Nuclear Explosion Fact Sheet

What is a nuclear explosion and how does it differ from a dirty bomb?
A nuclear explosion gets its energy from nuclear processes rather than the usual chemical reactions in ordinary explosives. As a result, it is anywhere from a thousand to a million times more powerful than the most powerful ordinary bomb. Its energy or yield is usually measured in kilotons. One kiloton is equivalent to one thousand tons of ordinary explosive. The bombs that leveled most of Hiroshima and Nagasaki were about ten kilotons or a little larger. Nuclear explosives have been made as large as several tens of megatons, where a megaton is a thousand kilotons or a million tons. It is believed unlikely that a terrorist group could make very high yield explosives.

At the same time as it generates its explosive power, a nuclear explosive generates radiation and also makes very large amounts of radioactive materials that will last from seconds to years. A typical nuclear explosion creates from one hundred to over one thousand times as much radioactive material as could be loaded in a dirty bomb.

Nuclear weapons have been made small and light enough to be delivered by airplanes and missiles. They would also fit in a truck and some would fit in the trunk of a car.

What is a suitcase bomb?
The US and possibly other countries have made weapons that might fit in a large suitcase. They would be rather heavy, however, and it is quite unlikely that a terrorist group could make such a bomb.

Can a nuclear explosive be detected?
All nuclear weapons give off a low level of radiation that would be detectable by suitable instruments if the weapon were in a suitcase, the trunk of a car, or other unshielded location. Shielding this radiation so it could not be detected would involve surrounding it with a considerable amount heavy of material such as lead. Most first responders are now equipped with simple radiation detectors that can warn of radiation. More sophisticated detectors used to identify nuclear explosives are becoming more widespread. These detectors are being installed at ports of entry and other locations in several countries, but putting together an effective system will take time.

What kind of damage would a nuclear explosion cause?
A nuclear explosion causes damage in four major ways. It creates a blast wave that extends for a mile or more and can destroy buildings and send debris flying at high speeds. It also creates a large source of heat that can inflict lethal burns out to one ore more miles (depending on atmospheric conditions), and can start large-scale fires. It creates both immediate (so-called prompt) and lasting radioactivity. If the explosion occurs on the ground, as would likely be the case in a terrorist event, this lasting radioactivity will be attached to ground particles that can be carried downwind and then “fall out” – in some cases tens to hundreds of miles away from the explosion. Finally, the explosion creates electromagnetic signals that can interfere with communications and radars under some circumstances.

A one-kiloton nuclear explosion will destroy most houses and kill most people within a radius of about a third of a mile. However, the distance out to which an explosive will do a certain level of blast damage increases slowly with increasing yield. For example, a ten-kiloton explosion gives the same blast effect about twice as far as a one-kiloton explosion. Burns and prompt radiation, in clear weather, would kill people in a somewhat larger radius. The heat would cause fires that might range out much further. Most of the deaths and damage from a nuclear explosion in a city would result from blast and heat effects,

What is fallout? How dangerous is it and how far does it reach?
Fallout results from the lasting radioactivity getting attached to tiny ground particles and falling out downwind. Fallout increases much faster with increasing yield than does damage from blast and heat. Exact figures depend on wind and rain conditions, but a one-kiloton explosion will spread a lethal dose of radioactivity on about one square mile, and a ten-kiloton explosion on about ten square miles. Detectable and possibly dangerous levels would extend considerably farther.

If the explosion occurred in an urban area, deaths from fallout are expected to be smaller than from immediate effects such as blast and heat in part because (depending on wind conditions) much of the fallout would occur in less inhabited areas, and in part because fallout takes time, making evacuation and sheltering possible. The social and economic damage from evacuation and subsequent decontamination could be quite high.

What can the public do to protect itself if a nuclear explosion occurs?
Not much can be done to protect areas immediately surrounding the explosion. As seen above, the devastation can extend out to or upwards of one mile, and heavy damage and casualties will occur beyond that. City services will likely be overburdened or even destroyed. That said, well-prepared local governments outside the area of total devastation can make quite a difference by maintaining communication with the public, having routes of evacuation identified early, and arranging for support services outside the affected areas. Because of this dire reality, prevention is overwhelmingly the area that should be emphasized.

What can the public do to protect itself from fallout?
More can be done about fallout than the immediate effects. Prepared local government organizations can identify the likely course of the fallout cloud early enough to allow for evacuation or, where possible, sheltering in many of the areas where it will be needed. The radioactive cloud can be tracked subsequently in real time. Again, realistic preparedness is the key to minimizing the damage to people from fallout.

Can terrorist organizations build nuclear bombs?
Fortunately, the materials for making nuclear explosives -- plutonium and a rare isotope of uranium -- are difficult to obtain. Plutonium must be made in a nuclear reactor. Uranium must be highly enriched in the needed isotope in a highly specialized set of facilities. A number of countries have carried out these activities and more could, but it would be difficult or impossible for a terrorist group to carry out these activities, at least without host government support. Even with government support, such activities are likely to be detected from abroad.

However, thousands of tons of plutonium and highly enriched uranium (HEU) do exist in the U.S., Russia, and elsewhere. Effective protection, control and accountability over these

materials are possible but may not be tight enough in all countries. The public and media should become informed about what is being done and should insist on adequate funding of protection, control and accountability measures. Good public awareness of the problems in time is probably the best contribution the public can make to nuclear safety.

How likely is a terrorist nuclear explosion?
No one can say for sure, but it is generally believed to be unlikely. This is mainly because both the materials needed and the weapons themselves are very difficult to make. Even if terrorists are able to steal enough nuclear material, they still need time to put the material into an effective explosive. They must either design the explosive themselves or have a design that will work with the material they have. They will need specialized tools and facilities, and at least a few experienced technicians, engineers and scientists. Moreover, some of the materials needed are lethal if handled improperly. Nevertheless, it is not impossible for a small group to make a nuclear explosive if it has enough plutonium or highly enriched uranium.

Stealing an actual nuclear weapon would be a difficult enterprise in any of the eight or so countries that have these weapons. Without cooperation from some part of the government concerned, it may be impossible.

What precautions is the government taking to prevent a nuclear explosion?
The U.S. government has exercised relatively tight control of plutonium and HEU, and very tight control of nuclear weapons. In cooperation with other governments, it is attempting to tighten controls in other countries. A test program is underway to help design an international system that will improve chances of detecting nuclear materials of all kinds in international shipping. In order to be effective, these programs require long-term funding and attention, and repeated testing in a real-life environment. They also require continued cooperation with a number of countries that have the materials for nuclear explosives or where shipment of such materials to the U.S. may occur.

More information on nuclear terrorism including additional fact sheets, backgrounders and reports is available on the CISAC website, http://cisac.stanford.edu.