Research Institute Recommendations
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Improving Your Chances for

Survival Under Thermonuclear Attack

As long as the possibility of a thermonuclear attack exists, we must be prepared to keep loss of life and damage to a minimum and be ready to take up life anew. This special Institute Report is designed to assist in the all important task of increasing the odds for individual and family survival.

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QUICK REFERENCE GUIDE

Survival Under Thermonuclear Attack

If hydrogen bombs should ever be dropped on this country, our survival as individuals and as a nation will depend on what we do *now* to prepare for and anticipate this emergency. It is because of the overriding importance and urgency of this problem, that the Research Institute has prepared this special guide in collaboration with Dr. John Heller, Director of the New England Institute for Medical Research.

Two purposes will be served by this Report. First read it and keep it for reference as the *only source of complete guidance* to your own planning and action as an individual citizen, head of your family and member of your community. Second, read it as a responsible business man who will find certain important opportunities in helping fill the physical needs for shelter and other equipment, as spelled out in these pages.

Also note that this Report addresses itself to the survival of the individual and does not deal with the special problems of industrial protection.

What You Will Find In This Report

As the reference table on the preceding page shows, the Report answers all of the important questions which must be asked in the face of a possible nuclear attack. The data have been drawn from the Atomic Energy Commission, the Department of Defense and the Executive Branch, and a great deal of scattered information released at different times and from different sources has been integrated into a single set of answers.

The worst possible situation as far as now can be foreseen is what is dealt with in our recommendations. Preparing for such an extreme eventuality is both prudent and hardly more expensive than planning for a lesser emergency. Thus the suggestions made in this Report will be applicable whether the major targets receive single 100 megaton bombs or clusters of 10 megaton bombs.

The only areas where these preparations will prove ineffective will be at the very heart of the bomb impact. Roughly speaking, this will be that area around a thermonuclear explosion where the blast effect results in an over-pressure of more than 10 pounds per square inch. In a 20 megaton bomb the radius of this area may be between 5 and 6.5 miles from ground zero.

Biological or chemical warfare are not discussed in this Report despite the fact that these techniques are often mentioned, along with neutron bombs, as possible weapons of Soviet attack. As techniques, they may be employed, but it is believed that their use will be *primarily tactical.* The difficulties presented by an attempt to use them against the whole civilian population are probably insurmountable.

How Can We Survive?

Most of the people in America will not be within the total destructive range of megaton thermonuclear bombs. And for the huge mass of these people, the availability of an adequate shelter will spell the difference between survival and a hideous death from radiation.

The Attack — When? How Much Warning?

We have no way of knowing exactly how much time will pass between the sounding of an alert and the actual detonation of bombs. Long-range detection apparatus will inform the military when a massive attack is under way. This information will be relayed to computers and finally to individuals before the attack alert is sent out to communities throughout the country. When the sirens sound, one might have anywhere between a few seconds to fifteen minutes to prepare for the initial series of events.

As for when, the best estimate is that such an attack will come at night. It is believed the Soviets would prefer to cope with our retaliation in daylight. And, when it is night in the United States it is daylight in the Soviet Union. If an attack upon us does come at night, most people will, of course, be in their houses. However, this is not certain and and a daylight attack is not precluded.

The First Danger: The Flash

As bombs increase in size, their blast range grows somewhat, but the thermal or incendiary range expands considerably more. Thus the first major problem will be that of heat from the flash. The range within which this heat can cause fire is known as the ignition range. The flash from a thermonuclear bomb, which will cause fires, is primarily the same kind of light as sunlight. There is no radioactivity associated with it, and its prime serious effect will be to burn individuals or ignite combustible materials.

It is essential to take shelter from the flash which can seriously burn one or ignite combustible materials. Therefore, to shield yourself get behind or underneath anything which will shield you from *light*. If you are away from a window, you will be adequately shielded from the flash by the walls and the roof of the house. (Another very good reason to be away from a window or any glass area is that the blast wave, which will come within a minute or two, will probably break the windows and send showers of glass flying.)

The flash from a thermonuclear bomb travels with the speed of light, 186,000 miles per second. However, in the very big megaton bombs all the light does not come in a single flash. There is an initial flash which is relatively "small" and then, within a second or two, comes the much greater wave of flash heat which is the really destructive one. In the case of the 100 megaton bomb this may last as long as 80 to 90 seconds.

In a very big bomb such as a 100 megatoner, the lapse of time between the initial and the secondary flash will be about six to ten seconds. During this brief interval, take cover from the flash. *Don't look up.* A multimegaton blast, high in the air when it is clear and there is good visibility, can blind a man at the distance of several hundreds of miles if he is looking directly at the fire ball. *Always shield or cover your eyes.* The light from the fire ball is many, many times the intensity of the sun!

recommendation: Do not attempt to get to a shelter when the alert sounds since there is no way of knowing how long a period there will be between the sounding of the alert and the initial flash. If you are outside in an exposed position, you might be seriously burned or your clothing might catch on fire.

The flash may come from on high because a high-altitude detonation is likely. Even in a surface burst, the flash would come from above the horizon. Fortunately, in this situation, the instinctive reaction would be to jump for the best kind of shade cover

for protection from the heat of the second flash — under a car, in a house, or even in the shade of a tree — anything that will put something solid and opaque between you and the light source is recommended. When the flash is over, go to the shelter.

Next: The Incendiary Effects

It is difficult to predict exactly how much heat will arrive at any particular spot. Assuming a very large bomb, exploded high in the air, enough heat to kindle a house would reach out for better than 30 miles. If there were heavy cloud cover between you and the bomb's detonation, much of the heat would be reflected by the cloud cover and fail to reach you. Ignition heat from a bomb is calculated in calories per square centimeter. Assuming a high air burst with excellent visibility and low humidity, here are some effects to be expected.

Heat Required for Ignition of Various Substances

	10 Megaton Bomb (cal/sq cm)
Cotton chenille bedspread (light blue)	8
Cotton muslin, oiled window shade (green)	11
Rayon twill lining (black)	2
Cotton venetian blind tape, dirty (white)	12
Cotton sheeting, unbleached, washed (cream)	30
Rayon twill lining (beige)	16
Cotton shirting (tan)	13
Cotton and rayon auto seat cover (dark blue)	13
Dust mop (oily gray)	5
Newspaper, single sheet	6
Kraft paper carton, corrugated edges exposed, used (brown)	25
Straw broom (yellow)	17
Dry rotted wood (punk)	9
Fine grass	10
Deciduous leaves	12

At about a 40 mile radius from a 100 megaton bomb explosion, there will be 25 calories. This is hot enough to make the paint on a freshly-painted house smolder. It is not hot enough, in all probability, to cause it to flash into fire. However, this is not true for the curtains hanging in the windows on the side of the house facing the flash, nor may it be true for the rugs and the furniture just inside these windows which may be exposed to 25 calories of flash.

Window glass will not keep out the heat impact of the flash. Examples of calories necessary to cause ignition in various substances are given in the following table. These figures are calculated for a 10 megaton bomb, and because of slower rate of energy delivery might be somewhat lower for a 100 megaton bomb.

Estimate of Projected Range of Blast Pressure and Heat from a 100 Megaton Air Burst with good visibility:

PRESSURE (Pounds per square inch)	RANGE IN MILES (Maximal)
10	12
5	20
2	40

HEAT (Calories per square centimeter)	RANGE IN MILES
35	30 (plus or minus 10 mi.)
25	35 " " " 10 "
8	55 " " " 10 "
3	80 " " " 10 "

BURST BELOW 50,000 FEET (shown in miles)

Megatons	*First degree Burns*	*Second degree Burns*	*Ignition of paper and Similar Items*
5	25	17	20
10	35	25	30
20	45	32	39
30	55	40	47
50	70	50	60
100	100	70	85

As the preceding table shows a house may burn down from combustion of materials either outside or inside which have a much lower ignition point than the house itself. Approximately seven calories is enough to cause a second degree burn. It has been estimated that with a 100 megaton bomb, no cloud cover and good visibility, there would result up to 13 calories out to 50 miles, and 8 calories out to 60 miles. These are "guesstimates". The U.S. has never detonated a bomb of this magnitude. Our graphs go only to 20 megatons, so we have to extend the lines of our graphs literally off of the paper and make approximate guesses.

From these facts it is clear that there can be a fairly wide area where small fires can start in substances requiring a relatively low ignition energy. It is important to remember that the same applies to upholstery in cars. Such a fire could very easily demolish a car, or a school bus, and any plan for transportation of children from school before radiation fallout arrives, must take into consideration the fact that busses may have caught fire and be useless.

Several possibilities exist for reducing this kind of conflagration. If all the windows in a vehicle are shut tightly, there may not be enough oxygen for severe burning to take place. The result would be nothing more than a scorched interior, assuming one were beyond the range where there is enough thermal energy for the tires to catch fire. One staff member of the Atomic Energy Commission, who feels he might be caught in his car at the time of an attack alert, has a window-cleaner bomb with which he plans to spray the windows in order to make them a little bit more opaque.

After the Flash — Fallout

The most threatening problem for those who have escaped the initial flash of a thermonuclear explosion (and this will apply to most of the population of the United States) is fallout. There are many misconceptions about the nature of this type of fallout and it is most important that the facts be clarified. First, we are *not* now discussing the type of fallout which has received so much publicity from nuclear bomb tests.

The discussion which has gone on through the years about this type of fallout refers primarily to the radioisotope, strontium 90. This radioactive isotope does pose a series of problems, but these will be considered later. This type of fallout is *delayed.* It is delayed because after a thermonuclear explosion it goes tremendously high into the stratosphere and stays there for a very long time, gradually falling to earth, days, weeks, months and even years later. This type of delayed fallout poses *no immediate threat of any kind.*

The fallout which does pose a threat is the so-called acute fallout. Acute fallout refers to very heavy dust-like particles. Many of them will be visible to the naked eye as dust. They will literally fall out of the mushroom cloud. These tiny pieces are radioactive and emit penetrating gamma rays.

This type of radiation is so similar to x-rays that, to all intents and purposes, it can be considered the same. Therefore, if you have ever had an x-ray, you have had this type of radiation go through you. Anyone who has a luminous dial wrist watch or a luminous dial alarm clock is being hit by gamma rays emanating from the dial every time the dial faces him, and he is close enough to it.

When Will the Fallout Occur?

The acute fallout will behave like rain in that it will fall as the cloud passes over. It will not begin to fall until the cloud is overhead. With about a 20-25 mile wind blowing the cloud in your direction, it should proceed at the rate of about one mile in three minutes. Under these conditions, if you are thirty miles from the burst it should take about ninety minutes for the cloud and the fallout to reach you.

An estimate has been given that the cloud will completely pass over you in a few hours. As soon as the cloud has passed over, the fallout will stop.

The dust-like particles are extremely heavy and dense – twice as dense as water. So they will fall almost straight down. These little particles of matter will be radioactive and will be emitting gamma rays. They may be likened to tiny pieces of intensely hot metal which fall to the earth and gradually cool.

Instead of heat being emitted, however, gamma rays are being emitted. In the same way, the radioactivity will cool, and the gamma rays will diminish. This occurs relatively rapidly. An approximate indication can be given by saying that the radioactivity will cool by a factor of 10 times in 7 hours, 100 times in 2 days, and 1,000 times in 2 weeks.

The radioactive dust will fall everywhere that any dust would fall and lie on the ground or on trees, and so forth, and emit its radiation, which travels in straight lines in the same way as light waves. The only protection from gamma rays is through putting enough *mass* between you and the source of gamma rays. For the greatest safety there should be a minimum of two feet of concrete plus a foot or two of earth between you and the radioactive dust, if you're building a concrete shelter, and different thicknesses if other materials are used.

How Much Radiation?

It is important to understand from what you are being protected. Radiation dosage is usually measured in units of roentgens, referred to by the letter R. R is a relatively arbitrarily-derived unit. To suggest some idea of what it means, in certain diagnostic x-ray procedures, you will have been exposed to 1 to 1.5 R. A human being can be exposed to 50 R and have no indication that he has been exposed to anything at all. In some cases this may go up to 75 or 100 R. But between 200 and 300 R, many people will have radiation sickness and some will die. At 600 R virtually everyone will die.

As an example, take the case of the Japanese fishermen in an open boat, down-wind from an American South Pacific multimegaton test. All of these fishermen were covered with radioactive dust and paid very little attention to it and, of course, took no precautions. They were out of doors in an intense and acute radioactive fallout situation. They received about 175 to 225 R. Though one later died of infectious hepatitis, not one of them died from the radiation to which he had been exposed.

Radiation has a cumulative effect. In this way, it is not unlike sunburn. Let us assume that we are at the Equator, on top of a very high mountain, and the sun is very intense. Let us assume that one half hour in this sunlight will result in an intense sunburn. Obviously, if you are outside only a minute, there would be very little burn. However, if during the course of the day you frequently go from the shade to the sun and back to the shade, and if the total exposure of your skin to the sun during that day is one-half hour, you will still have a severe sunburn.

As everyone knows who has been sunburned, the effects last for quite some time. The effects of radiation last a lot longer. One gets over many of the effects of radiation. There are some effects, however, from which one does not recover. For each R received, it has been estimated that the life will be shortened three and a half days. So try to avoid as much exposure to radiation as possible, even though you can take 50 to 75 R without any significant effects which can be observed immediately.

A possible misconception is that radiation is contagious. It is no more contagious than sunburn. Even if someone has been exposed to a super lethal dose of 10,000 R, no harm can come to you from being *right next to him.* He cannot communicate any of the radiation damage to you or others. The same is true for any other object which has been exposed to the rays. *This object is not dangerous* — no more so than if it had been placed in sunlight. It is only the radioactive dust, which emits the rays, that poses a danger.

Protection Against Radiation

When the dose rate of radiation in acute fallout is discussed, it is on the basis of the number of R that an individual would receive each hour standing in an open field. Thus if the fallout radiation in your area were 50 R per hour, you would receive a 50 R dose, if you stood in a field for one hour.

Remember, though, that the radiation is decaying or "cooling off" very rapidly. Thus a man in a 50 R per hour field of radiation *would not receive* a fatal dose in twelve hours (12 hrs. $\times$ 50 R/hr. $=$ 600 R). It would take 72 to 96 hours to receive a fatal dose because the radioactivity is decaying very rapidly.

If you are in a shelter and there is sufficient mass between you and the radiation, the radioactivity will be decreased by the protection factor of your shelter. Suppose the protection factor in your shelter is 1,000 fold. If the radioactive level on the ground right over the shelter, after acute fallout, is 50 R, the maximum you would be exposed to in your shelter would be 0.05 R. If you have a 5,000 fold protection, it would be one-fifth of this.

If we assume a tremendously heavy fallout, perhaps the heaviest that *could conceivably occur* in terms of our best estimate, it might be 10,000 R per hour. If you had a 5,000 fold protection factor, only 2 R per hour would get into the shelter.

At the end of the first seven hours after fallout, assuming the fallout to be of this enormous 10,000 R dose, there would be a decay of radioactivity of about 10 fold. In other words, if 10,000 R fell on the field around your shelter and you have a 5,000 fold protection factor, at the end of seven hours, the radioactivity outside would have decayed from 10,000 R to 1,000 R, and only 0.2 R per hour would be entering your shelter.

observation: The decay of radioactivity is not linear, but as mentioned previously, it would be down by a factor of 1,000 times at the end of two weeks. Thus even a 10,000 R area at the end of two weeks would be down to 10 R per hour. Starting with the maximum of 10,000 R per hour radiation one hour after the explosion and assuming a protection factor of 1,000, you would have received a total accumulated dose of 47.5 R at the end of two weeks.

Just how much fallout will fall in your particular area no one can predict. You will receive the fallout from the mushroom cloud which will pass over you and from other thermonuclear bombs which may have fallen to the west, since the prevailing winds are from west to east. However, if a radioactive cloud has to travel 1,000 miles to your area, the radioactivity is decaying just as fast in the cloud as it does on the earth.

The radioactivity decay factor is *absolutely independent of everything except time.* So the radioactivity of the fallout from bombs which had been detonated farther away, would diminish as the cloud drifted toward you. It would be following the same time-decay rate as the radioactivity which has fallen from relatively nearby thermonuclear explosions.

Clearly, in surviving a thermonuclear attack, the most important factor is the fallout shelter. This means plenty of mass between you and the radioactive dust.

Shelters and Equipment

Adequate mass between you and the radioactive particles is the only protection against fallout. And the best way of providing yourself with this sheltering mass is an underground shelter which is not susceptible to fire.

Where this is not feasible, if the location is too close to a body of water and there are water problems in digging underground, or if there is rock ledge necessitating blasting, or some other physical impediment, the shelter can be built above ground, provided *the walls are thick enough and sufficient dirt is piled on top of it.* Again the principle of mass between you and the radioactive dust is paramount. Two feet of concrete and one to two feet of earth is strongly recommended. As long as the total mass is the same, it does not make much difference what type of substances are used except for the structural strength that may be involved in a shelter. Two feet of concrete affords the same protection as three feet of earth, or six inches of steel, or three inches of lead, or five feet of water, or nine feet of wood. For an above-ground shelter, three feet of dirt on top of three feet of concrete is recommended.

Three basic kinds of shelters are possible. There is the backyard shelter for an individual and his family. There is the neighborhood shelter for a group of families; and the community shelter for a town, factory or school. Making a choice involves money. The one-family underground shelter, built

in the backyard, is the most expensive type per person. Least expensive is a community shelter for a large population group of many hundreds or thousands.

There is, however, a real problem as regards the community shelter which must be considered. Getting to the shelter, if you are within ignition range or possible ignition range (as much as 85 miles from the explosion), may be difficult or impossible. The upholstery of the cars will possibly catch on fire and perhaps even the tires. Thus the roads will be littered with burning cars and possibly burning trees. Your own car may catch on fire. If your community shelter is 5 to 8 miles away, you will have a real problem in trying to get there in time. Thus for those families in a probable, or even possible ignition range, the neighborhood or family shelter is the best choice. This should be a shelter which one can reach on foot within 15 to 20 minutes.

A neighborhood shelter is not too much more expensive than a community shelter and is certainly *far cheaper* than a private shelter. Furthermore, being alone in a time of disaster is, for most people, rather frightening. It helps considerably to share such an experience with others.

There is this important additional factor. In a neighborhood shelter the individuals will represent many skills available to cope with whatever situation occurs, as well as those to be handled on emerging from the shelter. Contractors estimate that a neighborhood shelter should cost somewhere between $125 to $200 per person.

A community shelter is reasonable for an area where people live quite close together and can reach it on foot. It also fills the requirement for those individuals who rent or do not have the funds immediately available for their contribution to the building of such a shelter.

observation: For those people who are beyond ignition range and in a presumptive range of very light fallout, a basement shelter may be adequate. However, remember that within ignition range the basement shelter may become a fire trap. In addition, it affords only a 100 to 200 fold protection. One hundred fold protection against a 10,000 R per hour fallout situation would result in a lethal dose of radiation in the basement shelter. But the number of people who might be exposed to so high a radiation dose would not be large. That is why the U.S. Government bases its recommendations on a 100-1,000 fold protection factor. The protection factors suggested in this Report are considerably higher than those the government is considering recommending. We have felt it advisable to suggest the maximums and allow you to make decisions based on these facts.

How Much Space and Air?

Adequate space is an important shelter requirement. There should be 15 square feet per person in the shelter, and it should be high enough for people to walk about with, perhaps an extra foot or two for overhead storage of various supplies.

Perhaps the most important factor *within* the shelter is air. There *must* be adequate oxygen intake. This should be a minimum of five cubic feet of air per minute, per person. This is recommended by virtually every agency, including the American Society of Heating, Refrigeration and Ventilation Engineers.

One method of providing air is through use of a hand-cranked low velocity blower which would suck air into the shelter. There is a possibility, however, that the occupants would not have the endurance to supply sufficient air in this manner. Also, the more work that is done in the shelter, the more air is needed.

A source of power *adjacent* to the shelter is strongly recommended. This source of power is so important for so many aspects of survival that it is almost mandatory. An electric generator, motor-driven, will do the job. But not the ordinary home or standby generator.

Many of these are made using mass-produced lawn mower engines which are not designed for continuous running night and day for two weeks with a guarantee of trouble-free operation. The period during which people must be in shelters is not the time for generator failure.

The military has a requirement for electric generators of a special design, including stellite valve seats, etc., which must perform for three months of continuous operation without maintenance. A simple modification of this engine is best for shelter use.

recommendation: Since nothing is perfect, and to cope with any remote chance of failure, we suggest that two of these units be used. If you need 3 kilowatts for a neighborhood shelter, it would be best to have two 1.5 kilowatt generators.

Fortunately these exceptionally good generators are cheaper than most of the commercially available home units. Arrangements can be made whereby they can be obtained for Civil Defense purposes at an *extremely low price.*

Wrong Fuel Can Be Dangerous

We do not recommend that ordinary gasoline be used for fuel for this generator. Gasoline left standing in a tank for a long time does settle out, and this can foul the carburetor. Thus for rather low kilowatt requirements, a *propane-driven generator* is suggested. Propane can be stored in tanks virtually indefinitely without deterioration.

For larger kilowatt requirements, select a diesel engine. Care must be exercised to obtain the correct diesel fuel to prevent deterioration, and the length of time before deterioration should be learned from the manufacturer.

The generator should not be in the shelter, but in a sealed alcove next to it with an access door. The carbon monoxide from the motor must be vented to the outside, and there must be an air intake for the generator. In some cases, it will be feasible to have the air intake for the generator come right out of the shelter and thus provide the suction of air *out* of the shelter which will, of course, pull fresh air *in* from the intake vents.

In many circumstances, it will be desirable to conserve fuel and have the generator operate only intermittently instead of constantly. This can be arranged with appropriate battery connections. In such a situation, air intake and exhaust must be handled by electric (DC) motor driven blowers instead of relying upon the generator motor's air intake suction. Air supply and exhaust must, of course, be continuous.

A Warning About Ventilation

There are two vital points involved in ventilation — *adequate oxygen intake* and *adequate exhaust of carbon dioxide.* No matter how great the oxygen level in the room, the carbon dioxide must be maintained at a low level. Even if there is an excess of oxygen, toxic reaction will occur if the carbon dioxide level goes up to 2 to 3 percent. When it reaches the 5 percent level, it will be extremely serious. This is an old and well known problem encountered for decades in submarines.

So, it is extremely important to have adequate oxygen intake and an exhaust system whereby the carbon dioxide is vented out of the shelter. If blowers sucking air in from the outside are used, these should be motor driven from the electricity derived from the generator. An emergency standby handcrank should be available.

The velocity of intake of these blowers should be low, because high-velocity intake might suck in radioactive dust. Since the dust is heavy, a simple upside-down "U" intake will be adequate to prevent sucking in big particles of dust. It is recommended that you have a filter in the system for smaller particles, or perhaps for particles stirred about by strong winds.

Are Fire-storms Dangerous to the Shelter?

The danger of fire-storms to the people in a shelter has been overrated. The U.S. Forestry Service believes that a fire-storm involving a 20, 30 mile radius or greater is unlikely. If the shelter entrance is forty feet from any building or dense woods, there will be no fire hazard in getting into it.

Should a fire-storm envelope a shelter, however, heat inside will not be a threat. The Naval Radiological Defense Laboratory deliberately created a fire-storm by burning 500 tons of wood above and around a shelter similar to that recommended in this Report.

The fire-storm was fierce and lasted for many hours. Maximum rise of temperature within the shelter was 5 degrees.

In an area where a fire-storm might develop, the danger lies in continuing ventilation of the shelter, thus drawing in noxious carbon dioxide and superheated air. Instead it is necessary to shut off the generators, air intakes and exhaust vents.

For this period a supply of oxygen tanks and an absorber of carbon dioxide is needed. Total cost per person is estimated at $4.00. Thirty-five cubic feet of pressurized tank oxygen is sufficient for 100 people in a shelter for 20 hours.

For absorbing carbon dioxide, a combination of 20% barium hydroxide and 80% calcium hydroxide, occasionally called barrel lime, is most useful. Eight pounds per person of this mixture will last 20 hours.

The material comes in small pellets with a color indicator which indicates saturation. They can be placed in trays on the floor and raked over when the color of the top layer changes.

Water is nearly as vital as air. The water from a drilled or artesian well will be perfectly safe. The water from a dug or shallow well will also be safe provided the well is covered so the dust cannot fall into it. Any cover which will prevent this from getting into the water is adequate. If there is a wood cover, it should be caulked.

Water from a spring is also perfectly safe if the spring is covered in the same manner as the dug or shallow well. In all of these situations (except for the rare situation of a gravity feed) a pump is necessary as is the electricity to drive it.

Municipal water will also probably be drinkable. Radioactive dust will, of course, fall into reservoirs, but being heavy (twice as dense as water) it will sink to the bottom. If it does not sink here, it will probably sink in some of the settling tanks through which municipal water must go.

Fortunately the particles of radioactive dust are *highly insoluble*. Therefore, only a very tiny amount of radioactive dust will go into solution in the water. If you have a faucet water softener (ion exchange resin) attachment, virtually none of these minute amounts of soluble isotopes will come through into the drinking water.

In the case of municipally supplied water, if the pump stations are abandoned or destroyed, or if mains are broken, this water will not be available. Therefore a fallout shelter well is worth considering. Alternatively, water can be stored in tanks. This must be changed periodically or algae and various other forms of microscopic life may grow in it. A very large tank to supply shelter occupants is perfectly safe if the water is changed periodically.

Sterile bottled water is most ideal for storage and also most expensive. It will have no living matter in it nor, if properly sealed, should any biological contamination be possible. The requirement per person in a shelter is a gallon a day although one could survive on less. Also, a source of running water will make life infinitely more easy and comfortable.

The problem of human waste is also greatly alleviated by running water. There are recommendations for using plastic, oiled, or waxed bags for human waste and placing them in a tightly-sealed garbage pail. Chemical toilets and similar items have also been mentioned. Although this may sound almost antiseptic, in operation these will be unpleasant unless and until it becomes possible to leave the shelter briefly to bury such waste.

If there is a good source of water available, it will be preferable to install small toilets in the shelter. These should be of the simple cabin-cruiser type with a hand pump. To conserve water, the tank flush type is not recommended. The hand-pumped type pulls in just enough water to flush the toilet and, of course, there must be a waste pipe leaving the shelter to a low point somewhere outside.

With an adequate source of water, even a stall shower can be contemplated for the shelter. This is not completely in the category of a luxury. If it should become necessary for someone to go outside of the shelter for a short period of time, one would want to be sure that when he returned he would not be bringing in particles of radioactive dust on his clothing or body. A shower is an excellent decontamination device.

Radiation Measuring Devices

How do you determine the amount of radioactivity on the outside? This is important for determining when you can leave the shelter, or how long you dare go out for a quick trip. Similarly, you will need to know the amount of radiation on the inside as well as how much radiation you have absorbed.

For all of these reasons, every shelter must be provided with an instrument that can measure radiation. Such an instrument, usually called a radiac device, comes in two types. The cheapest is called a dosimeter. A so-called charger, which is battery run, sets the instrument to zero. By holding it up to the light and looking through one end, you can perceive the total cumulative dose that it has been exposed to since the instrument was charged. Such radiac devices are quite useful but they have limitations. Many of them are fragile and a bump can either break it, or jar it to a false value.

Furthermore, to determine how radioactive it is outside, you must take a reading, place the instrument outside, wait a period of time, then retrieve it and see what the accumulative dose of radiation has been. This is awkward and of limited use only.

Therefore, in addition to a cumulative dosimeter, you should have another radiac device which is essentially a rate meter. This is larger and more expensive. It is portable and has a probe that one can point at things and determine *instantly* radiation per hour. It is of particular importance later in determining whether food is contaminated.

The sensing device in the probe is essentially a Geiger tube type of device and extras must be available. The entire rate meter is battery driven and plenty of extra batteries should be available, because it may be necessary to use it for some time.

Food, in the Shelter — and After

There must be a two-week supply of food per person in the shelter. Cooking probably will not be feasible because flame cooking uses oxygen, and electric cooking uses far too much electrical energy. But, any housewife knows what is adequate for her family in terms of canned or preserved or dried boxed foods for a two-week period. These should not be dehydrated foods that require addition of water. This supply should be changed every six months or so to prevent possible deterioration.

An additional six-week supply at a minimum should be on hand for consumption after coming out of the shelter. This should be of a special type such as pemmican or biltong or iron rations.

What About Communications With the Outside?

A radio is necessary for picking up CONELRAD stations. We recommend an antenna leading down into the shelter which can be attached to the radio, because nearby CONELRAD stations may be knocked out and you may have to pick up signals from some distance.

In a more elaborate set-up there is the possibility of having a shortwave set in the shelter. If there is a ham operator who can work the set in a neighborhood group, and if you are willing to install a shortwave set (expensive) in the shelter, there are advantages. Communicating with other individuals in other shelters will reduce the feeling of isolation.

Other Shelter Recommendations

Without going into too much detail, here are a number of other suggestions for the fallout shelter —

. . . *Electric Lights.* Two weeks in total darkness would result in serious morale problems. In addition to regular lights run off the generator, provide emergency battery-operated lights. Four cell hotshot batteries, wired to a 150 milliampere flashlight bulb will operate continuously for about 10 days.

. . . *Basic Tools.* Stock the shelter with such basic tools as shovels, rakes, hoes and axes. Fish hooks and line may come in handy later.

. . . *Bedding.* Simple cots that can be stacked out of the way are best. Sleeping bags can be used on the cots and have the advantage of being easily portable for later.

. . . *Smoking.* This should not be permitted in the shelter as it will complicate ventilation problems.

In any case tobacco may not be available for a long time.

. . . *Shelter Government.* In the case of large groups, some plan for making decisions should be organized ahead of time.

. . . *Medicines.* A well-stocked home medicine cabinet will provide the basic necessities.

Intruders

There has been a good deal of discussion about admitting strangers or any added persons into a shelter. Here are some factors to consider.

Anyone caught outside in heavy fallout, who has received a lethal dose of radiation, is under irrevocable sentence of death. Letting such a person into a shelter cannot conceivably help him.

If the shelter has been built allowing 20 square feet per person, some extras could be admitted. But allowing too many will only result in the suffocation of everyone because of inadequate oxygen or carbon dioxide poisoning.

It is unlikely that an intruder could *force* his way into a shelter. But he could blackmail the occupants easily by blocking up the air intake. This means there should be several intakes, camouflaged – or a single one reaching high in the air.

In any case, the important thing about extras is that the decision on how many to admit should be made well *before* the crisis.

When You Come Out From the Shelter

What you find on emerging from the shelter depends on where you will be. If you're in a complete ignition zone, everything will have been burned flat. There will be so little to work with, you will probably have to leave. And since there will be no surface transportation you will have to go on foot.

However, you will probably not have to walk very far to get out of the burned area. Big as the bombs may be, and wide as the ignition range is, it is unlikely that you will have to go more than 10 to 20 miles to get to an area which was completely unaffected by fire.

In a marginal zone, some houses may have burned, many windows may be broken, but others will be intact. Neighbors will have to help one another. It may be best to use the shelter as a center of operation for some time. But in the majority of areas everything will be intact and you can walk right back into your house.

How Much Radiation?

If the fallout has been *extraordinarily heavy* in your area there may be a radiation rate after two weeks of more than 1 R per hour. In that case, you will have to trek out in the same way as from an ignition zone, to another area, again not more than 10 or 20 miles away, where it is less radioactive. There will be such hot spots, radioactively speaking, but compared to the size of the country, they will be quite small.

Although most people will be able to take up residence in the same community they left when they went into shelters, the situation will be challenging. But it is unlikely to be as bad as many people now assume it will be.

How Much Food Will There Be?

The food available at any given moment in any community is quite limited in amount. It normally comes in from big distribution centers daily, but many of these centers will be demolished, as will roads, rail lines, cars, trucks, and other modes of transportation. This is the prime reason for the extra six-week food supply that was recommended earlier. This food supply is in *addition* to the two-week shelter supply.

The Federal Government plans to reopen transportation routes as quickly as possible and tap into the enormous agricultural surplus for distribution to the public. But this will take time, in many cases, the government thinks, as much as six months. Therefore the *minimum* of six weeks extra rations is important.

These rations should be in the form of pemmican, biltong, or iron rations, as we have recommended. These are dried, dehydrated foods. They are light in weight. If you have to leave your particular neighborhood, it will be easier to carry this food with you.

When the government finally gets the agricultural surpluses to individual communities, they will not be in the form of instant TV Dinners. We will have to relearn what to do with wheat and corn. If Victory gardens were needed in World War II, they will be far more essential now. Agricultural surplus will undoubtedly be adequate for a year, but by then new crops must be raised and ready for harvest. In a sense we will be back to frontier days when we had to grow our own food. Herds will have to be restocked from the animals that have survived and from other countries, such as Argentina. This will all be part of the process of rebuilding the country.

recommendation: Take the initiative to make a survey of the total available food in the entire area – town, township or county. This will give you some idea of possible reserves.

What Kind Of Food?

This point cannot be overstated: *radiation cannot hurt anything which is not alive.*

All processed stored food which is sealed from dust, such as canned goods, packaged cereals, and so forth, will be perfectly safe as soon as you wash off the dust which may be on top of the container. Similarly, if you have a banana on a shelf and it is covered with radioactive dust, brush the dust off, or wash it off, peel the banana, and it will be perfectly edible.

The radioactive dust will probably have cooled off so much by this time that it will be relatively innocuous. However, even if it is still slightly radioactive, (determined by your rate meter) washing it off is all that is necessary. The gamma rays will have no deleterious effect on any non-living thing.

It will be a long time before **meat** is available. It may be months; it may take a lot longer. The radioactivity which would have killed you if you had stayed on the surface, will have killed cattle, sheep, pigs, and even squirrels, other rodents, and birds. Although there will be areas in the country where this will not be so, whether they will be nearby cannot be predicted.

There will be no **milk** for a long time. If any milk cows should have escaped, their milk *must be* avoided because it will be highly contaminated with radioactive iodine which is extremely dangerous to children's thyroid glands, even though the radioactivity in iodine decays quite rapidly. Powdered or canned milk will be the only source of milk for quite a long period.

It is a little bit difficult to determine what will happen to **fish.** If you catch any fish it is possible that their meat may be contaminated, although it isn't very likely. Pointing the rate meter probe at the fish you have caught and cleaned will determine edibility.

There is the possibility, if the radioactive fallout has not been too great in the area, that animals such as cattle may still be alive, although the likelihood is that they will be dying. If they are slaughtered and skinned, the probability is very good that their meat will be edible. Contamination can be checked with one's rate meter. If there's extra meat it can be dried or smoked and thus preserved.

The Threat from Insects

If higher forms of animal life are killed off in an area, insects, many of which are quite resistant to radiation, will probably multiply tremendously. The chances are good that this will constitute a significant problem.

recommendation: While you probably would not want to store a large amount of dry insecticide powder in the shelter, it is a good idea to have a supply of this available.

The Dangers from Delayed Fallout

The delayed fallout – primarily strontium 90, as from bomb tests – will come down for months and years, and it will contaminate the earth. Plants will

take up the strontium, and we will eat these plants. Animals will eat the plants in which the strontium is contained, and we will drink their milk. But there exist a large variety of practical *methods to reduce this strontium* in man.

Without going into detail, some of these techniques can be mentioned. In certain soil, strontium will not penetrate very deeply. The method is to sow deep-rooted plants; or plow the top surface under and plant shallow-rooted plants. Calcium can be added to the soil which will markedly dilute and reduce strontium uptake by plants.

Hydroponics may become fashionable and other methods of reducing strontium uptake are feasible. However, there is no question but that we will get more radioactivity into our bones and into our bodies than if a thermonuclear war had never come to pass. What will this mean?

A Shorter Life Expectancy

Probably many of us will not live as long as we might now be expected. Nuclear attack may take five to ten years off our life expectancy. But this merely brings us back to what life expectancy was in 1940.

It has been estimated that a 1 R dose might reduce life expectancy about 3.5 days. Exposure to 100 R by small chronic doses might shorten it by a year. One thousand R, again in small chronic doses, will probably shorten it by ten years.

If these statistics sound frightening, take a look at some other statistics arrived at in the same manner. Smoking one package of cigarettes per day is said by some to reduce life expectancy by 3,000 days. If you are 25 per cent overweight, you will live 1,300 days less; and if you drive a car, statistics state that your life span will be reduced by an average of 470 days.

If we receive a lot of radioactivity, there will be an increase in cancer and leukemia. However three out of five of us will die from cancer as things stand now. Furthermore, within the next decade or so, medical science may be able to do something definitive about cancer and leukemia. Therefore we feel that the presumptive radiation damage we may receive is no reason to resign from the human race.

Genetic Effects

Considerable concern has been expressed about genetic effects. Some fear the increased likelihood of abnormalities or mutations. Here are estimates that may alleviate some of this fear. If every person in the entire world were to receive a dose of 10 R, which is extremely unlikely, the increase in mutation rate would be about 0.02 percent in the children. The normal mutation rate in man is now 4 percent.

Is It Worth It?

In a very real sense, a widespread shelter program can aid as a major deterrent to a nuclear war. If the Soviets felt they could kill 90 to 100 million Americans, they would probably assume – and rightly so – that we as a people could probably never get up off our knees again. However, if after two weeks, an overwhelming majority of Americans come out of their shelters, intact as a people, the situation will be vastly different.

Who Should Do It?

To a fairly great extent civilian defense has to be carried on by *civilians*. The federal government, state governments, and municipal governments cannot take the whole responsibility and the whole chore of survival off our hands.

If we undertake a shelter program for ourselves, we will have an enormous advantage over the Soviet Union in a thermonuclear war. By our heritage and tradition, we are accustomed to govern ourselves. Even if most of the federal executive and legislative leadership were knocked out and the same situation obtained at state, county, and municipal level, it would take Americans virtually no time at all to organize themselves, re-elect new leaders and reconstitute governmental bodies.

In the Soviet Union, the situation would be entirely different. With their monolithic leadership gone, the peoples would be fragmented, scattered, irresolute, with no idea as to how to proceed. Peoples who have spent their entire lives under a totalitarian form of government are in a very serious state when Big Brother is obliterated.

Why No Soviet Shelter Program?

The Soviet Union has been working on civil defense for several years. However, they must rely upon existing underground factories for shelters. Their people, unlike us, have neither the will, nor the knowledge, nor the wherewithal, to get together spontaneously in groups, neighborhoods, or communities to build their own shelters. Their tradition is to take no action, to have no opinion other than that dictated by the party elite.

Even if they wanted a major civil defense program, they do not have the materials necessary to build and stock such shelters. Shortages in the areas of building materials are so acute that even in 1961, simple housing problems remain unsolved. Thus we have an advantage over them in the event of thermonuclear war, *providing we build shelters.* And by taking these precautions, we might very readily be able to prevent this war from ever occurring.

After a Thermonuclear War . . .

When Americans come out of their shelters, they will have a country to rebuild. But it will *not* be the blighted, uninhabitable, hideous desert many envision. It will be rough, and it may take years to rebuild. But, this kind of challenge has never deterred Americans from the earliest days in New England, through the times of the pioneer, and indeed up to and including the present.

It is sometimes said that it is not dignified or worthy of us to go into holes in the ground like frightened rabbits. In revolutionary days Americans crouched behind stone walls as they fought. The British walked upright, and lost. The present day version of a stone wall, or a trench, or a foxhole, is a fallout shelter. The details are different, but the principle is the same.

It has been suggested that many of the conditions we will face after a war will be reminiscent of 1776. Most of us today feel that we could not go out of the house if we had nothing to put on our feet and if the ground were frozen or had snow on it.

But this *was* the case at Valley Forge, and the men *did* go out, and they walked on the snow and frozen ground. And as they marched, they spotted the snow with flecks of blood. But they not only marched, they fought and defeated one of the formidable armies of that day.

At Valley Forge they were probably hungrier than we will ever be. They were probably sicker than we will ever be with typhoid and diarrhea and dysentery. Yet they got up, and they marched, and they fought, and they won.

Neither Red Nor Dead

And there were doubting Thomases in our revolutionary days, and they have been with us ever since. There are those who chose to flee. There were, in the Eighteenth Century, people whose counterpart today say they would rather be "Red than dead."

Neither is necessary. We will be able to live in a post-thermonuclear war world. It would not be the kind of world we want to live in, but the best way to prevent it from ever occurring, is to be so prepared and so strong in our preparations, that it will never come.