An overview of nuclear threats

BY BRIAN K. GRIMES

Questions about possible radioactive releases caused by terrorist attacks require a comparison of consequences from such an attack with those involving other potential terrorist targets.

As NUCLEAR PROFESSIONALS, we all have been involved in responding to questions from family, friends, or the media about the possibility of terrorist-caused releases of radioactive material, in the wake of the September 11 terrorist attacks. As we think about the best way to respond to these questions, it is useful to consider how the context of concerns about the uses of nuclear material is changing, as well as how consequences from dispersal of radioactive material compare to consequences involving other potential terrorist targets.

In public discussion of issues raised by potential terrorist actions, it is important to impart information and perspective without providing a "how-to" manual that could be used by terrorists. This article therefore will focus more on general concepts than on specific structural and system strengths or weaknesses. We should also keep in mind that the motivation of terrorists in choosing a particular target may not be based on inflicting maximum public fatalities or injuries, but may involve causing perceived economic dislocation or psychological trauma, or making some symbolic point. As engineers and scientists, we can take some measures to reduce target vulnerabilities. Choices of targets and methods of attack, however, involve perceptions by terrorists of the effects of their actions, as well as the availability of means and opportunity for attack. Addressing these aspects requires intelligence gathering, threat assessment, and the elimination of terrorist infrastructures by governments throughout the world.

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Public and media perceptions

How has public perception of potential nuclear hazards changed since the 2001 terrorist attacks? New accidents and threat scenarios—at least new in the minds of the general public—now are of concern. These include aircraft crashes into nuclear facilities, armed assaults on nuclear facilities, dispersal of radioactive material by conventional explosives, and the detonation of stolen nuclear weapons. Immediately after the attacks, public interest focused more on the worst-case or extreme consequences of potential attacks rather than likely consequences. An increased concern about hazards from the dispersal of spent nuclear fuel is also evident.

An indirect result of the attack seems to be an increased interest and awareness of nuclear issues in general. An increased emphasis on nuclear power production as it contributes to national security and the need for a resolution of high-level waste issues had been raised in the administration's energy plan. Since September, the public appears more interested, and to a degree more conversant, in these issues.

Public perceptions are, of course, colored to a large degree by the amount and type of media coverage, so the reaction of the media (as perceived by the author) is also worth a few comments. Although antinuclear and sensation-seeking journalists have not disappeared, there is a great deal more interest by mainstream media seeking information, judgments, and opinion from multiple sources.

Recent treatments of nuclear threats in mainstream publications include the November 5, 2001, issue of *Newsweek* and the January 2002 issue of *Scientific American*. While the primary media focus continues to be on extreme nuclear threat scenarios, there is also media attention to other hazards, albeit not always providing a level playing field for nuclear facilities in the discussion. Some media reports are also, for the first time, providing more accurate information on the health effects of the 1986 Chernobyl accident. More balanced treatment in the media of both the benefits of nuclear technology and the context of non-nuclear hazards appears to be reflected in current public views.

The *Newsweek* article

The *Newsweek* article is interesting both for its consideration of nine potential targets in addition to nuclear facilities and in its attempt to assign priorities for action based on a qualitative risk index. *Newsweek* rates each potential target, from postal deliveries to water supplies, as to vulnerability (that is, how easy it would be to cause injury) and as to potential loss (that is, how many people could be killed). These two parameters, graphically represented to indicate "high," "medium," or "low" values, are then qualitatively combined to reach a priority for action.

The values assigned by *Newsweek* to the vulnerability and potential loss for some of the targets are questionable. For example, the vulnerability of nuclear power plants is rated as "high," when a medium or low rating would have been more accurate. The attempt to present a risk perspective, however, is a step forward in public discussion of hazards.

A difference that is noticeable in the *Newsweek* assessment between nuclear and other potential terrorist targets, such as

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sports stadiums, chemical plants, and skyscrapers, is the different threats assumed as initiating events. Only the nuclear facility is assumed to be hit by a large aircraft, although the potential fatalities from such an impact on a sports stadium or skyscraper are obviously greater.

Are nuclear hazards different?

So why are nuclear hazards perceived differently by the media and the public? Several factors contribute to the public perception that an accident involving dispersal of radioactive materials would be particularly catastrophic. The calculated worst-case consequences of reactor accidents are well published, and these include not only radiation exposures but also significant local land contamination. Extreme worst-case consequences of potential chemical releases or dam failures are not well published. Accidental radiation exposures are not common, so the public is not familiar with the effects or lack of effects from accidental exposures. There is also not large public comprehension of the fact that radiation is now routinely used to *cure* cancer in tens of thousands of patients each year.

Another factor that increases the significance of an event in the public mind is the absolute number of potential fatalities in a particular incident. This is easily demonstrated by the difference in public concern over a single aircraft crash causing perhaps 400 fatalities with the (absence of) concern expressed with regard to twice this number of fatalities due to traffic accidents (half of these alcohol-related) within the same week. This difference in perception is further emphasized, of course, by the continuation of approximately the same number of traffic fatalities every week of the year.

Along with certain types of chemical hazards, radiation has the potential to cause health effects that are not expressed for many years, so the accident is not "over when it's over." We can add to these differences the compounding effects of worry spread by individuals and organizations with antinuclear agendas.

New NCRP report

An interesting (but a bit verbose) recent report that provides a useful compilation of background material on the range of physical and psychosocial effects of a terrorist-induced spread of radioactive material is NCRP (National Council on Radiation Protection and Measurements) Report No. 138, "Management of Terrorist Events Involving Radioactive Material." It is directed primarily to emergency responders and those who provide training to them, but also contains information of interest to and use by other nuclear professionals. The events and consequences discussed range from a power plant release, to spent fuel damage, to radioactive material spread by conventional explosives, to detonation of a stolen nuclear weapon. The report provides a useful overview of the degree of immediate physical trauma resulting from exposures to very high levels of radiation. The synopsis of data on atomic bomb survivors from World War II also illustrates the relatively small long-term effects (expressed as cancers) from high levels of initial exposure.

A quotation (originally published in boldface for emphasis) from that NCRP report provides an important perspective on the effects of contamination from dispersal of radioactive materials: "It should be noted emphatically that *radioactive contamination* (whether internal or external), *is never immediately life threatening* and therefore, a radiological assessment or decontamination should never take precedence over significant medical conditions." (further emphasis added)

While that NCRP report maintains the linear no-threshold theory for projection of long-term effects of exposures to low levels of radiation, it does note a "factor of two" reduction in the risk coefficient at low doses or for prolonged exposures to take into account the normal recovery mechanisms of the body. Perhaps we can see a shift in the argument in the health physics/biological effects community from whether there is radiation damage repair at low doses to the magnitude and dose range of the repair mechanism.

Three points to emphasize

So, how do we bring perspective to our discussions with family, friends, or media contacts regarding terrorist threats to nuclear facilities and materials? First we can note the past and current attention to this subject by both government and industry. No one has their head in the sand in the face of this significant new challenge. As NRC Chairman Richard Meserve noted in a speech he gave on November 8 before the Institute of Nuclear Power Operations, in Atlanta, Ga.: "For decades, security against sabotage has been an important part of the NRC's regulatory activities and our licensee's responsibilities, applying defense in depth as the guiding principle. . . . Nuclear facilities are among the most robustly built structures in existence. Secondly, we require careful background checks to minimize the risk of insider assistance and have access controls, delay barriers, and intrusion detection systems to detect and deter potential attackers. Thirdly, we require that licensees be able to respond with force to a group of armed attackers using protective strategies involving layers of defense."

The NRC is now undertaking a "top-to-bottom" review of security measures, including the need for a commitment of governmental as well as licensee response resources. The Nuclear Energy Institute (NEI), working with the Electric Power Research Institute (EPRI), is reviewing available technical information relevant to assuring the safety of nuclear facilities with respect to potential terrorist actions. As Chairman Meserve also noted, "Any policy regarding the defense of nuclear facilities should be integrated in the overall response to the threat to infrastructure of all kinds. . . . The Office of Homeland Security will no doubt have to be a central player in this discussion. . . ."

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President Bush, in his January 29 State of the Union Address, mentioned American nuclear power plants, along with public water facilities and landmarks, as potential terrorist targets. Two of the four key focus areas in the President's strategy for homeland security are funding for emergency response and improved intelligence. Acceptance that nuclear facilities are possible targets, coupled with an emphasis on improved intelligence (threat reduction) and emergency response (threat interception and consequence mitigation), appears rational and balanced.

The second area we can address to bring perspective to concerns about a terrorist threat to nuclear facilities is regarding the substantial existing design capabilities of nuclear power facilities. This includes the layers of structural protection of the reactor core that provide a substantial degree of protection against even an impact by a large aircraft, the multiple and diverse emergency systems, the emergency plans in place (and regularly exercised in tests) for event assessment, evacuation, and cleanup, if necessary. With respect to the dry storage of spent nuclear fuel, we can explain that radioactive gases have decayed, so that the local cleanup of solid materials would be the principal concern if the concrete containers and steel liner were breached.

Although the likely offsite consequences of terrorist attacks on a nuclear facility are low, it is important to note that any radioactive contamination would be easily detected by licensee, state, and federal emergency response personnel with detection instrumentation that they now have and in the use of which they are trained. As noted in the NCRP report, contamination from dispersal of radioactive material would not be immediately life threatening. The most significant impacts of contamination from even a severe accident release would be the cost for local land contamination and cleanup.

Third, as discussed previously, we can bring awareness of what impact the same terrorist methods might have on other aspects of our daily lives. As Chairman Meserve noted in a January 17 speech at the National Press Club, in Washington, D.C., "development of appropriate defenses" (risk mitigation) rather than "risk avoidance" is the appropriate approach to a variety of potential targets. For example, he observed, the dissemination of anthrax spores through the mail does not prove that it is an error to operate a postal service.

Nuclear facilities, nuclear materials, and nuclear technology are among many infrastructure targets, all of which have importance to our well being and independence as a society.

What should we be working on?

So much for what we can do with what we have. What do we need to think about for the longer term? The following list is provided to engender thinking, and perhaps some action:

■ Assure that we maintain a balance between threat reduction and plant protection measures. The U.S. government and other governments throughout the world will need an ongoing intelligence, threat assessment, and terrorist infrastructure disruption effort. In addition, it is important that we coordinate our activities to protect nuclear facilities with the strategies employed by other countries. A failure of security or loss of control of materials at a nuclear facility elsewhere, whether or not it leads to a release of radioactive materials, will have at least some impact on public confidence in the adequacy of U.S. security provisions.

■ Develop measures of vulnerability and event consequences that apply to more than nuclear facilities. There will be a need for an allocation of government resources (and industry responsibilities) by the Office of Homeland Security and the Congress. Nuclear professionals who have extensive experience in risk analyses have the opportunity to contribute methodologies that assure a reasoned allocation of resources and concern among various infrastructure vulnerabilities.

■ Assure that the importance of a reliable supply of electricity to our national security is always a consideration in resource allocation decisions, and that the vital role of nuclear energy is recognized. Similarly, assure that the essential role of nuclear materials in medical, research, and industrial applications is taken into account.

■ Exercise a range of threat/release scenarios with licensees, and state, local, and federal organizations. Measured response to, for example, onsite explosions (such as a transformer failure) that are not the result of terrorist action may be as important to retain public confidence as preparation for a terrorist attack. While emergency exercise scenarios involving some law enforcement agencies have been occasionally employed, federal law enforcement and military agency interfaces that would come into play during a terrorist attack (or credible threat) need to be exercised at all power plant sites and larger materials licensees. This includes integration into facility and governmental emergency response plans the communication with federal military assets that would likely be involved in the event of any actual or pending attack.

■ Develop additional capabilities to respond to an event caused by dispersal of radioactive material by conventional explosives. About 40 states have an excellent core of trained responders, developed around nuclear power and DOE facility (and transportation) preparedness. These capabilities could be enhanced, and expanded to all 50 states, by providing additional radiation detection equipment, and training in its use, to local and state emergency response and law enforcement personnel.

■ Develop better ways of communicating radiation risks to the public.

—In this regard, the NCRP could add to its guidance development measures of realistic risk communication as an objective as important as radiation protection.

—The NRC could rethink its current Safety Goals and reformulate these in terms of a "net benefit to humanity" that could be applied to more than nuclear power facilities and nuclear materials use. This could include consideration of benefits, e.g., reliable electric power, as well as environmental impacts (or their absence), and resource conservation over long time spans. The probabilities and costs of accidents should be addressed, including the cost of land cleanup, which is now not considered in the Safety Goals. This expansion of the Safety Goal concept appears to be well within the legal mandate of the NRC, as the mandate includes environmental impact and alternatives assessment. Expansion of the concept would also better fulfill one of the original intents of the Safety Goals, which was to communicate a risk perspective to the general public.

In summary, nuclear facilities, nuclear materials, and nuclear technology are among many infrastructure targets, all of which have importance to our well being and independence as a society. We need to assure that discussions and countermeasures of all of these potential terrorist targets are considered on a level playing field with respect to the type of threat, vulnerability, consequences of successful or unsuccessful attacks, and benefit to our society. The importance to our national security of having abundant and reliable energy, and the vital role of nuclear energy in assuring this supply, cannot be overstated.

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