYL: CAN IT HAPPEN HERE?

Leonard A. Sagan, M.D.

The answer to the question posed by the title depends on just what the question means. If it means, "Can radiation emergencies happen here?" the answer is "Yes." We have already had emergencies at nuclear reactor sites, but most have been trivial. One (at Three Mile Island) was serious, although no personal injuries or severe overexposures occurred. If the question means, "Is a catastrophe the magnitude of Chernobyl likely at a commercial nuclear reactor site in this country, then the answer is "No."

There are three reasons for confidence in my answer. These are: (1) our elaborate efforts for prevention of accidents; (2) extensive planning for mitigation of accidents if they occur; and (3) the excellent safety record of the nuclear power industry in the Western World.

PREVENTION

All doctors know that an ounce of prevention is worth a pound of cure. Reactor safety has two elements of prevention: engineering and operating procedures and training.

Engineering

U.S. reactors are very different from those at Chernobyl. Key differences include the following: a flammable runaway reaction occurs when coolant is lost in Chernobyl-type reactors, but U.S. reactors automatically shut down when coolant is lost. Reactor shutdown requires 25 seconds there and 2 seconds here. In Chernobyl, there was an industrial-type roof over the reactor. In the United States, there is a leak-proof concrete containment (6 feet thick).

The massive release of radioactivity that occurred in the Soviet Union resulted from lack of containment, ie, lack of a massive concrete structure surrounding the reactor. At Three Mile Island, containment prevented all but an insigificant release of radioactivity. In addition, the containment creates the opportunity for fission products to be soaked up in the large amount of water existing in the containment. Since several fission products, such as iodine and cesium, are water soluble, they will be retained in the reactor building instead of dispersed into the atmosphere.

Operating Procedures

The second line of defense is the existence of operating rules. These procedures govern the operation of the reactor and are crucial to

Senior Scientist, Electric Power Research Institute, Palo Alto, California.

the safety of a nuclear power plant. They are established by the utility together with the Nuclear Regulatory Commission, which provides constant monitoring and has an engineer on site at all times, and by the Institute for Nuclear Power Operations (INPO), an owners' group that represents the industry's stake in maintaining safe operation of all nuclear plants. Both operating procedures and control systems in the United States would not have permitted the experiment that led to the explosion at Chernobyl.

MITIGATION

Authorities have three options in the event of a release of radioactivity to the environment. One is to do nothing, the second is to order protective sheltering, and the third is to order evacuation. Each may be prudent under certain conditions. Doing nothing is most prudent and least disruptive if the release and consequent human exposure are minor. If the incident is more serious, sheltering may be most prudent. Simply remaining indoors and closing windows can greatly reduce exposure from ambient radiation. If the incident is severe, as it was at Chernobyl, evacuation may be necessary. However, evacuation itself may produce injury and even fatalities and is clearly the more drastic and disruptive measure. During the emergency at Chernobyl, thousands of persons were temporarily hospitalized for anxiety associated with the emergency and evacuation. Because symptoms of anxiety can be confused with those of the acute radiation syndrome, many such hospitalizations are likely with any evacuation resulting from a nuclear emergency.

How are decisions for protective action made? The U.S. Environmental Protection Agency has recommended that evacuation be considered if a radiation dose to sensitive populations (pregnant women and children) is expected to exceed 1 rem to the whole body or 5 rem to the thyroid. For the general population, sheltering or evacuation is recommended if the anticipated dose is 5 rem to the whole body.

The emergency at the Three Mile Island power plant was the worst ever in the United States and the only one to result in an evacuation. If evacuation is defined as the removal of more than 100 persons, one evacuation occurs almost every week in the United States. Surprisingly enough, travel during an evacuation is safer than under usual conditions; apparently drivers are more focused and cautious.

For several reasons, a nuclear plant evacuation should be even safer. One reason is the presence of an early warning system. Following the TMI accident, rules were instituted that require notification of state authorities within 15 minutes of significant accident conditions. A second reason, also a result of TMI, is the requirement that a public warning system be installed that uses sirens and radio communication to alert the public quickly should an accident occur. Third, utilities now provide information to residents of the Emergency Evacuation Zone regarding the warning systems and their meaning and actions to be taken in an emergency.

The Risk: How Likely?

Nuclear power engineers have long recognized that the risk of an emergency cannot be reduced to zero. However, major emergencies will be rare; minor ones will be common.

Many studies have been conducted to quantify the risk of nuclear emergencies. The earliest was the so-called "Wash-740 Report," which was intended to answer the question, "If everything goes wrong, if there is no containment, and if the worst weather conditions exist, how many casualties will result?" Given those unrealistic conditions, the number of predicted casualties becomes very large. The unrealistic numbers have been used to frighten people ever since. They are unrealistic because the probability of such an event is vanishingly small. It is as if one asks, "How many people COULD be killed in the worst possible airplane crash?" For example, if two 747s collided above the stadium during a Washington Redskins' game, many thousands could be killed. Most of us are willing to ignore such improbable events. Indeed, some recent studies now find that no deaths at all would occur even after the worst of reactor accidents.

The Chernobyl catastrophe comes close to the scenario visualized by Wash-740, ie, release of a large fraction of the fission product inventory. Several hundred individuals were contaminated with radioactive water and smoke, many had burns, and some were injured by falling debris. Of this group, 32 died. All of those injured were plant workers or fire and emergency personnel. No member of the public required hospitalization as a result of the explosion.

Thinking the Unthinkable, Then What?

In spite of the safety systems described above, let us consider "WHAT IF?" What if there were a catastrophe producing several hundred contaminated and injured persons, such as at Chernobyl. How well are we prepared for that? Could we do as well as the Russians did? What programs are in place to deal with such emergencies? Responsibilities for nuclear emergency response lie with the utility for on-site response and with the state for off-site response. The utility's primary responsibility is the safe operation of the power plant and the health and safety of the people who operate it. The primary concern of the state and local governments is the safety of the public around the plant. Interrelationships are many. For example, some states (eg, Illinois) have the ability to monitor the radiation levels from all reactors from a central facility. Thus, state officials can be alerted to a problem at the same time as the plant staff. Likewise, the utility maintains a system of sirens in the communities around the reactor site to alert residents that information is being broadcast on local radio and television stations.

With regard to medical response to emergencies, the requirements are threefold: (1) arrangements must be made at local hospitals for the medical care of injured and/or contaminated employees; (2) radiological training must be provided to medical staff; and (3) periodic exercises and drills must be conducted to test how well facilities and personnel would function in an emergency.

Medical Care: Utilities generally use a three-level approach. Level one is first aid at the plant site. Plant staff are trained in cardiopulmondary resuscitation (CPR), decontamination, and first-aid techniques. This level is aimed at plant workers, who would be immediately available in the event of an emergency. Level two is comprised of one or more local hospitals with special equipment to measure and assess radiation levels and decontaminate the victims. Level three is a definitive care hospital that acts as backup to the local hospital; patients needing specialized care or services would be treated at this facility. At Chernobyl, the Soviets used this same approach, first aid was given at the plant for workers, local hospitals were used to examine and treat the mildly injured, and the severely injured were flown to Moscow Hospital #6, which was equipped to treat serious injuries.

Radiological Training: Training begins with seminars and courses for physicians on such topics as radiation effects, as well as practical training for physicians on handling radiation victims. These courses are usually presented by universities and medical schools. The Oak Ridge Associated Universities in Tennessee has the most extensive of these programs. Training of medical support staff centers around the drills discussed below. Seminars are usually held before the drills to review the procedures and afterward to discuss and critique the results.

Utilities using nuclear energy also provide educational seminars for physicians in communities around reactor facilities. Pennsylvania Power and Light, for example, conducted several weekend seminars for medical personnel in their service district, as has Commonwealth Edison.

Drills: The final requirement is for testing the emergency plans. Medical drills are performed annually and are reviewed by medical consultants. If improvements are needed, they are implemented. Some utilities videotape the drills for use in training, which is the third requirement.

In summary, the utility/medical dialogue is the thread that runs through the entire program. From first-aid training provided to plant staff through reviews of the annual drills by medical consultants, the dialogue is continuous. Could it be expanded beyond the hundred or so hospitals now directly involved? It could, and it is being expanded. The next sections explore facilities and resources beyond the local hospital that are available for emergency assistance.

Suppose Local Resources are Overwhelmed?

State government has primary responsibility once the accident extends beyond the plant site. Supporting the states is the new Federal Radiological Emergency Response Plan, which brings the resources of 12 federal agencies to help in a nuclear emergency. The plan was tested in a drill at the St. Lucie Nuclear Power Plant in Florida in March 1984. The next test is scheduled for June 1987.

Utilities also have available the combined resources of other nuclear utilities. Interutility cooperation in emergencies is common practice. For example, extensive storm damage in a particular area always elicits offers of help from neighboring utilities. Transmission line repair crews are quickly mobilized to assist in restoring electric service to the affected area. This type of cooperation is also available in a nuclear power emergency.

THE HISTORICAL RECORD

I have been discussing what COULD happen as a result of remotely possible conditions. Now I would like to turn to what DOES and HAS happened. I believe that the record of nuclear power worldwide in acutal reactor years of operation is now sufficient so that the history of emergencies and radioactive releases at operating nuclear power plants makes a more realistic basis for prediction than do theoretical computer models. One study[1] documents 59 such cases over 15 years--all plant workers--with no more than two cases occurring at any one time. The injuries ranged from falls (one fatal) through heat stress to heart attacks. All cases involved "nuisance" levels of radioactive contamination, that is, the radiation exposure did not present a hazard and medical treatment of the trauma or medical condition, if required, was not impeded.

I should like to emphasize that there has not been a single death at a commercial nuclear station in the Western World as a result of radiation exposure. Indeed, more than 99% of radiation workers receive less than 5 rem per year, the occupational limit. The largest accidental exposure was 20 rem. Actually, a commercial reactor is an unlikely place for a serious radiation overexposure. Of the 100 or so deaths recorded through 1980, none had occurred at reactor sites.[2] Almost 30 years of experience in the operation of commercial nuclear reactors point to a low probability for radiation injuries. However, the industry realizes the enormous consequences of even one fatal accidental exposure. As a result, the industry is constantly reviewing and improving procedures and is conducting research to assure that such an accident will never happen.

CONCLUSIONS

1. History shows that reactor emergencies in the United States are rare and have very limited consequences, both in the numbers of persons injured and the magnitude of injuries.

2. The engineering and regulation of nuclear reactors make it extremely unlikely that persons off-site would be significantly contaminated in the event of malfunction.

3. Utilities have systems in place to care for personnel who are injured and/or exposed.

4. Evacuation planning for nuclear facilities appears to be better than for other community emergencies (eg, earthquakes, hurricanes).

5. In the unlikely event of massive numbers of off-site injuries such as occurred at Chernobyl, a backup system of personnel and equipment is available through federal resources.

References

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2. Sagan L, Fry S: Radiation accidents: A conference review. *Nuclear Safety* 1980;21:562-568.