NUCLEAR SURVIVAL MANUAL

BOSDEC – The Concrete Curtain

JAMES R. FAIRLAMB

NUCLEAR SURVIVAL MANUAL

BOSDEC — *The Concrete Curtain*

NUCLEAR SURVIVAL MANUAL

BOSDEC — THE CONCRETE CURTAIN

BY

JAMES R. FAIRLAMB

FIRST EDITION

PUBLISHERS

DREXEL WINSLOW & FARRINGTON

P. O. BOX 55 • BUTLER, N. J.

Library of Congress Catalog Card Number 63-21932

Printed in the United States of America

The Colonial Press Inc.
Clinton, Mass.

CONTENTS INDEX GUIDE

DEDICATION

This effort is dedicated with love to all the children of the world. With it goes the fervent prayer that their parents will use more wisdom in making the life or death decisions coming up in the future than they did in getting our world into such a predicament.

FOREWORD

In the year 1963 the two way power struggle between the free world and Russia became a three way contest. By 1965 China will probably have accomplished a nuclear reaction; by 1970 China will have nuclear weapons; and by 1980 China will have a nuclear attack capability. Red China, those simple agrarian reformers, have already announced long and loud that they intend to exterminate capitalism the moment that they can gain more than they will lose. Chinese strategy may well be to defeat Russia ideologically and/or militarily and then take on the free world. As the ultimate aim; Red Chinese domination of the world! The first act must be the subjugation of India as a flank protection. You have witnessed the opening ploys. Let us not be completely and thoroughly naive.

The simple minded man who doesn't have sense enough to come in out of the rain has been the bench mark of stupidity for a long time. He is about to lose his place to the man who "doesn't have sense enough to come in out of the fallout."

Many people use the stock expression "I don't want to live like a mole or a rabbit and dive into a hole when in danger." In effect these people are saying that they don't have as much sense as a rabbit.

Why should people be subjected to ridicule for a natural desire to seek protection from danger? A nuclear attack would turn our entire country into a war theatre. Each citizen would become a soldier in a battle for survival. Every army in modern history has dug in for protection. Has any stigma ever been attached to a command to dig foxholes or trenches? What is so sensible about standing out in the open and inviting destruction?

An embattled population would necessarily play a passive role in a period of nuclear attacks. Certainly all civilians will automatically seek shelter. Whether they duck under the kitchen table or into a planned shelter is just a question of degree of protection. The principle is the same. To cope with this problem it will be necessary for most persons to discard ideas gleaned from scary, ill informed articles and to study the actual facts.

If you decide to build a shelter you will want to judge for yourself the degree of protection necessary or possible for you and your family. The purpose of this manual is to make all known facts available to you in one complete reference so that your decisions will be based on facts—not on the opinions of others.

One of the main facts to consider is this—if you build a protective shelter and never use it during a nuclear attack you may lose several thousand dollars. If you don't build it and a nuclear attack occurs—you may lose your life.

It doesn't seem logical to trust to luck or some one else's predigested opinions on such a vital matter. It makes just as little sense to design and build a shelter for fallout protection only, when a combined blast and fallout shelter can be built with a little more effort and money. You will need a strong shelter—not a bargain basement.

We are all afraid of the unknown. Fear is a poor basis for intelligent planning. This is the main reason why a clear understanding of nuclear problems is so necessary to the average man. This manual is not intended to solve your problems. It is designed to give you the basis for wise decisions. After all, it is your problem —your decision and no one can make it for you. You are entitled to facts—not salestalks, not piecemeal information, not communist propaganda or cabdriver opinions.

Nuclear energy is a fact of life. It cannot be ignored or side stepped. Yet that is what people are trying to do when they say that they don't want to live in a nuclear world. They might as well say that they don't want to live in a world where cancer and blindness are a part of life's risks. Facts must be faced—as they always have been faced.

Hundred of thousands of public spirited persons have volunteered for Civil Defense and Disaster Control duty. The vast majority serve their country without pay and unfortunately, with very little thanks. They work very hard to plan the protection and conservation of our citizenry in any kind of disaster. They have been terribly handicapped by official apathy at the national level, lack of intelligent and much needed laws with teeth in them and—money.

For instance, sixteen years after exploding the first nuclear bomb, our government still has not made a real effort to decentralize industry or make mandatory shelters in our schools. What an opportunity we have missed to protect our most valuable asset—our children. All of the schools built since 1946 could have had combination shelters and cafeterias in their basements had someone been far sighted enough. This could have been done with very little additional expense. Think of the peace of mind that would have resulted from just a little intelligent planning at the proper level.

A diligent search of government literature failed to disclose one instance where an underground family bomb shelter has been built and tested near a nuclear test explosion. Why hasn't this been done? Since only persons associated with the government and the government itself have access to basic nuclear weapon data, all tests must be done by the government. Obviously all nuclear data in any book on the subject must be based on government released information.

Fortunately President Kennedy has given many indications of his awareness of the problems and has taken initial measures to do something about them. In the past two years several very interesting and informative books have been published. Let us hope that the effort is expanded and that the flow of really useful information needed will be supplied.

Have you ever had a vague, uncomfortable feeling that interviews and speeches to which you listened are selling defeatism? That you are being softened up by a well organized line of pro communist propaganda featuring no shelters, complete unilateral disarmament, peace at any price, etc. Overlooked is the fact that our past gestures of cooperation were taken as signs of weakness or stupidity. This line is epitomized by the typical fellow traveler slogan "better red than dead." Just a few thousand well placed and highly articulate fellow travelers can make more noise and influence more people than the overwhelmingly vast majority of Americans who feel otherwise. The aim of this propaganda is confusion and division of our citizens in times of crisis and decision.

America must realize that even capitulation to communism would not be a guarantee against nuclear war. What happens when the Chinese produce a nuclear weapon? When the Russians and the Chinese start warring among themselves? The entire world will become radiation contaminated in various degrees—and there is very little we can do about it by ourselves. The implications of nuclear problems to come stagger the imagination. To attempt to solve these problems by unilateral disarmament would be like atttempting to reduce crime by firing the policemen.

Human nature has not changed very much in centuries. Yet it is man's supreme egotism, reflected in each generation—that his generation is different. That human nature has changed drastically in the 20 or 30 years of his generation when it has not, indeed, changed much in the past 2,000 years. Little has been learned from history or from the men with a desire to rule the world—and with so little time on earth to accomplish this dream: Genghis Khan, Alexander, Napoleon and Hitler. How short or convenient is our memory! The more we placated Hitler, the bolder and hungrier he became. Finally, under the most adverse conditions we had to face the truth. The meek will some day inherit the earth—but at this stage of our evolution only the strong and resolute can remain free.

What we call Communism today is actually Fascism. It enlists the aid and support of some simple minded, even well intentioned people and mistaken malcontents alike. They then spend half their lives damning Fascism—and the other half serving it under the delusion that they are helping their fellow men.

Magazine articles, newspaper ads and talks given by presumably well intentioned but uninformed persons have bombarded you with information of sorts. This purports to show that you will be blinded by a nuclear explosion, maimed or killed by hurtling debris including bodies, incinerated by fires and tossed around by blast waves. Of course, they seldom mention that all of these dire predictions are based on the assumption that you will not have an adequate shelter and will be, in fact, out in the open. These articles quote barbers and taxicab drivers and probably boost circulation—but they do not contain any useful information. They are emotional appeals to the natural desire of everyone for peace and safety and they ignore facts. Several excellent, factually informative magazine articles have been conspicuous by their objective and helpful approach.

Individual scientists and groups of scientists have been particularly vocal on the subject of shelters. Some say build shelters and others say it is useless. This advice comes from men with comparable scientific backgrounds. Their political and philosophical backgrounds usually differ. However, the fact that a person is a scientist is not proof that he is particularly competent to judge other affairs with superior ability.

Much of the information in this manual was developed from Office of Civil Defense, Department of Defense and Atomic Energy Commission publications. Some of the statistics are based on data obtained by extrapolation, interpolation and the application of scaling laws. The subject of nuclear weapon behavior is so complex that the use of these methods is sometimes necessary. The results of these computations should not be construed as exact figures, because of the many conditions and forces which differ with each nuclear explosion. Because many figures presented are approximate for any given weapon explosion, they serve as planning guide-lines and should be verified and confirmed by radiation instrument checks under the actual conditions prevailing at any given time. With so many variable factors involved it was considered essential that every effort be made to use maximal figures for most weapon effects to present the worst possible conditions for each statistic. Therefore, these figures may vary in different degrees from other statistics covering the same area of interest.

This manual is not intended to provide the electrical, plumbing or carpentry details of shelter building. No effort has been made to explain how every bolt is to be set, every electrical outlet placed, every yard of concrete poured or every reinforcing bar placed. It is intended as a guide for shelter construction, a reminder and a checklist—not a detailed blueprint.

With a combined ceiling mass of seven feet and space equal to 500 cubic feet per person you can wait out the explosion, thermal radiation, firewinds, blast including an overpressure of 100 psi and early fallout and still be more than 90% safe two and one-half miles or more from the ground zero of a fifty megaton explosion. You will not be incinerated, barbecued or hit by hurtling bodies if you are in a well designed shelter. You can take intelligent steps to increase your chance of survival.

The purpose of this manual is not to consciously sell the idea of building a shelter. If you decide to do so, remember that you can eliminate the generator, well and other desirable but non-essential features that are expensive and still have the same degree of protection but not the same amount of convenience.

There is something slightly ridiculous about expecting intelligent citizens to protect themselves from nuclear explosions crouched in makeshift $50 leantos covered with sandbags. Practically all officials seem reluctant to tell the people that they must spend more than the cost of a television set for nuclear protection. Our purpose is to explain the problem and avenues of solution. If at times the solution seems involved and redundant it is because the problem is involved and all known means of planning a shelter are presented. For instance, three types of air filtration are shown in the BOSDEC concept—but only one is necessary. We believe you can make your choice if you have the information available. That is what we are trying to do.

Your main problem may not be to survive a nuclear attack but to survive a nuclear war and to just exist in the immediate post attack world until that war is won. The BOSDEC system would then prove to be much more than just a nuclear bomb shelter.

Many questions you may now have regarding this concept would be answered at that time.

It would be tragic if America built a nuclear weapon to win a war and instead lost a civilization.

Our most fervent prayer is that you will never use your shelter under the conditions for which it was designed — and that a true peace, honorable and just to all mankind will come to the people of the world. If it does not, our main protection from the iron curtain and the bamboo curtain may well be survival shelters — the concrete curtain.

Illegitimi non carborundum!

James R. Fairlamb.

CHAPTER 1

Surviving Immediate Effects of a Nuclear Explosion

SURVIVAL FOR ONE MINUTE

All nuclear weapon explosions produce basic reactions. The exact degree is dependent on variables. But at the instant of an explosion several events start to occur. They will be mentioned in the order observed or felt. These effects are covered in greater detail in chapters three, four and five. 1.01

Irrespective of location, three nuclear weapon explosions would probably be the maximum to which any one person would be subjected. If he survived these three possible bursts—he would have survived them all. Whether 50 or 500 bombs were delivered in an attack is academic where the immediate personal effects of an attack are concerned.

1. The flash is over in less than one second.
2. The thermal radiation is over in less than one minute.
3. The blast or shockwave is over in less than one minute.
4. The initial nuclear radiation is over in less than one minute.
5. The early fallout is over in less than one day.
6. Outside radiation is reduced to 1/100 in two days.
7. Delayed fallout is mostly over in less than one week. 1.02

THERMAL RADIATION

About 35% of a burst's energy consists of thermal radiation. During surface or air bursts (below ten miles) it is delivered in two phases or pulses. The first phase is an ultraviolet flash representing 1% of the radiant energy. The second phase carries 99% of the thermal radiation, lasts about 30 seconds for a 10 megaton burst and is the main cause of skin burns. Bursts above a 20 mile altitude emit thermal radiation in a single, one second pulse. The heat effect produced by an explosion in the first minute is called "prompt thermal radiation". 1.03

FLASH

The flash or initial phase of thermal radiation is many times brighter than the sun. It travels at the speed of light, 186,000 miles per second, and lasts for just a few millionths of a second. Anyone looking directly into this flash would be blinded. Sunglasses do not provide protection against this eye damage. The blink reflex takes 0.15 second, so the flash is over before the eye can blink. Ultraviolet radiations cause more eye damage than visible or infrared rays and permanent eye injury may be expected by persons looking directly at the fireball. But the ultraviolet flash is so brief that any protection, a newspaper for example, could prevent blindness. If caught in the open or near a window, action should be taken to minimize burn injury before the maximum of the second pulse. Up to this time only 20 percent of the thermal radiation will have been received. A large proportion can be avoided if shelter is obtained before or soon after the second thermal pulse maximum which is 3.2 seconds after burst for a 10 megaton explosion. It occurs more slowly for larger weapon yields. 1.04

FIREBALL HEAT

For several seconds after an explosion the core of the burst is so bright it cannot be looked into with the naked eye. Called the fireball, this core is millions of degrees in temperature and between 3.5 and 4.5 miles in diameter for a 10 megaton or a 20 megaton explosion. The heat travels at the speed of light, lasts about 30 seconds for a 10 megaton air burst, and is mostly infrared. The fireball rises at a rate of about 250 to 350 feet per second and reaches its maximum diameter in approximately one to one and one-half minutes. Both the flash and the fireball can cause serious burns to exposed skin within up to 30 miles from ground zero (guide 3.10). 1.05

AFTERWINDS

The strong updraft of the hot fireball creates inflowing winds called "afterwinds" which are largely responsible for sweeping dirt and debris up into the stem of the fireball. This debris is irradiated and later descends to earth as fallout. 1.06

FIRESTORMS

The flash and the fireball heat also start fires and may cause "firestorms". Firestorms are generated when air rushes in to replace superheated rising air and fans the flames of many small fires. Closely built up areas or dense forests are necessary for transmitting fire from one object to another before a firestorm becomes possible. The firestorm which badly damaged the German city of Hamburg during the second world war, reached temperatures of up to 2500° F. However, a properly designed and equipped shelter, with air intake and exhaust ports kept closed so that the firestorm would not draw the air out of it, would experience a temperature rise of only a few degrees under the same temperature conditions. Firestorms appear to reach a maximum two to three hours after an explosion and would decrease to moderate about six hours after the burst. 1.07

VAPORIZATION

The fireball's intense initial heat is rapidly dissipated as it moves outward from ground zero. The speed of this movement is so great that the burst's initial heat lasts less than one minute. However, in that fraction of a minute the fireball will vaporize almost everything above ground within about a 2.3 mile radius of a 20 megaton burst. It will burn everything above ground within a wider range depending on size and type of weapon, height of burst, etc. Heavy concrete structures have been known to resist vaporization within the area of the fireball. 1.08

INITIAL NUCLEAR RADIATION

Between 3% and 5% of nuclear explosion's energy is wrapped up in the initial nuclear radiation. It is that part of the nuclear radiation that occurs within one minute after the explosion. The time is the same for all weapon yields. At the instant of explosion, radioactive products of the bomb itself bombard the earth with initial nuclear radiation which creates induced neutron radioactivity at and near the crater site. 1.09

Included in this radiation are nearly all the neutrons and prompt gamma rays, both being released within one second after the burst. The initial nuclear radiation covers an area about the size of the fireball which is 4.5 miles in diameter for a 20 megaton weapon. It is most dangerous within two miles from ground zero. Within one minute practically all the weapon residues will have risen to such a height that appreciable amounts of initial nuclear radiation cannot reach the ground. The effects of this type of radiation are generally afforded little attention since within the area directly under the fireball, where initial nuclear radiation is possible and most dangerous, the blast and thermal effects are an equal or greater hazard to inadequately protected persons. 1.10

BLAST

About 50% of the explosive energy is expended in producing the blast effect. This effect follows the flash, heat and initial nuclear radiation very closely. It travels more slowly and is not felt as quickly as the heat and light. A fraction of a second after the burst this high pressure wave develops and leaves ground zero at about 2,000 miles per hour. It quickly decelerates to about the speed of sound, 760 miles per hour. In 10 seconds (for a one megaton burst) it is about 3 miles from ground zero. At 50 seconds after the explosion it has progressed to about 12 miles from ground zero. This blast wave creates very strong winds called "blast winds" (1.21). These blast winds start at velocities of hundreds of miles per hour but slow to hurricane speed at about 10 miles from ground zero. 1.11

OVERPRESSURE

The energy of a blast wave is measured by the amount of overpressure created. Overpressure is the amount of pressure occurring in excess of normal atmospheric pressure which is 14.7 psi at sea level at 70° F. A given pressure occurs at a distance from the ground zero of a nuclear burst in proportion to the cube root of the bomb energy yield. 1.12

At a little more than three miles from ground zero a 10 megaton explosion creates a 15 psi overpressure. A 100 megaton burst creates a 15 psi overpressure seven miles from ground zero. This is about twice the distance of the 10 megaton burst for the same overpressure. In other words a weapon with ten times the yield of any other just about doubles the radius of equivalent overpressure. 1.13

AIR BLAST

Air blast in the form of a blast wave has little effect below the surface of the earth. When a blast wave hits the earth most of its energy is reflected. This reflected wave can cause damage. The direct (unreflected) and reflected waves merge into a "Mach front" at a distance from ground zero about equal to the height of the explosion. 1.14

MACH FRONT

The overpressure of a Mach front is usually about twice that of the direct blast wave. In a building the direct pressure of a blast wave might be reflected from the walls and then could be twice the unreflected pressure. A person's location against a wall could be the most dangerous so far as direct blast effects are concerned because the reflected overpressure is then at its peak. On the other hand a location away from the wall, while decreasing this hazard, increases the possibility of body displacement. 1.15

BLAST WAVE

The blast wave is actually divided into two phases. The compression or positive phase and the suction or negative phase. The compression phase lasts for about two to four seconds for a one megaton explosion, depending on the distance from ground zero. The compression phase will reach a point 5 miles from ground zero in about 20 seconds for a one megaton burst. It is the most dangerous phase of the blast wave. The suction phase lasts longer (about 2 or 3 times as long as the compression phase) but does not vary as much (about 4 psi under the ambient pressure) from normal pressure. One particular hazard of the suction phase is its ability to suck air out of a shelter unless the shelter air intake and exhaust ports are closed and secured. Government shelter tests show that animals in a shelter survived when the outside overpressure was 90 pounds per square inch. 1.16

Blast and overpressure from any megaton range weapon will crush almost all above ground structures within about a three mile radius from ground zero. Reinforced, heavy, poured concrete structures stand a chance near the periphery of this three mile radius depending on weapon size, terrain and other variables. 1.17

A shallow (top of earth cover equal to original grade) buried concrete arch, with a 16 foot span and a central angle of 180°, consisting of 8 inch thick concrete with a 4 foot earth cover was only moderately damaged (could be used) at 160 psi to 220 psi overpressure. It was lightly damaged at 120 psi to 160 psi overpressure. 1.18

At about 12 miles from ground zero the blast effect is almost gone and the overpressure reduced to that prevalent during a very high wind. The overpressure and wind velocity decay for a 20 megaton ground burst is shown in guide 1.19. 1.19

OVERPRESSURE AND WIND VELOCITY DECAY
20 MT GROUND BURST

Overpressure (psi)	Wind Velocity (mph)	Distance from GZ (miles)
100	1400	1.8
70	1100	2.0
40	850	2.8
20	600	3.6
10	310	5.1
5	165	7.6
3.5	120	10.0
2	75	15.2
1.3	45	20.0

Guide 1.19

At distances more than three miles from ground zero each one psi of overpressure equals about thirty to forty miles per hour wind velocity. Since the blast and blast winds follow the thermal radiation by a few seconds any fires started by the intense heat may be either fanned into greater activity or snuffed out by the blast winds depending on the type of fire, location, time of year and weather conditions. 1.20

BLAST WINDS

The passage of a blast wave or the Mach front resulting from it, creates very strong winds called "blast winds" which accompany the blast wave. Blast winds are much stronger than the afterwinds accompanying the updraft of the rapidly rising fireball. Blast winds blow away from ground zero during the compression phase and blow back toward ground zero during the negative or suction phase. 1.21

GROUND SHOCK AND SHOCKWAVES

Shock from a ground burst transmitted solely through the earth is usually small compared with shock of the air blast waves from the same explosion, which passes over the surface. When the blast effect occurs underground or underwater it is called a shockwave. Underground bursts expend much of their energy in transmitting groundshock and digging a crater. Craters produced may be as wide as 3500 feet and as deep as 800 feet depending on the size of the weapon and the ground material at the crater site. An underwater explosion at a depth of one hundred feet creates waves of the magnitude shown in guide 1.22. 1.22

WAVES CREATED BY 100 FT. DEEP UNDERWATER EXPLOSION

Weapon Size (MT)	1 Mile from GZ	1½ Miles from GZ
5	40 ft.	25 ft.
10	45 ft.	30 ft.
20	50 ft.	35 ft.

Guide 1.22

FALLOUT

A 10 megaton explosion must occur at an altitude of less than 7000 feet for appreciable fallout to be generated. A one megaton burst must occur below 3000 feet to create significant fallout. 1.23

About 10% to 15% of all nuclear explosion energy is in the form of early and delayed fallout. The composition and rate of decay of radioactive fallout depends upon the basic materials used to construct the weapon. Since the fallout consists of weapon residues plus the dirt and debris sucked into the ascending fireball, the size of the individual fallout particles will also depend partially on the type of ground material at ground zero (rock, sand, clay, etc.). The fallout from one 15 megaton explosion consisted of particles from about 25 microns to about 500 microns or from one thousandth to one fiftieth of an inch in diameter. Fallout descends in two stages; early fallout and delayed fallout. 1.24

EARLY FALLOUT

Early fallout contains about 60% of all fallout energy. It falls within 24 hours after the burst. Depending on location relative to ground zero of the explosion, the early fallout will start to fall about one half hour after the flash. This is mostly fallout that had been swept up into the fireball and contaminated. It is the most dangerous fallout and can contaminate large areas with an intensity sufficient to create an immediate hazard to people within those areas. 1.25

Naturally the largest fallout particles fall first. They are about the size of grains of sand or sugar i.e. within a 20 to 2000 micron range. Directly under the fireball and close to its periphery some of the fallout may be up to one half inch in diameter. The density of fallout is about 2.5 grams per cubic centimeter or approximately that of dry sand. A human hair is 75 microns in diameter. 1.26

All early fallout descends within one day. The two types of hazards that these fallout particles represent are:

1. Actual contact of radioactive material with the skin which can cause "beta burns". Beta burns are caused by beta particles. They should be washed off immediately.
2. Continuous body exposure to scattered and direct gamma rays emanating from fallout particles.

Early fallout is another very good reason for remaining in a shelter for at least the first day or two after an explosion. 1.27

DELAYED FALLOUT

Forty per cent of all fallout is the delayed type which falls more than 24 hours after the explosion. This delayed fallout is buffeted about by high altitude winds and will usually settle in low concentration over wide areas. 1.28

Rain or snow may cause delayed fallout particles, that are at an altitude of less than 20,000 feet, to be deposited in greater concentrations in some localities. Areas in which rain or snow precipitate above average amounts of fallout are called "hot spots". Potential fallout from megaton range explosions ordinarily attains altitudes above 20,000 feet, and spends little time below that height in the area where rain and snow usually occurs. 1.29

Most delayed fallout will descend hundreds or even thousands of miles away and will take months or years to eventually settle to earth. It will represent a long term hazard. In the meantime the delayed fallout radioactivity will be steadily decaying. 1.30

CHAPTER 2

Types of Nuclear Weapon Explosions

There are three general types of nuclear weapon explosions. Each type produces different effects and creates a different set of dangers. If and when a decision to build a survival shelter is made, the hazards of each type must be recognized. Always remember the three factors that can work in a shelter occupants favor; time, space and barrier shielding. 2.01

AIR BURST

An air burst is simply a nuclear explosion in the air during which the fireball does not touch the surface. 2.02

THERMAL RADIATION EFFECTS OF AN AIR BURST

An air burst creates about 25% more thermal radiation than a surface or subsurface explosion. Flash and heat is dispersed more widely and with less obstruction than is the case with the other two types of explosions. Air bursts at altitudes of more than 20 miles reduce the chance of exposed people being burned. However, a burst occurring at this altitude would increase the incidence of flash blindness just as far as a person can see. Atmospheric haze and smog tends to lessen the thermal radiation effect of an air burst by interposing a natural shield between the heat and light of the explosion and the earth. 2.03

NUCLEAR RADIATION EFFECTS OF AN AIR BURST

Intense initial nuclear radiation is emitted by an air burst. This can be dangerous within about a two mile radius of the fireball core. At three miles from its source, this initial radiation is negligable even for a 10 megaton explosion. Alpha and beta particles cannot reach the ground from an air burst. An air burst does not create early fallout. 2.04

BLAST EFFECTS OF AN AIR BURST

An air burst creates the most powerful blast effect since it is relatively unimpeded by the atmosphere through which it passes. Some of the air blast wave energy may be translated into ground shock if the air burst is close enough to the ground. 2.05

TIMING OF EFFECTS OF 1 MEGATON AIR BURST ALTITUDE 6500 FT.

Time After Explosion (Seconds)	Effect	Distance From GZ (Miles)
1.8	Fireball is 6300 ft. in diameter	
1.8	Blast wave	1.0
4.6	Mach front forms—16 psi OP	1.3
11.0	Blast wind—180 miles per hour	3.2
11.0	Mach front—6 psi OP	3.2
37.0	Blast wind—40 miles per hour	9.5
37.0	Mach front—1 psi OP	9.5

Guide 2.05

Summary: An air burst usually produces a most effective blast wave, about 25% more thermal radiation, intense initial nuclear radiation, negligible groundshock and much less fallout than a ground burst. An air burst does not create a crater. 2.06

GROUND BURST

A nuclear explosion occurring on or very close to the earth's surface—either land or sea—is called a surface burst. If it occurs on or over land it is a ground burst. In any event its fireball touches the surface. 2.07

THERMAL RADIATION EFFECTS OF A GROUND BURST

A ground burst causes thermal radiation to be directed upward and outward. Therefore, it creates only about 80% as much thermal damage as an air burst. The earth or water absorbs much of the thermal effect that is directed downward. The flash or heat of a ground burst does not have the damage potential of an air burst i.e. an unobstructed path to possible unprotected victims or structures. The burst must also pass through or around natural and man made barriers not encountered by an air burst. This lessens the ground burst thermal radiation damage potential. 2.08

INITIAL NUCLEAR RADIATION EFFECTS OF A GROUND BURST

The initial nuclear radiation is less of an immediate hazard when emitted by a ground burst. More of it is absorbed by the earth or water and less consequently finds a human target. 2.09

BLAST EFFECTS OF A GROUND BURST

A ground burst creates less blast than an air burst at considerable distances from ground zero. However, close to ground zero the blast is greater from a ground burst. The ground shock of a ground burst is more intensified than that of an air burst since more of the full power of the explosion is transmitted or absorbed by the ground in the process of digging the crater. Ground shock damage can extend out to a distance equal to about two crater diameters. Primary blast and reflected shock, which together form the Mach front, occur at almost the same instant during a ground burst. 2.10

FALLOUT RADIATION EFFECTS OF A GROUND BURST

A ground burst creates the greatest fallout hazard. Its fireball and blast originate at or near the ground. Thus, accompanying afterwinds suck much more dirt and debris into the ascending nuclear cloud for radiation and eventual distribution as fallout. 2.11

Summary: Ground bursts generally produce less effective blasts, at considerable distances from ground zero, than air bursts. However, close to ground zero more blast is produced by ground bursts. They create less thermal radiation and less immediately dangerous initial nuclear radiation. Ground bursts generate much more ground shock and many times the amount of fallout created by an air burst. Ground bursts dig craters. 2.12

SUBSURFACE BURST

Subsurface bursts are underground or underwater explosions where the burst occurs considerably below the earth's surface. 2.13

THERMAL RADIATION EFFECTS OF A SUBSURFACE BURST

Thermal radiation created by a subsurface burst would be minimal or non-existent depending on the depth of the explosion. 2.14

INITIAL NUCLEAR RADIATION EFFECTS OF A SUBSURFACE BURST

During a subsurface burst the initial nuclear radiation is generally absorbed by the surrounding earth or water (water is an excellent radiation shield) as the case may be. There is less initial nuclear radiation for a subsurface burst than for a comparable ground burst. 2.15

BLAST EFFECTS OF A SUBSURFACE BURST

A subsurface explosion of the underground type would produce considerable ground shock; more than an air or ground burst. The possibility of an enemy exploding a weapon underground is remote. It would be pointless. Underwater bursts could be a very likely and important mode of attack; a method calculated to kill defenders and leave the buildings and equipment virtually unharmed; a method comparatively easy to use; weapons easy to deliver—say by fishing boats. A burst 2700 feet underwater will produce a tremendous shock-wave. The resulting waves would be 20 to 50 feet high and would fan out, at ever decreasing size waves, to about 100 miles. The implications for residents of tideland areas are particularly serious. Not only would the danger of flooding exist, but the water would be radioactively charged. 2.16

FALLOUT RADIATION EFFECTS OF A SUBSURFACE BURST

A moderately deep underground burst produces very little fallout. The amount would be roughly in proportion to the depth of the burst. Underwater bursts can produce fallout laden rain. Here, again, the amount of contaminated rain so produced would depend on variables including depth of explosion, weather conditions, size of weapon, etc. 2.17

Summary: Subsurface bursts create very little thermal radiation or initial nuclear radiation. Underground bursts produce considerable shockwaves. Underwater bursts create potentially dangerous fallout and extremely dangerous shockwaves. 2.18

CHAPTER 3

Thermal Radiation

Thermal radiation is felt as heat and the ultraviolet flash can, of course, be seen. The heat lasts less than one minute. At one mile from ground zero of a one megaton explosion complete protection from the thermal radiation would be provided by two feet of concrete. 3.01

HEAT

Two factors cause thermal radiation heat energy to decrease with increasing distance from ground zero of a nuclear explosion:

1. The heat from the thermal radiation is absorbed over increasing areas as it moves away from the burst.
2. Attenuation of the thermal radiation as it passes through air. The thermal dose is inversely proportional to the square of the distance from the explosion. Four miles from the ground zero the heat energy would be only one quarter that received at two miles or one half the distance from the same explosion. Attenuation is due to two factors—
   a. Absorption: Atoms and molecules in the air absorb, and, thereby, remove part of the heat from a nuclear explosion.
   b. Scattering: Heat is diverted from its normal path by means of oxygen and nitrogen in the air. Another important form of scattering is the reflection and bending of light rays by smog and dirt particles in the air which causes diffusion rather than direct transmission of thermal radiation. 3.02

The scattering effect is very important. Ordinarily thermal radiation will travel in a straight line from the fireball especially after an air burst. Much of the thermal radiation arriving at a target from fairly long distances will have been scattered. This heat will then arrive from many directions. Clouds can reduce the amount of thermal radiation received at a point on the ground. Dense smoke or fog interposed between an air burst and the target can reduce to as little as one tenth the amount of heat which would have been received with clear visibility. 3.03

HEAT REFLECTION AND ABSORPTION

Thermal radiation is emitted quickly. The intensity rate is high on the surface but the conductivity is low. The extent of heat absorbed or reflected depends on the type, color, thickness, temperature and moisture content of the material or object. Thermal radiation absorbed by a material produces the heat that determines the damage done to that material. The length of time of the heat exposure and the degree of heat are very important factors. Highly reflecting and transparent materials will not absorb much thermal radiation. Even a thin material can often transmit a large proportion of the heat and thereby escape damage. However, the heavier the fabric or material, the better the protection from heat. Providing the color is the same, wool provides more protection than cotton. 3.04

Dark materials will absorb much more thermal radiation than the same material when light colored. Dark materials char more readily than light colored fabrics. When charred, a light colored material assumes the same characteristics as a dark material. Light colored fabrics reflect or transmit up to 90% of thermal radiation to which they are exposed. They absorb very little. 3.05

Surface damage to building materials can be minimized by the use of light colored paints and hard varnishes to reflect the thermal radiation. A number of modern plastics including Bakelite, cellulose, acetate, Lucite, Plexiglas, polyethylene, Teflon and vinyl plastic withstand heat so well that more than sixty calories per square centimeter are necessary to produce melting or even darkening. This is many times the amount of heat that would cause dangerous human burns (3.10). Glass is highly heat resistant. 3.06

BURNS

Thermal radiation has one very dangerous capability. It has the intensity necessary to inflict fatal damage to the human body in the form of burns. A building or survival shelter strong enough to protect against blast will provide sufficient protection from direct heat. Earth is an excellent heat absorber. 3.07

Thermal radiation causes three main types of burns:

1. Flash burns are caused by direct exposure. They are not deep burns because of the short exposure duration. Flash burns can be most severe when intervening clothing is drawn tightly against the body at points such as the elbows and shoulders. Loose fitting clothes with some air space next to the skin minimize flash burn injuries.
2. Flame burns are caused by thermal radiation originated fires. These burns would be usually deeper and consequently more serious than flash burns. In fact, they would be much like burns resulting from fires of non-nuclear origin.
3. Hot gas burns which are dangerous even when protected from flash or flame burns. Hot gas burns are a particular hazard if superheated air is inhaled. 3.08

The larger the nuclear weapon yield, the more thermal radiant exposure required to produce an equivalent effect. The lower yield weapons deliver their heat in a very short time (less than one half second). The more powerful weapons require as much as several seconds. Generally the longer the exposure time for a given thermal dose, the less damaging is that dose. A thermal dose of seven calories per square centimeter of skin area from a one megaton explosion can produce a second degree (blistering) burn. It takes about nine calories per square centimeter (cal/cm^2) from a ten megaton weapon to cause a similar second degree burn. Four calories per square centimeter from a ten megaton burst will cause first degree (redness) burns. Third degree burns destroy the full thickness of the skin. 3.09

The unit used to express the degree of thermal exposure is the "calorie per square centimeter (of skin area)". This is abbreviated to "cal/cm^2." Thermal radiation doses between 3 and 4 cal/cm^2 cause first degree burns (redness); between 6 and 10 cal/cm^2 cause second degree burns (blisters) and over 10 cal/cm^2 cause increasingly severe burns which may be classified as third degree burns (charring) depending on circumstances. Thermal exposure to over 12 cal/cm^2 will cause third degree burns. 3.10

BURN RANGES FOR EXPOSED PERSONS — AIR BURST CLEAR ATMOSPHERE — DISTANCE FROM EXPLOSION THERMAL RADIATION RECEIVED

Explosion Yield	Third Degree Burns (Charring)		Second Degree Burns (Blisters)		First Degree Burns (Redness)	
Megatons	Miles	Cal/cm^2	Miles	Cal/cm^2	Miles	Cal/cm^2
1	8	12	11	6.5	15	3.1
2	10	12	15	6.7	20	3.2
4	14	12	19	8	25	3.3
5	17	12	20	8.2	27	3.4
7	18	12	23	8.5	30	3.5
10	20	12	27	9.1	35	3.6
20	29	12	32	9.6	45	3.8

Guide 3.10

EYE INJURIES

Most thermal radiation burns would be similar to those which would result from fires of non-nuclear origin. The big exception is the possibility of serious eye injury. There are two main types of thermal radiation eye effects:

1. Permanent injury from chorioretinal burns.
2. Temporary injury or flash blindness from explosion flash.

Permanent eye damage can be caused if the focusing action of the eyes causes them to concentrate enough direct thermal energy on the retina. The fireball must be in the field of view before focusing can take place. Should this occur, permanent eye injury may be suffered at distances from ground zero greater than the distances at which heat causes skin burns. 3.11

If the retina receives more light than it needs for seeing, but less than the amount which would cause a burn, flash or temporary blindness can ensue. Flash blindness is apt to occur at greater distances at night since the pupil is enlarged and the eye is adapted to the dark. During the daylight hours the pupils are small and the range within which flash blindness can occur is correspondingly shorter. Atmospheric conditions also affect the distances at which eye damage can occur. 3.12

Scattered thermal radiation (3.02) does not cause permanent damage to the retina of the eye. It can contribute to flash blindness resulting from the dazzling effect of bright light. Burns near the center of the eye can cause considerable loss of vision. However, if a chorioretinal burn is mild, eyesight may scarcely be affected. This is also true if the burn is around the outside edge of the retina. 3.13

Among Japanese survivors of the Hiroshima nuclear bomb attack on August 6, 1945 and the Nagasaki attack on August 9, 1945 only one case of retinal injury was reported although there were many cases of temporary blindness lasting up to 2 or 3 hours. It is a fair assumption that only a small proportion of people would be facing a nuclear explosion in such a way that the fireball would be in their field of vision at any given instant. 3.14

CHAPTER 4

Nuclear Blast

The blast effect of a nuclear explosion behaves like a wall of pressure leaving the core of the fireball in a wave at very high speed. The passage of this blast wave creates turbulance in the air as it pushes outward from the burst. This turbulance is called a blast wind. The blast wave consists of a compression and a suction stage (1.16). This tremendous force causes blast injuries which can be divided into two general categories. 4.01

INJURIES DUE TO BLAST

The two types of injuries resulting from a nuclear explosion are: direct injuries caused by the high air pressure injuring lungs and tissues; indirect injuries caused by flying objects and by physical movement or displacement of the body. 4.02

DIRECT CAUSES OF INJURIES DUE TO BLAST

Direct blast injuries are affected by three blast wave factors.

1. The peak overpressure in effect during blast wave passage.
2. The rate of pressure rise of the blast wave.
3. The duration of the compression stage of the blast wave.

Guide 4.03 provides information on peak overpressures and compression stage durations. 4.03

If the pressure rise is at a rapid rate (the time rise period is short) the blast wave will have greater damaging effects on the body than that of a slowly increasing pressure. This is similar to the effect of exerting an equal pressure in the form of a punch or a shove. A pressure increase in stages is less dangerous than a single sharp pressure rise. 4.04

An increased duration time will increase the possibility of damage for a given peak overpressure; but only to a certain point. When this point, which could be a duration of from 30 to 400 milliseconds according to body size, is reached it is only the amount of peak overpressure that is important for a short rise time blast wave. The compression stage positive phase duration for a given peak overpressure varies with the weapon energy yield and explosion height. 4.05

For explosions in the megaton range the duration of the compression phase of a sharp rising blast wave lasts so long that the peak overpressure is the primary factor to be considered where direct injury is concerned. Any nuclear attack is almost certain to involve megaton yield weapons. 4.06

1 MT WIND VELOCITY — POSITIVE PHASE DURATION PEAK OP — ARRIVAL TIME PEAK OP 10 MT PEAK OVERPRESSURE — PEAK OP ARRIVAL TIME

Miles From GZ	1 MT Wind Velocity (MPH)	1 MT Positive Phase Duration (Sec.)	Peak OP (psi)		Peak OP Arrival Time (sec)	
			1 MT	10 MT	1 MT	10 MT
1	900	1.75	50	150	2.5	1.5
2	464	2.25	18	48	6.5	5.
3	278	2.69	9.4	29	11	9.5
4	177	3.02	5.5	18	15	13
5	117	3.24	4	13	20	16
6	89	3.40	2.6	8	24	21
7	72	3.43	2.1	7	28	26
8	60	3.44	1.7	6	32	30
9	51	3.45	1.4	5	36	34
10	44	3.45	1.3	4.5	42	37
20	35	3.45	1.0	2	90	83

Guide 4.03

An important factor which could affect the damage a blast wave might do is "dynamic pressure". This is air pressure resulting from the drag from blast winds acting on structures and objects. Dynamic pressure is influenced by peak overpressure, duration of compression (positive) phase and shape of object. At overpressures less than 70 psi the peak overpressure is more than the dynamic pressure. The 70 psi overpressure occurs at about the time the blast winds have a velocity of less than 1100 miles per hour. Therefore, for practical purposes, the peak overpressure is the governing factor in considering underground survival shelters. 4.07

Studies indicate that a peak overpressure of 35 psi with a positive pressure phase duration of 400 milliseconds could be fatal provided the rise time was short. Lung damage can occur at overpressures as low as 15 psi. Eardrums could rupture at overpressures from 5 psi to 40 psi. There could be eardrum rupture in about one-half the instances where the overpressure is between 20 psi and 30 psi. 4.08

Loose objects, including occupants, within an underground shelter, could be tossed around by the effect of part of a blast wave being translated into ground shock. This tossing effect could occur even though the shelter showed no signs of damage. The amount of ground shock would be proportional to the OP of the blast wave. All objects which might be subjected to this type jolt within the shelter should be secured, possibly by automobile seat belt type apparatus. 4.09

PEAK OVERPRESSURES AT MAXIMUM DISTANCES FROM GROUND ZERO

Peak O P (psi)	Blast Wind Velocity (MPH)	Air Burst Distance in Miles				Ground Burst Distance in Miles			
		1 MT	5 MT	10 MT	20 MT	1 MT	5 MT	10 MT	20 MT
1	35	10.0	17.0	21.0	27.0	8.2	14.0	18.0	22.0
2	75	7.0	11.5	14.4	18.0	5.3	9.0	11.4	15.0
3	100	5.5	9.0	11.4	14.4	4.0	7.0	9.0	11.0
4	130	4.5	7.0	9.7	12.0	3.3	5.6	7.0	9.0
5	165	4.0	6.7	8.4	11.0	3.0	5.0	6.0	7.6
6	190	3.5	6.0	7.5	9.5	2.6	4.4	5.6	7.0
7	215	3.2	5.5	7.0	9.0	2.3	3.9	5.0	6.2
8	240	3.0	5.0	6.2	8.0	2.2	3.8	4.7	6.0
9	270	2.7	4.6	6.0	7.3	2.0	3.4	4.3	5.4
10	300	2.5	4.1	5.2	6.5	1.9	3.3	4.1	5.2
15	400	1.5	2.4	3.0	4.0	1.6	3.0	3.5	4.3
20	500	1.0	1.7	2.2	3.0	1.3	2.2	3.0	3.5
25	580		1.2	1.5	2.0	1.2	2.1	2.6	3.3
30	670		1.0	1.1	1.4	1.1	2.0	2.4	3.0
40	850			1.0	1.0	1.0	1.7	2.2	2.7
50	940						1.5	2.0	2.4
60	1050						1.4	1.7	2.2
70	1100						1.3	1.7	2.1
80	1300						1.2	1.6	2.0
90	1400						1.2	1.5	1.9
100	1500						1.2	1.5	1.8

Guide 4.07

PROBABLE FATALITY PERCENTAGES FOR ESTIMATED OVERPRESSURE RANGES

Probability of Death (Percentage)	Estimated Overpressure Range (psi)
1	35 to 45
50	45 to 55
99	55 to 65

Guide 4.08

Thoracic (chest) and abdominal cavity areas are prone to feel the effects of compression and decompression caused by blast waves. Damage also occurs at the junctions between tissues and air containing organs. Hemorrhage and rupture of the organs are the main consequences. Lungs are affected by edema (fluid in the lungs). Body damage of these types should be handled with minimal bodily activity, since death can occur in many cases that otherwise might recover. Brain injuries would usually be the result of flying debris or body displacement rather than the overpressure. 4.10

INDIRECT CAUSES OF INJURIES DUE TO BLAST

The indirect nuclear blast injuries caused by the blast wave and blast winds are similar to those caused by cyclones or hurricanes. Depending on the velocity of the wind and the weight of the object, the blast wave will pick up almost everything in its path and hurl it through the air. The only protection against being hit by flying objects or becoming a flying object is to be underground. It is as simple as that. 4.11

Tests conducted with a 165 pound dummy in a 5.3 psi overpressure area (about 170 mph wind velocity) showed that it attained a maximum velocity of 21 feet per second within one-half second after the blast wave arrived. The dummy traveled 13 feet before hitting the ground and then slid or rolled another 9 feet. Under similar conditions a prone dummy did not move. This emphasizes the advantage of taking prompt action at the instant of explosion to secure some protection from the blast in the interval before the blast and blast winds arrive. This protection may best be secured by falling prone with the head directly away from the explosion. Even with the head directly toward the burst the body area exposed would be minimal and the possibility of body displacement likewise reduced. 4.12

Available data indicates that an impact velocity of 10 feet per second would probably not be fatal in most cases; between 10 feet and 20 feet per second some fatalities might occur; at velocities more than 20 feet per second, death would result in a sharply rising percentage of cases. 4.13

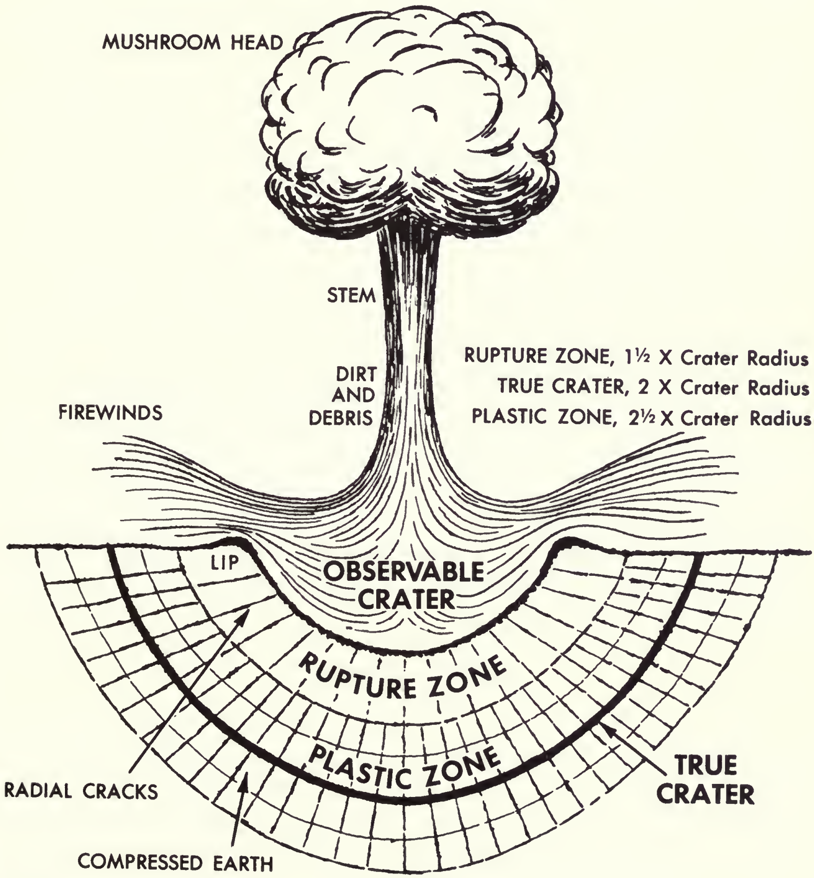
CRATERS

The blast of a ground explosion expends much energy in digging a crater. The crater depth decreases with increasing height of the explosion. Cratering becomes insignificant long before a burst height is reached at which the fireball just touches the ground. A significant crater will not be formed unless the height of the explosion is less than about one-tenth the maximum fireball radius. 4.14

Multiplying the radius or depth of the crater formed by a ten megaton explosion by the cube root of ten provides the crater radius or depth of a 100 megaton explosion. This radius or depth would be about twice the value of a ten megaton burst. This rule is valid for other bomb yields. 4.15

The formation of a crater is deceptive. There are actually three zones or areas involved. Two of these zones spread out fanwise from the observable crater or third zone and are under and around it. These three zones are the observable crater, rupture zone and plastic zone. 4.16

CRATER ZONE GUIDE



Guide 4.16

OBSERVABLE CRATER

The observable crater is that part of the total crater that can readily be seen. 4.17

RUPTURE ZONE

The rupture zone is that part of the true crater which is directly adjacent to the observable crater. Explosion stresses not powerful enough to blast material out of the ground, but which exceed the strength of the earth in the rupture zone, create radial cracks. The rupture zone including the observable crater has a diameter of about one and one half times that of the observable crater. 4.18

PLASTIC ZONE

The plastic zone is the third area affected by the cratering action of a nuclear ground burst. It is directly adjacent to the rupture zone. The plastic zone consists of earth which has been subjected to sufficient dynamic strain to deform it, but not enough to dig a crater or cause radial cracks. The line of demarcation between the rupture and plastic zones is somewhat arbitrary since the two zones blend together. The plastic zone has a diameter of approximately two and one half times that of the observable crater. It is in the plastic zone that the first hope of survival from blast in an underground BOSDEC type shelter is possible. 4.19

Survival in the plastic zone is a possibility especially if the shelter is designed to take advantage of the soil particle's tendency to lock together in the form of an arch in the plastic zone. This arching effect permits stresses to be transmitted around a properly designed shelter instead of through it. Such a buried reinforced concrete arch type shelter would suffer only light damage at overpressures between 120 psi and 160 psi. Reflected pressure build-up at the interface of the soil and an underground shelter is very small. 4.20

TRUE CRATER

All of the observable crater and rupture zone plus about one half of the plastic zone may be referred to as the true crater. It has a diameter of roughly two times the observable crater. Within this true crater area there would be almost complete destruction caused mainly by direct ground shock and partially by shock in the ground induced by blast waves above the surface. In the area beyond the true crater the effects of ground shock are unimportant but blast waves may damage weak underground structures or shelters not sufficiently buried. A small, well designed underground shelter would suffer only light damage such as slight cracking and severance of brittle pipe connections at a distance from ground zero equivalent to two and one half observable crater radii. 4.21

MAXIMUM CRATER DIMENSIONS (APPROXIMATE — FEET)

	1 MT	5 MT	10 MT	20 MT
Observable Crater				
Depth — Dry soil	300	500	650	800
Depth — Rock	240	400	520	640
Radius — Dry soil	650	1100	1400	1700
Radius — Rock	520	880	1120	1360
Rupture Zone				
Depth — Dry soil	450	750	975	1200
Depth — Rock	360	600	780	960
Radius — Dry soil	975	1650	2100	2550
Radius — Rock	780	1320	1680	2040
Plastic Zone				
Depth — Dry soil	750	1250	1625	2000
Radius — Dry soil	1625	2750	3500	4250

NOTE: There is practically no effect of blast in rock in the plastic zone.

Guide 4.21

The statistics shown in Guide 4.21 are for maximum radii and depths. Authoritative estimates for these effects, under the same conditions, range down to about 50% of these values. The more conservative estimates, while appearing high, are used here to present the maximum danger potential. 4.22

Approximately one half the dirt displaced from a nuclear explosion crater is thrown out of the crater. The balance is compressed into the walls and floor of the crater by the force of the burst. 4.23

CHAPTER 5

Nuclear Radiation Guide

TYPES OF NUCLEAR EXPLOSIONS

FISSION

The fission process consists of splitting the nucleus of a heavy element such as uranium 235 or plutonium 239 into two lighter nuclei. The splitting releases the binding force which holds the nucleus of the atom together and results in the release of great energy. Fissionable atoms release neutrons which strike other fissionable atoms causing them to split apart. This releases more neutrons thereby continuing the chain reaction. Neutrons produced in fission are almost all high energy or fast neutrons. 5.01

FUSION

The fusion process consists of combining two light (hydrogen isotopes) nuclei into a nucleus of a heavier atom and thereby releasing tremendous energy. Fusion requires a temperature of millions of degrees only attainable by fission. Fission triggers fusion and the result is a thermonuclear explosion. Weight for weight a fusion explosion is about three times as powerful as a fission burst. Generally the total energy of a thermonuclear explosion is attributable one half to fission and one half to fusion. More high energy neutrons are created by fusion than by fission. 5.02

TYPES OF NUCLEAR RADIATION

The complete utilization of one pound of uranium or plutonium in fission releases energy equal to that of 8000 tons of TNT. About 125 pounds of fission products per megaton of fission energy are produced by a nuclear fission explosion. They decay by the emission of beta particles often accompanied by gamma rays. This radioactivity is large initially but falls off at a rapid rate as a result of radioactive decay. 5.03

There are only two ways by which the surface of the earth and objects upon it may become contaminated as a result of a nuclear explosion; by induced radioactivity following the capture of neutrons by various elements present in the earth or sea and by fallout—the descent of radioactive particles from the mushroom head and stem formed by a nuclear explosion. Because of the particulate matter involved, fallout has a tendency to collect on horizontal surfaces such as streets, roofs, tops of vehicles and on the ground. The simplest way to remove it is by hosing it down if water is available. 5.04

The amount of radioactive contamination and its distribution is mainly dependent on the energy yield of the explosion, the relative contributions of fission and fusion to the total yield, the height of the burst, weather conditions and the terrain over which the explosion occurs. About 90% of the total radioactivity is contained in the mushroom head of the fireball and 10% in the stem. Megaton range explosions seem to have most of the radioactivity in the lower third of the mushroom cloud. 5.05

Depending on the elements used in constructing a nuclear weapon, a wide and varied mix of radiation is involved. There are four types of nuclear radiation created by a nuclear explosion. These are the products of the changes that constituent elements of the weapon undergo before losing their radioactivity and becoming stable (19.12). 5.06

ALPHA PARTICLES

Alpha particles have a positive electric charge and have mass and weight. They are usually emitted by the heavier radioactive elements such as polonium 210, 214 and 218, plutonium, radium 226, radon 222, thorium 230 and uranium 234 and 238. Alpha particles cannot penetrate the outer layer of unbroken skin. They lose their energy just passing through two or three inches of air or even a piece of paper. They are potentially dangerous only when they are ingested by means of radiation contaminated air, water or food. 5.07

BETA PARTICLES

Beta particles have a negative electric charge and have mass and weight. They are physically identical with electrons which are subatomic particles moving at high speed. Beta particles are usually emitted by light to medium radioactive elements. They cannot penetrate heavy clothing and have a range of about ten or fifteen feet in air. They can cause "beta burns" when in direct contact with the skin. Beta particles are potentially dangerous mainly when they are ingested by means of contaminated air, water or food. 5.08

GAMMA RAYS

Gamma rays are pure energy consisting of short, highly penetrating electromagnetic waves and have neither mass nor weight.

They are much like X-rays and are emitted by many materials at the same time that alpha and beta particles are being thrown off. Gamma rays leave a radioactive nucleus at 186,000 miles per second, the speed of light. The penetrating power of a gamma ray is related to its energy measured in MEV (5.15). Generally, the higher the energy the more powerful the radiation force striking a barrier, and the thicker that barrier must be to reduce the amount of radiation passing through it by a given factor. 5.09

To reduce the effect of gamma radiation by a factor of one hundred would require the following approximate densities for these several MEV penetrating powers.

GAMMA PENETRATION
MEV ENERGY VS. DENSITY SHIELDING

Factor of 100

	½ MEV	1 MEV	2 MEV
Concrete	12 inches	15 inches	20 inches
Earth	20 inches	24 inches	30 inches

Guide 5.10

Gamma radiation from fallout originates from many energy sources. These rays vary in energy up to a maximum of about 3 MEV. The net average penetrating effect of this energy mix is roughly equivalent to the 1¼ MEV average energy of cobalt 60. The approximate energy of gamma rays created by nitrogen capture (5.13) is 6.5 MEV, while that from fission products within one minute after a nuclear explosion is about 2 MEV. 5.10

Gamma rays striking a barrier are either absorbed, partially scattered and trapped within the barrier or passed through the barrier unchanged in direction after being partially absorbed. The degree to which these gamma rays are attenuated is a function of their power measured in MEV. Gamma radiation is also halved by passage through about twenty-five feet of air. 5.11

NEUTRONS

Neutrons are neutral particles having mass and weight but without an electrical charge. They are present in all atomic nuclei except light (ordinary) hydrogen. Neutrons are needed to start the fission process and many neutrons are produced by fission and fusion reactions in nuclear explosions. 5.12

Neutrons may be divided into two general types: fast or high energy neutrons and slow or low energy (thermal) neutrons. Many fast neutrons may be slowed down and slow neutrons captured during the neutron-nuclei interactions following a nuclear explosion. These interactions can be classified in two categories: absorption (capture) and scattering. As fast neutrons pass between the weapon and the ground, many of them collide with the relatively light nuclei of oxygen and nitrogen in the atmosphere and are slowed down. The resulting slow neutrons and others of low energy may then be captured and removed by nitrogen nuclei collisions. Usually they emit gamma radiation in the process. This gamma radiation is easier to attenuate than the neutron radiation. 5.13

Scattering collisions either result in conversion of neutron energy into gamma radiation for fairly fast neutrons or transfer of neutron energy to the interacting nucleus without change and without creating gamma radiation for many high and low energy neutrons. The fast and slow neutrons that escape nitrogen capture or scattering collisions may be driven into the ground creating, by interaction with soil elements, "induced radioactivity". 5.14

UNITS OF NUCLEAR RADIATION ENERGY AND BIOLOGICAL DAMAGE MEASUREMENT

MEV — MILLION ELECTRON VOLTS

The energy or penetrating ability of nuclear radiation is measured in units of MEV or million electron volts. The amount of material required to produce this energy is measured in curies. A curie is the amount of radioactive material in which the radioactive atoms are disintegrating at the rate of 37 billion atoms per second. The amount of material is not important here. The penetrating ability is important. 5.15

ROENTGENS

Roentgen is the unit of exposure dose which measures the ability of gamma rays (and X-rays) to produce ionization in air. The abbreviation of roentgen is r and of roentgens per hour is r/hr. 5.16

RADS

Rad is a unit of any radiation absorbed dose. 5.17

REMS

Rem (roentgen equivalent man) is a unit of biological damage making it possible to use one unit to measure all types of nuclear radiation. 5.18

RBE

RBE (relative biological effectiveness) is a unit which converts rads of different types of nuclear radiation into rems. This unit is necessary since a rad of one type radiation may cause more or less biological damage than a rad of another type of radiation. 5.19

RADIATION CONVERSION

Many authorities believe that the radiation value for neutrons is RBE equals 1.0, but other sources, also authoritative, feel that neutrons should be assigned a higher RBE value. There is also some diverse opinion on alpha particles. The higher value in each case has been used in the following guide 5.20.

RADIATION CONVERSION GUIDE

Type of Radiation	Rads	X	RBE	=	Rems
Gamma	1		1		1
Beta	1		1		1
Alpha	1		20		20
Neutrons (slow)	1		5		5
Neutrons (fast)	1		10		10

Guide 5.20

The formula is rads x RBE = rems. The figures in guide 5.20 for alpha particles and neutrons may vary depending on the nuclear radiation energy involved. 5.20

INITIAL NUCLEAR RADIATION

All nuclear radiation that occurs during the first minute after a nuclear weapon explosion is called initial nuclear radiation. All nuclear radiation occurring more than one minute after the explosion is called residual nuclear radiation. 5.21

Deep underground or underwater explosions do not create initial nuclear radiation. Air and ground bursts produce four different nuclear products that are emitted within one minute after the explosion. They are neutrons, gamma rays, alpha and beta particles. Initial nuclear radiation is a relatively greater menace with a low yield explosion than with a higher yield burst. The greater the yield the higher proportion of blast and thermal injuries. 5.22

The initial nuclear radiation includes:

1. Nearly all the neutrons. These neutrons, which include the

"prompt" neutrons that are released in one millionth of a second, travel a shorter distance through the air than the initial gamma rays before being attenuated by the same factor. The attenuation ratio is about 5 to 3. Damp earth and water have very high efficiencies as barriers against neutrons. Neutrons are greatly slowed down and captured by weapon residues or by the air through which they pass. However, enough escape to become a hazard at considerable distances from the burst. This is also true of gamma rays. Near the explosion center the neutron dose is greater than the gamma dose. With increasing distance the neutron dose decreases more rapidly than the gamma dose, and beyond a certain point the gamma rays predominate. Ultimately the neutrons become a negligable factor in comparison to gamma radiation. 5.23

2. All of the "prompt" gamma rays. These are all released in the first second after a nuclear explosion. They are gamma rays that have been produced in fission and as a result of neutron reactions. Most gamma rays accompanying the fission process are absorbed by weapon materials and converted into other forms of energy. Only one percent succeed in penetrating any great distance from the explosion. Gamma radiation decay is greatest at the beginning. Gamma rays continuing after the prompt emission are called "delayed" gamma rays. Both prompt and delayed gamma rays are a part of the total initial nuclear radiation. Delayed gamma rays suffer little absorption by weapon residues. Delayed gamma rays, and those resulting from the nitrogen capture of neutrons in the air, contribute about 100 times more nuclear radiation than the prompt gamma rays to the total nuclear radiation received at a distance from an explosion during the first minute after the burst. The initial gamma radiation dose from a surface burst is about two thirds that from an air burst at the same distance. 5.24

Gamma rays, in a vacuum, move in a straight path at the speed of light (186,000 miles per second). In the atmosphere these rays are scattered by interacting with oxygen and nitrogen. They then may reach their target from all directions. Most of the dose will come from the direction of the explosion but a considerable amount will come from other directions. This effect is called "skyshine" or "scattering". The more changes in direction a gamma ray undergoes, the lower its energy. 5.25

The initial nuclear radiation dose measured in rems for various ranges from the ground zero of an air burst is shown in guide 5.26

INITIAL NUCLEAR RADIATION DOSE RANGE
AIR BURST

Radiation Dose (rems)	1 MT (miles from GZ)	10 MT (miles from GZ)
100	1.8	2.4
500	1.5	2.1
1000	1.4	2.0
6000	—	GZ

Guide 5.26

A one megaton air burst creates an initial nuclear radiation dose of 35 rems at 2 miles from ground zero and only one rem at 3 miles from GZ. A ten megaton air burst produces approximately a 3 rem dose at 3 miles from ground zero. 5.26

The approximate initial gamma radiation range for various doses from one, five and ten megaton explosions is shown in guide 5.27.

INITIAL GAMMA RADIATION DOSE RANGE

DOSE IN ROENTGENS		RANGE IN MILES		
Yield	3000 r	1000 r	100 r	30 r
1 MT	1.3	1.5	1.8	2.0
5 MT	1.6	1.8	2.3	2.5
10 MT	1.8	2.0	2.3	2.5

Guide 5.27

The total unshielded initial gamma radiation dose for a 5 megaton explosion would be about 4500 roentgens at a distance of one and one-half miles from ground zero. 5.27

The percentage of the 5 megaton, 4500 roentgen dose (5.27) which would be received as a function of time is given in guide 5.28 —percentage of radiation, seconds after explosion.

TIME AND PERCENTAGE FOR INITIAL GAMMA RADIATION RECEIVED
5 MT EXPLOSION AT 1.5 MILES FROM GROUND ZERO

Seconds	1	1.5	2	2.5	3	4	5	6	7	8	10	15	20
Percentage	5	10	17	20	30	42	50	60	76	80	90	98	100

Guide 5.28

It is apparent from guide 5.28 that if shelter can be taken within one or two seconds after observing the explosion flash a person can avoid a big percentage of the initial gamma radiation. The greater the energy yield of the explosion, the slower the rate of gamma ray release and the better your chance of avoiding most of it. Initial gamma radiation has much more energy than any other gamma radiation except that which occurs in the very earliest stages of fallout radiation decay. Since practically all neutrons are released in the first second, protective action taken against initial gamma rays (5.28) would be useless with regard to neutron effect. While less than one percent of the total nuclear explosion energy is in the form of neutrons, they represent much more of a hazard than would be indicated by this small proportion. 5.28

RESIDUAL NUCLEAR RADIATION

All radiation occurring more than one minute after a nuclear explosion is called residual nuclear radiation. It consists of three separate stages of contamination:

1. Induced radioactivity which is induced at the crater and directly under the fireball by neutrons driven into the earth at the instant of explosion. These neutrons are captured by various elements in the soil, especially sodium and manganese. This radioactivity decays much more rapidly than fallout radiation. It extends less than one mile from ground zero.
2. Early fallout is that which falls to earth within one day after the explosion.
3. Delayed fallout is that which falls to earth more than one day after the explosion. 5.29

FALLOUT PARTICLE SIZE AND PERCENTAGE OF RADIOACTIVITY CARRIED

Size of Fallout Particles (microns)	Percentage of Radioactivity Carried
Less than 20 microns	12%
20	8
25	10
32.5	10
37.5	18
50	12
62.5	8
75	6
87.5	4
100	5
125	3
150	3
200	1

Guide 5.30

EARLY FALLOUT

Fallout descends in particles of various sizes. Naturally the heaviest particles fall first. These particles are measured in microns. A micron is one-millionth part of a meter and a meter is 39.37 inches. Particles with a 75 micron diameter fall at the rate of one mile per hour. Guide 5.30 shows the percentage of total fallout radioactivity carried by each size particle. This information is useful for filter system planning. 5.30

The fallout dose from a 20 megaton ground burst has been estimated to be as shown in guide 5.31 for the first hour after an explosion. 5.31

ESTIMATED FALLOUT DOSE FROM 20 MT GROUND BURST

Miles From Ground Zero	Roentgens
2 up to 15 miles	10,000 r down to 1000 r
15 up to 75 miles	1,000 r down to 100 r
75 up to 120 miles	100 r down to 0 r

Guide 5.31

An estimated statistical contour of probable early fallout behavior has been developed based on observation and partly on computations. The reference dose rate must be adjusted proportionately for known dose rates. 5.32

EARLY FALLOUT PATTERN FOR 1 MT GROUND BURST 15 MPH WIND

Reference Dose Rate r/hr	Downwind Distance miles	Maximum Width miles
3000	23	6
1000	42	10
300	74	12
100	120	18
30	210	30
10	300	42
3	390	50
1	440	56
0.3	500	60
0.1	530	62

Guide 5.32

Fallout particles are not only an immediate danger to exposed persons but they can contaminate clothing, rugs, curtains and upholstered furniture at considerable distances from ground zero.

When this occurs these items must be either buried or stored in an isolated location pending sufficient radioactive decay. Laundering, dry cleaning or vacuuming or a combination of all three methods may then further reduce the radioactivity. 5.33

DECONTAMINATION BY EARTH MOVING TECHNIQUES

There are several protective measures that may be taken near a survival shelter to reduce the fallout radioactivity. Most people will not have the necessary equipment available. The government may have the equipment but probably will have more urgent uses for it. This is what must be faced. About 50% of the fallout dose rate at a shelter will come from within a radius of 50 feet. About 75% will come from within a radius of 200 feet. These figures are based on a dose rate measurement three feet above ground in the center of a large, flat, uniformly contaminated area. A 250 foot strip when decontaminated will reduce the radiation dose rate by a factor of ten—the dose rate would be only one tenth that prevailing if the strip was not decontaminated. 5.34

One method that could be used to decontaminate the area surrounding a shelter would be to scrape off or otherwise remove a one foot layer of the contaminated soil. It must then be buried or dumped at a safe distance. Another method would be to cover the ground surrounding the shelter area with a one foot layer of uncontaminated earth. Removing earth from within a 200 feet radius reduces nuclear radiation to one fourth. 5.35

A hole three feet in diameter and four feet deep will provide a protection factor of 40 (6.08) even if the fallout is up to the edge. If a radius of four feet from the hole is kept clear of fallout a protection factor of 100 will be effected. 5.36

CONVERSION OF KNOWN DOSE RATE TO DOSE RATE AT ANY OTHER TIME

The rate of early fallout radioactive decay for various times from one hour to 10,000 hours is shown in guide 5.37 based on a theoretical reference starting dose rate of 1000 roentgens per hour measured one hour after the explosion. The residual radiation percentage of the total radiation that has been and will be received to infinity is shown in the two right hand columns. The dose rate for any given time up to 1000 hours can be determined by proportionment if the actual dose rate for any one time is known. For instance, if the dose rate at 10 hours after the explosion is 21 roentgens per hour; what would be the dose rate 100 hours after the burst? Since the known dose rate at the end of 10 hours is 21 roentgens per hour or one third of the guide 5.37 dose rate which is 63 roentgens per hour; the 100 dose rate would be one third of the guide 5.37 rate (4 r/hr) or 1.33 roentgens per hour. Guide 5.37 also shows that 88% of the total nuclear radiation to infinity would have been released by the end of this 100 hour period. 5.37

RESIDUAL RADIATION DECAY*

Time After Explosion Hours	or Days	Dose Rate (Reference) R/Hr	Residual Radiation Decay Percentage to Infinity: Percent Already Received	Percent to be Received
1		1000	55	45
1½		610	59	41
2		440	62	38
3		230	66	34
5		130	69	31
7		100	71	29
10		63	75	25
15		40	78	22
24	1	23	80	20
36	1½	15	82	18
49	2	10	83	17
72	3	6.2	86	14
100	4	4	88	12
200	8	1.7	90	10
343	14	1.0**	91	9
400	16	.70	92	8
600	25	.42	94	6
1000	41	.24	95	5
2000	83	.13**	97	3
10,000	416	.017**	99	1

*Residual radiation is nuclear radiation emitted more than one minute after the explosion.

**See 6.18

Guide 5.37

An infinity radiation dose is the amount of nuclear radiation that would be received from continuous exposure to fallout for an infinite time. The two columns in guide 5.37 showing these "percentage to infinity" figures are based on the assumption that early fallout is complete and that, except for normal radioactive decay, the contamination status does not change. By using guide 5.37 in conjunction with information in paragraph 6.20 it is possible to compute the dose which would be received for any given time period. It is only necessary to know the dose rate at any one time more than one hour after the explosion. 5.38

If all the early fallout from a nuclear explosion arrived in a specific locality within 6 hours after the burst, the total dose received would be about as shown in guide 5.39 assuming that the sixth hour dose rate was 100 roentgens per hour. By using proportionment the total dose for other radiation values can be computed.

TOTAL RADIATION DOSE RECEIVED — DOSE RATE 100 R/HR 6 HOURS AFTER BURST FALLOUT COMPLETE 6 HOURS AFTER EXPLOSION

At End Of	Total Dose Received
1 Day	900 Roentgens
2 Days	1200 Roentgens
5 Days	1600 Roentgens

Guide 5.39

Though the dose rate would be decreasing steadily, the total accumulated dose would keep increasing. Since the first few days are the most dangerous, shelter protection is most urgently required during this time. If a person was sheltered for just the first 48 hours after the completed fallout, he would avoid most of the first 1200 roentgen dose. 5.39

Fallout released from a one megaton explosion into a 15 mile per hour wind has provided some interesting information about radiation conditions 22 miles downwind (Guide 5.40) and 100 miles (Guide 5.40A) downwind from the explosion. 5.40

LONG HALF LIFE RADIOISOTOPES

Before most of the delayed fallout reaches the ground the short lived radioisotopes will have decayed almost completely. Those having long half-lives will remain. Two of these, strontium 90 with a half life of 27.7 years and cesium 137 with a half life of 30.5 years, have great biological importance. Cesium 137 is a principal hazard from delayed fallout because it is a gamma ray emitter even more than one year after a nuclear explosion. These two radioisotopes make a negligable contribution to the external radiation dose when compared with that from the early fallout. Their importance lies in the possibility that they may get into the body directly by way of fruits and vegetables or indirectly by eating meat from animals who have eaten contaminated vegetation. Roughly ten percent of all atoms undergoing fission eventually form strontium 90 or cesium 137 atoms. 5.41

FALLOUT CANNOT INDUCE RADIOACTIVITY

There are several very important points about fallout that should always be remembered. Fallout cannot induce radioactivity. Radioactivity can only be induced by neutrons released by fission or fusion. This only occurs within about one mile of a nuclear explosion and in the first second after the burst. Fallout radiation causes rearrangement of orbital electrons in atoms which can cause ionization in the body. This ionization can result in complicated, dangerous body cell changes. Fallout radiation does not affect atomic nuclei and therefore cannot induce radioactivity. For this reason water and food are not spoiled by exposure to fallout. Cans containing food should be washed before opening and consuming the contents, if they have been exposed to fallout dust. This minimizes the possibility of fallout radiation getting into the body. 5.42

FALLOUT FROM 1 MT BURST — 22 MILES DOWNWIND 15 MPH WIND

Time After Explosion	Conditions	Dose Rate (r/hr)	Total Dose (r)
1 hour	Fallout had not arrived	10	Very little
1 to 2 hours	Main fallout has arrived	1000	1000
6 hours	Decay has started	300	3000
18 hours		80	4800

Guide 5.40

FALLOUT FROM 1 MT BURST — 100 MILES DOWNWIND 15 MPH WIND

Time After Explosion	Conditions	Dose Rate (r/hr)	Total Dose (r)
1 hour	Fallout had not arrived	0	0
6 hours	Fallout begins to arrive	1	1
9 hours	Fallout essentially complete		
18 hours	Fallout decay starts	5	80

Guide 5.40A

BIOLOGICAL EFFECTS OF NUCLEAR RADIATION

In most cases the biological effects of a given total radiation dose decreases as the rate of exposure decreases. 1000 rems in a single whole body dose would be fatal. The same dose, if absorbed over a period of thirty years, would probably not have any noticeable external effects in the majority of people. 5.43

IONIZATION

The main cause of body damage by neutrons is due to ionization, caused by interaction of fast neutrons with hydrogen and nitrogen in living tissues. Soil and rocks contain some ionizing radiation materials that occur normally in nature; potassium 40, uranium, thorium and radium. The character of mutations in future generations is not changed by ionizing radiation. It is the frequency of these mutations that is increased. 5.44

SYMPTOMS

The shedding of hair is one of the most reliable indications of exposure to radiation. Loss of hair usually occurs two weeks after receiving a 300 rem dose. If the hair grows back it is a sign that the patient will recover from most of the immediate effects of radiation. Conversely, if the hair fails to grow back, it is an indication of serious damage. Usually the only immediately perceptable reaction to a large radioactive dose is an itching or tingling sensation. 5.45

RADIATION BY INHALATION

Inhalation of fallout particles would probably be a small hazard. Almost all particles over 10 microns in diameter and over 90% of those particles more than 5 microns in diameter would be prevented from entering the body by the nose. Most early fallout particles having the greatest radioactivity will be considerably more than 10 microns in diameter (5.30). However, air that is suspected of containing fallout particles should not be directly inhaled. A dust filter type respiratory mask should be used. 5.46

Early fallout fission products are mostly oxides. Many of these do not readily dissolve in body fluids. This is fortunate since the amount of absorption of these products through the intestine walls is dependent to a large degree on the solubility of particles. 5.47

The oxides of strontium and barium are soluble. They enter the bloodstream more readily and find their way into the bones. Where healthy or fully developed bones are involved less absorption takes place. Iodine is also present in soluble form and soon enters the blood and is concentrated in the thyroid gland. Even under these conditions only about ten percent of the strontium offered to the body is absorbed and retained. Actual tests made on a group, after an accidental exposure resulting from a nuclear test explosion, showed only iodine, strontium, barium and the rare earth group in the body in appreciable amounts. 5.48

The most radiosensitive parts of the body are the lymphoid tissue, bone marrow, spleen, reproductive organs and the gastrointestinal tract. The moderately sensitive parts are the skin, lungs and liver. The least radiosensitive body parts are the muscles, nerves and adult bones. 5.49

The shorter the radioisotope half life, the stronger, more intense is its radiation. Therefore the isotopes representing the greatest potential internal hazard are those with short radioactive half lives and long biological half times. The biological half time is the time required for an element in the body to decrease to one half its original value by the natural biological process of elimination. 5.50

NUCLEAR RADIATION SHELTER TIME GUIDES

The government has prepared and published* two guides which can provide information of extreme value after a possible nuclear attack. Both guides are tools with which you may have to plan post attack survival. Due to the complexity of nuclear weapon behavior and the many variables possible, and in fact almost inevitable, they are approximate for any given explosion. Both guides are predicated on the fact that two factors must be known. First, the elapsed time since the explosion and second, the dose rate at one given time after the explosion. These guides are valid only if the contamination status remains unchanged, except for normal radioactive decay, for the time period involved and if the fallout is complete. They should never be substituted for radiation instrument measurement of both dose rate and total accumulated dose. 5.51

NUCLEAR RADIATION DOSE RATE — TIME GUIDE*

Using guide 5.52, at a location where the nuclear radiation dose rate at a given time is known, the approximate dose rate at any other time can be computed. Assume that the known dose rate is 35 roentgens per hour two hours after a nuclear weapon explosion. The information required; when will the radiation dose rate have decayed to 5 roentgens per hour? To determine the answer, use the extreme left hand column and find the two hour figure. Using a straight edge follow the two hour figure horizontally until the figure closest to 35 is found. Follow that column vertically down to the figure closest to five. In this instance the applicable figure is 5.1 and the further use of a straight edge going back to the Time column at the left shows that the dose rate will reach 5 roentgens per hour a short time before the tenth hour or about nine hours and fifty minutes after the explosion. 5.52

Providing the dose rate for a given time is known, the radiation dose rate for any time before or after can be determined by using guide 5.52 again. For example, the known dose rate is 35 roentgens per hour at 2 hours after the explosion. First find the 2 hour figure, follow it horizontally to the 35 r/hr figure and read up or down that vertical column. By going back horizontally to the time column from the chosen roentgen per hour figure the necessary time and dose rate will be shown. Thus it will be seen that the dose rate was 182 r/hr at 30 minutes after the burst and would be 1.8 r/hr one day after the explosion. 5.53

NUCLEAR RADIATION ALLOWABLE STAY TIME GUIDE*

One of the major problems of sheltered persons may be that they may have to leave the shelter to spend time in contaminated areas. This could be necessary for rescue missions or for moving to more protected or less contaminated areas. Let us assume that a radiation dose radio report has been received. By referring to guide 5.52 it has been determined that a person may be exposed to a lethal radiation dose if he stays in his present location. He must find out how long he can remain outside without serious radiation exposure. First he would verify the radiation level in his immediate vicinity by using a radiation survey instrument. We will further assume that an authority has advised that he may receive an allowable dose (AD) of 30 roentgens without danger. The dose rate (DR), at the time of entry into the contaminated area, is 50 roentgens per hour ten hours after the explosion. He wants to know how long he can stay in the area without absorbing more than 30 roentgens. If he knows the dose rate at time of entry and the elapsed time since the burst, he can use guide 5.54 to figure his allowable "stay time". Here's how. The allowable dose (AD) of 30 roentgens is divided by the dose rate (DR) of 50 roentgens per hour at entry time to provide AD/DR or 30/50 equals .6 —now .6 is found in the first column and followed horizontally to the right with a straight edge until the vertical column headed 10 hours is reached. The allowable stay time is shown as 37 minutes. The same formula may be used to determine allowable stay times for other values. 5.54

***Figures used in guides 5.52 and 5.54 are from "Effects of Nuclear Weapons", United States Department of Defense, Atomic Energy Commission 1962.**

NUCLEAR RADIATION DOSE RATE — TIME GUIDE

Time After Explosion	Dose Rate—Roentgens Per Hour																			
6 min	16	32	66	95	127	159	318	477	636	795	954	1,272	1,590	-----	-----	-----	-----	-----	-----	-----
12 min	7	14	28	41	55	69	138	207	276	345	414	552	691	1,380	-----	-----	-----	-----	-----	-----
18 min	4.3	8.6	17	25	34	43	86	129	172	216	259	344	431	862	1,290	-----	-----	-----	-----	-----
30 min	2.3	4.5	9.1	13	18	23	45	68	91	114	136	182	227	456	681	908	1,140	-----	-----	-----
42 min	1.5	3.0	6.0	9.1	12	15	30	46	61	76	91	122	152	304	456	608	760	912	1,220	-----
1 hr	1.0	2.0	4.0	6.0	8.0	10	20	30	40	50	60	80	100	200	300	400	500	600	800	1,000
1 hr 30 min	0.6	1.2	2.4	3.7	4.9	6.1	12	18	24	31	37	48	61	122	183	244	305	366	488	610
2 hr	0.4	0.9	1.8	2.6	3.5	4.4	8.7	13	18	22	26	35	44	87	131	175	219	262	350	437
3 hr	0.3	0.5	1.1	1.6	2.1	2.7	5.4	8.0	11	13	16	21	27	54	80	107	134	161	214	268
5 hr	-----	0.3	0.6	0.9	1.2	1.5	2.9	4.4	5.8	7.3	8.7	12	15	29	44	58	73	87	116	145
7 hr	-----	-----	0.4	0.6	0.8	1.0	1.9	2.9	3.9	4.9	5.8	8	10	19	29	39	49	58	78	97
10 hr	-----	-----	-----	0.4	0.5	0.6	1.3	1.9	2.5	3.2	3.8	5.1	6.4	13	19	25	32	38	51	64
15 hr	-----	-----	-----	-----	0.3	0.4	0.8	1.2	1.6	1.9	2.3	3.2	3.9	7.8	12	16	19	23	31	39
1 day	-----	-----	-----	-----	-----	-----	0.5	0.7	0.9	1.2	1.3	1.8	2.3	4.5	6.8	9.0	12	13	18	23
1 d 12 hr	-----	-----	-----	-----	-----	-----	0.3	0.4	0.6	0.7	0.9	1.2	1.5	2.9	4.4	5.8	7.3	8.7	12	15
2 d	-----	-----	-----	-----	-----	-----	-----	-----	0.4	0.5	0.6	0.8	1.0	1.9	2.9	3.9	4.9	5.8	7.8	10
4 d	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.3	0.4	0.8	1.3	1.7	2.1	2.5	3.3	4.2
1 wk	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.5	0.7	0.9	1.2	1.4	1.8	2.3
2 wk	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.3	0.4	0.5	0.6	0.8
4 wk	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.3	0.4

Guide 5.52

NUCLEAR RADIATION ALLOWABLE STAY TIME GUIDE

AD/DR Allowable Dose Divided By Dose Rate	Time of Entry to Area After Nuclear Explosion																		
	Minutes			Hours															
	6	12	30	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40
	Exposure Time (Hours & Minutes) Needed to Produce AD/DR Values at Above Entry Time																		
0.2	1-11	0-25	0-15	0-14	0-13	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12
0.3	9-40	1-00	0-22	0-22	0-20	0-19	0-19	0-19	0-19	0-18	0-18	0-18	0-18	0-18	0-18	0-18	0-18	0-18	0-18
0.4	312-24	2-22	0-42	0-31	0-27	0-26	0-26	0-25	0-25	0-25	0-25	0-25	0-25	0-24	0-24	0-24	0-24	0-24	0-24
0.5	∞	6-12	1-02	0-42	0-35	0-34	0-32	0-32	0-32	0-31	0-31	0-31	0-31	0-31	0-31	0-30	0-30	0-30	0-30
0.6	------	19-20	1-26	0-54	0-44	0-41	0-39	0-39	0-38	0-38	0-38	0-37	0-37	0-37	0-37	0-37	0-37	0-36	0-36
0.7	------	82-06	2-05	1-08	0-52	0-49	0-47	0-46	0-45	0-45	0-44	0-44	0-44	0-44	0-43	0-43	0-43	0-43	0-42
0.8	------	624-48	2-56	1-23	1-02	0-57	0-54	0-53	0-52	0-51	0-51	0-51	0-50	0-50	0-49	0-49	0-49	0-49	0-49
0.9	------	2,000-00	4-09	1-42	1-12	1-05	1-02	1-00	0-59	0-58	0-58	0-57	0-57	0-57	0-56	0-55	0-55	0-55	0-55
1.0	------	∞	5-56	2-03	1-23	1-14	1-10	1-08	1-06	1-05	1-05	0-04	1-04	1-03	1-02	1-02	1-02	1-01	1-01
1.25	------	--------	15-30	3-13	1-54	1-38	1-31	1-28	1-25	1-24	1-23	1-22	1-21	1-20	1-19	1-18	1-17	1-17	1-16
1.5	------	--------	48-20	4-57	2-30	2-05	1-54	1-49	1-45	1-43	1-41	1-40	1-39	1-37	1-36	1-34	1-33	1-33	1-32
2.0	------	--------	1,562-00	11-52	4-06	3-13	2-46	2-35	2-29	2-24	2-20	2-18	2-16	2-13	2-10	2-08	2-06	2-05	2-04
2.5	------	--------	∞	31-00	6-26	4-28	3-48	3-28	3-16	3-08	3-03	2-59	2-55	2-51	2-46	2-45	2-40	2-38	2-36
3.0	------	--------	--------	96-39	9-54	6-09	5-01	4-28	4-10	3-58	3-49	3-43	3-38	3-30	3-24	3-17	3-14	3-11	3-08
4.0	------	--------	--------	3,124-00	23-43	11-05	8-12	6-57	6-16	5-50	5-33	5-19	5-10	4-58	4-44	4-32	4-26	4-20	4-15
6.0	------	--------	--------	∞	193-19	35-35	19-48	14-43	12-19	10-55	10-02	9-24	8-57	8-19	7-46	7-15	7-01	6-48	6-34
10.0	------	--------	--------	--------	∞	728-49	124-00	59-18	39-34	30-39	25-42	22-35	21-32	17-52	15-41	13-57	13-05	12-24	11-42

Guide 5.54

CHAPTER 6

Nuclear Radiation Protection Shields

There are two distinct types of nuclear radiation. Protection from both types should be considered. These types are:

1. Initial radiation includes both neutrons and prompt gamma rays. To attenuate (reduce) this type radiation requires especially thick barriers. The attenuation of initial radiation is further improved by using specially mixed concrete (6.15).
2. Fallout radiation does not need as thick a barrier as that required to attenuate initial radiation.

It must be remembered that nuclear radiation is only one phase of the protection problem. Thermal radiation and blast protection are equally urgent. All three types of protection can be analyzed, computed and planned. However, the final decision must take into account the necessary amount of barrier to protect from the worst possible condition. This depends on distance, but would be either blast or initial radiation for an underground shelter. 6.01

There are three forms of nuclear radiation protection. Barrier shielding which consists of placing a barrier between the radiation source and the target. Geometry shielding which simply means that the greater the distance from the radiation, the less the dose received. The third form of protection is entirely automatic. Time shielding consists of time and the natural radioactive decay that is always working in our favor. Essentially the solution to the survival problem is to put as much mass, distance and time as possible between the explosion and the target. 6.02

BARRIER SHIELDING

A material used for a survival shelter has a different value as a barrier when used to attenuate initial radiation than when it is used to reduce the lower energy fallout radiation. The exact guide headings should be carefully noted when the guides are used. 6.03

Different materials have different barrier effects in stopping nuclear radiation. The efficiency of any material is the product of its density (mass) and its thickness (area). In addition, where initial radiation is involved, the constituent elements of the material are a big factor. The more dense the material, the more it will weigh per cubic foot and the greater will be its ability to stop nuclear radiation. 6.04

HALF VALUE LAYER THICKNESS

One method of relating this ability to stop fallout gamma radiation among different materials is to show the thickness of each material that is needed to stop one half the gamma rays emitted by a specific source. This factor is called the half value layer or HVL. Each HVL thickness added to the first reduces the gamma ray penetration by an additional one half. If the unshielded radiation dose is 1000r, one HVL thickness would reduce it to 500r; the second HVL would reduce it to 250r and the third HVL to 125r, etc. 6.05

The shielding efficiencies for several materials are shown in Guide 6.06.

MATERIAL SHIELDING EFFICIENCIES

Material	HVL (inches)	Pounds per Cubic Foot
Lead	.3	710
Steel	.7	480
Concrete	2.2	144
Earth	3.3	100
Cinder block	5.0	66
Water	5.3	62

Guide 6.06

EQUIVALENT HVL PROTECTION FACTORS
MATERIAL FIGURES IN INCHES

No. of HVL's	Protection Factor(PF)	Radiation Reduction Factor	Steel	Concrete	Earth	Cinder Blocks	Roentgens Per Hour
1	2	0.5	.7	2.2	3.3	5.	500.0
2	4	.25	1.4	4.4	6.6	10.	250.0
3	8	.125	2.1	6.6	9.9	15.	125.0
4	16	.0675	2.8	8.8	13.2	20.	62.5
5	32	.03375	3.5	11.0	16.5	25.	31.25
6	64	.01687	4.2	13.2	19.8	30.	15.625
7	128	.00843	4.9	15.4	23.1	35.	7.8125
8	256	.00421	5.6	17.6	26.4	40.	3.9062
9	512	.0021	6.3	19.8	29.7	45.	1.9531
10	1,024	.00105	7.0	22.0	33.0	50.	.9765
11	2,048	.00052	7.7	24.2	36.3	55.	.4882
12	4,100	.00026	8.4	26.4	39.6	60.	.2441
13	8,200	.00013	9.1	28.6	42.9	65.	.1225
14	16,400	.00006	9.8	30.8	46.2	70.	.0612
15	32,800	.00003	10.5	33.0	49.5	75.	.0306
16	65,600	.000015	11.2	35.2	52.8	80.	.0153

Guide 6.07

By using guide 6.07 it is possible to find out the approximate degree of protection provided by several materials which might be used in survival shelters. It is not necessary that just one material be used for shelter construction to use the HVL table. Let us assume that the shelter has a roof and walls of concrete 11 inches thick. Further assume that there is 33 inches of earth over and around the shelter. Eleven inches of concrete equals 5 HVL. Thirty-three inches of earth equals 10 HVL. Adding the two numbers of HVL—totals 15 HVL. By checking in the left hand columns of guide 6.07 it will be seen that the shelter has a protection factor of 32,800. 6.07

PROTECTION FACTOR

The protection factor or PF of a shelter is the ratio of a dose which would be received without protection to the dose that would be received by a person in a sheltered location. For example, a protection factor of 10 means that you would receive 10 times more radiation if you were unsheltered. Conversely you are receiving only one tenth the radiation in the shelter compared to the radiation outside. Guide 6.08 shows a useful system for relating the total mass thickness of a material in pounds per cubic foot directly to the protection factor required. Providing the density of any two or more materials is known, they may be combined to compute their protection factor. 6.08

FALLOUT PROTECTION FACTOR GUIDE *

Mass Thickness Pounds per Cubic Foot	Equals	Protection Factor (PF)
20		5
40		10
60		20
100		50
125		100
160		200
200		500
220		1,000
260		2,000
300		5,000
330		10,000
360		20,000
420		40,000
480		80,000

Guide 6.08

NOTE: *The figures shown in Guide 6.08 for protection factors are approximate due to the many variables involved.

TENTH VALUE LAYER THICKNESS

Another widely used method of judging the approximate ability to attenuate fallout gamma rays among different materials is to show the thickness of a given material that is required to attenuate these gamma rays by a factor of ten. This system is much like the HVL. It is called the tenth value layer thickness or TVL. Each TVL thickness added to the first reduces the radiation penetration by an additional factor of ten. The first TVL reduces the radiation to one tenth, a second TVL added reduces it to one hundredth, and a third TVL added reduces it to one thousandth, etc. The accuracy of this TVL method decreases with each additional layer. Here are the shielding efficiencies for concrete and earth expressed in terms of TVL thickness. 6.09

EQUIVALENT TVL PROTECTION FACTORS CONCRETE AND EARTH

FALLOUT RADIATION

Number of TVL Thicknesses	Protection Factor	Concrete (inches)	Earth (inches)
1	10	8	12
2	100	16	24
3	1,000	24	36
4	10,000	32	48
5	100,000	40	60

Guide 6.09

Neutrons and prompt gamma rays that are part of the initial nuclear radiation have a much higher MEV energy (5.10) than fallout radiation. They require much more shielding to be attenuated to the same degree. The amount of concrete and earth necessary to provide equivalent protection factors is given in guide 6.10. A person would be comparatively well protected from the initial nuclear radiation of a one megaton air burst one mile away by being sheltered by a barrier consisting of either about one foot of steel or four feet of concrete. However, at this distance of one mile from the explosion the shelter must be of a special blast resistant design to survive the blast. 6.10

Three methods of computing fallout protection have been displayed; half value, mass thickness in pounds per cubic foot (protection factor) and tenth value layer. Guide 6.11 shows the relationship between these three methods, using concrete as a common denominator. While the figures are as shown in the three tables (6.07-6.08-6.09), they reflect the approximate character of the basic tables. The protection factors of 10 and 100 show a lower mass thickness than is indicated by the HVL and TVL thicknesses. However, the other values are remarkably close. Always use the most conservative figure. 6.11

EQUIVALENT TVL PROTECTION FACTORS CONCRETE AND EARTH

INITIAL RADIATION

Number of TVL Thicknesses	Protection Factor	Concrete (inches)	Earth (inches)
1	10	18	26
2	100	36	52
3	1,000	54	78
4	10,000	72	104

Guide 6.10

EQUIVALENT PROTECTION FACTORS — CONCRETE HVL — MASS THICKNESS — TVL

FALLOUT RADIATION

Protection Factor	HVL (inches) Thickness	Mass Thickness (PCF)	TVL (inches) Thickness
10	8	40	8
100	15	125	16
1,000	22	220	24
10,000	30	330	32
100,000	37	480	40

Guide 6.11

GEOMETRY SHIELDING

The exposure rate for a single small area of high radiation can be computed if the dose rate at the source is known. This can be done taking into consideration only the geometry shielding effect of distance. The formula used to do this is called the "inverse square law". To determine the exposure rate at a given point, square the distance in feet from the radioactive source and divide that figure into the known source roentgen rate. More simply: When the distance from the radiation source is doubled, the exposure rate is quartered. Here is an example of a practical application of this information. A person is standing 10 feet away from a radiation source. If he stays there for one hour he will absorb an almost certain fatal dose of 1000 rems. If he steps back just 10 more feet, his dose in the same time would be 250r—providing him with an almost certain chance to recover. The main problem with using geometry shielding computations such as shown in guide 6.12 is that they are not accurate for dispersed or scattered radiation. 6.12

GEOMETRY SHIELDING PROTECTION EXAMPLES SINGLE SOURCE

Radiation at Source (Dosage Rate r/hr)	Distance From Source (feet)	Square of Distance	Exposure Rate (r/hr)
500	20	400	1.25
1,000	500	25,000	.04
10,000	1,000	1,000,000	.01
100,000	5,000	25,000,000	.004
200,000	50	25,000	80.
200,000	100	10,000	20.
200,000	200	40,000	5.

Guide 6.12

Fallout gamma radiation is attenuated by a factor of 1000 by passage through one half mile of air and is halved by passage through only 25 feet of air. 6.13

NEUTRON BARRIERS

Shielding protection from neutrons poses several special problems. The mass density that attenuates gamma rays so readily, is also effective for reducing neutron radiation. However, to really have maximum protection from neutrons requires different, more difficult shielding. Elements having a low atomic weight such as water provide the best neutron shielding. The hydrogen and oxygen constituents of water both meet this requirement. The interaction between neutrons, hydrogen and oxygen during the attenuation process creates gamma rays. Protection from this gamma radiation must be provided. Concrete and damp earth provide good protection against neutrons and gamma rays. This is true since concrete and damp earth have hydrogen to slow down and capture neutrons and calcium, silicon and oxygen to absorb gamma rays. 6.14

A very special type of concrete can be used to attenuate neutron radiation. It is called "heavy" concrete and includes in its mix iron (oxide) ore (limonite) and small pieces of iron scrap. Seven inches of this heavy concrete can reduce the neutron flux by a factor of ten. Eighteen inches of ordinary concrete would be needed to provide the same degree of attenuation (6.10). Two other effective aids to neutron attenuation can also be added. They are the mineral barytes (a compound of barium), and colemanite which contains a high proportion of boron. Boron has an unusual property; it absorbs neutrons without becoming radioactive. Colemanite, incorporated in a concrete mix, captures slow (low energy) neutrons readily and releases low intensity gamma rays which are fairly easy to attenuate. 6.15

TIME SHIELDING

Nuclear radiation is a mixture of many different radioisotopes, all of them decaying at different rates. Some of them have a half life of a few seconds, others a half life of hours, still others have half lives of days, months and years. Several have half lives of thousands of years, up to about one million years. The half life of a radioisotope is the time needed for the radioactivity of a given isotope to decay to one half its original intensity. The mixture of these radioisotopes, emanating from a nuclear explosion, has been calculated to decay according to a formula (6.18). 6.16

Fallout radiation will decay from one minute after a nuclear explosion to one day after the burst by a factor of 3000. At the end of one week the radiation dose rate will be one tenth that of the rate at the end of one day. The total decay factor from one minute after the explosion to one week after it will be 30,000. At three months after an explosion the radiation intensity will fall to about 0.01% (one ten-thousandth) of its value at one hour after the explosion. 6.17

Nuclear radiation decreases by a factor of ten as time increases by a factor of seven. A radiation dose rate of 1000 roentgens per hour at one hour after an explosion would decay in seven hours to 100 roentgens per hour. Forty nine hours after the explosion (7 x 7) the rate would be 10 r/hr (factor of 10). This 10 r/hr would decay to 1 r/hr by 343 hours (7 x 49) after the explosion. This formula can be inaccurate by as much as 25% for the first two weeks and 50% for the period from two weeks to six months. After six months the dose rate decreases at a more rapid rate than the generally applied formula given here. Other examples of the use of this rule are: at 14 hours after an explosion the dose rate will be one tenth that prevailing 2 hours after the burst; at 21 hours the dose rate will be one tenth that at 3 hours, etc. 6.18

With a 100,000 r/hr dose rate outside, a shelter with a protection factor of 10,000 would reduce it to 10 r/hr inside the shelter. Seven hours later the 10 r/hr dose rate would decay to about 1 r/hr — a comparatively safe radiation rate which would still be rapidly decaying. 6.19

NUCLEAR RADIATION — TIME DECAY

Time After Explosion	Reference Dose Rates Roentgens Per Hour		
1 hour	1000	5000	10,000
7 hours	100	500	1,000
49 hours (2 days)	10	50	100
343 hours (2 weeks)	1	5	10
2352 hours (14 weeks)	0.1	0.5	1
98 weeks	0.01	0.05	0.1

Guide 6.18

LIFETIME NUCLEAR RADIATION COMPUTATION

A simple method of computing the expected lifetime dose to which a person would be exposed after a nuclear explosion has been used by the government. It is based on the assumption that the person remains in the same location, under the same conditions for the rest of his life. Fallout is complete and the only change is normal radioactive decay. The dose rate for the first hour in the area is multiplied by the elapsed hours since the explosion and the figure obtained is multiplied by a factor of five. Any dose rate between about 100 r/hr and 200 r/hr during the first hour in the area would indicate a possible eventual fatality unless the exposed person moved to a more protected or less contaminated location. The situation of this theoretical person would become more dangerous if the 100 r/hr dose rate was effective more than one hour after the explosion. Whenever different methods of computing lifetime doses are used, the maximum figure should be used as a planning guide. 6.20

LIFETIME NUCLEAR RADIATION COMPUTATION EXAMPLES

Exposure First Hour in Area	x	Elapsed Hours Since Explosion	x	Formula Figure	=	Total Expected Lifetime Dose (r)
50 r		1		5		250
6 r		12		5		360
10 r		24		5		1,200
3 r		30		5		450
0.5 r		40		5		100
0.1 r		400		5		200
0.025 r		343		5		43

Guide 6.20

There are several ways to use the information which can be developed by computing expected lifetime doses (6.20). Several typical uses follow:

> Example 1. A nuclear attack creates a dose rate of 6000 r/hr at the end of one hour. A shelter having a protection factor of 10,000 is occupied. What would be the expected lifetime dose for the occupants if they remained in the shelter? The exposure dose rate would be 0.6 r/hr in the shelter. 0.6 x 1 x 5 = 3 roentgens lifetime dose. Obviously people cannot stay in a shelter for a lifetime. Assuming that the occupants stay in the shelter for two weeks and then emerge, what will be their radiation status? The outside radiation will have decayed from 6000 r/hr to 6 r/hr (6.18). The anticipated outdoors lifetime dose at this point is 6 x 343 x 5 = 10,290 roentgens. The shelter occupants must plan to move to a less contaminated area. They will be safe enough in their shelter while they make plans; that is if the food and water hold out.

> Example 2. These people are fortunately five or six miles from ground zero. The outside radiation is 300 r/hr for the first hour. They wait two weeks (343 hours) then emerge. Their anticipated lifetime dose will be .3 x 343 x 5 = 515 roentgens. This situation is marginal. They can go back into the shelter or move to an area where the dose rate is lower i.e. further away from ground zero. If they have a bulldozer (and fuel) they could remove a one foot depth of topsoil from a 250 foot radius of the shelter and attenuate the radiation by geometry shielding. This is most unlikely of course. Actually their plight is not critical. They could spend only one half their time in the shelter and still absorb less than 300 roentgens in a lifetime. Since most of the figures for practically all of the tables shown are approximate, they should be used as a guide for planning purposes. The execution of all plans must be based on accurate radiation survey and dosimeter readings if they are available. 6.21

You can do nothing about time shielding or time. You cannot start it. You cannot stop it. If you are alive, it will help you after a nuclear attack; if you are dead, it will mean nothing to you. You can do nothing about geometry shielding before or during a nuclear attack. You cannot pick the target much less the actual ground zero of an explosion. Even though the odds are fantastically in your favor that any nuclear weapon explosion would be more than two miles from you, you cannot be absolutely certain. The only possible step you can take to protect yourself is to build or have available an adequate shelter. Then if you survive the acute, sharp jab of initial radiation, blast and heat in that first critical minute after a burst, you may take advantage of geometry and time shielding against the chronic, nagging attrition of fallout radiation. 6.22

CHAPTER 7

Nuclear Explosion Survival Range

It is possible to put together the facts that have been assembled in preceding chapters and use them to assess the chances of nuclear explosion survival in a BOSDEC type shelter. 7.01

MINIMUM SURVIVAL DISTANCES FROM GROUND ZERO
GROUND BURST

Effect	1 MT	5 MT	10 MT	20 MT
Heat (fireball radius)	.8 miles	1.2 miles	1.8 miles	2.3 miles
Blast (100 psi overpressure)	1.0 miles	1.2 miles	1.5 miles	1.8 miles
Initial Radiation (1000 rems)	1.5 miles	1.8 miles	2.0 miles	2.2 miles
Crater (observable—radius)	650 ft.	1100 ft.	1400 ft.	.3 miles
Crater (rupture zone—radius)	975 ft.	1650 ft.	2100 ft.	.5 miles
Crater (plastic zone—radius)	1625 ft.	2750 ft.	3500 ft.	1.7 miles

Guide 7.01

THERMAL RADIATION

The fireball radius of a 20 megaton weapon is about 2.3 miles. This is the greatest distance, of any dangerous effect, from the ground zero of a ground burst. All other effects shown in Guide 7.01 occur less than 2.3 miles from ground zero. It has been established that survival is possible, in a well designed shelter, under the periphery of the fireball. We will assume, however, that the shelter is just outside the fireball area. The heat will not be a problem in a BOSDEC type shelter. 7.02

BLAST

The blast from a 20 megaton explosion will generate an overpressure of 100 psi at 1.8 miles from ground zero. The BOSDEC shelter will provide ample protection from this overpressure. Actually the overpressure would be only 60 psi at 2.3 miles from ground zero and BOSDEC can withstand more than double that 60 psi overpressure. Blast will not be a problem. 7.03

INITIAL NUCLEAR RADIATION

Initial nuclear radiation at 2.2 miles from a 20 megaton ground burst would be about 1000 rems per hour and rapidly decreasing. With a protection factor of only 1000 (against initial radiation) the shelter occupants would see a dose of less than one rem. No problem here. 7.04

CRATER

The plastic zone would extend out to 1.7 miles from ground zero. Beyond that point there would be very little shock. At 2.3 miles from ground zero there would be even less. Definitely no great danger from ground shock. 7.05

Summary: About the only conclusion that can be drawn is that survival is not only possible in a BOSDEC shelter 2.3 miles from the ground zero of a 20 megaton explosion, it is practically a certainty. Indeed, an occupant of such a shelter would have an excellent chance of survival at two miles from the explosion. Using the fireball radius as a limiting factor, survival appears probable at 1.8 miles from the ground zero of a 10 megaton burst; 1.2 miles from a 5 megaton explosion and about one mile from a one megaton explosion. These figures indicate that survival is probable 4.8 miles from the ground zero of a 100 megaton burst. 7.06

SURVIVAL PRECAUTIONS

The things which should be considered are these:

1. Be certain to plan a shelter to provide the basic protective features.
2. If you must use the shelter be sure the intake and exhaust ports are closed and secured.
3. If you are in an area where firestorms are possible, stay "buttoned up" for 12 to 18 hours. BOSDEC system provides enough air and the firestorm should be past its peak in about 6 hours.
4. Do not leave anything loose in the shelter. The overpressure transmitted into and through the ground may turn loose articles into projectiles inside the shelter even though the shelter itself is not damaged. This is the reason for the admonition — no glass in shelters. Bunks should be securely fastened to the wall. Automobile seat belts may be utilized for a short time if conditions indicate an immediate need. 7.07

SQUARE AND CUBE ROOTS — SQUARES AND CUBES

Since computing many weapon effects involves the use of square and cube roots and inverse square roots, these figures are given below for ready reference. 7.08

Number	Square	Cube	Square Root	Cube Root
1	1.000	1.000	1.000	1.000
1.5	2.250	3.375	1.225	1.145
2	4.000	8.000	1.414	1.260
2.5	6.250	15.62	1.581	1.357
3	9.000	27.00	1.732	1.442
3.5	12.25	42.88	1.871	1.518
4	16.00	64.00	2.000	1.587
4.5	20.25	91.12	2.121	1.651
5	25.00	125.00	2.236	1.710
5.5	30.25	166.4	2.345	1.765
6	36.00	216.0	2.449	1.817
6.5	42.25	274.6	2.550	1.866
7	49.00	343.0	2.647	1.913
7.5	56.25	421.9	2.739	1.957
8	64.00	512.0	2.828	2.000
8.5	72.50	614.1	2.915	2.041
9	81.00	729.0	3.000	2.080
9.5	90.25	857.4	3.082	2.118
10	100.00	1000.0	3.162	2.154
20	400.00	8000.0	4.472	2.714
50	2,500.00	125,000.0	7.071	3.684
100	10,000.00	1,000,000.0	10.000	4.642

Guide 7.08

CHAPTER 8

Shelter Building Controversy

There has been so much printed in newspapers and magazines about the pros and cons of survival shelters that an examination of the controversy seems in order. The problems and possible benefits of nuclear power will be with us for eternity. Yet, the whole question of what to do about it has been treated by many people as something that can be handled or rather ignored by using a few childish stock phrases. 8.01

Consider the first few automobiles that appeared on the dirt roads of America a comparatively few years ago. The only response of many people was "get a horse". Had someone predicted that within a short time vast highway systems would be built and the whole mode of American life changed, he would have been labeled insane. If this person had the preception to predict that someday every home would incorporate a garage, that big cities would have huge garages, many of them underground, for the sole purpose of parking these automobiles, they would have been packed off to a psychiatrist — except that psychiatry was largely unknown then. The point was and is: we live in a rapidly changing world. 8.02

Certainly millions of Americans must have enough vision and imagination to understand that the nuclear weapon problem cannot be solved by sweeping it under a verbal carpet of trite cliches. Practically all the comments against survival shelters follow the same general pattern. They are repeated endlessly by persons unfamiliar with nuclear power, shelter theory and communist objectives in the cold war. 8.03

COMMUNIST OBJECTIVES

Communist objectives are generally agreed to be these:

(a) To force America to capitulate without a fight.
(b) To promote the idea that communism is inevitable.
(c) To set Americans against Americans.
Divide and conquer.
(d) To force America into spending itself into bankruptcy.
(e) To get America to disarm without adequate inspection.
(f) To talk America out of building survival shelters.
This will leave us a fit subject for nuclear blackmail.

This is an easily recognizable pattern. Everyone must agree that if these communist aims are achieved we will lose our liberty without a missile ever being launched from an enemy pad. 8.04

POPULAR CLICHES

Now consider the popular cliches in use, always bearing in mind the communist aims. These cliches are used by millions of fine, loyal anti-communist citizens — but the basic conception and impetus is supplied and fostered by many misguided people who wittingly or unwittingly play into the hands of communists.

(a) I don't want to live in a world which has been devastated by blast, firewinds, radiation and hurtling debris.

(b) If everything will be blown down or burnt within 30 miles of a nuclear explosion, why should I try to save myself?

(c) Some people are going to have guns in their shelters and they won't be shooting communists. They will be shooting women, children and neighbors.

(d) We should forget about shelters and spend all of our effort and money on backward nations and on outlawing nuclear war.

(e) We shouldn't build shelters because this will worry the communists and they may attack us with nuclear weapons.

(f) I can't afford a survival shelter.

These remarks with variations are heard everywhere. 8.05

ANALYSIS OF POPULAR CLICHES

If every citizen had a shelter we would have a great deterrent force. Why? Because then we could not be blackmailed when the moment of decision arrived. The communists respect only strength and preparedness. The emergence of America from lethargy will inspire a stepped up tirade of ridicule. What a terrible thing it would be if we end up talked out of the precious liberty for which Americans have fought and died. 8.06

"I DON'T WANT TO LIVE —"

Of course the people saying this want to live. In fact they will probably be the first ones trying to get into someone else's shelter. Ironically the choice whether or not they want to live is not theirs to make. The enemy will decide that to a certain degree. One wonders whether these people have a moral right to say in effect, that they don't want to live and that therefore their wives and children must die too. 8.07

Once enough of this type people think that they are resigned to dying, they become a perfect target for communist propaganda.

They do not have to die. All they must do is accept capitulation to communism and they can live. That is why this cliche is so vicious. These people seem to get most of their mental exercise jumping at conclusions. Have they ever considered that every American has a duty to protect his family, himself, his country and the free world? 8.08

"IF EVERYTHING WILL BE BLOWN DOWN OR BURNT —"

This statement ignores one basic fact. An underground shelter cannot be blown down or burnt. Potentially dangerous blast and thermal radiation merely pass over a properly designed and built shelter. Heat requires time for destruction. A pan of water can be placed over a fire for one second and it will not heat the water appreciably. Thermal radiation from a nuclear explosion lasts much less than one minute. 8.09

"SOME PEOPLE ARE GOING TO HAVE GUNS —"

This type of trash about shooting women and children has been quoted by a high churchman and also a reporter for a national magazine. Judge for yourself how sensible and responsible these people are if that is their real opinion of their fellow citizens. This type statement usually is voiced by people who are not too bright, who are merely reflecting their own probable reactions or who, for reasons of their own, are trying to discredit the protection concept. 8.10

As for shooting neighbors trying to force their way into a shelter — what kind of neighbors are these? Are these the people who would rather die than come out into a devastated world? If a person built a five person survival shelter for his wife and three children, and someone tried to force his way in by throwing out two children occupants so the intruder and his wife could move in — then he should be shot. 8.11

If someone walked into the minister's or reporter's home and took over, what would they do? Communism constantly strives to stir up controversy, sow discord, encourage weakness and promote panic. When an article is read — think! What is the author trying to do? What message is he trying to get across? What are his reasons and his logic? Most of these statements will be found to be emotional appeals to every normal person's longing for peace and security and revulsion toward the use of force. Even though almost everyone recognizes that the shooting of women and children is far-fetched and unlikely, it does promote a negative reaction. That is all it is meant to do. 8.12

Police protection would, of necessity, come practically to a standstill during a nuclear attack. Each person must then take the responsibility for protecting his family and home from criminal elements. No thinking person would deny that he had the right and duty to keep armed hoodlums out of his home. This right is guaranteed to all Americans. 8.13

There is no reason, moral or otherwise, why an individual should work, plan, save and build a shelter for his family and then let anyone come along and put him and his family out of it. In the event of a war the government would have its hands full. In a land of present plenty all can plan to feed and protect themselves if they are foresighted. There are certain things every person must do for his family and himself. 8.14

"WE SHOULD FORGET ABOUT SHELTERS —"

Since when can peace be secured by unilateral disarmament and a posture of weakness. Lack of adequate survival shelters for our citizens in a nuclear world is a real weakness. Have we learned nothing from our dealings with Hitler? Nothing from the plight of peaceful India? How can any reasonably intelligent person expect a proven bully to change his ways because his intended victim refuses to protect himself? 8.15

One may as well try to eliminate automobile accidents by cancelling his collision insurance and donating the premiums to a school for poor drivers, as to insure peace by donating money to backward countries. Yet this suggestion has cropped up. The idea of helping backward countries may have some merit but not as a means of insuring peace, and certainly not as a substitute for building shelters. 8.16

"BUILDING SHELTERS MAY PRECIPITATE A NUCLEAR ATTACK"

Remember, communists respect just one thing — strength. A nation protected from nuclear attack is much stronger than one whose citizens are unsheltered. Just as long as the communists realize that they will not gain as much as they lose — they will never attack. A well armed, survival sheltered America is needed to deter a nuclear attack. 8.17

A government believing it might lose 80% of its citizens would be far more compliant than one that knew that 80% of its citizens would survive. Communists have always attacked at a time and place of their own choosing. The theory that a shelter program would cause them to change their timetable can be discarded. It will deter any possible attack. 8.18

If we must die as a result of a nuclear attack, let us at least die fighting for our lives and freedom and not just lie down in the open without even the wits to dig a hole into which to retire for protection. 8.19

"I CAN'T AFFORD A SHELTER"

Maybe the person who says "I can't afford a shelter" really means it. The chances are that this is just a quick and easy way to defer or brush off an unpleasant decision. Millions of Americans live in apartment houses and other places that preclude the possibility of building individual shelters. They have a very special problem. Let us hope the government steps in and makes possible adequate shelter protection for them. 8.20

For the majority of citizens the decision must be a personal one. The FHA guarantees loans for shelters, payable over long periods of time. A good shelter program is financially possible. If a person can afford a $4,000.00 car, a $20,000 home or a recreation room, hi-fi or color TV set and wall-to-wall carpeting he probably can afford a survival shelter. 8.21

Isn't it slightly ridiculous for a person to spend thousands of dollars for a garage to protect an automobile and then balk at spending an equal amount to protect his family? A survival shelter in normal times can be used for many purposes; storage space for food, clothing, household supplies and deepfreeze which otherwise would take up valuable present space. The uses to which a shelter may be put are only limited by a person's ingenuity. 8.22

Summary: Unless the decision to protect your family is made on the basis of common sense and logic, you may well wake up some day to find out, along with all other citizens, that our country has been talked out of free and independent existence and into a communist state; that this was done without the launching of a single missile from a communist pad; that freedom will have vanished and that we all can then say — and really mean it, "I DON'T WANT TO LIVE IN A WORLD LIKE THIS". 8.23

CHAPTER 9

Getting To The Shelter

If a person has a shelter, the big question is whether he and his family will have time to get into it. This depends on many factors that cannot be foreseen; such as geographical location, time of attack, proximity to the shelter, size of community in which he lives and degree of warning. There are two types of warnings that must be considered. 9.01

STRATEGIC WARNING

A typical example of a strategic warning occured on October 22, 1962, the day the United States blockaded Cuba. All Americans were aware that there was a possibility, however remote, that a nuclear attack could follow this action. A strategic warning is signaled by events which in themselves are not sufficient to constitute a war threat but which contain an element of dangerous consequences. This type warning concerns interpretation of events and could provide hours or even days of warning. 9.02

TACTICAL WARNING

A tactical warning is based on information which does not require interpretation. In the event of a nuclear attack, a tactical warning would probably come from our outlying early warning systems. This would provide up to fifteen minutes warning. However, the almost inevitable strategic warning coupled with the tactical warning would be of tremendous significance if intelligent plans for such an eventuality had been made. A tactical warning is not concerned with whether or not there is an attack, but solely with how much time is available before the explosions may be expected. 9.03

ENEMY OBJECTIVES

The very first objective of any enemy attack would be to knock out American retaliatory capabilities. This strategy is essential. Missile launching sites are more dangerous to attackers than civilian populations. Our Strategic Air Command bases, Polaris submarines, hard, soft and foreign missile pads all must be neutralized before the enemy could afford the comparatively unrewarding luxury of bombing American cities. 9.04

POSSIBILITY OF A COMPLETE SURPRISE ATTACK

There is little chance that any aggressor could mount a nuclear attack on the United States and make all the preparations necessary to brace themselves for the inevitable devastating counter attack without tipping their hand. Here is why. A potential enemy must do these things:

(a) Move all their naval vessels into position.
(b) Deploy military forces to exploit the tactical advantages resulting from a surprise attack.
(c) Reinforce garrison troops in presently occupied countries or face uprisings everywhere.
(d) Bolster homeland defenses for the swift disaster that is certain to be visited upon them.
(e) Recall all high government officials abroad at the time.
(f) Prepare all missile and aircraft bases for maximum use.

In addition for the next few years a potential enemy must use aircraft to deliver nuclear weapons. This makes impossible the task of completely concealing an attack. All weapon carrying aircraft must be dispatched hours ahead of the missiles so that the delivery on all targets would be coordinated. These targets would include hundreds of different locations scattered in Europe and North America. 9.05

The timing of such an attack would require almost unbelievable planning, accuracy and good luck to succeed in hiding all the preparation activities from diplomats and other information sources. Our modern technology is such that it would require a miracle for a complete surprise to be achieved even if all other information sources failed. 9.06

A warning time of many hours would only be important if a person already had a shelter. It allows time to use a shelter—not to build one. 9.07

Vast areas of America are so geographically situated that even hundreds of nuclear weapons would not knock out towns in those areas. From the Mississippi River to the Pacific coast states and almost the entire mountainous parts of southeastern and northeastern United States are practically invulnerable to a knockout blow. 9.08

DAY TIME ATTACK

Throughout the country a high percentage of housewives and pre-school children would be at home or close to it at any given minute of the day. With thirty minutes warning it might be possible to pick up school children very close by and get them into the shelter. Here, again, preplanning and a thorough knowledge of local civil defense regulations will pay off in the event of an emergency. 9.09

There would probably be fifteen to thirty minutes with a tactical warning. For people employed in suburban or rural areas who work within several miles from home, there is an excellent chance of getting home in time. 9.10

A no-warning day light attack will force everyone to take whatever cover is at hand wherever they may be. School children will be in the care of their teachers. At this time a terrible price may be paid if a community has planned and built schools without adequate shelters. 9.11

NIGHT ATTACK

Depending on the hour, from 75% to 95% of all Americans would be home if an attack came at night. Due to the time differential between the United States and the Soviet Union, the American night time is the Russian day time. It would seem logical that an enemy attack would occur early in the evening to permit them to absorb the counterattack during their daylight hours. 9.12

With just a few minutes warning, a family could be shepherded into a shelter at home. With no warning, even in a target area, a person observing the flash of an explosion twelve miles away would have one minute to get into a shelter before the blast wave arrived. 9.13

NEAR PROJECT

In order to be certain that even sleeping persons can be alerted, your government has perfected a device which plugs into any electric outlet serviced by a public utility. This box emits a very distinctive signal when our warning system determines that enemy missiles or aircraft are on their way for an attack. It will probably sell for a nominal price. The system is called the NEAR project. Some power stations have already been equipped to trigger the signal. Others are being similarly equipped and the entire system should be operational in the near future. The signal device is automatic and performs the function of a nuclear attack alarm clock. A person's chances of survival are enhanced by the careful planning and preparation which will enable him to make the best possible use of whatever warning time is available. 9.14

PROTECTION AT WORK

If a person works for a farsighted employer he may have a shelter in his office or plant in which he can spend the first critical minute after a nuclear explosion. He may then be able to get home in thirty minutes before fallout starts, providing he has a planned route which does not conflict with Civil Defense regulations. 9.15

PROTECTION AWAY FROM SHELTER

If a person should be caught far from home in strange surroundings when a warning signal sounds, there are several things that can be done to increase chances for immediate survival. 9.16

Try to get inside. A basement corner is best since if offers protection from building collapse. Lie down, curl up and face away from glass or loose objects. Face the wall if in a corner with no windows. Face away from the wall if not in a corner since this increases protection to face and eyes. 9.17

If in the country, try to crawl into a culvert or any low spot protected by the terrain. Get under one end of a bridge or into a ditch. As a last resort slide under a car. 9.18

Anyone remembering to count the seconds between the initial flash and the arrival of the blast wave, can divide that figure by five and the result will provide the approximate mileage from the ground zero of the explosion. 9.19

Summary: Even if a family is somewhere else when an attack occurs, a home survival shelter is a worthwhile haven, a meeting place in which to ride out the storm of a world gone crazy. The peace of mind that goes with at least making the effort to protect a family makes the project well worthwhile. That is the pessimistic side of the coin. At best the shelter will provide protection for members of a family who are home or close to home in the event of an attack. The alternative is a simple, duck under the kitchen table and pray situation. A shelter will provide a family with as much physical security as can be obtained in a nuclear world. 9.20

CHAPTER 10

Nuclear Attack Possibilities

Building a nuclear survival shelter is something like buying insurance. It's a good idea to investigate the reason for the policy, its cost and the extent of protection or coverage that can be expected. On the basis of available information, certain estimates can be made about the form an initial nuclear attack might take and the general outline an ensuing nuclear war might follow. 10.01

ESTIMATES OF COMMUNIST ATTACK CAPABILITY

An Office of Civil and Defense Mobilization (now called the Office of Emergency Planning) study in 1959 showed an attack pattern presumed to involve the use of 263 nuclear weapons by an enemy. The study assumed each bomb to be 20 megatons or smaller with a total attack force of about 3,000 megatons. These 263 bombs would be aimed at 224 targets. 10.02

Other United States government sources have estimated that the communists would have from 300 to 1,000 intercontinental ballistic missiles (ICBM's) by mid 1962. In 1961 another government authority thought that the communist arsenal contained 35 to 50 nuclear tipped ICBM's. By the end of 1962 the nuclear weapon stockpile was estimated to contain 80 nuclear bombs and associated delivery hardware (ICBM's). Intercontinental ballistic missiles are not in themselves a threat. They are the means of delivering nuclear warheads on target. 10.03

NUCLEAR ATTACK WEAPON SIZES

The effectiveness of a nuclear weapon does not progress geometrically according to size or yield. A 50 megaton bomb is not 2½ times as devastating as a 20 megaton bomb. Therefore, the chances are that smaller yield bombs would be used in an attack. The largest to be expected; 20 megatons. 10.04

Twenty megaton bombs are less expensive, use less precious nuclear material and are easier to deliver than 50 megaton bombs. A 20 megaton weapon will do about two thirds as much damage as a 50 megaton bomb. 10.05

NUCLEAR ATTACK PATTERN

An estimate that appears to be possible for the next few years would comprehend the delivery of between 300 and 500 nuclear weapons by an enemy. These would be delivered in a mixture of air and ground bursts. Each bomb would be 20 megatons or smaller. They would be aimed at about 300 target areas. These areas would include all missile sites, military bases and probably basic steel, chemical and oil industrial complexes. 10.06

POSSIBLE METHODS OF BOMB DELIVERY

In the immediate future (until 1965) these weapons would probably be delivered about 40% by missiles and the balance by a combination of aircraft and probably some seacraft. After 1965 the percentage of bombs delivered by missile would increase fairly rapidly until practically all weapons used in an attack would be delivered in this manner. This appraisal of the delivery technique possibilities is just one persons opinion based on information available to everyone. 10.07

NUCLEAR ATTACK TIMETABLE

It would seem self evident that in the event of a nuclear war a big percentage of an enemy's nuclear weapons would be launched immediately. This must be done in an effort to achieve a knockout blow. However, if all the weapons were fired in the initial attack and something went wrong the assailant would be a sitting duck. Therefore, a kind of balance must be maintained by an aggressor. 10.08

The percentage of weapons fired in the first hour or day of a surprise attack would probably run about 50% to 70% of the total available to the enemy. These weapons would be used for strategic purposes. The balance of the bombs would be divided into two categories. About 20% to 40% to be used during the first 30 days of the war for tactical purposes. Tactical targets would include targets still intact after the initial attack and other locations which posed a problem to the attacker. 10.09

The approximately 10% of weapons remaining would probably never be fired. To do so would completely denude the attacker militarily. With even a few bombs left they would be in a position to use nuclear blackmail even if almost completely wiped out. With these bombs they might try to place America in the same position that we occupied after the Korean war. You will remember that we then achieved the almost impossible—we snatched defeat from the jaws of victory. 10.10

POSSIBILITY OF INVASION

If communist agents reported that enough of our people and facilities were destroyed, and if there were enough enemy survivors, an invasion of our country might be attempted. This must be done before we had a chance to bring our resources to bear on the problem and after the radiation had subsided or decayed to a reasonably safe level. This would be approximately between two weeks and six weeks after the initial attack. 10.11

There are other invasion risks that must be considered, and which could form the basis for an entire book. This is neither the time nor place to go into detail about them. However, there are so called neutrals who might take advantage of a weakened, tormented America to try what they would never dream about while the United States was powerful and strong. While some of these neutrals are genuinely friendly to us, they are subject to political developments which could change their attitude practically overnight. Cuba is a typical example of this type of change. We cannot afford to overlook any eventuality when our very life as a nation may hang in the balance. 10.12

TARGETS

Every attack target must be counted on to receive at least one bomb. Many of them may receive a second bomb if they are extremely dangerous to the enemy. The absolute limit that any target would be likely to receive would be three bursts. There would be few, if any, of these areas. In a suitable shelter, a person will be safe unless he is less than about two miles from ground zero of one, two, or at most, three nuclear bomb explosions. The enemy is more noted for the power of their ICBM's than for the accuracy of their missile guidance systems. 10.13

Out of a total of between 224 to 300 target areas, the enemy could not spare more than one or two weapons for any one target. Within a radius of 30 miles from ground zero there are 2,800 square miles. The area in which there would be almost complete devastation from a 20 megaton explosion would be only 28 square miles (3 mile radius). 10.14

CHANCE OF SURVIVAL

A majority of people living in a target area and over 90% of all other Americans can survive a nuclear attack if they are in suitable shelters. Persons protected in a shelter anywhere within 30 miles of a target would have a 100 to 1 chance to survive one nuclear burst. Obviously the odds decrease the closer anyone gets to the target and increase further away from the target. 10.15

CHAPTER 11

Essentials For Survival

Air, water, food, fire (heat energy), clothing, shelter (from natural elements), tools, utensils, medicine and electricity are essentials for survival. These are generally considered to be necessary for man's survival under any circumstances. We can exist without the last four items on the list. Mere existance is not enough if we are to rise up after an attack and rebuild our civilization. 11.01

The first three essentials (air, water and food) must be available in order to remain alive. The second four (fire, clothing, shelter and tools) are almost as necessary. But it is conceivable that we could survive for some time without them. The last two items are comparatively new to our civilization. 11.02

A survival shelter should have as many sources as possible for each of the first four necessities. In planning survival facilities, arrangements must be made for adequate supplies of each necessity before the need arises. A person must know how necessary they are, how difficult they may be to obtain and the estimated time before they may become available to citizens after an attack. 11.03

AIR

The most essential element of life is air. A person can live for only about five to eight minutes when deprived of air. 11.04

Air is abundant; it is free, it is everywhere. It does not normally need processing. It does not need to be grown, transported, cooked or purchased. It merely requires filtration by well known, simple methods to insure its availability during and after a nuclear attack. 11.05

OXYGEN CONCENTRATION IN AIR

A minimum oxygen concentration of 16% in air is necessary to sustain life. An oxygen concentration analyzer is available which provides oxygen concentration percentages. It is simple to operate but is expensive. 11.06

CARBON DIOXIDE CONCENTRATION IN AIR

A carbon dioxide concentration in excess of 3% in air can be fatal. A carbon dioxide test unit is available to provide concentration information. It is inexpensive but complicated to use. 11.07

AIR SUPPLY METHODS

Survival shelter air can be supplied by several methods:

(a) A blower powered by public utility electricity.

(b) A blower powered by generator electricity.

(c) A blower manually operated by a hand crank.

(d) Emergency oxygen cylinders, commercially available. Oxygen cylinders contain 244 cubic feet of 99% pure oxygen. They would be quite expensive for shelter storage due to the cylinder cost. 11.08

CARBON DIOXIDE REMOVAL BY SODA LIME

It is possible to insure a supply of good air in temporarily sealed shelters by using soda lime to remove excess carbon dioxide. This technique in conjunction with the use of makeup oxygen from cylinders can be used in times of emergency. Soda lime regenerates itself continuously by chemical reactions. Eventually it becomes completely saturated and can no longer regenerate. It must then be discarded and replaced. The indicating type which changes color from white to pink when it is becoming saturated should be used. 11.09

CARBON DIOXIDE REMOVAL BY ZEOLITE

Another system, for removing waste gases from a sealed chamber containing three people (a spacecraft), has been developed by a large chemical company. During a period of 720 hours (30 days) more than 210 pounds of carbon dioxide (1.1 pounds per person per day) can be trapped by a substance called Zeolite, which may be used indefinitely. The carbon dioxide when trapped may be expelled from the chamber or shelter. This system, if it is made available for shelter use, could solve one of the biggest air purification problems when used in conjunction with a supply of cylinder oxygen. 11.10

WATER

Man can survive only a few days without water or substitute liquids. Water is less abundant than air. It is normally available in a potable form from lakes, rivers, streams, rainfall and from underground reservoirs called water tables which may be tapped by wells. 11.11

WATER AND RADIOACTIVITY

Water shares one peculiarity, among others, with air. In a pure state neither can become radioactive. Only impurities consisting of fallout made radioactive by the nuclear explosion can radioactively contaminate air and water. Dust particles in air and solids suspended in water can and do become radioactive and thereby transmitters of nuclear radiation when they have been directly charged by the nuclear explosion products. Fortunately the earth acts as a gigantic and effective filter. Water from a moderately deep well will usually be free from radiation and can be safely used due to its underground source. 11.12

RESERVOIR WATER

If reservoirs are a persons main water source there is a chance that his supply may become contaminated. Regular normal water treatment including coagulation, sedimentation and filtration techniques will remove contamination. 11.13

When reservoir water is merely chlorinated it may be unfit to drink for several days after an attack. Dilution and natural radioactive decay will cause the contamination to decrease with time. 11.14

WARNING—Boiling fallout laden water is of absolutely no value in removing radioactivity. 11.15

SHELTER WATER SOURCES

Shelter liquid supplies can be made available by these methods:

(a) A 550 gallon or smaller water storage tank.
(b) Water extracted from shelter atmosphere by the dehumidifier.
(c) Canned water, fruit juices, soft drinks and broths.
(d) Contents of the hot water heater if the tank was shut off from the usual supply before the nuclear attack.
(e) A well.

Water may also be available from a supply previously stored in plastic containers shortly before an emergency. 11.16

FOOD

All food must be grown. This takes time. It is not possible to speed up the process appreciably. Much that we eat today must be dug or picked, processed, transported, warehoused, distributed and purchased. 11.17

In a normal peacetime economy this is a time consuming process. Imagine how much longer it would take to do all these things after an attack. Then the whole process would be complicated by special soil tests and preparation, partially destroyed processing facilities, crippled transportation, burned out warehouses and sharply curtailed distribution facilities. 11.18

Consider these examples. It takes anywhere from 3 months to 3 years to bring meat to market. Vegetables spend as much as 6 months in transit to the consumer. This is the situation in peacetime with everyone cooperating, everything going smoothly and a surplus of food in almost every category. 11.19

We must assume that most of our foodstuffs will go up in nuclear smoke in the event of an attack. Some will be burned, some blasted to pieces and much will be contaminated. A lot will just rot for lack of refrigeration, transportation, warehousing or people to process it. 11.20

FOOD WAREHOUSING

Remember that almost all processed food is stored in warehouses located close to large population centers for rapid and easy distribution. Unfortunately this logical peacetime system makes our food supply extremely vulnerable in the event of a nuclear attack. 11.21

To lessen this danger to our vital food supply the government might encourage the building of underground warehouses. Fast depreciation tax write off certificates have been issued to business in the past for far less important facilities. 11.22

There is one place where food, already admirably packaged for warehousing, can be stored safely, conveniently and economically—in a person's own home. More specifically in his own survival shelter. 11.23

FOOD SUPPLY REQUIREMENTS

As an absolute minimum, a 90 day supply of food is recommended. A six month supply is more realistic. A 24 month supply would not be beyond the realm of common sense. This does not mean that a person and his family would spend 3, 6 or 24 months in a shelter, but they will need food from their own supply when they do emerge from the shelter. (See Chapter 15 for complete shelter menus and shopping lists.) 11.24

By sound planning, and possibly after making a few minor sacrifices, anyone can gradually build up a reserve supply of food. A reserve which will see them through any emergency up to and including a nuclear calamity. 11.25

This type planning should give a person great peace of mind. It will also ease the tremendous burden his government will bear in feeding others who could not or would not prepare for a nuclear emergency. Again, remember, the better prepared we are—the less susceptible our government will be to nuclear blackmail. Our efforts will also help to decentralize and disperse food supplies which in turn will aid in eliminating wartime distribution problems. 11.26

FIRE AND HEAT ENERGY

Fire or heat energy consists of heat energy for cooking, for maintaining a comfortable atmosphere and for lighting. Heat energy for these three purposes is not as abundant as air or water. It is more abundant than food. In normal times there are many sources of heat energy: electricity, propane or natural gas, wood, coal, charcoal, alcohol, candles and kerosene. These possible sources of emergency energy are reviewed below. 11.27

ELECTRICITY

Electricity is useful for all three purposes of cooking, heating and lighting. It is the only source of energy that meets all three requirements. It provides the best illumination and shelter cooking energy. When used for cooking it does not burn valuable oxygen. It has one major drawback; it cannot be conveniently stored. There are two possible sources of readily usable electricity in a survival shelter. 11.28

PUBLIC UTILITY ELECTRICITY

Public service utility electricity may, and probably will, be subject to frequent interruption if not outright power failure in the event of a nuclear attack. Whenever it is available this power should be used for lighting, heating and cooking in a shelter. This source should be first choice for use with electrically powered utensils such as hot plates, frying pans, heating pads and coffee makers. 11.29

GENERATOR ELECTRICITY

Generator electricity is an excellent replacement for public utility electricity. It should never be used when utility power is available because generator power can be stored in the form of the fuel oil upon which the generator operates. When a generator is used the energy expenditure for heating, ventilation and cooking should be planned so it runs for the shortest possible time. All electrical chores should be arranged and charted to get maximum power usage for a limited time each day, up to the limit of the generator capacity. This conserves fuel. All electrical needs except lighting may be taken care of in one hour a day or in a short time as possible. Care must be taken in planning generator use to make certain that generator capacity is not exceeded. 11.30

BATTERY ELECTRICITY

The third source of emergency shelter electricity is battery power. It should be used mainly for emergency lighting and for powering portable radios. While batteries have the advantage of being storable, they are not long lived enough to count on for much more than a few days use unless they are used for occasional service. Then they may last for a few months. They are useful and necessary but they also have serious limitations. There are several exceptions. 11.31

Flashlights that can be recharged by plugging into an electrical outlet seem to be a more dependable source of emergency lighting. Main utility or generator electricity must be available often enough to make recharging feasible if rechargable flashlights are to be of much service. 11.32

A storage battery can be useful for radios, emergency lighting, generator starting and other light or intermittent electrical chores. A storage battery may be kept charged by plugging it into an electrical outlet when either utility or generator power is available. This requires a battery charger unit. Another device which is pedaled like a bicycle is on the market. It permits charging the storage battery solely by foot power. 11.33

PROPANE AND NATURAL GAS

Gas is useful for cooking and heating under normal conditions. Natural gas cannot be stored. Propane can be stored but the chance of an explosion due to the possible heat of a nuclear burst makes the storing of gas in or near a shelter hazardous. Gas burns precious oxygen in a shelter. The use of gas in a survival shelter is not recommended. 11.34

COAL

Coal has just one advantage. It can be stored. It is hard to ignite, control and extinguish so that it can be reignited. It burns precious shelter oxygen and gives off noxious gases. No coal in a shelter. 11.35

WOOD

Wood is abundant and excellent for cooking, heating and incidental lighting. It can be stored. It burns oxygen and requires a flue. Wood may be useful in the shelter lock (12.07) for post attack use when radiation levels have decayed to a safe level but before normal organic fuels are available. Wood cannot be used in the primary shelter. 11.36

CHARCOAL BRIQUETS

Charcoal can be stored and contains more heat energy per cubic foot than wood. It consumes oxygen and in a shelter gives off noxious gases. While it would be excellent for post shelter use it is definitely dangerous for shelter cooking. 11.37

ALCOHOL

Alcohol must be considered the first choice substitute for electricity for use in cooking. It is available in canned solid form in stores and is easily and conveniently stored in small containers which are easy to ignite, extinguish and reignite. It does burn oxygen. Alcohol may be used for emergency shelter cooking when electrical services are unavailable. 11.38

CANDLES

Candles are easily stored. They are useful for emergency lighting and for heating small quantities of food. They burn oxygen. Long thin candles are best for lighting and short thick candles for heating food. They may be used in a shelter in the absence of anything better. 11.39

KEROSENE

Kerosene is mainly useful for lighting. It is dangerous to store, burns oxygen and can create smoke. It is not for shelters. 11.40

CLOTHING

Clothing is a subject to which much thought should be given. Not only for the comparatively short period of actual attack but for the intermediate period after the attacks and before a return to nearly normal sources of clothing. The discussion of clothing here is divided into three groups; adults, teenagers and children. Generally all clothing should be selected for its warmth and durability—not its style or fashion. 11.41

ADULTS

Adults should not be too much of a problem. Having achieved their full growth, most adult sizes become to a degree static. Most adult outer garments are discarded for esthetic rather than functional reasons. They are out of style or worn. Very seldom do they stop being a protective covering—shielding the wearer from the elements. Most adults could get by in an emergency for 2 or 3 years with the clothes they have. 11.42

MEN

Men should have on hand a 36 months supply of the following articles:

Undershirts	Handkerchiefs	Belts
Shorts	Sweaters	Scarves
Socks	Shoes	Gloves
Shirts	Overshoes	Raincoats
Pajamas	Jackets	Slacks
Hats	Overcoats	

11.43

WOMEN

Women should have on hand a 36 months supply of the following articles:

Panties	Girdles	Overcoats	Scarves
Brassieres	Jackets	Raincoats	Sweaters
Blouses	Shoes	Skirts	Slacks
Stockings	Overshoes	Gloves	
Slips	Handkerchiefs	Night clothes	

11.44

TEENAGERS

Teenage clothes would be the same general types worn by adults. Denims and other long wearing, inexpensive and easy to maintain materials should be favored. Teenagers should have a 36 months supply of clothes with due consideration for growth possibilities. 11.45

CHILDREN

Children's clothes would be similar in types to adult clothes. There are some special needs of infants and very small children. These needs are listed below:

Diapers	Rubber pants	Sweaters
Shirts	Vests	Night clothes
Hose	Shoes	Hats
Coats	Coveralls	Gloves

Special care must be exercised in gauging probable child growth over a 36 months period. This is especially true of these articles for children: shoes, socks, underwear and trousers. It is much better to store clothes on the large side since oversize garments are more comfortable than undersize ones. Children can always grow into oversize clothes. 11.46

GENERAL SHELTER CLOTHING SUGGESTIONS

Shoes—Sneakers or comfortable slippers would be especially suitable for shelter wear for the entire family. Since activity would be somewhat restricted (that's the understatement of the year) the usual shoe problem of normal existence should be less acute. Preference should be for thick soled, long wearing shoes for protection when it is safe to leave the shelter. These shoes definitely should be on the large side for children. They may then be worn over slippers or padded by wearing extra socks to get maximum use from them. 11.47

White Coveralls—These coveralls mentioned elsewhere (Guide 16.03) are especially suited for wear outside the shelter. Large, and many small, particles of radioactive dust can easily be seen on them and brushed off. The one piece type construction keeps out much fallout laden dust. 11.48

Old Suits and Overcoats — Men, especially, should keep suits and overcoats which would ordinarily be discarded. Reason: It may be necessary, at some time immediately after an attack, to leave the shelter for a few minutes for a dire emergency. Clothing exposed to such high radiation should be discarded and not brought back into the shelter. An old suit or coat will provide as much protection from radiation as a new one. 11.49

After an attack we do not know what we will find when we finally leave our shelters. Maybe the government will not be able to provide food, medicine and clothing for some time after an attack. It may have to concentrate on defense hardware. It will be up to each of us to have on hand the dozens of small items upon which we depend to live, but which we take so much for granted in our normal everyday life. 11.50

HAND TOOLS

There are certain hand tools that are inexpensive and practically indispensable. These and other very useful tools and items of equipment are listed below as a checklist. These tools should enable anyone to make minor repairs, remove debris and perform general utility chores. The 12 foot ladder makes an excellent emergency stretcher and a good bridge if one is needed. 11.51

HAND TOOLS

1. 1 hoe
2. 1 crowbar
3. 1 wrecking bar
4. 1 sledgehammer
5. 1 pick (point & chisel)
6. 1 coal shovel
7. 1 axe
8. 1 hatchet
9. 1 block & tackle
10. 1 claw hammer
11. 1 hacksaw w/10 blades
12. 1 pair wire clippers
13. 1-50 ft. length Manila rope (½")
14. 1-12 ft. ladder
15. 1-50 ft. water hose
16. 1 ball peen hammer
17. 1-2 man manual wood saw
18. 1 spade
19. 1 pr. rubber insulating gloves
20. 2 steel wedges
21. 1 soldering (non-electric) iron
22. 1 monkey wrench
23. 1 crescent wrench
24. 1 set open end wrenches
25. 1-6-ft. carpenters rule (folding)
26. 1 measuring tape
27. 3 assorted screwdrivers (slotted)
28. 1 carpenters crosscut saw
29. 3 assorted screwdrivers (Phillips head)
30. 1 hand drill
31. 1-1" augur bit
32. 1 set drills
33. 1 set wood chisels
34. 1 cold chisel
35. 1 adapter, water hose to basin
36. 1 set files
37. 1-24" stillson wrench
38. 1 pair vise grip pliers
39. 6 ft. 5000 lb. close link chain w/grab hook and ring
40. 1 putty knife
41. 6 brainard tel-o-posts (telescopic jack posts)

Guide 11.51

MEDICINE

There are certain medical supplies so basic that they would be found in almost every medicine chest. These items plus others useful for handling minor aches, pains, cuts and bruises are listed as a reminder for persons stocking a shelter. Don't forget to include special medicines presently required or that may be required in the foreseeable future. 11.52

MEDICAL SUPPLIES

1. Sleeping pills (for children)
2. Aspirin
3. Baking soda
4. Boric acid
5. Petroleum jelly
6. Anti-acid powder
7. Band aids
8. Laxative
9. Hydrogen peroxide
10. Burn ointment
11. Toothache drops
12. Milk of Magnesia
13. Non-habit forming pain pills
14. Ammonium ampoules
15. Styptic pencil
16. Bandage scissors
17. Rubber gloves
18. Elastic bandage tape
19. Eye drops with dropper
20. Water purification tablets
21. Medicones
22. 1 roll gauze bandage
23. 4 triangle bandages
24. 3 ace bandages
25. 2 padded splints
26. 1 tourniquet
27. 6-4 x 4 gauze pads
28. 6-2 x 3 gauze pads
29. ¾″ wide adhesive tape
30. Tongue depressors
31. Q-tips
32. Baby powder
33. Baby oil
34. Sanitary napkins
35. Red Cross First Aid Book
36. Home medical book
37. Hot water bag
38. Antiseptic solution
39. Salt tablets
40. Vitamins
41. Medium first aid dressings 8″ x 7½″
42. 1″ adhesive compress
43. Tweezers
44. Assorted tubular bandages

Guide 11.52

SHELTER FROM THE ELEMENTS

Shelter from the elements refers to shelter in its basic pre-nuclear meaning. Shelter from rain, cold, snow, sleet, hail, heat, tornados, cyclones, floods and hurricanes. Fortunately a properly designed survival shelter automatically protects against almost all the natural elements. 11.53

There can be problems with heat and cold in a survival shelter. Since most shelters are covered by considerable earth and concrete, the range of temperature should be comparatively narrow due to the natural insulating qualities of these two barriers. In some deep mines the temperature seldom varies more than a few degrees from 75°F regardless of surface temperatures. In a shelter without artificial heating or cooling, the temperature should never go below 50°F or above 85°F. The actual range of temperature in a BOSDEC type shelter is estimated to be between a low of 60°F and a high of about 80°F. 11.54

The shelter should have a wool blanket for each occupant.

While shelter temperatures may not always be cozy by normal standards, the shelter would be livable without any artificial heating or cooling. 11.55

The exact temperature of any shelter depends on many variables including the following:

(a) Depth of shelter.
(b) Barrier materials used.
(c) Time of year.
(d) Size of shelter.
(e) Number of occupants.
(f) Amount of heat generated by cooking, etc.
(g) Part of country in which the shelter is located. 11.56

CHAPTER 12

BOSDEC

To understand this new shelter concept it may be necessary to discard many preconceived notions about survival shelters gleaned from other sources. There is no such thing as an economical bomb shelter. One might just as well talk about an economical war. Neither exist. The object of a shelter is not to save money. It is to protect and save lives. This does not mean that intelligent planning must be abandoned in favor of thoughtless spending. 12.01

Conditions for each family, each home will differ markedly. Terrain, type of original house construction, financial resources, size of family and geographical location all bear directly on shelter requirements. Perhaps no one will want to build a shelter and equip it in exactly the manner described here. This does not matter. 12.02

BOMB SHELTER IN DEPTH CONCEPT

Instead of dogma the BOSDEC or bomb shelter in depth concept provides building block units of safety and convenience. How much of the system you will need or use is entirely up to you. The decision is yours alone. The ultimate responsibility for the safety and security of your family will also be yours. From BOSDEC it is hoped you will find enough information, in factual form clearly explained, to make the proper decisions. 12.03

BOSDEC SYSTEM PRINCIPLES

BOSDEC is based on the centuries old defense in depth principle used by ancient Roman legions and modern armies alike. Basically the plan places a shelter within a shelter and provides dual barriers between the weapon effects (blast, heat and fallout) and the shelter occupants. Maximum application of this principle will protect shelter occupants from the hazards of air or ground nuclear bomb bursts created by a 20 megaton weapon at any point more than 2.3 miles from the shelter. The BOSDEC shelter will provide complete protection even closer to ground zero of smaller yield nuclear bomb bursts. It provides both geometry and barrier shielding. BOSDEC consists of three sections or areas. 12.04

PRIMARY SHELTER

The primary shelter is the center or heart of the system. It is the place where you and your family will ride out the effects of a bomb explosion, direct nuclear radiation, thermal radiation, firewinds, blast wave and early fallout. The primary shelter occupants can safely stay in this section for up to 24 hours with all ventilation intake and exhaust ports closed. This can be done without using supplemental oxygen supplies and without the necessity of carbon dioxide absorption. The primary shelter is sunk five feet below the surface of the ground. It is surrounded on three sides by earth. The fourth side opens into a basement room called the secondary shelter. 12.05

SECONDARY SHELTER

The secondary shelter is directly below the home and has most of the protective features of the primary shelter. One main exception; the secondary shelter does not have an earth cover. Both the primary and secondary shelters have two feet thick reinforced concrete ceilings. But the primary shelter has a five foot thick earth cover over the concrete ceiling. A one foot reinforced concrete ceiling plus seven feet of earth cover would be just about as effective and much less expensive. The secondary shelter has a protection factor of 2000 (6.07) and could be occupied as soon as the outside nuclear radiation level has decayed enough. Since it is an integral part of the home, it could be occupied in normal times by a member of the family as a self contained apartment. The secondary shelter is connected to the outside by another basement room called the shelter lock. 12.06

SHELTER LOCK

The shelter lock is the third section or area of the BOSDEC system. It contains a fireplace for heat and cooking after safe radiation levels are reached but before complete return to normal outside conditions. The shelter lock may also be stocked with a supply of firewood to service the fireplace. Shelter refuse, well sealed pending permanent disposal by burial outside, may be placed in the shelter lock temporarily. The shelter lock can have any type ceiling but a minimum of four inches of reinforced concrete is recommended. 12.07

The net effect of these three sections of the BOSDEC system is to provide a weather tight concrete apartment that contains rooms providing varying degrees of nuclear explosion protection in event of attack and also permits near normal living in the post attack intermediate period. This apartment may be all that remains if the residence overhead is destroyed. 12.08

COLLATERAL BOSDEC ADVANTAGES

There are certain other advantages to the BOSDEC principle. Ready access into one's basement is important to persons with claustrophobic tendencies. Children may use the primary shelter as a playroom in normal times. These factors are especially important since the more familiar one becomes with the shelter, the less disturbed he will be when the need arises that forces him to use it for survival. 12.09

BOSDEC BASIC REQUIREMENTS

The BOSDEC system requires that certain criteria be met if a person is to take full advantage of all the provisions of the maximum features designed into it. To use a presently existing home it must have a below grade, windowless basement surrounded on at least three sides by earth. The basement should be at least 20 feet by 30 feet, preferably larger. The ceiling should be 90 inches high and at least 4 inches thick reinforced concrete, preferably thicker. The walls must be concrete or concrete block. 12.10

PRIMARY SHELTER SPECIFICATIONS

Ideally, the BOSDEC shelter system should be built into a new concrete or concrete block type house perched on a hillside. The basement should be reinforced poured concrete. The basement layout should provide adequate space for the secondary shelter and shelter lock and the necessary construction features which BOSDEC requires. Shelter walls and ceilings could be incorporated in the foundation construction and basement planning. The excavation for the primary shelter could be accomplished at minimal expense if done at the same time. The primary shelter must be at least a few feet above the water table. Unfortunately all these ideal conditions will not exist for most of us. Existing homes must be analyzed to determine what parts of the BOSDEC principle can be used. This much is certain; almost every home can use some of the BOSDEC features. 12.11

PRIMARY SHELTER DESIGN FEATURES

The primary shelter is designed to provide:

(a) Sufficient air for four occupants for 24 hours or for six occupants for 16 hours without outside ventilation or resort to mechanical or chemical methods of air supplementation.

(b) Protection from an overpressure of 100 psi (a 50 megaton burst creates 80 psi at two miles from ground zero).

(c) A roentgen reduction or protection factor of 10,000. Actually the maximum BOSDEC system insures a protection factor of several times 10,000.

(d) 600 cubic feet of space for each of four occupants.

(e) 90 square feet of space for each of four occupants.

(f) 15 cubic feet per minute of fresh air for each of four occupants. This air to be supplied by an electrical blower with a manual override and incorporating a glass filter on the intake port.

(g) One gallon of stored water per day for each of six occupants for ninety days.

(h) Space for storing a ninety day supply of food for six occupants.

(i) An alternate escape route to the surface.

(j) A baffled entrance, surrounded by an 18 inch high concrete water barrier dam to keep possible water from entering primary shelter area from the secondary shelter area. 12.12

PRIMARY SHELTER VENTILATION

The BOSDEC system is designed to permit complete closing of ventilation intake and exhaust ports for a period of from 16 to 24 hours without requiring any other method of oxygen supply. This is desirable to insure protection from thermal radiation, firewinds and the positive and negative stages of the blast wave and its accompanying blast winds. 12.13

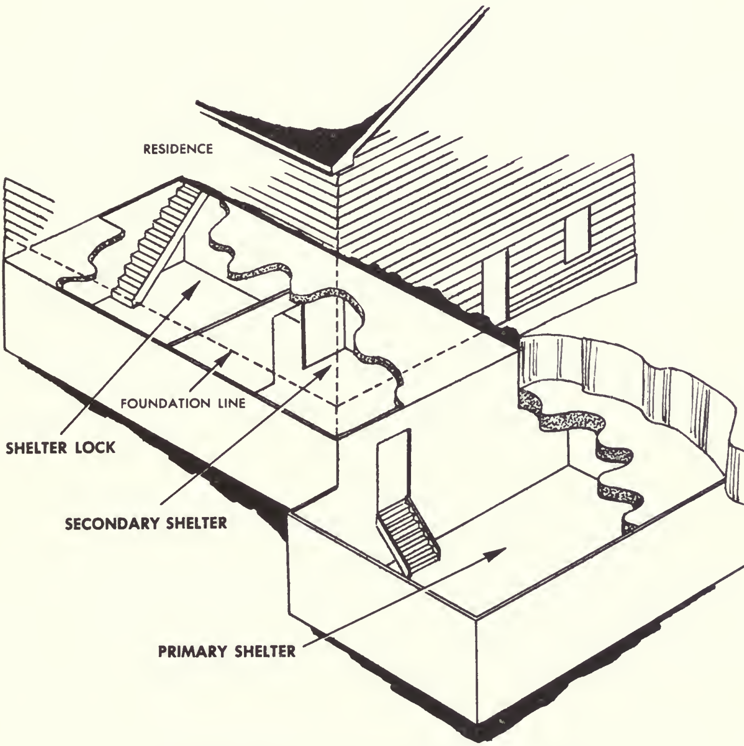
Automatic check valves should be installed on all external stacks such as intake and exhaust ports, etc. These check valves should also embody provisions for closing and locking them closed manually from within the shelter. 12.14

It is necessary to know the net cubic feet of space required to safely permit a specified number of occupants to stay in a shelter for 24 hours and shorter periods without outside ventilation. This information is given in guide 12.15

PRIMARY SHELTER AIR CHANGES

Occupants	1 Air Change Per Day	2 Air Changes Per Day	3 Air Changes Per Day
2	1200 cubic feet	600 cubic feet	400 cubic feet
3	1800 cubic feet	900 cubic feet	600 cubic feet
4	2400 cubic feet	1200 cubic feet	800 cubic feet
5	3000 cubic feet	1500 cubic feet	1000 cubic feet
6	3600 cubic feet	1800 cubic feet	1200 cubic feet

Guide 12.15



Cross Section of BOSDEC System

Guide 12:16

CHAPTER 13

How To Meet BOSDEC Specifications

GENERAL CONSTRUCTION

The best nuclear survival shelter is provided by reinforced poured concrete heavily framed with steel and designed to be earthquake resistant. It is better able to withstand blast than brick and cinder or concrete block. Poured concrete produces much less flying debris than either brick or block when damaged. Even an aboveground reinforced poured concrete building will be only moderately damaged by overpressures up to 10 psi, which is the overpressure created 5 miles from ground zero of a 20 megaton burst. Good building factors are resilience and ductility of frame, strong beam and column connections and plenty of support and diagonal bracing. All concrete should have a compressive strength of 3000 psi or more. Concrete construction should conform to the specifications of "Building Code Requirements for Reinforced Concrete (ACI 318-56)". A copy of this publication may be obtained from "The American Concrete Institute, P. O. Box 4754, Redford Station, Detroit 19, Michigan." Price—one dollar. 13.01

Concrete costs about $55.00 per cubic yard including cost of forms and eight pounds of reinforcing steel per cubic yard. If cinder blocks are used for survival shelter construction, they should be filled with earth for greater density and more barrier shielding. 13.02

PRIMARY SHELTER CONSTRUCTION

The two foot thick roof of the primary shelter can be built in two 12-inch layers. The first layer is the ceiling of the shelter and is structural and should be reinforced. The second 12-inch layer is used as a radiation shield only and need not be reinforced. 13.03

The top of the shelter roof should be at least five feet below a well tamped and seeded grade. The use of an aerodynamic mound contour can reduce the incidence of blast reflection. This earth cover serves to buttress the shelter. The roof, outside walls and floor of the primary shelter should be protected by a vapor barrier consisting of six mil black polyethylene insulating plastic. Inside and outside walls should be further protected on both sides by a moisture resistant coating. The ground above the shelter should be sloped one half inch in each foot for effective drainage unless an aerodynamic mound contour is used. The walls should be 16-inch and the floor 18-inch reinforced concrete. The hermetically sealing entrance door should be reinforced concrete in a gasketed steel frame. 13.04

All electrical wiring in the BOSDEC shelter should be installed through conduits. The primary shelter should have a baffled entrance with no fewer than two right angle turns. This is important since radiation, like light, has a tendency to travel in a straight line. A floor drain or sump in the center of a gently sloping primary shelter entrance area may be useful depending on circumstances. When built into a shelter, the drain should lead through good drain pipe to a dry well prepared prior to building the shelter. 13.05

Under certain conditions it may be desirable to install a 24-inch or 36-inch thick by 4-inch square shelter observation window. Properly placed it would allow outside observation with safety. The window is also an effective radiation shield. Gamma ray absorbing, special windows are made by adding a large percentage of lead oxide to the glass. This can increase the weight of the glass to 390 pounds per cubic foot or almost the weight of steel (480pcf). Ordinary glass with excellent visual characteristics has been made up to 141 inches (11½ feet) thick. 13.06

EMERGENCY ESCAPE HATCH

There is always a possibility during a nuclear attack that the main shelter entrance might become blocked by debris from a collapsing house or other material. To guard against such a catastrophe an emergency exit should be incorporated in the primary shelter. This can be done by embedding several securely joined sections of 48-inch diameter reinforced concrete sewer or water supply pipe in the shelter wall or ceiling. The type with rungs for climbing up or down should be specified. 13.07

This pipe should extend straight up or outward at an angle of about 30 degrees to permit easy ascent by an average person. The pipe section coming to grade should have a water and air tight gasketed metal cover which covers the exit end of the pipe about one inch below the outside grade. The surrounding grade should be sloped one half inch in each foot for drainage and should be well tamped and seeded. A gasketed metal cap or cover should be placed at the inside shelter terminal and kept in place by suitable stainless steel bolts. The entire length of pipe can then be filled with clean dry sand preferably on a very dry day. A package of food or other vital necessities may be placed in a sealed plastic container and stored in the sand near the exit end of the pipe. This package could always be reached from outside the shelter in the event the owner could not get into the shelter. 13.08

GENERATOR AND BLOWER INSTRUCTIONS

Complete and detailed instructions on how to operate, adjust and make minor repairs to the generator, air intake motor blower, filter and exhaust systems should be posted in the primary living quarters and also in the generator and air intake rooms. Special instructions for servicing the air filters, including how often to change them, should also be posted. The exact location of replacement filters and spare parts should also be listed. This can be extremely important. 13.09

PRIMARY SHELTER COMPARTMENTS

The primary shelter should be divided into four compartments or rooms, the walls of which should be load bearing. These four rooms are the living quarters, including the storage section for food, tools and supplies; the air intake and filter area; the water tank compartment; and the generator and air exhaust room. 13.10

PRIMARY SHELTER LIVING QUARTERS

The primary living quarters should contain the following items. Control valves and switches should be grouped together and clearly marked as to function:

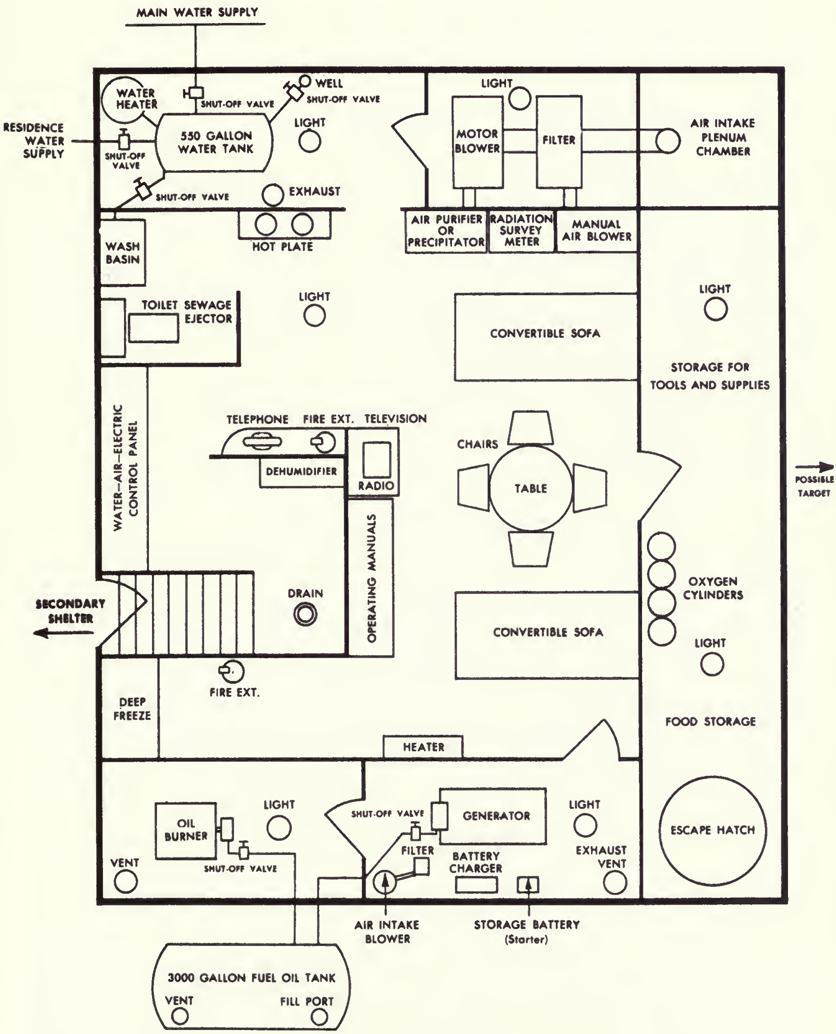
1. Water supply control valve for residence.
2. Water supply control valve for shelter.
3. Electric switch for main utility power for residence.
4. Electric switch for controlling generator.
5. Control valve for fuel supply tank to oil burner.
6. Control valve for fuel supply tank to generator.
7. Control valve connecting well to water storage tank.
8. Electric switch controlling motor driven well pump.
9. A 24 or 36-inch thick by 4-inch square observation window.
10. A radiation detection and survey meter.
11. Two dry chemical fire extinguishers.
12. A 1300 watt electric wall heating panel.
13. A wash basin with hot and cold running water.
14. Toilet with sewage ejector.
15. Telephone extension.
16. Two foldaway double beds with mattresses or convertible sofas.
17. Four chairs (one a rocking chair).
18. One folding table.
19. Deepfreeze.
20. 100-gallon electric water heater. This heater normally supplies the residence above.

21. Electric outlets for:
    a. Air blower for generator room
    b. Cooking
    c. Radio (make certain it works in a sealed shelter)
    d. Lights
    e. Spare outlet
    f. Television
    g. Air purifier
    h. Hot water heater
    i. Deepfreeze
    j. Well pump
    k. Air blower for living quarters
    l. Dehumidifier
    m. Wall heating panel
    n. Oil burner
    o. Storage battery charger
22. Manual crank for motor driven air blower. The blower is in the air intake and filter room.
23. Instruction card for operating, etc. motor blower, generator and exhaust and filter systems.
24. A well with two casings. One connected to a motor driven electric pump for use when electricity is available. The other connected to an old fashioned manual pump handle. Both pipes to be connected to the 550 gallon emergency water storage tank for replenishing water supplies.
25. An exhaust port to atmosphere from the primary living quarters should be installed to vent stale air. A positive pressure of one quarter to one half inch of water should be maintained in the living quarters to facilitate venting stale air and to keep out fallout. This pressure is built up in the shelter by the air intake blower and permits automatic venting without a mechanical exhaust system. The intake and exhaust openings should be far apart to enhance circulation and to keep exhaust fumes from being drawn back into the shelter by the intake.
26. A dehumidifier. In a shelter, humidity and heat may be two big problems. Most people can only stand exposure to high humidity and 95°F heat for about ten hours. A healthy persons may tolerate high humidity and 90°F heat for about 100 hours. 13.11

PRIMARY SHELTER STORAGE ROOM FOR FOOD, TOOLS AND SUPPLIES

The storage section for food, tools and supplies is actually a part of the living quarters; somewhat like a closet. The physical arrangement of this storage space can be planned individually according to that part of the BOSDEC system being used. 13.12

PRIMARY SHELTER FLOOR PLAN



Guide 13.11

PRIMARY SHELTER AIR INTAKE AND FILTER COMPARTMENT

The air intake and filter compartment is the part of BOSDEC which draws in outside air by a motor operated blower, removes fallout laden dust particles by means of glass filters and delivers clean air to shelter occupants. Access from the primary shelter living quarters to the air intake compartment should be through a one half inch gasketed, air tight steel door. The barrier wall between the two rooms should have a mass thickness of 60 pounds per cubic foot. 13.13

PRIMARY SHELTER VENTILATION MOTOR BLOWER

Unfortunately a shelter occupant is always under a threat of power failure. In many cases this possible loss is not critical. When the power failure affects the shelter ventilation the matter becomes serious. Therefore, a motor blower with a manual override should always be selected for shelter ventilation. Since this one piece of equipment is so important, consideration should be given to the purchase of two blowers. One motor operated and the other manually operated. There could easily be circumstances when two blowers would be very useful. For example, mechanical failure or temporary shelter overcrowding. 13.14

CHEMICAL VENTILATION

During a nuclear attack it would be extremely dangerous to have any outside ventilation ports open. The risk that they could not be closed and secured in time to avoid the vacuum cleaner effect of the negative phase of a blast wave is great. The risk run by shelter occupants who may be in a locality where firestorms are possible is likewise great. They may find that superheated air is being forced into the shelter. 13.15

The only logical protection from these two hazards can be obtained by sealing the shelter (closing and locking the ventilation ports). In a BOSDEC shelter of the maximum protection type, ventilation would not be a problem for 16 to 24 hours. Under these conditions chemical ventilation has many advantages. 13.16

It is possible for six or even more people to live in the primary shelter for days without outside ventilation. Six people need seven cubic feet of pure oxygen per hour if the carbon dioxide is being removed by 2.3 pounds of soda lime at the same time. 1.2 pounds of activated charcoal per hour will absorb the pollutants and body odors from six people (guide 13.17). Commercial oxygen that is pure enough for human use is available in 244-cubic feet cylinders and soda lime in 25-pound pails. One cylinder will suffice for six people for about 40-hours when used with 81 pounds of soda lime for carbon dioxide absorption. 13.17

OXYGEN, SODA LIME AND CHARCOAL REQUIRED FOR SEALED SHELTER

	People in Shelter				
	2	3	4	5	6
Pure Oxygen (cubic feet per hour)	2.3	3.5	4.6	5.8	7.0
Soda Lime (pounds per hour)	.8	1.2	1.6	2.0	2.4
Activated Charcoal (pounds per hour)	.4	.6	.8	1.0	1.2

Guide 13.17

Obviously this method is cumbersome, expensive and complicated but it does permit sealing the shelter against blast and firewinds during the most vulnerable periods. A chemical air reconditioner for shelter service is reputed to be planned by a company that designed a portable chamber for Astronauts. (11.10) 13.18

FILTERS

There are three general types of filters that are involved in shelter ventilation. The most important form of filtering involves the trapping of dust particles. This minimizes the chance of fallout penetrating the shelter. For this purpose glass filters are recommended because of the danger, however remote, that paper filters might ignite as a direct or indirect result of thermal radiation. Wherever filters are used the filtering media should be so located as to make servicing easy. 13.19

The other two types of filters are in a sense not filters. They are activated charcoal which absorbs odors, and silica gel which absorbs moisture. Each of these substances is useful under certain conditions and will be mentioned later in this chapter. 13.20

PRECIPITATOR ELECTRIC FILTERS

An alternate or supplementary method of filtering is available. It is done by precipitators (electric air cleaners). They are more than 92% effective in preventing passage of radioactive particles down to a size of .001 of a micron. Dust from delayed fallout averages 0.1 to 10 microns in diameter and early fallout is much larger and consequently much easier to trap. A human hair is 75 microns. Precipitators are very effective against germ warfare and are used in atomic and military installations. Their main drawback is that they require electricity. 13.21

AIR PURIFIER FILTERS

Recently an inexpensive air purifier has been placed on the market. The specifications of the unit indicate that it may work very well in a small shelter. There may be some question about its capacity for use in larger shelters. It weighs 20 pounds and is 7½ inches high by 21½ inches wide by 12 inches deep. It uses a 3/8 inch washable foam filter to catch most visible dust and dirt particles. Smoke and particles down to a 0.03 micron size are then trapped by a 3/8 inch glass fiber filter with an efficiency between 90% and 100%. A 3/4 inch thick activated carbon bed weighing 2½ pounds removes 90% to 100% of all odors. A motor and 5 inch diameter air blower then distribute 44 cubic feet of clean air per minute into the shelter or room over an 18 inch ultraviolet lamp. It sells for less than $60.00 and its use might eliminate the need for a precipitator or even a separate intake blower and filter under the proper conditions. This unit requires electricity (100 watts). It is most efficient in a sealed room and is very quiet in operation (54 DB). Under conditions of average air contamination the unit will function effectively for about 2000 hours (roughly 12 weeks constant use) before filters need replacement. Dissembly and assembly are simple and do not require tools. 13.22

PRIMARY SHELTER WATER STORAGE

A 550 gallon stainless steel water tank should be placed in the water tank compartment. If outside water sources fail, this stored water would probably see shelter occupants through even prolonged emergencies. It should be plumbed into the normal house water supply system and connected to the well for emergency replenishment. 13.23

To insure gravity flow, the water tank could be raised onto a concrete cradle. A plastic water level indicator should be located in the primary shelter living quarters. Sufficient freeway around the tank should be planned. Since the house water system would be connected through this emergency water tank, all plumbing connections would be directly to the hot water heater, primary and secondary shelter wash basins and toilets, and the secondary shelter shower stall and bath tub. 13.24

AIR INTAKE AND FILTER COMPARTMENT EQUIPMENT

The air intake compartment incorporates a plenum chamber to protect the filter from blast. The air line must have a right angle bend in the plenum since radiation would travel in a straight line into the living quarters from the filter trap otherwise. The air intake compartment would contain two principal pieces of equipment. An electric blower, with a manual crank for use in event of power failure, is the heart of the ventilation system. It should have a minimum capacity of sixty cubic feet per minute. The hand crank should be located in the living quarter compartment. If this is not feasible a blower must be placed in the living quarters. 13.25

The second, equally important, item is an absolute type filter system with a capacity of sixty cubic feet of air per minute. An absolute type filter is 99.97 percent efficient when tested with particles of a 0.3 micron diameter. The main filtering media should be fiber glass. The system can incorporate a bed of activated charcoal to remove odors and a bed of silica gel to control or at least minimize humidity. The use of activated carbon is dependant on whether provisions, such as a supplementary cylinder oxygen supply, for "buttoning up" the shelter are planned, and if so, to what degree. The same is true of silica gel. The filter will be located between the air intake port and the blower. Particulate filtering (fiber glass) will always be necessary. Activated charcoal and silica gel usage will be selective. Therefore these two chemical filters should be arranged to permit bypassing them when their action is not needed. Activated charcoal and silica gel may be renewed by heating. The silica gel then regains its absorption efficiency and the charcoal is reactivated. When there is no noticeable reduction in the odors of a closed room for a period of from 12 to 24 hours, the activated charcoal filter is probably saturated and should be reactivated or replaced. Since heating the charcoal reactivates it by releasing all previously absorbed odors, it should never be done in a closed, unventilated place. Do not use a charcoal filter when cleaning agent, insecticide or grease generated odors are present. These odors will quickly saturate the charcoal and minimize its usefulness for more important tasks. 13.26

An air intake line connecting the outside to the blower through the filtering media is an important part of this system. The inlet port should be thick walled, three inch inside diameter stainless steel pipe. It should extend at least one foot above the surface to keep water out and be bent to a 90° angle (radiation has a tendency to travel in a straight line). An automatically closing blast check valve with provision for manual closing and locking the port from within the shelter should be used. The inlet port opening should be screened to keep out insects and protected by a guard cage to prevent debris from damaging it. A lead from the radiation survey meter may be located at the inlet port. By subtracting the shelter radiation reading from the inlet port reading the efficiency of the filtering system can be readily checked. To insure a safety double check on radiation levels, another lead from the survey meter can be placed between the filter and the blower, if one is available. 13.27

There is another method of placing survival shelter air intake ports. If the home above the shelter is built solidly of fire resistant materials, the inlet may be located inside the house over the secondary shelter. The air coming into the shelter would be cooler in summer, warmer in winter, less contaminated and less humid at all times. 13.28

Retractable intake and exhaust ports may be a very valuable ventilation feature since they eliminate the chance of blast winds snapping ventilation stacks off. 13.29

PRIMARY SHELTER GENERATOR AND AIR EXHAUST COMPARTMENT

The purpose of a separate compartment for generator and air exhaust use, within the primary shelter, can be stated in one word —isolation. A generator may be run on gasoline or fuel oil. If gasoline is used a potentially dangerous fire hazard is created. To a lesser degree fuel oil is a hazard. Fuel oil can also be used in normal times with an oil burner for residence heating. The generator and air exhaust compartment serves to isolate the noise and noxious exhaust fumes of the generator from the primary shelter living quarters. The generator room should have its own filtered air intake.. 13.30

The main public utility electric line should be brought into the residence above the shelter, through the generator compartment. A relay should be arranged so the generator will start when the main house power fails—and will shut off when public utility power is restored. In addition a separate shut off switch for the generator should be located in the primary shelter living quarters. This shut off must be used if the shelter is sealed. The generator needs air to function. 13.31

A storage battery should be used for automatic generator starts. This battery can also provide excellent emergency lighting for short periods. This battery should be kept in the generator room. There is a company that makes a "Shelter Cycle" which will, when peddled one hour every three days, keep a storage battery charged. The battery may also be charged through a battery charger connected to main utility power when available or connected to the generator when public power fails. 13.32

The air intake, filter, blower and exhaust port servicing the generator compartment would be similar to that used for the primary living quarters. Of course there is no need for activated carbon or silica gel in the generator room system. 13.33

Access to the generator compartment from the living quarter should be through a one half inch steel, gasketed air tight door. The wall separating these two compartments should have a mass density (protection factor) of 60 pounds per cubic foot. 13.34

The information given in guide 13.35 is helpful when figuring generator wattage loads to prevent overloading. It covers the power draw of different size fractional horsepower motors. Always start the largest size motor first. 13.35

FRACTIONAL HORSEPOWER MOTOR CURRENT DRAWS

Motor Size (H.P.)	Starting (Watts)	Running (Watts)
1/8 hp	500	300
1/4 hp	1000	550
1/3 hp	1500	700
1/2 hp	2000	750
3/4 hp	2500	1050

Guide 13.35

The approximate current drain for some common electrical appliances is shown in guide 13.36. This permits rapid calculations insuring more efficient use of generator power. The wattage shown is averaged for equivalent appliances made by different manufacturers. 13.36

ELECTRIC APPLIANCE CURRENT DRAWS

Appliance	Watts	Appliance	Watts
Hot water heater	3000	Dehumidifier	240
Rotisserie-broiler	1400	Blanket	200
Radiant heater	1300	Blower	200
Hot plate	1250	Sump pump	130
Frying pan	1250	Radio-phonograph	110
Toaster	1110	Trickle battery charger	100
Coffee maker	850	Air purifier	100
Egg cooker	500	Radio	80
Well pump	340	Heating pad	60
Deep freeze	300	Precipitator	60
Television	260	Shaver	15
Oil burner	260	Clock	2
Refrigerator	250	Electro-luminescent light	2

Guide 13.36

GENERATOR AREA EQUIPMENT

A 3000 gallon fuel oil tank should be placed about three feet underground to service the residence oil burner in normal times and the generator during emergencies. The line from the storage tank to the oil burner and generator should be a very good grade of flexible metal tubing. Ground shock affects (4.21) unyielding pipe connections even though storage vessels themselves may be unharmed. The fuel storage tank must supply the oil burner and the generator by gravity flow to insure availability when electricity for pumping is unavailable. Fill and vent pipes for the oil tank must be laid to the surface. The fill pipe must be capped by a screw-on airtight cap. The vent pipe should extend one foot above grade to keep out surface water, should be bent to a 90 degree angle to minimize radiation penetration, screened to keep out insects and protected by a guard cage to minimize damage by falling trees or other debris. It would be similar to the primary shelter living quarter air intake port. It should have a damper type automatic check valve capable of being closed and locked in the closed position manually from within the shelter. 13.37

A positive pressure of one quarter to one half inch of water should be maintained in the generator compartment to facilitate exhausting stale air to the atmosphere and to keep out fallout particles. This pressure will be built up in the generator room by the intake blower. It permits automatic venting without a mechanical exhaust system. The intake and exhaust ports should be kept far apart to enhance circulation and to prevent exhaust fumes from re-entering the shelter. 13.38

The generator and air exhaust room should contain the following equipment:

1. A 4000 watt (four kilowatt) diesel generator. This should be installed, serviced and maintained according to the manufacturers instructions.
2. An air intake system that supplies all necessary air for generator operation. This includes an air blower with sufficient capacity to supply the system.
3. A filter with fiber glass filter material.
4. An exhaust port for venting exhaust fumes from generator to atmosphere. This port located so that these fumes will not be drawn back into any part of the shelter. The outlet at the surface should be bent, screened and caged for reasons mentioned previously.
5. One lead from the shelter radiation survey meter should be located in the generator room to double check any possibility of a filtering system malfunction.
6. A storage battery for automatic generator starts and emergency lighting should be placed in the generator compartment. 13.39

AUTOMATIC-ELECTRO UTILITY SYSTEM

An automatic-electro utility system especially designed and built for shelter service is commercially available. It contains the following units:

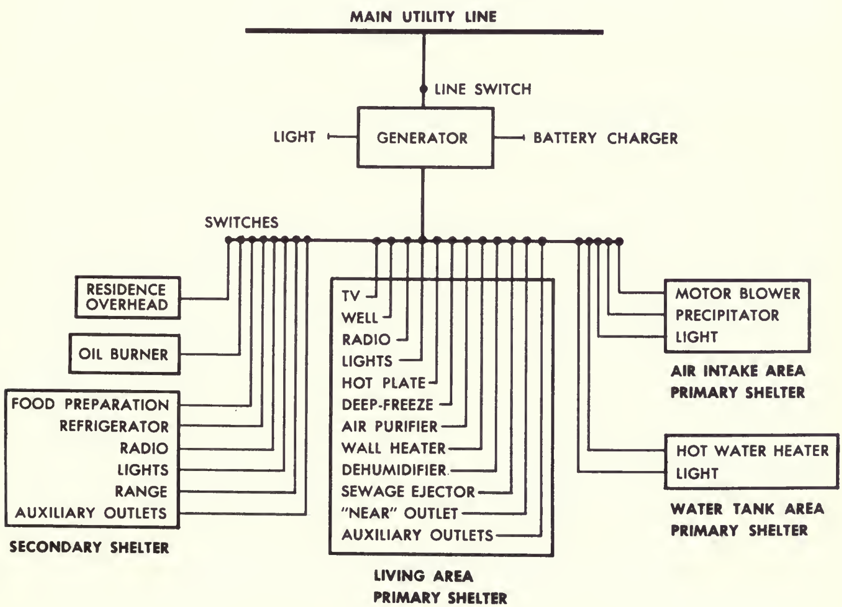
1. Electric generator—from 2000 to 6000 watts for fuel oil use. It is available with an automatic switch-over

when utility power fails. The 6000 watt model uses 0.7 gallon fuel oil per hour.

2. Comfort cabinet—contains four items.
    (a) Air conditioner—with sealed unit.
    (b) Heater—radiant type.
    (c) Dehumidifier—provides two quarts of water per person, per day for washing, etc.
    (d) Refrigerator
3. A sump pump for waste water ejection.
4. Fresh water supply tank—connected to present supply.
5. Multiple fallout air separator for filtering intake air. Air circulation is adjustable, with positive exhaust system. Manual blower override supplied.

This system may be placed in relay with house electric supply in normal times to provide house electricity during peacetime power interruptions. 13.40

ELECTRIC SUPPLY SCHEMATIC GUIDE

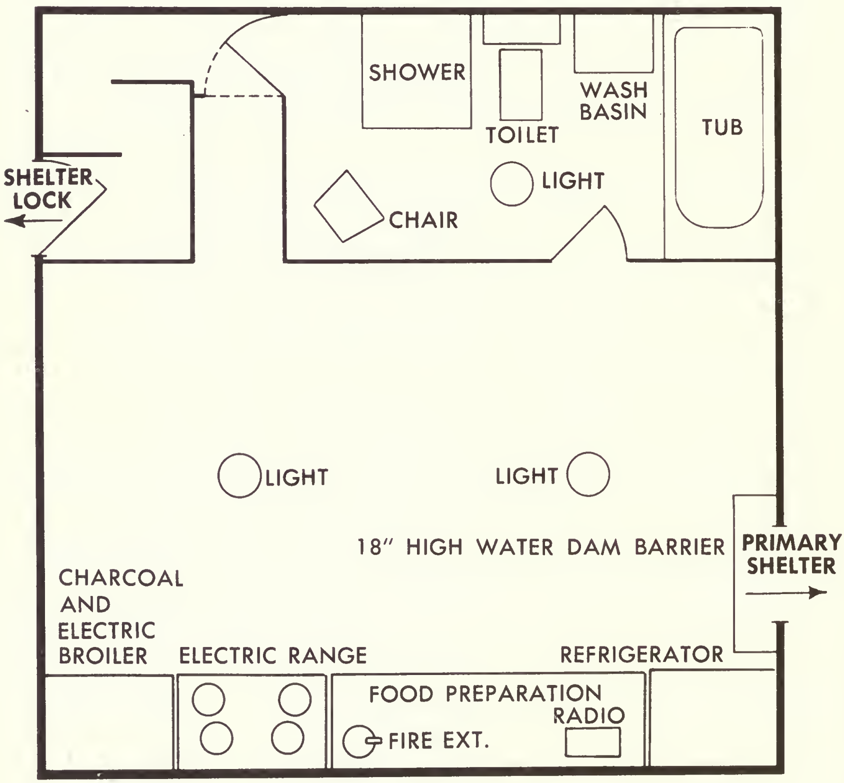


Guide 13.39

THE SECONDARY SHELTER

The secondary shelter of the BOSDEC system is directly under the house. It is on a different level than the primary shelter, closer to the surface. Since the secondary shelter does not have an earth shield it cannot provide as much protection as the primary shelter. It does have a protection factor of more than 2000 plus a certain amount of barrier and geometry shielding contributed by the roof and walls of the house overhead. 13.41

SECONDARY SHELTER FLOOR PLAN



Guide 13.41

Since the secondary shelter does not contain a generator and well or have an earth cover, it lacks the convenience and 10,000 protection factor of the primary shelter. The addition of an air intake blower, exhaust port and storage space would convert it into a primary shelter with a protection factor of 2000. The further addition of a generator and well would provide all facilities usually planned for a primary shelter. The secondary shelter is furnished for extensive cooking and fairly normal living. Millions of Americans live in localities unlikely to be targets. They could have fallout problems, but the expense of the complete BOSDEC system or even a major part of it would be unwarranted. They must weigh all the facts; is the investment for the 10,000 protection factor and added conveniences worth the extra cost? 13.42

SECONDARY SHELTER SANITARY FACILITIES

The secondary shelter has a bathtub and shower, wash basin and a toilet located near its entrance. This location permits rapid showering for fallout removal, after essential trips outside the shelter, without possibility of fallout scattering inside the shelter. Discarded clothes may be quickly placed in the shelter lock until radiation decay can reduce their contamination to safer levels for clothes laundering, etc. 13.43

SECONDARY SHELTER VENTILATION

The entrance to the secondary shelter from the shelter lock should be baffled by no less than two right angle turns in the same manner as the primary shelter entrance. One important advantage of using the complete BOSDEC system should be noted. When outside nuclear radiation has been reduced to one tenth the first hour level (seven hours after weapon burst) the door connecting the primary and secondary shelters may be opened to permit the secondary shelter air to replenish the primary shelter atmosphere. This extends the time the shelter can remain sealed against possible firestorms, etc. After the fire and high radiation danger has passed, the primary shelter ventilation system will provide air for both primary and secondary shelters. 13.44

SECONDARY SHELTER EQUIPMENT

The secondary shelter contains the following items of equipment:

1. Wash basin connected to deep dry well.
2. A bathtub and shower connected to dry well.

3. Toilet with sewage ejector connected to deep septic tank. A check valve should be placed in sewage line.
4. Electric range.
5. Refrigerator.
6. A fire brick charcoal pit, waist high with a stainless steel grill rack and a manually and electrically operated spit.
7. Dry chemical fire extinguisher.
8. Electric outlets for:
    (a) Lights
    (b) Range
    (c) Refrigerator
    (d) Radio
    (e) General utility
    (f) Food preparation appliances

These items will vary according to what part of the BOSDEC system is used. 13.45

THE SHELTER LOCK

The shelter lock is on the same level as the secondary shelter and is part of the house basement. The shelter lock should have a four inch thick reinforced concrete ceiling. This is a sufficient barrier since the shelter lock will not be occupied while outside radiation levels are high. It is the connecting room or link between the secondary shelter and the outside world. From the shelter lock an occupant would step out into the world to survey the results of a nuclear attack for the first time. 13.46

The walls between the shelter lock and the secondary shelter should be sixteen inch thick concrete. The door into the secondary shelter from the shelter lock should be one half inch steel, gasketed and airtight. 13.47

SHELTER LOCK EQUIPMENT

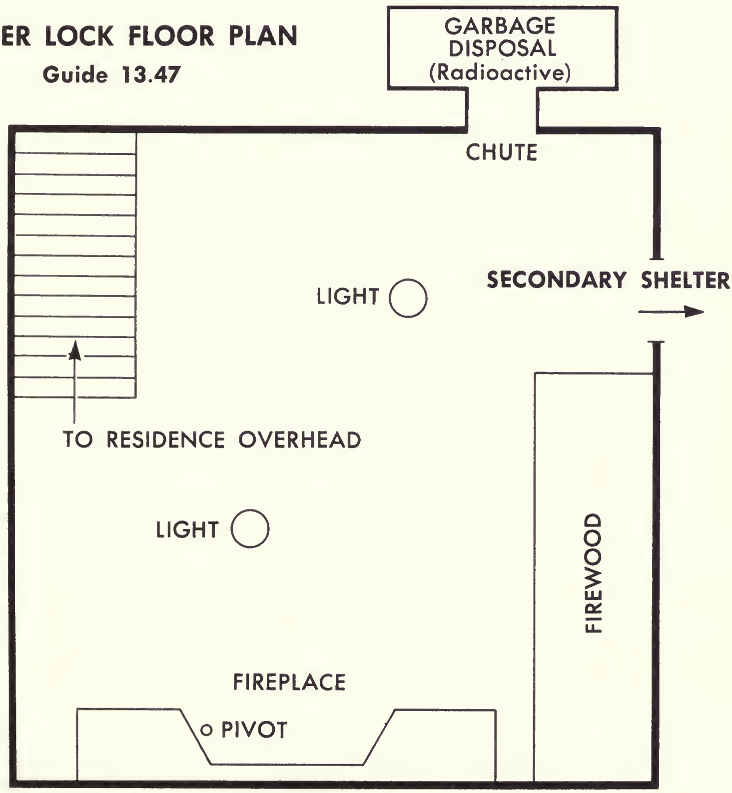
The equipment and contents of the shelter lock are a matter for personal choice. Certain essentials should be included and are listed below:

1. A fireplace for cooking and heating. It should utilize a "heatilator" type construction with built-in air intake and heated air outlets for circulating warm air. Old fashioned iron pivots should be installed in the fireplace to provide means of suspending cooking utensils. An adequate supply of firewood should be stored in the shelter lock. The fireplace could be used after the return to near normal conditions when radiation levels were low enough.

2. A wall opening should be provided in the shelter lock wall which faces the earth surrounding the basement. This opening should be large enough to accept medium size cartons. It should have a heavy metal hinged door leading to a chute which ends in a predug pit outside the shelter lock. The use of this chute permits the rapid disposal of cases (14.14) containing sealed cans, which in turn contain primary shelter refuse. Use of this disposal feature eliminates the need for going outside the shelter with the resultant exposure to radioactivity. Disposal can be accomplished in a few seconds away from the primary or secondary shelter. This is important when radiation levels are high outside. Failure to incorporate this feature in the shelter lock might make necessary valuable time consuming trips outside. Holes at least one foot deep must be dug to bury waste, radioactive or otherwise. Unless this is done, dogs, other animals or rodents might find, dig up and eat this refuse, spreading disease far and wide. 13.48

SHELTER LOCK FLOOR PLAN

Guide 13.47



SHELTER PREPARATION PROCEDURES

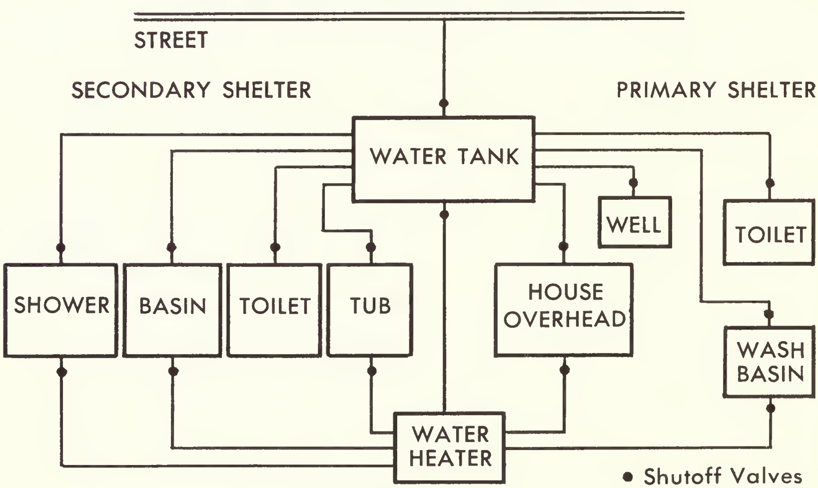
It must be assumed that a family having a BOSDEC type shelter will keep it in shape to be used at a moments notice. Anything less than complete survival preparedness may be tempting fate. The generator, air intake electric motor blowers, filters and other equipment should be checked every month to be certain they are in perfect operating condition. Children who are old enough should take turns familiarizing themselves with the chores they may have to do some day. 13.49

When the decision to go to the shelter has been made, certain things should be done immediately. The necessary controls for these actions should all be located in the primary shelter living quarters, so that it will not be necessary to tarry upstairs. Basically there are three main items requiring control; water, electricity and air. 13.50

WATER SHUTOFF

First make certain that the shelter water storage tank and other water containers are full. Then shutoff the main outside water supply valve to the house and shelter, and drain the house water lines. If the house was designed with this contingency in mind the drain problem will be simple. The house water supply lines would be at their lowest point in the secondary shelter in the basement. A faucet type drain valve incorporated in the line at its

WATER SUPPLY SCHEMATIC GUIDE



Guide 13.51

lowest point would permit easy drainage and when drained, rapid closure of the valve without tools. Drained water could be caught in plastic containers and saved for shelter use. Turn off the water tank and heater supply to the residence. The next step may be taken when convenient. Turn on the valve connecting the shelter water storage tank to the shelter water system. 13.51

ELECTRICITY SHUTOFF TO THE HOUSE

Switch off the main public utility electricity to the house. Shutoff the fuel oil supply to the oil burner and make certain the fuel supply to the generator is assured. Since under normal conditions it may be desirable to use the oil burner and the generator at the same time, the control valve should be a three-way type. The third position would permit fuel supply to the oil burner and generator simultaneously. The generator should be wired with a relay so that it would automatically cut in when outside power fails and would shut off when public utility current is restored. There should be a separate switch for shutting down the generator when it is not needed. All switch and control actions should be practiced frequently until all prospective shelter occupants are thoroughly familiar with them. 13.52

AIR SHUTOFF

All air intake and exhaust ports should be kept closed and secured at all times before actual shelter use, except when participating in shelter use drills. This eliminates the possibility of forgetting to close the ports during an actual nuclear attack. The port may be opened at any time after an attack if circumstances permit. If all shelter doors are kept open in normal times there will be enough fresh air circulating. Leaving the doors open also allows faster entrance to the shelter in an emergency. It will only be necessary to close the doors as you pass into the shelters. Ample air for many hours will be available even with the shelter "buttoned up." The generator needs air to operate. It cannot be used with inlet and exhaust ports closed. There will probably be utility electricity right up to the instant of nuclear attack and possibly afterwards, depending on geographical location and other factors. 13.53

GENERATOR ELECTRIC CURRENT DRAW

A safety margin of at least 10 percent of the capacity should be maintained when using a generator. A 4000 watt generator should not service appliances or outlets drawing more than 3600 watts. The available or useable current should be enough to cover all appliances, equipment and outlets in normal use plus the largest single cooking appliance. Of course the two heaviest current users, the radiant wall heater and the water heater should have separate switches and should be turned on only by switch when enough of the other appliances are not in use. The two heaters should not be on automatic (thermostatic) control. 13.54

PRIMARY SHELTER ELECTRIC CONTROL PANEL			
PRIMARY SHELTER SWITCHES			
LIVING AREA—CONTINUOUSLY "ON"		**GENERATOR AREA**	
☐ "NEAR" ALARM	10*	☐ Battery charger	100*
☐ Electro-luminescent light	10*	☐ Motor blower	200*
☐ Lights	300*	☐ Light	100
☐ Deepfreeze	300*	☐ Generator	
☐ Radio	80*		
LIVING AREA—INTERMITTENT "ON"		**AIR INTAKE AREA**	
☐ TV	260	☐ Motor blower	200
☐ Dehumidifier	240	☐ Light	100
☐ Air purifier	100	☐ Precipitator	60
☐ Sewage ejector	130		
LIVING AREA—OCCASIONALLY "ON"		**WATER TANK AREA**	
		☐ Light	100
		☐ Well pump	340
☐ Toaster	1110		
☐ Hot plate	1250		
☐ Fry pan	1250	☐ Wall radiant heater	1300
☐ Auxiliary outlets		☐ Water heater	—
SECONDARY SHELTER SWITCHES			
☐ Radio	80	☐ Range (2 burners)	2500
☐ Lights	200	☐ Refrigeration	250
☐ Food preparation	—	☐ Rotisserie	1250
☐ Auxiliary outlet	—	☐ Auxiliary	—
☐ **SHELTER LOCK MASTER SWITCH**			
☐ **SECONDARY SHELTER MASTER SWITCH**			
☐ **PRIMARY SHELTER MASTER SWITCH**			
☐ **RESIDENCE MASTER SWITCH**			

Guide 13.54

To effectively use the available current, a chart showing appliance current draw may be used. Such a chart (or control panel) for the shelter described in this manual, is shown in Guide 13.54. The appliances or equipment marked with an asterisk (*) are "on" continuously when the main utility or generator power is available. This does not mean that they will necessarily draw current all the time. For example, the battery charger will only draw current when the battery needs charging; the deepfreeze will be on and off in cycles. Appliances listed on the chart as intermittent would be turned on frequently. Other appliances would be used occasionally—at most once or twice a day. 13.55

By totaling all appliance current draws shown in Guide 13.54, except the cooking appliances and wall and water heaters, it will be noted that the current draw totals 2630 watts. This 2630 watt current draw plus the 1250 watts for the fry pan or toaster totals 3880 watts and indicates a 5000 watt (5 kw) generator since it is too close to 4000 watts to provide an adequate safety margin. For practical purposes a 4000 watt generator would be satisfactory. It would be most unusual for lights to be on in the generator, air intake and water tank areas while at the same time the well pump, motor blower and both precipitator and air purifier were in use. The TV would probably not be operating after a nuclear attack and few people would have a precipitator and an air purifier. It would be a simple matter to arrange power use in such a manner as to make the simultaneous use of these units practically impossible. These examples are shown as a guide to the type of planning necessary. 13.56

CHAPTER 14

General Food Information

There will be many problems concerning survival shelter food. Some can be anticipated. Others are unforeseeable. They will vary from one family to another and from one location to another. The food that will be stored will depend largely on size of family, religion, geographical location, eating habits, money and space available. One thing is certain, there are at least three staples which will not be available during, and shortly after, a nuclear attack. 14.01

UNAVAILABLE FOOD

The following conditions will probably prevail in the event of a nuclear attack and its immediate and intermediate (90 days to 2 years) aftermath. Fresh milk will be impossible to obtain and either canned evaporated or dry powdered milk must be substituted. Fresh eggs, for which there is no home substitute available, are another food staple that will be scarce in most parts of our country. However, chickens have a great tolerance for radiation and fresh eggs will probably be one of the first staples available after a nuclear attack. The third staple missing from our diet will be butter. There is no easily storable substitute for butter as a spread. For cooking purposes vegetable shortening or bacon grease may be used. 14.02

For some time after a nuclear attack these fresh foods will be scarce or completely unavailable: meats, fowl, seafood, vegetables, fruits and eggs. Since most of these may be obtained as canned foods, no insurmountable problem exists in this respect. 14.03

SELECTING FOOD

There are several useful rules to keep in mind when shopping for shelter food supplies. Buy only foods that would be enjoyed under normal conditions whenever possible. This is much easier on shelter occupants who will be under emotional stress. It also enables the family to eat the food regularly and thus rotate the more perishable foods such as frozen vegetables, frozen meats, packaged sugar, flour and crackers as well as the canned foods. All food bought for shelter use should be dated when purchased to simplify rotation. Buy the same quality food that would ordinarily be used.

In a shelter under attack no one will be in a mood to experiment with new, economical or strange foods. 14.04

When buying shelter food select the proper size containers for the family to be fed. Careful selection will help eliminate left-overs that might be difficult to preserve. For example, don't buy large cans of food for two people or small cans for a family of six. Buy foods in case lots for convenient storage and watch the specials. 14.05

FOOD PREPARATION

All foods to be prepared and eaten in the primary shelter should require no more than plain heating or at most heating in water. When the family can safely go into the secondary shelter, broiling, roasting and baking may be attempted. This would only be feasible in the absence of imminent attack when electricity or wood and suitable food and additional adequate ventilation were available. 14.06

NEW COMMERCIAL FROZEN FOOD STORAGE SYSTEM

A new process "Liquifreeze" developed for use by transportation companies, keeps "in transit" foods such as frozen meat, vegetables and other foods safe for periods up to thirty days. It is not presently available for home use. Food to be kept frozen is sprayed with liquid nitrogen. A device automatically sprays the food when the temperature approaches a preselected point. The food is cooled to one hundred twenty degrees below zero (f). If and when a home unit is marketed, frozen foods may be kept really deep frozen for a month or more without electricity. The commercial unit is so small that it fits on top of a highway trailer and is supplied by cylinders of liquid nitrogen. Since gaseous nitrogen is inert, and the spray device works within a closed container, it should be safe. 14.07

SEQUENCE OF FOOD USE

FRESH FOOD

When planning menus for a survival shelter it is sensible to use whatever food is available in a logical order. It would not be wise to prepare canned foods when fresh vegetables were available. All fresh vegetables, fruits, meats and bread, etc., would be served first. If this is not done they may spoil or become stale. Even fresh fruits and vegetables that have been subjected to radioactivity may be eaten if properly prepared. They should be well scrubbed and peeled to remove the contaminated outer skin or leaves. Absorbent type foods such as cauliflower or broccoli cannot be decontaminated in this manner. They must be discarded by burial. 14.08

FOODS IN DEEPFREEZE

All food in the deepfreeze may and probably will be subject to interrupted electrical service. If the deepfreeze is kept tightly closed, even without electricity, most of the food can be cooked and eaten a week or more after the electricity shut-off. Thawed foods may be prepared in advance for another few days. Good food management could permit living out of the deepfreeze for about two weeks after electric supply failure. 14.09

CANNED AND LONG SHELF LIFE FOODS

Canned and dehydrated foods, bought for use when the dangers of nuclear attack and resulting radiation have passed, are used last. This food would be eaten in the intermediate period after the attacks but before normal productivity and distribution facilities are available. It would probably be prepared in the secondary shelter. 14.10

FOOD PREPARATION SUGGESTIONS

It is unlikely that electricity or other heat energy suitable for food preparation will be abundant in a survival shelter during the first crucial few days after an attack. It should be conserved. As much food as necessary should be prepared as quickly as possible for any one meal. If and when electricity is available heat enough water for coffee, tea or cocoa and soups to cover needs for the entire day's menu. Then store these liquids in vacuum bottles or jugs until used. A small night light should be kept plugged into an easily observable electric outlet. It uses little power and will alert occupants to the availability of electrical power. 14.11

UTILIZATION OF CANS AND CARTONS

A good sturdy wall type can opener should be used to open cans with a clean cut, folded under edge. Save the can tops. Cans may be used in emergencies for drinking purposes; water, coffee, tea or soup. Use care in drying them thoroughly after each use. 14.12

Empty cans may be filled with refuse. The refuse laden cans may be covered by the original lid using the widest size masking tape available (up to three inch width). Place the can top first on the gummed side of the tape then place the lid on the can and tape is securely in place. This will seal in odors. 14.13

These sealed refuse cans should then be repacked into their original cartons and the cartons resealed with masking tape. They may then be discarded outside the shelter (13.48) as soon as conditions permit. Cartons should be opened with care to permit their use in this manner. 14.14

PRIMARY SHELTER FOOD

Food recommended for use in the primary shelter was selected because, in most cases, it could be eaten cold in an emergency. Canned ham, canned bread and chow mein are good examples of this planning. 14.15

SECONDARY SHELTER FOOD

Food suggested for use in the secondary shelter usually requires more preparation and more involved cooking. For instance, packaged macaroni and spaghetti—both requiring cooking in precious water and the use of sauces. Obviously they would not be too suitable for primary shelter use. 14.16

SERVING FOOD

Heat and moisture resistant plastic coated paper plates, cups and bowls should be used for survival shelter food service. It is best to try out the type which may be used in the shelter before buying a supply. Good water would be wasted washing dishes, especially under nuclear attack conditions. Fresh plates may be required for each meal, but if they are not too soiled they may be cleaned and reused several times. 14.17

Carefully used cups may be reused a number of times. Here's how. After draining the last drop of coffee or tea, drink half a cup of water. This will help satisfy water intake requirements and freshen the cup for further use, at least for the rest of the day. When a cup has been used for a hot liquid, make certain it is still strong enough to hold another hot liquid. If not, use it for cold water or cereals. To insure that each member of the family reuses the same cup, plate or bowl, buy them in different colors or designs and assign a color or design to each shelter occupant. 14.18

KITCHEN UTENSILS FOR SHELTER USE

There are certain kitchen utensils and other items of kitchen equipment that are absolutely essential. Other utensils are very convenient. All are listed in guide 14.19 as a reminder. Unless otherwise specified, all utensils should be stainless steel if possible. The plastic dishes listed are for use after the attack but before our country returns to a nearly normal status. They are unbreakable and therefore safe. 14.19

KITCHEN UTENSILS

	Quantity	Item		Quantity	Item
1.	2	2 qt. saucepans	22.	1	carving set
2.	2	rubber spatulas	23.	1	pair kitchen scissors
3.	1	combination bottle opener	24.	2	small vacuum bottles
4.	1	salt shaker	25.	1	large vacuum jug
5.	1	pepper shaker	26.	1	funnel
6.	1	sugar bowl	27.	1	vegetable peeler
7.	1	8 inch iron skillet	28.	8	table knives
8.	1	large cooking spoon	29.	8	table forks
9.	1	large kitchen fork	30.	8	soup spoons
10.	1	large kitchen knife	31.	16	teaspoons
11.	1	small kitchen knife	32.	2	serving spoons
12.	1	graduated mixing cup	33.	8	salad forks
13.	1	nest mixing bowls	34.	8	plastic cups
14.	1	pressure cooker	35.	8	plastic saucers
15.	1	stainless steel pitcher	36.	8	plastic dinner plates
16.	1	large pr. kitchen tweezers	37.	8	plastic soup bowls
17.	1	grease can w/strainer top	38.	2	plastic serving bowls
18.	1	candle holder—for heating	39.	1	large plastic garbage pail w/cover
19.	1	can opener (wall mounted)	40.	1	large old fashioned iron pot w/handle
20.	1	can opener (hand type)			
21.	1	Hibachi charcoal grill			

Guide 14.19

KITCHEN SUPPLIES FOR SHELTER USE

While the kitchen supplies listed in guide 14.20 are mostly for use in the primary shelter, many of these or similar items will also be needed in the secondary shelter after the critical nuclear attack period. This becomes a matter of personal decision. The items listed represent one months supply for a family of two or three as captioned. 14.20

KITCHEN SUPPLIES FOR PRIMARY SHELTER

One Month Supply Item & Type	Family Size 2 People	 3 People
1. Paper plates plasticized—moisture & heat resistant	120	180
2. Paper cups and dispenser (9oz) moisture & heat resistant	120	180
3. Paper bowls—moisture & heat resistant	60	90
4. Paper towels (rolls)	2	3
5. Paper napkins	180	270
6. Aluminum foil (rolls)	2	3
7. Sponges	1	2
8. Saran wrap	1	2
9. Hot pad holders	1	2
10. Chore boys	1	2
11. Detergent (plastic bottle)	1	2
12. Candles (for light)	30	30
13. Candles (for heat)	10	15
14. Dish towels (cotton)	2	3
15. Twine (balls)	2	2
16. Cleanser	1	2
17. Solidified alcohol	15	20

Avoid the use of glass containers whenever possible.

Guide 14.20

SECONDARY SHELTER FOODS

Meat & Seafood (canned)	Miscellaneous
1. Bacon	15. Au gratin potatoes
2. Corned beef hash	16. Spaghetti (packaged)
3. Sausages	17. Macaroni (packaged)
4. Meat balls	18. Buckwheat mix
5. Chili con carne	19. Canned cheese
6. Tamales	20. Tomatoes
7. Chipped beef	21. Brown bread
8. Salmon steaks	22. Flour
9. Crab meat	23. Relish
10. Shrimp	24. Maple syrup
11. Clams	25. Oatmeal
12. Oysters	26. Various hot cereals
13. Smoked bologna	27. Baby foods (as indicated)
14. Country cured ham	

Guide 14.21

SECONDARY SHELTER FOODS

There are many delicious canned foods on the market which for one reason or another are not deemed suitable for the limited facilities of a primary shelter. However in the period between the close, mandatory confinement in the primary shelter and before food supplies return to normal there will be occasions when the family would enjoy a change of diet. The foods shown in guide 14.21 can be stored, prepared and served in the secondary shelter with its expanded cooking facilities. The amount of each listed food to be bought is left to one's discretion. Of course, all food listed for primary shelter use can also be served in the secondary shelter. It might be sensible to keep a few packages of vegetable seeds in the shelter for a do-it-yourself post war project. 14.21

CHAPTER 15

Primary Shelter Menus

CALORIE INTAKE

Shelter occupants need a well balanced diet with a proper calorie intake. Equally important is the need for tasteful, pleasant food. For this reason all purpose wafer type nutrition has been rejected here as a basis for shelter feeding. An inactive adult can easily live on 1500 calories per day. One authority states that an inactive adult can live on half of that or 10,000 calories for two weeks. The menus in this section of the manual are designed to supply a well balanced diet with an average intake of 2000 calories per day. 15.01

MEAL TIME CYCLES

These menus are planned for a ten day cycle with different food every meal, every day for ten days. At the end of ten days the cycle may be repeated. These are suggested menus subject to change or improvement according to personal tastes. All food stocks have been figured generously so that the food supply could be stretched considerably without starving anyone. The shopping lists are based on the theory that it is better to have too much than too little. All foods should be stored in a cool dry location. 15.02

SELECTION OF FOOD

Foods for shelter use were selected not only on the basis of nutrition value but also because they have almost universal appeal to the American appetite. Other foods which might be interesting to fewer families were listed under "Secondary Shelter Foods" (14.21). All foods selected for either shelter have one thing in common; they do not require refrigeration. Primary shelter foods were limited to those items of the heat and eat type. One point to watch, be sure to get the two pound canned ham that does not require refrigeration. Some canned hams do need refrigeration. Do not under any circumstances discard liquids canned with vegetables or fruits, etc. This valuable source of shelter liquid could safely sustain life for weeks in a dire emergency. 15.03

COST OF MEALS

The average cost of all food on the following menus is about 35 cents per person per meal. All stored foods should be clearly dated so that food may be rotated to insure a fresh supply always available in the shelter. Place all packaged foods in polyethylene bags and tape or heat seal them for protection from moisture, etc. This should be done preferably on a day when the humidity is very low. This would not be necessary if food packers would can several staple food items. Some of the main staples that should be available canned are: sugar, flour, rice, salt, butter, pancake mix, dry cereals, au gratin potatoes and dehydrated eggs. The menus in this section provide for about 20 ounces or 1¼ pounds of food per person per day. It is easy to figure the total weight of all the food to be stored in the shelter; 1¼ pounds x occupants x days supply of food. 15.04

BREAKFAST

All cereals are eaten with evaporated milk diluted by equal parts of water. This milk is also used with coffee, tea and cocoa, unless instant hot chocolate is used. Milk for drinking is prepared from evaporated milk in the same proportion. Some of the cereals listed are made with a sugar coating and do not need additional sugar. Breakfast servings allow for about 4 ounces of fruit juice, 2 ounces of cereal, 8 crackers and 2 ounces of jam or jelly. Coffee, tea, milk, cocoa or hot chocolate are included in every breakfast. 15.05

BREAKFAST MENU

Day	Juice	Cereal	Supplement: Jam with Soda Crackers
1	Pineapple	Cheerios	Grape
2	Orange apricot	Cornflakes	Elderberry
3	Grapefruit	Grapenuts	Orange marmalade
4	Prune	Wheaties	Strawberry
5	Orange	Shredded wheat	Peach
6	Apricot nectar	Grapenut flakes	Currant
7	Pear nectar	Rice Krispies	Plum
8	Grape juice	Sugar pops	Crabapple
9	Apple juice	Frosted flakes	Raspberry
10	Tomato	Raisin bran	Cherry

Guide 15.05

LUNCH

Lunch consists of hot soup, a light supplement and coffee, tea, milk, cocoa or hot chocolate. Every third day, or oftener, a meat, chicken, fish supplement or spread is planned. Lunch servings allow for 5 or 6 ounces of soup, 2 or 3 ounces of supplement (depending on type of supplement) and 6 or 8 Ritz type crackers. Deviled ham or boned chicken would not be served in the same size portion as, for instance, applesauce. 15.06

LUNCH MENU

Day	Soup	Supplement—Ritz Crackers And:
1	Clam chowder	Apple butter
2	Chicken noodle	Whole cranberries
3	Bean and bacon	Deviled ham
4	Lentil	Peanut butter
5	Vegetable	Applesauce
6	Mushroom	Boned chicken
7	Pea	Jellied cranberries
8	Minestrone	Tuna fish
9	Pepper pot	Cheddar cheese dip
10	Cream of chicken	Sardines (skinless & boneless)

Guide 15.06

DINNER

Dinner, of course, is the main meal in the shelter as it is in normal everyday life. It should be served and eaten in as normal a manner as possible. The pychological effect on the entire family will be well worth the trouble. The menus may be switched if personal religious observances are better served by so doing. Dinner servings are based on 6 to 8 ounces of entree, 4 ounces of each vegetable and 4 ounces of dessert. Coffee, tea, milk, cocoa or hot chocolate are also served. 15.07

DINNER MENU

Day	Entree	Vegetables		Dessert
1	Chicken a la king	Rice	Green beans	Peaches
2	Ham (canned)	Mashed pot	Corn	Pineapple
3	Beef stew	Small pot	Carrots	Vanilla pudding
4	Chicken stew	Rice	Succotash	Plums
5	Salmon	Mashed pot	Peas	Pears
6	Meatballs	Spaghetti	Asparagus	Gelatin (raspberry)
7	Frankfurters	Beets	Baked beans	Apricots
8	Chicken chowmein	Fried noodles	Lima beans	Cherries
9	Lamb stew	Spanish rice	Spinach	Chocolate pudding
10	Pork loin	Sweet pot	Applesauce	Fruit cocktail

Guide 15.07

SHOPPING LIST FOR PRIMARY SHELTER MENUS

To implement these breakfast, lunch and dinner menus it is necessary to break down all meals into components and then calculate the requirements for each size family. This has been done and the list of food needed is shown in guides 15.08 and 15.08A. The third column "ounces per portion" gives the basic food allowance used. The fourth and fifth columns show the amount of each item required by a family of two or three using the foregoing menus for one month. To ascertain the amount of food required by a family of four just double the amount for a family of two. To figure the needs for a family of five, add the amounts for a family of two and a family of three, etc. To find the amount needed by a family of three for six months, multiply the one month supply by six. Several items such as rice, instant mashed potatoes and applesauce are listed more than once since they appear on the ten day menus more than once. 15.08

SHOPPING LIST FOR PRIMARY SHELTER MENUS

Item No.	Food	Ounces Per Portion	Ounces of Food for One Month Family of 2	3
1	Pineapple juice	4	24	36
2	Orange apricot juice	4	24	36
3	Grapefruit juice	4	24	36
4	Prune juice	4	24	36
5	Orange juice	4	24	36
6	Apricot nectar	4	24	36
7	Pear nectar	4	24	36
8	Grape juice	4	24	36
9	Apple juice	4	24	36
10	Tomato juice	4	24	36
11	Cheerios	2	12	18
12	Corn flakes	2	12	18
13	Grapenuts	2	12	18
14	Wheaties	2	12	18
15	Shredded wheat	2	12	18
16	Grapenut flakes	2	12	18
17	Rice Krispies	2	12	18
18	Sugar pops	2	12	18
19	Frosted flakes	2	12	18
20	Raisin bran	2	12	18
21	Grape jelly	2	12	18
22	Elderberry jelly	2	12	18
23	Orange marmalade	2	12	18

24	Strawberry jam	2	12	18
25	Peach preserves	2	12	18
26	Currant jelly	2	12	18
27	Plum preserves	2	12	18
28	Crabapple jelly	2	12	18
29	Red raspberry jam	2	12	18
30	Cherry preserves	2	12	18
31	Clam chowder	6	36	54
32	Chicken noodle soup	6	36	54
33	Bean & Bacon soup	6	36	54
34	Lentil soup	6	36	54
35	Vegetable soup	6	36	54
36	Mushroom soup	6	36	54
37	Pea soup	6	36	54
38	Minestrone soup	6	36	54
39	Pepper pot soup	6	36	54
40	Cream of chicken soup	6	36	54
41	Applebutter	3	18	27
42	Whole cranberries	3	18	27
43	Deviled ham	2	12	18
44	Peanut butter	2	12	18
45	Applesauce	3	18	27
46	Boned chicken	2	12	18
47	Jellied cranberries	3	18	27
48	Tuna fish	2	12	18
49	Instant cheddar dip	2	12	18
50	Sardines	2	12	18
51	Chicken a la king	6	36	54
52	Ham (canned whole)	6	36	54
53	Beef stew	6	36	54
54	Chicken stew	6	36	54
55	Salmon	6	36	54
56	Spaghetti & meat balls	8	48	72
57	Frankfurters	6	36	54
58	Chicken chow mein	8	48	72
59	Lamb stew	6	36	54
60	Pork loin	6	36	54
61	Minute rice	2	12	18
62	Instant mashed potatoes	4	24	36
63	Whole potatoes	4	24	36
64	Minute rice	2	12	18
65	Instant mashed potatoes	4	24	36
66	Beets	4	24	36
67	Fried noodles	2	12	18
68	Spanish rice	4	24	36
69	Sweet potatoes	4	24	36
70	Green beans	4	24	36

Item No.	Food	Ounces Per Portion	Ounces of Food for One Month Family of 2	3
71	Corn (kernalettes)	4	24	36
72	Carrots	4	24	36
73	Succotash	4	24	36
74	Peas	4	24	36
75	Asparagus	4	24	36
76	Baked beans	4	24	36
77	Lima beans	4	24	36
78	Spinach (chopped)	4	24	36
79	Applesauce	4	24	36
80	Peaches	4	24	36
81	Pineapple	4	24	36
82	Vanilla pudding	3	18	27
83	Plums	4	24	36
84	Pears	4	24	36
85	Gelatin (raspberry)	3	18	27
86	Apricots	4	24	36
87	Cherries	4	24	36
88	Chocolate pudding	3	18	27
89	Fruit cocktail	4	24	36

Guide 15.08

CONDIMENTS, STAPLES, COFFEE, TEA, ETC. FOR SHELTER

Certain foods are difficult, if not impossible, to plan for on a per person basis. These items must be obtained for use with the menus and are actually a continuation of the "Shopping List" (15.08). There are probably some foods which your family likes that are not on this list. By all means include them if they do not require refrigeration or extensive preparation. Vary amounts to suit individual tastes. 15.08A

Item No.	Food	Ounces of Food for One Month Family of 2	3
90	Evaporated milk	240	360
91	Sugar	120	180
92	Soda crackers	100	150
93	Ritz crackers	100	150
94	Salt	16	16
95	Pepper	4	4
96	Mustard	6	6
97	Ketchup	28	42
98	Coffee (instant)	48	72
99	Tea	24	36

100	Hot chocolate	16	24
101	Mayonnaise		
102	Chocolate syrup (for children)		
103	Canned candy		
104	Canned nuts		
105	Brown bread		
106	Date nut bread		
107	Canned bread (white, raisin, rye, etc.)		

Guide 15.08A

EMERGENCY TRAVEL FOOD

There is always a possibility that one or more of the shelter occupants must leave the shelter for a few days or longer due to a dire emergency. The following kit is planned to feed one person for two weeks or four people for four days. It is not intended to do more than sustain life until the traveler can return to the shelter. All of the food may be eaten hot or cold while on the go. The entire supply can be packed easily into one medium sized carton and sealed. The approximate weight is 25 pounds. 15.09

EMERGENCY TRAVEL FOOD

No.	Quantity	Item
1	1	Small saucepan
2	1	Sterno stove
3	3	Cans sterno
4	15	Books matches
5	10	Plastic spoons
6	10	Plastic forks
7	14	Paper cups (plasticized)
8	14	Paper plates (plasticized)
9	1	Can opener
10	16	Tea bags
11	1	Can instant coffee
12	2	Cans evaporated milk (small)
13	60	Individual sugar packs
14	1	Salt shaker
15	2	8 oz. cans beef stew
16	1	Can spaghetti and meatballs
17	1	1 lb. can chicken stew
18	4	3 oz. cans tuna fish
19	4	6 oz. cans boned chicken
20	1	15 oz. can frankfurters
21	1	13 oz. can chicken a la king
22	2	7 oz. cans corn
23	2	7 oz. cans peas
24	2	7 oz. cans string beans
25	2	7 oz. cans spinach
26	2	7 oz. cans baked beans
27	2	7 oz. cans carrots
28	2	7 oz. cans lima beans
29	3	Packages soda crackers or saltines
30	6	Packages dehydrated chicken soup

Guide 15.09

CHAPTER 16

Shelter Equipment And Supplies

No one knows just what the condition of a post nuclear war world would be. Many items listed here and elsewhere in this manual may seem out of place. They would be if shelter occupants could be sure that they would spend two weeks in a shelter and then come out to find their home and its contents intact and undamaged. Remember, the equipment and supplies taken into the shelter and the shelter itself may be the only material possessions shelter occupants would have when they emerge to face the future. 16.01

PERSONAL SANITARY NEEDS

There are certain personal sanitary and grooming supplies that everyone uses; tooth brushes, tooth paste, soap and toilet paper are examples. Other supplies are used specifically by men or women. In addition, individuals have certain items which they prefer to use. Most of these classes of needs are listed in guide 16.02 which list may be expanded by adding individual specific requirements. 16.02

PERSONAL SANITARY NEEDS

1. Toothbrushes
2. Toothpaste
3. Toilet soap
4. Dental tape
5. Combs
6. Hair brushes
7. Whisk broom
8. Hand brushes
9. Shampoo
10. Deodorants
11. Hair oil
12. Pair manual hair clippers
13. Nail files
14. Safety razor
15. Razor blades
16. Shaving soap
17. Shaving brush
18. Nail clippers
19. Bobby pins
20. Hair nets
21. Hair combs
22. Hair pins
23. Cold cream
24. Face lotion
25. Lipstick
26. Pumice stone
27. Waterless soap
28. Toilet paper
29. Kleenex
30. Sponges

Guide 16.02

SHELTER HOUSEKEEPING SUPPLIES

A list of essential supplies, including some items that are just plain handy to have on hand, is appended (16.03) for use as a checklist. The family must decide which of these items to stock and how many of each. No one can do more than make suggestions. If an encyclopedia is available, it would be a very interesting and informative asset in the shelter. 16.03

SHELTER HOUSEKEEPING SUPPLIES

1. Masking tape
2. Scotch tape
3. Rubber bands
4. Button assortment
5. Book matches
6. 1 mirror
7. 1 calendar
8. 4 dozen pencils
9. Writing paper
10. Heat applied patch assortment
11. Household oil
12. Sewing needles
13. Thread
14. 2 lighters
15. 6 cans lighter fluid
16. 6 spare light bulbs
17. 1 spare night light bulb
18. Old fashioned iron
19. Straight pins
20. Safety pins
21. 1 broom
22. 1 mop
23. Sheets
24. Towels
25. Pillow cases
26. Face cloths
27. Soap powder
28. 3 assorted zippers
29. Thimble
30. Pillows
31. Chairs
32. Dust pan
33. Blankets
34. Playing cards
35. Glue
36. Disinfectant
37. Old newspapers (for wrapping)
38. Old magazines (for reading)
39. White coveralls for each occupant
40. Chess set and board
41. Checkers

Guide 16.03

HARDWARE SUPPLIES

A suggested list of hand tools for equipping a shelter is included in guide 11.55 under the chapter heading "Essentials for Survival." Most of the hardware supplies listed below have obvious uses. For instance, putty and sealing graphite for plugging cracks or holes and nails or screws for making minor repairs. Two items listed are very important; yellow and red lumber marking crayons. When searching through the debris of collapsed houses, etc. a red X mark means there is danger of further collapse. A yellow X means "this location has been searched." For some obscure reason it is called a "giraffe mark." 16.04

HARDWARE SUPPLIES

1. Nails
2. Wood screws
3. Sheet metal screws
4. Nuts and bolts
5. Concrete rawl plugs
6. Electric insulating tape
7. Fuses for electrical system
8. Sealing graphite
9. 100 empty burlap bags for sandbagging (60 lb. bags)
10. Sakcrete
11. Manufacturers recommended spare parts for generator
12. Manufacturers recommended spare parts for blower
13. Manufacturers recommended spare parts for chain saw
14. Yellow and red lumber marking crayons
15. Solder and flux
16. Wood putty
17. Glaziers putty

Guide 16.04

PORTABLE MECHANICAL AND ELECTRICAL EQUIPMENT

Most of the fixed type mechanical equipment, such as the motor blower, etc., to be used in the shelter is listed in Chapter 13. There are six items, necessary or useful, that should be in the shelter. Four are mechanical and two electrical. The mechanical items are:

1. A 20 ton hydraulic jack for moving heavy debris.
2. A 5 ton screw jack for moving debris.
3. A bicycle for rapid emergency transportation.
4. A liquid fueled power chain saw and a fuel supply.

The chain saw would be extremely useful for felling trees and sawing firewood when outside radioactivity has decayed sufficiently. The fuel supply, in a safe container, should be either buried outside the shelter or possibly stored in the shelter lock. 16.05

The two electrical items are the electric dehumidifier and the storage battery charger that were described in Chapter 13. Both pieces of equipment are extremely important and relatively inexpensive. It should be noted once again that humidity can be one of the most annoying hazards in a shelter. 16.06

GENERAL PURPOSE EQUIPMENT AND SUPPLIES

There are many items that should be placed in a shelter. Some of these are difficult to classify. They are grouped here under the heading "General Purpose Equipment." All items listed have obvious uses. 16.07

GENERAL PURPOSE EQUIPMENT AND SUPPLIES

1. Flashlights
2. Flashlight batteries
3. Portable radio
4. Radio batteries
5. Radiation detector
6. Batteries for detector
7. Citizens band radio or walkie talkie
8. Batteries for radio or walkie talkie
9. 3 chemical fire extinguishers
10. 4—244 cubic ft. oxygen cylinders
11. 12—25 lb. pails indicating soda lime
12. Pencil sharpener
13. 2—3 way electric sockets
14. 2 extension cords
15. 1 stapler
16. 3 boxes refills for stapler
17. 12 air intake filters
18. 1 penknife
19. 1 hunting knife
20. Fishing line
21. Fish hooks
22. 1 waste basket
23. 1 hunting rifle
24. Ammunition for rifle
25. Storage battery
26. A clock
27. Identification tags for each family member
28. 1 canteen
29. 1 adjustable plastic hat
30. A supply of clean rags
31. 1 Martindale mask
32. 1 thermometer
33. 1 Bible
34. Pair of dosimeters for each shelter occupant
35. 1 reading device for dosimeters

Guide 16.07

CHAPTER 17

General Radiation Information

RADIATION DETECTORS

Radiation measurement devices may be divided into two general types; survey meters and dosimeters. Survey meters are calibrated in roentgens per hour (r/hr) and dosimeters in roentgens (r). The term roentgen relates to the effect of radiation on air. The equivalent term relating to the effect of radiation on human tissue is the "rem" or roentgen equivalent man. Since there is a nearly constant relationship between the energy absorbed per gram of air and the energy absorbed per gram of tissue over a wide range, the term or unit of roentgen is used to measure radiation damage to tissue. Alpha radiation is not included in overall roentgen readings. Beta and gamma types of nuclear radiation are included. 17.01

SURVEY METERS

Survey meters detect and measure radiation dose rate. When survey meters are used to measure contamination of people, food, water, equipment and living quarters they must be capable of indicating very small amounts of radiation. Therefore, survey meters with a range of 0 to 50 roentgens per hour should be used for this type of survey. 17.02

If a survey meter is used to measure external radiation, readings up to 500 roentgens per hour may be necessary and a meter with a range of 0 to 500 r/hr should be used. Even a survey meter calibrated for this range should be capable of giving indications of higher dose rates, otherwise there might not be any way to become aware of doses exceeding 500 r/hr. 17.03

Certain radiation measurement instruments are designed to be used in shelters, but to provide dose rate information from points outside by means of cables extending to the outside. These meters should indicate gamma dose rates up to 1000 r/hr. One such device has provisions for four cables which will show outside (or inside) radiation levels at four different points (five including the meter). The value of such an instrument can scarcely be overestimated. Several possible locations for these remote cables in a BOSDEC type shelter are mentioned in Chapter 13 (13.27). Other possible locations could include the secondary shelter, shelter lock and the house overhead. 17.04

DOSIMETERS

Dosimeters detect, measure and register total accumulated gamma dose. Some direct reading types indicate radiation accumulations by color changes. Other types consist of film badges with a piece of X-ray film in a metal holder. This film is sensitive to radiation and when developed by standard methods, film is darkened in proportion to amount of radiation received. The film is compared with various control films from the same lot of film that have been exposed to a known amount of radiation. The film badge must be worn at all times by the person to whom it is assigned. No one else may wear it. It must be developed before it can be read. While the total accumulated dose is not known immediately, the record is permanent. 17.05

There is another type dosimeter which records radiation when electrically charged, starting with zero. Some of these can be read by holding them up to the light. Others must be read in a reading device designed for this purpose. The electrical type could give false readings due to electrical leakage caused by dropping or other damage. They are usually worn in pairs. Neither film badge nor electrical pocket dosimeters will register alpha radiation. This is not important since external alpha exposures are not a hazard. 17.06

NORMAL RADIATION EXPOSURES

The average person receives about 15 roentgens of nuclear radiation in a lifetime from natural sources plus small amounts from medical and dental X-rays. A tiny amount may even be absorbed from wrist watches. The main sources of this radiation are in order of magnitude; medical procedures, natural causes, cosmic radiation, fallout from nuclear tests, TV tubes and watch dials, etc. and industrial exposures. 17.07

RADIATION DOSES AND RECOVERY TIMES

The human body can absorb up to 100 roentgens in a short time without any probable immediate ill effects. It can take some radiation damage and repair it without serious permanent effect. Radiation sickness is not contagious. Occasionally people under very severe strain may appear to have the same symptoms. 17.08

The absorption of 100 to 200 roentgens would cause some slight ill effect in most people. The recovery time would be about two weeks. However, a dose of 200 to 600 roentgens would cause severe illness or death within five to seven weeks. If not fatal, recovery time from most of the apparent illness would be about ten to sixteen weeks. A whole body dose of over 600 roentgens received in a short time would probably be fatal. However, these same dosages would not be as dangerous if absorbed over a long period. 17.09

SAFE ROENTGEN DOSAGES UNDER EMERGENCY CONDITIONS

There are four possible ways that radioactive materials can get into the body; by breathing, swallowing, breaks in the skin and absorption through the skin. Certain radiation exposure dosages would be unthinkable under normal circumstances and the risk considered unacceptable. However, under emergency conditions these following dosages would be tolerable as a maximal limit; less than 300 roentgens in a lifetime, less than 100 roentgens in a month, less than 25 roentgens in one day and less than 10 roentgens in an hour. 17.10

EMERGENCY EXCURSIONS FROM SHELTER

LEAVING SHELTER

If it ever becomes necessary to leave the shelter under conditions of substantial but comparatively safe radioactivity, the following procedure should be used. First check outside radiation dose rate and time.

1. Dress in old clothes. Put on white coveralls over the clothes, overshoes, plastic hat, gloves and Martindale mask.
2. Put the following articles in the coverall pockets for emergency use:
   (a) Matches
   (b) Pocketknife
   (c) Bandaids
   (d) Soap
   (e) String
   (f) Safety pins
   (g) Tissues
   (h) Clean rags
3. Take a canteen of water.
4. Seal coveralls as follows:
   (a) Place rubber bands at wrists and ankles.
   (b) Seal wrists and ankles with masking tape.
   (c) Seal pockets with masking tape.
   (d) Seal zipper with masking tape.
   (e) Wrap rags around shoes and secure with heavy rubber bands. 17.11

RETURNING TO SHELTER

When returning from emergency excursions outside shelter, check carefully elapsed time since leaving and outside radiation dose rate. It is especially important to use great care in undressing in the "Shelter Lock," washing and removing the Martindale mask.

1. Before undressing or removing the mask, brush off thoroughly or wash down if necessary or possible in the shelter lock or outside. This removes most of the contamination.
2. Remove coveralls, outer clothing, hat, boots and shoes.
   - (a) Keep mask and gloves on while doing this.
   - (b) Clothes should be left in "Shelter Lock" for contamination check later.
   - (c) Hold breath and remove mask and then gloves. Leave mask and gloves in "Shelter Lock".
   - (d) Wash hands thoroughly in cold water paying special attention to finger nails.
   - (e) Take a cold shower—not a bath, using plenty of soap. Put on clean clothes. 17.12

CHAPTER 18

Emergency Shelter First Aid

Every home and shelter should have a late edition of the Red Cross First Aid Manual. A few simple suggestions, in outline form, are listed here for quick reference when a First Aid manual is not available. Immediate emergency measures for handling bleeding, breathing problems, burns and fractures are outlined. It would be worthwhile to memorize these basic first aid procedures. 18.01

BLEEDING

To stop bleeding apply pressure at once—hard and fast.

1. Use hands, bandage or clean cloth.
2. Do not stop to wash wound.
3. Bring edges of wound together.
4. Apply pressure for 30 minutes if necessary.
5. Use tourniquet as last resort unless skilled in its use. 18.02

BREATHING PROBLEMS

Remove mucous, debris, food, dentures, any obstruction or foreign material from mouth.

1. If breathing, place head to one side to keep blood or fluids from flowing into air passages.
2. If not breathing, apply mouth to mouth insufflation.
    - (a) Tilt head to sword swallower position using pillow or blanket under the shoulder.
    - (b) Pinch patient's nose shut.
    - (c) Place your open mouth over patient's mouth.
    - (d) Inhale through nose.
    - (e) Exhale into patient's mouth 12 to 16 times per minute for adult, 20 times per minute for child.
    - (f) Keep this up for two hours or more.
    - (g) Upon revival adjust your breathing rhythm to patient's efforts. 18.03

BURNS

Light burns (reddening of skin) leave uncovered.

1. Treat pain with pain relievers or leave alone.

Deeper burns (blisters and skin destruction) cover with clean dressing without ointments or salves.

1. Don't puncture blisters unless likely to break.
    (a) If necessary make small sterile incision at blister edge.

Severe burns should be handled same as deeper burns.

1. Patient should drink solution of one teaspoon salt in one quart water. One gallon of this solution may be drunk in first 24 hours. 18.04

FRACTURES

Splint fractures without moving patient.

1. Firmly support broken limb.
2. Simple fractures can be recognized by tenderness to touch.
    (a) Also by unnatural shape of part.
    (b) By swelling.
    (c) By change in color of skin.
3. Compound fractures are indicated by broken skin and/or protruding bone. 18.05

PREGNANCY

Married couples who are or may become expectant parents should have some basic instruction on how to handle an emergency delivery. A visit with the family physician or members of a local first aid squad should provide much useful information. 18.06

IDENTIFICATION TAGS

Each member of a family should have a stainless steel tag to be worn at all times for identification purposes. This information should be inscribed (preferably engraved) on it

1. Name
2. Address
3. Phone Number
4. Birth Date
5. Blood Type
6. Allergies
7. Religion
8. Alternate Address
9. Social Security No.

The alternate address would probably be that of a close relative. 18.07

CHAPTER 19

Basic Nuclear Physics

ELEMENTAL STRUCTURE

Practically all materials in our world consist of elements or combinations of elements called compounds.

1. An element is a substance all of whose atoms have the same atomic number but not necessarily the same atomic weight.
   Examples are:
   a. Lead
   b. Gold
   c. Hydrogen
2. An element cannot be decomposed by ordinary chemical means. A compound can be decomposed. Examples of compounds:
   a. Water—H_2O
   b. Salt—NaCl 19.01

ELEMENTS

An element is formed when a large number of identical atoms are bound together. When atoms are grouped together in certain numbers and combinations they form molecules. Many molecules consisting of identical atoms form an element—if different atoms, they form compounds. 19.02

ATOMS

All atoms contain a nucleus with a heavy dense core surrounded at a relatively great distance by electrons which orbit around the nucleus at high speed. These electrons are small, almost weightless and have a negative electrical charge. 19.03

NUCLEUS

Nuclei consist of balls of matter larger and heavier than electrons. These balls are called:

1. Protons—have a positive electrical charge.
2. Neutrons—do not have an electrical charge.
3. The atomic weight of a substance is the sum total of the number of protons and neutrons in the nucleus.

When you weigh yourself you are actually ascertaining the sum of the weight of all the nuclei in your body.

The nucleus of each atom is held together by a force called binding energy.

1. Some of this energy is released when a nucleus is split in two by fission.
    a. This is due to the fact that it takes less binding energy to hold together the two fragments resulting from the split than to hold the original nucleus together before fission.

If a mothball was made of nuclei it would weigh almost 30,000,000 tons. That is how heavy a nucleus is for its size. 19.04

PROTONS

For each proton in a nucleus there is one negatively charged electron in orbit around the nucleus. A proton is approximately equal in weight and size to a neutron.

1. The number of protons in the nucleus determines the number of electrons in orbit.
2. The number of protons also determines the nature of the element and its atomic number.
3. Proton's positive electrical charge equals the negative charge of the electron.

Natural elements exist with the number of protons ranging from 1 (hydrogen) to 92 (uranium).

1. Whenever the number of protons change, a different element is formed.

Certain elements not existing in nature have been created by man.

1. Their atomic numbers range from 93 to 102.
2. Since uranium is 92, these manmade elements are called transuranic elements.
    a. They are all radioactive.
    b. Plutonium (94) used for nuclear weapons is very important. 19.05

NEUTRONS

Neutrons are the balls of matter in the atomic nucleus which do not have an electrical charge. They are about 1800 times heavier than electrons. The number of neutrons in a nucleus ranges from 0 to about 150. In certain elements different atoms of the same element have the same number of protons but vary in number of neutrons.

1. Since chemistry is concerned with orbital electrons, these are chemically the same element.
    a. Since all these atoms have the same number of protons, they will have an equal number of electrons in orbit.
    b. Since they have a different number of neutrons in the nucleus, the various atoms of the same element will not all weigh the same.
2. Nuclear physicists and physical chemists view these as different substances of the same chemical form.
    a. They vary in atomic weight.
    b. They are called isotopes. 19.06

ISOTOPES

Most isotopes are unstable, therefore radioactive. Some are stable and not radioactive. The first element hydrogen has 3 isotopes, and tin the fiftieth element has 25 isotopes. There are more than 1200 known isotopes.

1. Two isotopes of the same element will have the same atomic number but different atomic weights.

An example of how materials become radioactive isotopes in a reactor, using cobalt as an illustration, is shown. The ordinary cobalt is inserted into an opening in the reactor.

1. Natural cobalt has 27 protons and 32 neutrons.
    a. A rod of cobalt is inserted into the reactor.
    b. Billions of cobalt atoms are bombarded by billions of neutrons.
        I. This flow of neutrons is called the "neutron flux."
    c. A few of the cobalt atoms, possibly one in a billion, captures a neutron and then has 27 protons and 33 neutrons.
        I. These atoms have changed from cobalt 59 to radioactive cobalt 60 which gives off strong gamma and some beta radiation.
        II. Cobalt 60 has a half life of 5.3 years.
        III. It was made radioactive by a process called "neutron capture".
        IV. Substances are made radioactive <u>only</u> by "neutron capture". 19.07

FISSION

Fissionable refers to those atoms which can be split apart by nuclear bombardment releasing large amounts of energy in the process. It means that the material must be capable of sustaining and multiplying the chain reaction process so that a large number of fissions can be made to take place in a very short time. The terms fissionable and radioactive are not equivalent.

1. Only two readily available materials are capable of sustaining and multiplying a chain reaction.
    a. Uranium 235—used as fuel for atomic reactors.
    b. Plutonium—a man made element created by a nuclear reaction in an atomic reactor, used mainly for nuclear weapons.

These fissionable materials bring about a chain reaction in the following manner:

1. They emit bits of elementary matter—neutrons.
    a. These neutrons strike other atoms of the same material causing them to break open, emitting more neutrons and releasing binding (fission) energy. Neutrons produced in fission process are mostly high energy or fast neutrons.
        I. For a neutron to penetrate an atom to cause fission it must be slowed down. Slowed down neutrons are called "thermal neutrons". They are most liable to nitrogen capture and removal from nuclear radiation. This capture usually creates gamma radiation which is easier to attenuate.
        II. Water, graphite and other materials will slow down neutrons so as to produce fissioning. These are called "Neutron Moderators".
    b. Regrouping of split atomic material creates new atoms called fission products.
        I. Many of these are radioactive.
        II. Energy and new atoms result.
        III. This is a chain reaction.
    c. The quantity of a fissionable material which will provide a self sustaining chain reaction is called a critical mass. It is necessary to have a small surface area in relation to mass to be critical, otherwise more neutrons would escape by the surface than would be produced in the mass.
        I. The quantity of a fissionable material not sufficient to do so is called a subcritical mass.
        II. As soon as one more neutron is being made than is being lost, the mass is critical. At this point the multiplication

of the chain reaction starts to increase at a fantastic rate.

d. Controlled fissionable energy is produced by atomic reactors.

e. Uncontrolled fissionable energy results from the explosion of nuclear weapons. 19.08

IONIZATION

All radioactive materials emit ionizing radiation. Ionizing is a term used covering forms of radiation which cause rearrangement of orbital electrons in the atoms of a substance through which the radiation passes. The end result being formation of ion positive and negative pairs. In living tissue these can cause biological damage. There are many nonionizing forms of radiation:

1. Heat
2. Light
3. Radar
4. Radio

These do not have enough energy to affect orbital electrons and damage from these forms of radiation is usually confined to the outer layers of the body.

1. Damage is usually apparent and protective measures can be taken such as in the case of sunburn.
2. This is not true of ionizing radiation since electron rearrangement in the body cannot be felt.
    a. Biological damage is not apparent until it may be too late. 19.09

IONIZING RADIATION

There are three types of ionizing radiation:

1. Gamma—short electromagnetic pure energy rays having no mass or weight.
    a. Gamma radiation originates when the discharge of one of these alpha or beta particles from a nucleus doesn't take enough energy along with it to leave the nucleus in quite a contented state.
        I. If the particle leaving the nucleus doesn't take with it all the energy that the atom wants to get rid of, it throws off some of the energy in the form of gamma radiation.
            (a) Therefore, gamma radiation can be given off by many radioactive materials in addition to giving off alpha or beta radiation.
        II. Gamma radiation is stopped by electrons.

2. Beta—elementary particles carrying negative electrical charges identical with an electron.
3. Alpha—relatively heavy atomic particles.
    a. Each particle contains 2 protons and 2 neutrons bound together.
    b. They are identical with the nucleus of a helium atom. 19.10

RADIATION

Radiation is a common expression for energy emitted in both wave and particle form. Actually it should apply only to the transmission of electromagnetic waves. Small amounts are emitted naturally by many radioactive materials by means of the decay process. Radiation cannot be detected by the human senses, therefore, radiation detection and measurement instruments must be used.

Materials cannot be made radioactive by being subjected to radiation. They are only made radioactive by being subjected to an intense "neutron flux" which results in "neutron capture". 19.11

RADIOACTIVE ATOMS

The nuclei of radioactive atoms contain excess energy and are referred to as being in an "excited" state.

1. They rid themselves of this excitation by emitting the excess energy in the form of radiation.
    a. All nuclear radiation falls into two general classes.
        I. Rays
        II. Particles—of subatomic bits of matter.
2. The more electrons in a material, the more gamma radiation will be stopped.
    a. A heavy element must be used to stop neutrons.
        I. Hydrogen
        II. Paraffin
        III. Water
3. The process of getting rid of excess energy is called radioactive decay.
    a. Some radioisotopes decay directly to a stable state in one step.
    b. Others decay through a series of steps or chains forming different radioactive elements called "daughter products" before finally reaching a stable state.
        I. They emit radiation during each step of the process.

II. The type of radiation can vary during each step. 19.12

BIOLOGICAL NUCLEAR EFFECTS

The body consists of mostly empty space. To us it seems fairly solid but considering that one drop of water contains 6 sextillion (a 6 with 21 zeros after it) atoms it must be realized that all things that seem solid are actually porous. The rays that pass through a body without hitting anything are the means of registering X-rays on film. Each ray penetrates to a different depth before finding its target and producing its effect on the body. 19.13

The rays from radioactive materials do not hit the nucleus in large numbers. Few of them have enough energy to penetrate or change the nucleus. They hit the electrons orbiting the nucleus and the energy of the ray is spent. The energy from the rays is transferred to the electrons ejected from the atoms. This is the process called ionization. 19.14

Atoms in their normal state are electrically neutral—they contain the same number of electrically negative electrons in orbit as they contain electrically positive protons in their nucleus. When radiation causes displacement and rearrangement of these electrons, positive and negative ions are created. These ion pairs in sufficient quantities can cause complex changes in body chemistry which result in degrees of sickness or death depending on amount of ionization caused. The radiation effect goes on all the time. Bodies are constantly being bombarded by cosmic rays and rays from radioactive materials in the structure of our life. 19.15

When an electron is knocked off an atom, the cell of which the atom is a part is damaged. The body repair mechanism repairs the cell. This radiation may be bad or it may be good. No one really knows. We have learned to live with it since the beginning of man. 19.16

INTERNAL RADIOACTIVE POISONING

There are two radiation problems; external radiation exposure and internal radioactive poisoning. This section will take up the ingestion of radioactive particles. The body is actually a chemical processing plant. It normally processes food and air, converting them into energy, body tissue, bone and other body requirements. It absorbs most things through breathing and swallowing. Since many of the body needs are chemical in form it has a problem when radioactive substances are introduced into it. For instance, the bones use calcium. Radium is chemically very much like calcium. Therefore, when radium is taken into the body the bones have a tendency to accept it and radium is deposited in the bone.

1. Much that is inhaled is immediately exhaled.
2. Materials which are not soluble when swallowed are rapidly excreted through the feces.
    a. Soluble materials go into the bloodstream.
        I. The bloodstream carries them to different parts of the body in accordance with its usual procedure of supplying body needs.
            (a) Each part of the body responds chemically to the material offered and accepts it because it is similar to materials it ordinarily uses or rejects it.
            (b) If radioactive iodine is offered the thyroid gland will pick it up.
3. Sodium, hydrogen and potassium are widely used in the body and these elements are widely distributed throughout the body and picked up whether radioactive or not.
    a. The body reacts to substances chemically whether or not they are radioactive.
    b. If none of the organs accept the substance it passes on to the kidneys and then out of the body.
        I. A very healthy body with no calcium or other deficiencies may not accept as much radioactive substances.

The biological half life of a radioactive element is the period of time which it takes for one half of it to be excreted from the body by natural processes. Combining the radiological half life with the biological half life gives the effective half life of the material in the body. 19.17

CHAPTER 20

America After A Nuclear Attack

One can only guess at the way of life of Americans in a period immediately following a nuclear attack and war. Obviously we could expect no mercy whatsoever from the communists in the unlikely event that they were victorious. We would then sink into a dull, zombie like existence—with all the well described frustrations of a police state. We would probably face a small fascist controlling group with a rubber stamp legislature of fellow travelers operating under the guise of phony democracy. If America is resolute and strong—well armed and well protected we will not come out second best. It's useless to talk of winning a nuclear war. There will not be a winner. 20.01

ABSORBED RADIATION

After the bombs have dropped and the debris of war has been cleared away there will still remain one big unavoidable problem. Radiation and people who have absorbed radiation. Let us assume that 1000 nuclear bombs have been delivered on American targets. The majority of these will have fallen on three main types of targets; military installations, cities and critical industrial areas.

Assume further that no two bombs have fallen in the same total destruction area. This means that no bomb has fallen within, let us say, three miles of another bomb. Since the total destruction area of a nuclear weapon of large size is about 30 square miles, we will have 1000 bombs times 30 square miles or 30,000 square miles of total destruction and of dangerous initial (neutron induced) radiation ground radioactivity. 20.02

AREAS OF INTENSE RADIATION

This means that out of the 3,000,000 square miles in the continental United States, 30,000 or roughly 1% of the country will be intensely radioactive for long periods of time—possibly a lifetime for many of us. Included in the 1% will be cities containing miniscule proportions of total area but large percentages of total population. People living in these city targets must be relocated—and quickly. All the industrial capacity in the world will mean nothing without people to run the machines and use that capacity. Military targets will not necessarily face loss of life and human damage comparable to big city losses. The surrounding ground will be just as deadly radioactive and must be evacuated perhaps for a period of up to 50 years. The same is true of the huge metropolitan centers. These three classes of territory must be evacuated. New housing for the people evacuated must be built in relatively radiation free parts of the country. 20.03

No one can say how long it would be until people could return to prewar homes, military bases and factories. It is thought by many authorities that present methods of long range radiation decay computation are pessimistic and that radioactive decay proceeds at faster rates than indicated by formulas presently used. More data on this subject would be obtained over the post attack years by actual surveys of bombed areas. 20.04

RADIATION WEATHERING EFFECT

The weathering effect of rain and snow, when better understood, may indicate huge carry offs of radioactive surface materials by rivers, streams, sewers and other means. When emptied ultimately into the ocean, the vast dilution of such dangerous materials might speed the habitability of otherwise dangerous areas. 20.05

New techniques, to neutralize fallout radiation, by plowing under one foot of top soil in critical radioactive areas and the gathering and burying of contaminated debris—all may mean speedier returns to pre-attack locations than would be indicated by present methods and calculations. 20.06

RECONSTRUCTION AND RELOCATION PROGRAMS

All this relocation and rebuilding must be done under adverse conditions with equipment shortages, in radioactive atmospheres. Obviously a completely unique and dynamic program must be planned. It may well be that reconstruction will be under the supervision of the Army Corps of Engineers. Unfortunately, all Americans are not shining knights and even as it is in peacetime, so will there be looting, thievery and other crimes committed. Since local and possibly even regional police protection will be spotty at best, the military probably will have to maintain order throughout the country.

This type of activity gives rise to the often heard complaint that we will come out of a nuclear war with a fascist police state run by the military. This is said with the implication that this would be worse than turning into a communist state. 20.07

MILITARY LEADERSHIP

The military leadership of our country has always had the unpleasant task of providing protection, always in time of danger, to our citizens. This requires firmness and disciplines that are necessary to get the job done in wartime emergencies. It is naturally repugnant to freedom loving peoples. It will be necessary, during and after a nuclear war, to impose many restrictions and regulations upon the citizenry for not only their own protection but also for the benefit of the country as a whole and the majority of the population. This is inevitable. 20.08

Army, navy and airforce officers by their training, heritage and customs, represent one of the best types of American citizen. If we must have regimentation, how much better it will be to have a temporary, American directed effort under civilian control than to have a permanent one directed by commissars solely interested in alien philosophies and problems. 20.09

REGISTRATION

One of the first post war projects must be a complete registration of all citizens. Time will be short and speed absolutely essential. Registration will be on a basis of radiation exposure and age. There will emerge from this registration a new class system — not one as we now think of it, but classes divided according to radiation absorbed. 20.10

AREA CERTIFICATIONS

The country must be radiation surveyed and divided into zones or areas according to radioactivity remaining in each zone. With these two compilations completed an immense program to relocate all people with high radiation absorbed doses in low radiation areas must be undertaken. At this point the question of age becomes all important. Young people with high radiation absorbed doses must be given an emergency expedited status and rushed to the lowest radiation areas. Old people with high radiation absorbed doses will not be in quite as precarious a position for reasons to be covered later. 20.11

RADIATION BANKING CONCEPT

To properly assign all people to classes according to radiation dose absorbed will require a formula. No doubt the "banking" formula or a variation of it will be employed. This formula is based on the fact that as we go through life we can absorb a certain amount of radiation each year and not suffer any immediate ill effects. This amount is credited to an individual's "radiation bank account" each year. As radiation is absorbed by the same person, his radiation bank account is debited. The balance in his bank account is the total radiation that he can absorb or withdraw without any immediate ill effects. The exact value of the deposit each year and the withdrawals are a matter of question at this time. Authoritative sources differ on these values. Further, these values differ according to whether normal peacetime industrial radiation problems are at issue or whether emergency wartime life or death conditions are considered. 20.12

DEPOSITS AND WITHDRAWALS

For the sake of discussion we will say that the amount of radiation that could be credited to a person's account each year would be 8 roentgens or 640 roentgens for an 80 year life span. The allowable bank withdrawal may be 5 roentgens per year within certain limitations which result from the fact that some deposits are "time deposits" which may not be withdrawn ahead of time. The time limitations might be these maximums. Not more than 10 roentgens may be withdrawn in any one hour, or more than 25r in any one day. The limit for one month would be 100r and for a lifetime 300 roentgens. (17.10). 20.13

The one big drawback to the use of a commonsense system of citizen conservation is that very few people have dosimeters, let alone shelters. Therefore, estimates must be made in a post war period. The only possible way to eliminate guesswork will be to develop a method of testing designed to show total absorbed dose, possibly by rate of cell mitosis (cell growth) or ionization counters. 20.14

As an example let us take a man 40 years old. He has a "bank account" of 320r and has received a total accumulated dose of 120r. His bank balance is 200r and deposits will be made at the rate of 8r per year for the rest of his life. Assume that he will live to be 80 years old. His maximum bank account in his eightieth year will be 520r. He may be assigned to an area where the average yearly dose rate for the next 40 years, will be 13 roentgens per year. Since this is the average rate over a 40 year period, the starting dose rate at his time of entrance to his assigned area might be considerably higher than 13r per year. These and other figures and examples are not necessarily based on facts. They are intended to convey an idea of what type of system might be used. The principle must be to make assignments to areas by age and absorbed dose. Otherwise the wasteful practice of assigning someone 60 years old, with no appreciable absorbed dose, to an area where the dose rate is 2r per year could occur, while a person 30 years old with an absorbed dose of 240r might end up in an average 20r per year area. 20.15

A certification of age and absorbed dose for each person would be almost mandatory in a post war world. A complete continuous record for each person will be maintained in order to make area assignments intelligently. 20.16

OLDER PEOPLE

In previous history it has almost always been the young men of America who died for their country in perilous times. We may see the position reversed. Older people with small absorbed dose certifications will be able to go into higher radioactive areas and operate the bulldozers and other decontamination equipment with the least harm to themselves, and the most benefit to their country. Time will run out for many older citizens. That is, they will approach the end of life with substantial unused absorbed dose credits in the "bank". They will be able to volunteer for extremely hazardous duty in highly radioactive areas without paying the penalty exacted from young people; a lifetime spent with marginal radioactive absorbed dose credits. We may yet live to see the day when grandfather comes clanking back home from the "front" on a bulldozer in a parade of decontamination veterans to the cheers of the crowd lining the decontaminated curb on Fifth Avenue. 20.17

RECONSTRUCTION EFFORTS

When the radiation survey of all habitable areas of the United States has been completed and the registration and rad certification of all people in our country has been done, we can then decide what products and services should have priority. Basically the decision will be; what do we need and where can we make it. 20.18

Obviously food, water, shelter and clothing needs will have top priority. Soap, medicines, tools and utensils will come next. After these primary needs will come bulldozers, plows, machine tools, hardware—such as nails and screws, generators, tanning equipment, cement mixers, blockmaking equipment, radio and broadcasting apparatus. 20.19

BASIC MATERIALS

Practically all manufacturing is predicated on the availability of certain basic raw materials such as iron ore, coal, oil and bauxite (for aluminum). These materials will have a top priority. A certain amount of these essentials will be immediately available—in transit, in storage or otherwise stockpiled and in various stages of processing in places difficult to wipe out with a nuclear attack. 20.20

Mines and oil wells are, by their nature, scattered all over the map. This is a disadvantage under normal conditions—but it would be a big asset during and after a nuclear attack. Transportation might be somewhat of a problem in getting these resources to steel mills and refineries. Water transportation and pipelines would probably be least affected by a nuclear attack. It would appear that basic materials and their transportation, while presenting difficulties, would be delivered to facilities left intact or at least operable. 20.21

HEAVY MANUFACTURING

Our post attack economy will require the tools of reconstruction and decontamination as well as the essential supplies for existence. Items such as tractors, diggers, compressors, generators, trucks, pumps, electronic communications equipment, motors, packaging equipment and heavy generating facilities all require steel and all must have a high priority. The area diversification of many of our big companies with dozens of plants scattered widely will be a tremendous asset. Even plants used for making conveniences may be converted to the items urgently needed. 20.22

Very few Americans have ever seen the United States as a whole. Almost 10,000 towns and cities over 700 population. Thousands of them containing one or more factories or manufacturing facilities. Many of these facilities are for processing farm supplies—but a surprising number, especially in the midwest, make a large variety of equipment. A nuclear attack, no matter how big, could not knock out our manufacturing capability completely. 20.23

Reservoirs, housing and factories—mining and steel mill machinery plus cement making facilities, all these needs must be met. The interrelationship among all these activities is so complex that one can not say with authority just where the cycle starts—but start it must. 20.24

MEDICINE

Fortunately, many of our leading pharmaceutical companies are located in rural areas not likely to be destroyed by nuclear blast or heat. This circumstance can do much to alleviate the inherent health problems inevitable in the aftermath of a nuclear war. 20.25

CLOTHING

Much of the material, used for fabricating clothing, comes from mills scattered in dozens of small towns in predominately rural areas. This may prove to be a plus factor in solving clothing problems under post war conditions. It would be almost impossible to knock out all mills in our country or even the majority of them with the most intense nuclear attack possible for many years. 20.26

GOVERNMENT PLANNING

Our government, which has spent over many years millions of dollars on obscure projects of interest to very few people, must certainly have investigated thoroughly possible post attack conditions and planned for them. These plans are understandably secret. However, anything less than a complete survey of facilities and their capabilities for producing necessities of life outside possible target areas, would be an inexcusable dereliction of responsibility. Done now, this would be a simple matter. Delayed, a terrible price may be paid. 20.27

Glossary

Afterwinds — Winds created by the fireball updraft. They are drawn inward and upward and are less powerful than blast winds.

Air Burst — A nuclear explosion occurring at a sufficient height to keep the resulting fireball from touching the ground.

Alpha Particles — A form of radiation lacking energy enough to penetrate even the outer layer of skin. Usually emitted by naturally heavier radioactive elements such as uranium, radium and thorium.

Barrier Shielding — A mass placed between the fallout and the shelter occupant. The density and thickness provide the shielding effect.

Beta Particles — A form of radiation that can be stopped by less than 100 feet of air or by heavy clothing. They are more powerful than alpha particles but not as penetrating as gamma rays.

Biological Half-time — The time required for the body to rid itself, by natural biological means, of one half the initial value of an element taken into the body.

Blast — The initial shock generated at the instant of bomb burst.

Blast Wave — The wall of pressure moving outward from the blast created by a nuclear bomb burst.

Blast Wind — The air movement of hurricane type winds that are caused by, and accompany the blast wave.

BOSDEC — Abbreviation of Bomb Shelter in Depth Concept. It consists of three areas. A primary shelter surrounded on three sides, also top and bottom, by a minimum of one foot of reinforced concrete and five feet of earth. The fourth side opens into a secondary shelter connected to the outside by a shelter lock.

Burst — The explosion of a nuclear bomb.

CFM — Abbreviation of Cubic Feet per Minute.

Combined Shielding — Radiation protection combining geometry and barrier shielding into the total shield.

Crater — The hole in the ground created by a nuclear ground burst.

Cube Root — The number or quantity of which a given number or quantity is the cube. The cube root of 8 is 2.

Curie — The amount of a particular radioactive substance which undergoes 37 billion radioactive transformations per second.

Delayed Fallout — Consists of dirt and debris which has been swept up into the fireball, becomes radioactive, is carried aloft by the explosion and high altitude winds and then returns to earth more than 24 hours after the explosion.

Direct Nuclear Radiation — Alpha, Beta, Gamma and neutron radiation emitted by the products of a nuclear explosion at the time of the burst. It is effective for less than one minute and only within a radius of 2 or 3 miles from the explosion.

Dose Rate — The amount of radiation to which a person is exposed, expressed in units of time.

Dosimeters — A meter used to detect and register the total accumulated exposure to ionizing radiation to which a person has been exposed.

Early Fallout — Heavier pieces of radioactive debris that descend to earth starting about 30 minutes after the burst and continuing for up to 24 hours.

Energy Yield — The effective energy generated by a nuclear explosion.

Fallout — Dust and dirt particles which have been made radioactive by the nuclear products of a burst.

Fireball — The intensely hot and brilliant ball of fire which starts to form at the instant of explosion. The heat lasts 10 seconds to approximately one minute depending on weapon size.

Firestorm — A phenomenon caused by many small fires, usually in cities or forests, combining into one superheated conflagration. This heat generates inrushing winds that supply additional oxygen that intensifies the fire but also limits its spread.

Firewinds — Created by the action of extremely hot fires burning up atmospheric oxygen which causes a vacuum into which cool air is drawn at high speed.

Fission — A method of creating a nuclear explosion by splitting nucleus of a heavy element such as Uranium 235 or Plutonium 238.

Fissionable Materials — Materials capable of self sustaining chain reactions.

Flash — The initial ultraviolet flash from a nuclear explosion which lasts a few millionths of a second.

Fusion — Fusion creates a nuclear explosion by causing two light nuclei to unite into one heavy element. Fusion is roughly three times more effective than fission as a producer of energy. It requires the millions of degrees of fission temperature to trigger the fusion explosion.

GZ — Abbreviation of Ground Zero.

Gamma Rays — The highly penetrating electromagnetic rays emitted by the products of a nuclear bomb burst.

Geometry Shielding — The term used to describe the fallout protection inherent in distance from the fallout. The greater the distance from the radiation, the less danger from the same fallout.

Ground Burst — A nuclear explosion taking place at or very close to the ground.

Ground Shock — The shock or blast effect transmitted through the ground as a result of a ground or underground nuclear bomb burst.

Ground Zero — The center of a point at which a ground burst occurs. Also, the point on the ground directly under an air burst.

HVL Thickness — Abbreviation of Half Value Layer thickness.

Half Life — The point at which an alpha or beta particle and gamma ray will have lost one half of its radiation by radioactive decay. Since radioactive materials do not decay at an even rate the whole life of these rays will be much longer than twice the half life. The decay rate is accelerated at first but slows down gradually.

Half Value Layer Thickness — The thickness of any particular material which will stop one half the gamma rays from passing through it.

Hot Spot — Zone of radioactive contamination containing more radioactivity than adjacent areas.

ICBM — Abbreviation of Intercontinental Ballistic Missile.

Initial Nuclear Radiation — Nuclear radiation occurring during the first minute after a nuclear weapon explosion.

MEV — Abbreviation of Million Electron Volts. A unit of measurement indicating the penetrating power of gamma rays.

MPS — Abbreviation of Maximum Protection Shelter.

MT — Abbreviation of Megaton.

Mach Front — The combined forces or pressures of a shockwave (blast) and reflective shock.

Mass Thickness — The product of the unit weight and thickness of a wall or slab which determines its protection effectiveness.

Maximum Protection Shelter — A shelter with a Roentgen reduction factor of more than 10,000 and capable of withstanding an overpressure in excess of 100 psi.

Megaton — A unit of energy equivalent to 1,000,000 tons of TNT.

Micron — A unit of measurement equal to one millionth part of a meter. A meter is 39.37 inches. A human hair has a diameter of 75 microns.

Mil — One thousandth of an inch.
Millicurie — One thousandth of a curie.

Milliroentgen — One thousandth of a roentgen.

Mutual Shielding — The barrier shielding supplied by adjacent buildings or other masses.

NEAR — Abbreviation—National Emergency Alarm Repeater. A unit being developed by the Government to plug into AC electric outlets to provide an automatic attack warning.

Neutron — A particle without an electrical charge. Part of the nucleus of an atom. Neutrons are needed to start the fission process. Many neutrons are produced by fission and fusion explosions.

OP — Abbreviation of Overpressure.

Overpressure — The amount of pressure in excess of normal atmospheric pressure which is 14.7 psi at sea level.

PCF — Abbreviation of Pounds per Cubic Foot.

PF — Abbreviation of Protection Factor.

Plastic Zone — The zone immediately adjacent to the rupture zone of a nuclear explosion crater area. The earth is subjected to enough stress to deform it, but not enough to produce a crater or radial cracks.

PSF — Abbreviation of Pounds per Square Foot.

PSI — Abbreviation of Pounds Per Square Inch.

Primary Shelter — In the BOSDEC system this shelter is at the center of a protective mass and is the place where imminent attacks, actual bursts, thermal radiation, shockwaves, firewinds, initial high radiation and early fallout would be waited out.

It is the basic, most highly shielded protective core of the BOSDEC system and may only be entered by going through a shelter lock and a secondary shelter.

Primary Shock — Initial blast originating at the instant of the nuclear explosion.

Protection Factor (PF) — This term expresses the relative amount of radiation that would be received by an occupant of a shelter compared to the amount he would receive if unprotected. This factor is computed by dividing the outside radiation by the shelter radiation—both measured in roentgens per hour—which, of course, reflects the protective effects of combined barrier and geometry shielding.

r — Abbreviation of Roentgen.

r/hr — Abbreviation of Roentgens per hour.

RAD — Abbreviation of Radiation Absorbed Dosage. A unit of any absorbed nuclear radiation dose.

RBE — Abbreviation of Relative Biological Effectiveness. A formula for relating rads of different radiations to that of gamma rays.

REM — Abbreviation of Roentgen Equivalent Man. The biological damage one roentgen will do to a human. Used to express all types of radiation damage in one term.

Radiation Reduction Factor — This is the reciprocal of Protection Factor. If the protection factor is 1000 the radiation reduction factor would be .001 or one thousandth. It consists of the fraction of external radiation which passes into the shelter.

Radioactive Decay — A process during which radiation decreases by a factor of ten when time increases by a factor of seven. Many of the radiation emitters are short lived and much of the radiation decays rapidly at first, leaving the longer lived emitters which slows down the total decay rate.

Radioactivity — A condition precipitated by nuclei spontaneously undergoing atomic disintegration by the emission of alpha and beta particles and sometimes the electromagnetic radiation of gamma rays.

Radioisotopes (Byproducts) — Materials which may be made radioactive in an atomic reactor.

Ratemeter — The same as a survey meter.

Reflective Shock — A blast wave striking the ground, a building or some resistant surface produces a reflective pressure which may double the unreflected peak overpressure.

Roentgen — A unit of gamma ray exposure dosage measurement named for a German physicist, Dr. Wilhelm Konrad Roentgen, who discovered X-rays in 1895. All normal atoms have at least one electron orbiting around the nucleus. Roentgens are a measure of the number of electrons which the radiation knocks out of orbit.

Roentgens Per Hour — The measurement of a radiation exposure dose rate is expressed in roentgens per hour (r/hr) which is the amount of radiation to which a person would be exposed in one hour.

Rupture Zone — The area immediately adjacent to the crater of a nuclear ground burst. The ground is subjected to enough force to create radial cracks, but not enough to produce a crater.

Secondary Shelter — In the BOSDEC system this shelter leads into the Primary Shelter and serves as the intermediate area between the shelter lock and the Primary Shelter. The secondary shelter contains many of the requirements for post attack life. It will have a PF of about 2000 with a two foot thick concrete ceiling.

Shelter Lock — The outer shelter connecting the outside with the Secondary Shelter in the BOSDEC system. The Shelter Lock has a low protection factor.

Shielding — The combined effects of barrier and geometry shielding plus the radioactive decay time factor determines the cumulative roentgen radiation dose in a shelter when the outside radiation readings are known. The shielding alone determines the PF.

Shockwave — Another term for blast wave. Usually refers to underground or underwater bursts.

Skyshine — Radiation reaching a target from many directions due to the scattering effect of oxygen and nitrogen in the air.

Square Root — The number or quantity which when squared will produce a given number or quantity. Three is the square root of nine.

Subsurface Burst — A nuclear explosion occurring under the surface of the earth.

Surface Burst — A nuclear explosion occuring at or very close to the surface of the earth.

Survey Meter — A radiation meter which detects and measures the radiation dose rate in roentgens per hour (r/hr).

Tenth Value Layer Thickness — The thickness of a given material that will reduce radiation to one tenth of its unshielded value.

Thermal Radiation — The heat radiation from a bomb burst. It comes in two phases. The initial ultraviolet flash and the fireball with its mostly infrared heat.

Thermonuclear Explosion — A fusion type explosion requiring fission temperatures to trigger it.

TVL Thickness — Abbreviation for Tenth Value Layer thickness.

Bibliography

GOVERNMENT PUBLICATIONS:

Fallout Shelter Surveys: Guide for Architects and Engineers 1960, Pub. NP-10-2

Fallout Shelter Surveys: Guide for Executives, Pub. NP-10-1

Family Fallout Shelter 1959, Pub. MP-15

Civil Defense Technical Bulletin 1958, Pub. TB-5-3

Windowless Structures — A study in blast resistant design 1952 — TM 5-4.

Rescue Techniques and Operations 1953, Pub. TM 14-1

Effects of Nuclear Weapons, U.S. Atomic Energy Commission, U. S. Department of Defense 1962 $3.00

Clay Masonry Family Fallout Shelters 1960, Pub. MP-18

Advisory Bulletin No. 243 OCDM August 24, 1959

First Aid: Emergency Kit, Emergency Action FCDA (OCDM) L-2-12 1958

Fallout Protection OCD Dept. of Defense H-6 1961

Peacetime Radiation Hazards in the Fire Service
Basic Course — Resource Manual OE-84019 and OE-84020 Instructors Guide Circular No. 657 U. S. Dept. Health, Education & Welfare and U. S. Atomic Energy Commission 1961.

Living With Radiation: Fire Service Problems No. 2
U. S. Atomic Energy Commission 1960

Basic Civil Defense OCDM 1959 1G-3-2

Nature of Radioactive Fallout and Its Effects on Man, Part 1 and Part 2 1957

CD in Industry by Virgil L. Couch, Director
FCDA Industry Office April 1956

RECOMMENDED COLLATERAL READING

You Can Survive the Bomb — by Col. Mel Mawrence with John Clark Kimball. Published by Avon Book Div. of The Hearst Corporation, 959 Eighth Avenue, New York 19, N. Y. 1961. 50¢. Contains much detailed and useful information. Highly recommended.

Fallout Shelter Handbook — by Chuck West
Published by Fawcett Publications, Inc., Greenwich, Connecticut 1962. 75¢. Contains 20 pages of construction information which is worth the cost of the entire book. Best information available on this subject.

Nuclear Attack and Industrial Survival — by McGraw Hill Publishing Company, 330 West 42nd Street, New York 36, N. Y. January 1, 1962 issue of Aviation Week and Space Technology (and all other McGraw-Hill Magazines.) Reprints available at 20¢ each. A completely unbiased and objective appraisal of Nuclear hazards and problems obviously prepared and published with a great sense of responsibility to the American people. A must!

Equipment and Food Selection Service

The equipment and supplies that are mentioned in this manual were selected with considerable care. As a reader, you are entitled to know what products were used in compiling the checklists and menus in this book. All foods and menus were tested in actual practice. As an author we considered it unethical to mention brand names in the manual unless the product could not be easily described in any other way. If you are interested, you may fill in the attached form with name and address and enclose it with a self addressed, stamped envelope in an envelope addressed to the publisher. In return you will receive a list of equipment, supplies and foods which were used in compiling the manual. Please feel free to comment on your opinion of the book. The brands chosen were selected on the basis of quality, packaging, uniformity, ease of preparation and availability. Our selection of a certain brand does not necessarily mean that it is superior to other brands or products, nor does it constitute a recommendation to buy such a product. It is for information purposes only. Many fine products were eliminated from consideration as shelter supplies because they were not available nationally.

The items chosen for the list were compiled without the prior knowledge of any equipment manufacturer or food processor.

Gentlemen:

Please send me a copy of the equipment, supplies and food list.

NAME ____________

ADDRESS ____________

CITY ________ STATE ________ ZIP CODE ________

Send your request to:

Drexel Winslow & Farrington
P. O. Box 55
Butler, New Jersey

NOTES

NOTES

NOTES