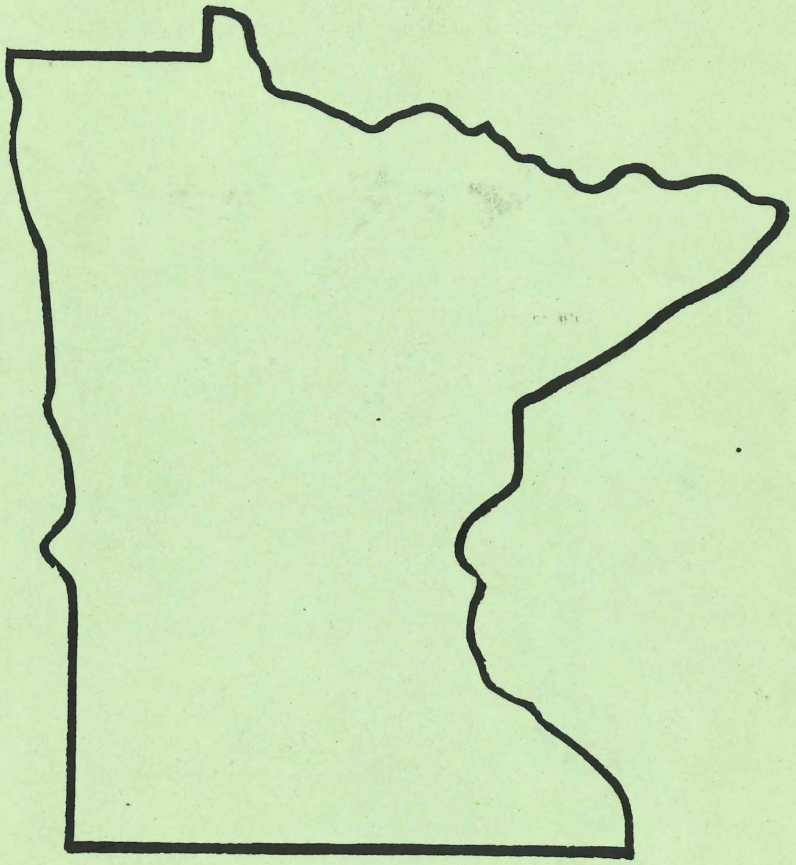
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MINNESOTA RADIOLOGICAL REPORT TO COUNTY CIVIL DEFENSE DIRECTORS



State of Minnesota
Department of Public Safety
Division of Emergency Services

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INTRODUCTION

The art of prognostication is difficult even for something relatively simple such as a sporting event. How much more difficult it is to analyze the extremely complex issue of nuclear war, and yet it is possible to study nuclear war by searching out the basic data, facts, and studies developed over the last 38 years. Not only can one build certain conclusions based on this research, but often specific studies were done to answer important questions.

The emergency service network has the responsibility to deal with the world as it is. It would be unconscionable to refuse to work in a disaster because it is imagined to be too great. It would be ideal if nuclear weapons did not exist, and perhaps nations can agree to reduce the number of them. As long as these weapons are a threat, there is a responsibility recognized by government to plan for the safety of its citizens.

The emergency management system does not advocate preparing to have a nuclear war. Rather, its motivation is government's responsibility to aid citizens in times of disaster. Also, no false hopes are given about winning nuclear war. There is no such thing as winning a nuclear war. The standard of living and well-being of a nation will be greatly diminished by nuclear war. No one would win.

It is especially important to study the dangers of nuclear war in an intelligent, practical, and realistic way. The emergency services system needs this information and the public deserves it.

Some people state that it is common sense that tells us no one can survive a nuclear war. But, is it? Wars have continually occurred throughout human history, and thus there is a common wisdom about them in general. But, nuclear war has never occurred. Common wisdom about war is that it causes great suffering and loss on both sides, however, a nation is better off if it is prepared than if it is not. Of course, the best situation is world peace, and it is imperative that our government

constantly strive for world cooperation and arms control agreements. Yet, until a much greater degree of superpower cooperation and agreement is achieved than currently exists, it is prudent to have civil defense plans and preparations available. It is far better to have them and not need them, than to need them and not have them. Thus, common sense tells us to aim for peace but be prepared.

An underlying problem is that frightening descriptions about the destructiveness of nuclear war can easily be grasped and spread, whereas effort is required to dig-up and think through the mass of scientific data, facts, studies, and writings on nuclear war. The purpose of this research paper is to set forth the basic information on nuclear war through the perspective of civil defense and survival. This study is not intended to minimize the disaster that nuclear war would be. Given the recent media attention emphasizing the effects of nuclear war this should be thoroughly perceived, at least in the United States. Unfortunately, the situation is usually presented to appear hopeless, therefore, requiring idealistic and utopian solutions. This approach is uncertain and dangerous for it undermines the foundations of such pragmatic approaches as deterrence and civil defense.

There is always hope - more so if we seek peace but are prepared. As the President of the San Francisco Bay Chapter of the Physicians for Social Responsibility professed, "We know the present situation is grave, the prognosis is guarded; but we also know that in medicine there is always hope, for the annals of medicine are full of tales of critically ill patients who have outlived their pessimistic physicians."[1]

NUCLEAR WEAPONS EFFECTS

General Description

The detonation of a nuclear device results in the release of extraordinary amounts of energy. Certain aspects of the weapons effects vary according to the design of the weapon and other conditions but gross phenomena remain the same.

Energy Distribution of a Nuclear Explosion:

50%	Blast and Overpressure
35%	Thermal Radiation
10%	Residual Nuclear Radiation
5%	Initial Nuclear Radiation

The most powerful effect is an explosive blast. This takes place as a destructive high-pressive wave (blastwave) is created and forced outward from the detonation. This is followed by a large increase in air pressure (overpressure). As an example, a 1 Megaton air burst would create an overpressure of five pounds per square inch at four miles from ground zero, and a wind of 160 MPH for a few seconds even though the blast effect diminishes with distance from ground zero.[2] Pressures of 4.5 to 10 tons per square meter maintained for almost half a second could be expected below the detonation.[3] Generally speaking, the overpressure destroys large buildings while people are injured by the winds or missiles in the winds.

A second important direct effect is thermal radiation. The fireball formed from the nuclear detonation emits visible, ultraviolet and

infrared light rays. These radiations can cause fires in easily combustible materials or can cause burns to exposed people. However, this effect is reduced by clouds, mist or rain, hills or blocking terrain, and buildings obstructing the radiation path. For example a medium haze would reduce the thermal pulse effects by 50%.[4] Most fires would start from blast damaged utilities and fuel supplies. The best estimate is that 10% of all buildings, located about four miles from ground zero, would sustain serious fire damage.

Initial nuclear radiations are created in the form of alpha particles, beta particles, neutrons, x-rays, and gamma rays. The threat of exposure to injurious amounts of initial nuclear radiation is limited to a radius of about 3 miles from ground zero. A person 3 1/3 miles from ground zero of a 5 MT (megaton) blast would receive an exposure of less than 1 R(roentgen).[5]

These are the direct, concentrated effects of a nuclear detonation. The area of damage can be quite extensive - a 1 MT surface burst will cause damage and fires over 80 square miles of a metropolitan area.[6]

An important point to note, however, that is often misunderstood is that small nuclear weapons are more efficient at causing damage than larger ones. This is because the radius of blast and fire effects vary in proportion to the cube root of the weapon yield - roughly a 1,000 fold increase in bomb size increases the radius of direct effects by a factor of 10.[7] As a result, a nuclear weapon 1,000 times as powerful as the Hiroshima bomb, under similar conditions, would produce equivalent blast damage over an area about 100 times as large (not 1,000 times as large).[8]

Away from the area of direct effects there are two wide-ranging nuclear weapon effects: electromagnetic pulse (EMP) and radioactive fallout.

EMP is a wave phenomenon similar to radio waves but at much higher field strength and of much shorter duration (fractions of a second). Elevated nuclear detonations produce strong EMP over hundreds or thousands of miles. EMP does not pose a physical threat to humans but electrical or

electronic systems can be damaged by EMP. An attacker might use this effect to attempt to damage communications and electric power systems.

A nuclear device detonated near the surface of the earth will vaporize and carry great amounts of soil material up into its mushroom cloud. In the atmosphere, radioactive materials condense on and into this debris. Depending on the size and height of the particles, this radioactive fallout will drop back to earth near the detonation or be carried thousands of miles by atmospheric winds before returning to the surface. Radioactive fallout can pose grave health threats to great numbers of people located out of the range of direct effects. People exposed to enough fallout radiation will die and those exposed to lesser amounts may become ill.

This is a brief overview of nuclear weapons effects. To conclude, it is interesting to compare a nuclear detonation with a conventional bomb. A nuclear weapons detonation is similar to a chemical bomb explosion caused by TNT in several ways. A regular bomb will produce blast, overpressure, heat, and light as a nuclear bomb does. The major difference is in the magnitude of these effects. The nuclear weapons effects of ionizing radiation, radioactive fallout and EMP are not experienced in conventional bomb detonations, but there are some similarities. The gamma radiation and EMP of nuclear detonations are electromagnetic radiations as are the heat and light radiation of a conventional detonation. When light hits glass (a solid), some of the light is reflected, some is absorbed, and some travels directly through the glass. Gamma radiation acts similarly, but it can penetrate many different solid materials to a much greater extent than light energy.

HIROSHIMA AND NAGASAKI

During World War II, Hiroshima was the seventh largest Japanese city (population 350,000). On the morning of August 6, 1945, air-raid sirens sent the populace running for shelter. An all-clear signal was given as the American bomber formations had flown by to other cities. At this time three U.S. planes were still approaching, but such a small group was ignored: "...all but a few persons had left their air-raid shelters and were on their way to work. It is estimated that some three-fourths of the population were then in the congested four square mile center of the city, many of them still in the streets."[9] At this moment, the first atomic bomb was used against a population.

The bomb detonated above the ground near the city center killing over 70,000 people. The radius of destruction was 6,000 to 8,000 feet. Many were injured and more died later.

At Hiroshima and later at Nagasaki, nuclear radiation was not the dominant cause of death or acute injury. Most of the survivors suffered from a combination of effects: estimates indicate 70% suffered from blast effects, 65% from serious burns, and 30% from nuclear radiation.[10]

A human catastrophe occurred. Even though the population was not prepared to protect itself against nuclear weaponry, their standard civil defense preparations, had they been in effect at the time of the detonation, would have saved many lifes. Bomb shelters could have given some protection from blast, thermal radiation, initial nuclear radiation, and fallout. In Nagasaki, some people survived uninjured 1,800 feet from ground zero inside a tunnel shelter built for air raids.[11] Air raid shelters would have provided significant protection from burns and initial radiation and some protection from blast.

It was believed by some that these cities would remain nuclear deserts for many years, but the renewal of vegetation after the detonations appeared to be greater and faster than what had been the case before the

bombings.[12] At Hiroshima, the day after the blast, bridges were open to traffic; in two days, trains ran; in three days, street cars were operating. Even though the populace did not know how to protect themselves from this new weapon and everyone was caught by surprise, 230,000 people survived the attack.[13] Today, Hiroshima is a successful economic center whose 1981 population totaled 910,000. It is also interesting to note that the survivors of the Hiroshima and Nagasaki A-bomb attacks have had a higher average life expectancy than the Japanese population in general.[14]

The scale of destruction from only these two bombs was unprecedented. Yet, comparing this to the conventional bombing of Japanese cities in terms of square miles destroyed, the two A-bomb attacks amounted to only 3% of the total destruction.[15] But, the fact remains, given the advances in bomb size, numbers of warheads, and delivery systems, today's nuclear arsenals could cause mass destruction on a scale far greater than ever before.

RONGELAP

In the 1950's the U.S. was undertaking extensive weapons testing in the South Pacific. At one test in 1954 a 15 megaton detonation took place on Bikini Atoll. Because predicting the weather and the resulting fallout patterns from nuclear detonations is so difficult, a tragic accident occurred. Natives of the Rongelap Atoll in the Marshall Islands were exposed to an estimated whole body dose of 175 rads in a two day period.[16] (Basically for gamma radiation: Roentgens = rems = rads)

To put this dose into perspective, a radiation exposure chart for humans is provided.[17]

		Accumulated radiation exposures (R) in any period of			
		a	b	c	
	Medical care will be needed	One Week	One Month	Four Months	
A	NONE	150	200	300	A
B	SOME (5 percent may die)	250	350	500	B
C	MOST (50 percent may die)	450	600	-	C
		a	b	c	

It can be seen from the table that a radiation exposure of 450 roentgens (R) in less than a week will kill about 50 percent of an exposed group of people. 600 R is required for the same effects if the dose is gradually received over one month. This is because the body is able to repair most of the radiation damage if given sufficient time. Almost everyone exposed to a dose greater than 600 R in a short period of time would be expected to die.

These dosages refer to radiation exposure received over the entire body, thus affecting all organs. If radiation is concentrated or limited to one body area, much higher doses are required to be lethal.

On Rongelap those receiving the highest doses experienced nausea and vomiting but no one was incapacitated. For a dose of 175 RADS in a two day period the table suggests that medical care is called for and that the probability of death from this exposure is very small.

These Marshallese were evacuated, given medical attention and returned to homes when radiation levels subsided. As a result of ingesting fallout - contaminated food and water, children were estimated to have received 500 - 1400 Rads to their thyroid glands; adults somewhat less.[18] Exposed Marshallese have been examined yearly by teams of physicians. Twenty-nine of eighty-six exposed people developed thyroid nodules. In three of these cases the nodules were found to be cancerous.[19]

Children 5-19 years of age showed some growth retardation as a result of a thyroid hormone deficiency caused by thyroid injury.[20] In a study 20 years after the incident, other than the above injuries, one case of leukemia was noted. No other illnesses or genetic effects were found.[21]

The island inhabitants knew nothing about radioactive fallout. People walked with bare feet and children played in the radioactively - contaminated sand. The civil defense measures of sheltering or evacuation could have been effective. Also, large doses of potassium iodide could have prevented the major problem - thyroid damage - by limiting the uptake of radioactive iodine.

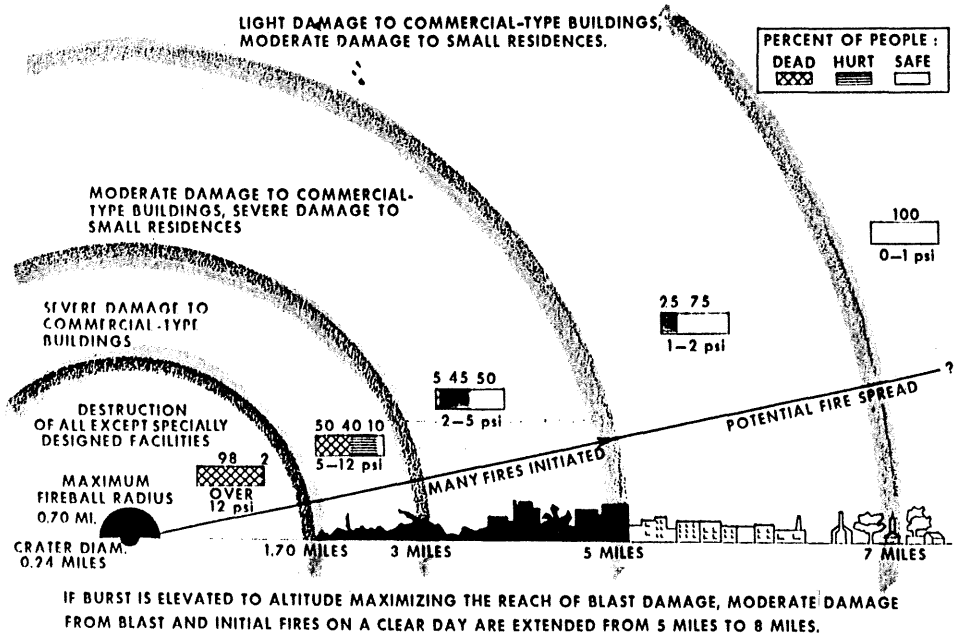
Up to this point, this study has looked at the effects of nuclear weapons and several special situations involving nuclear weapons in the past. This section will look at critical survival factors.

This can be done by studying each factor separately or by analyzing the factors in an integrated study of nuclear war. This study will look at the factors separately but will draw upon studies that have used an integrated approach. Because no data exists from a large scale nuclear war, the results of any study will be hypothetical. Yet, it is incumbent upon us to create scientific, objective models to garner as much knowledge as is possible, because this knowledge will help us decide what needs to be done and how to do it.

BLAST EFFECTS

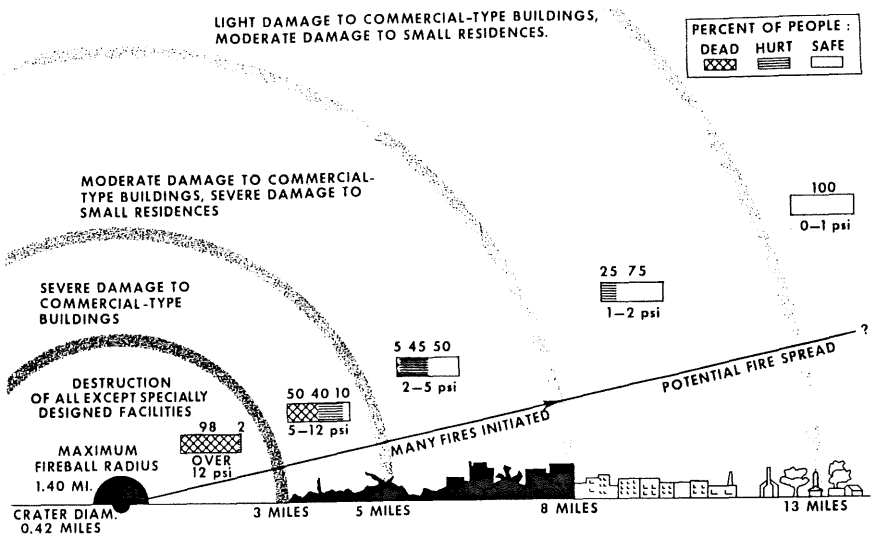
The blast effects of nuclear weapons compose about fifty percent of the energy of the detonation. This tremendous release of concentrated energy poses the greatest threat to life and material. The illustrations below indicate the range of destruction of a one megaton and a five megaton detonation:[22]

DIRECT EFFECTS OF 1 MT. BLAST (SURFACE BURST)



IF BURST IS ELEVATED TO ALTITUDE MAXIMIZING THE REACH OF BLAST DAMAGE, MODERATE DAMAGE FROM BLAST AND INITIAL FIRES ON A CLEAR DAY ARE EXTENDED FROM 5 MILES TO 8 MILES.

DIRECT EFFECTS OF 5 MT. BLAST (SURFACE BURST)



IF BURST IS ELEVATED TO ALTITUDE MAXIMIZING THE REACH OF BLAST DAMAGE, MODERATE DAMAGE FROM BLAST AND INITIAL FIRES ON A CLEAR DAY ARE EXTENDED FROM 8 MILES TO 13 MILES.

In understanding blast effects it is important to relate the significance of air bursts versus surface bursts. A surface burst is the detonation of a nuclear weapon at or near the surface of the earth such that the fireball makes contact with the earth. An air burst is the detonation of a nuclear weapon at such a height that the fireball does not contact the earth's surface.

Comparing effects in an attack, the air burst can maximize the area of structural damage and loss of life because the magnitude of blast, thermal radiation and initial nuclear radiation received at ground level are maximized. On the other hand, because of the great volume of earth and debris irradiated and vaporized by the surface burst, the amount of radioactive fallout created is maximized. A surface burst or subsurface burst also maximizes the amount of destructive shock imparted to an underground, hardened target such as a missile silo.

Therefore, logically, an enemy would use air bursts to attack soft surface targets such as cities or refineries and surface (or subsurface) bursts against hardened military targets. Such surface bursts pose grave, wide-ranging threats from radioactive fallout.

Electromagnetic Pulse (EMP)

EMP was first discovered about twenty years ago during weapons testing. The fact that it is not harmful to humans is reassuring yet an enemy attack could take advantage of EMP effects to cause damage to electronic components and systems across the country. Communications are probably most vulnerable.[23] Damaged equipment would be repairable (e.g., replacing damaged transistors) but replacement parts would have to be rationed and might not be readily available. Experimentation indicates that civil defense radiation equipment is not susceptible to direct damage from EMP nor are hand-held citizen band walkie-talkies or AM and FM radio receivers. A table showing the relative sensitivity of components and systems to EMP follows:[24]

SENSITIVITY TO EMP DAMAGE

ELECTRONIC COMPONENTS:

MICROWAVE SEMICONDUCTOR DIODES	MOST SENSITIVE
FIELD-EFFECT TRANSISTORS	
RADIO-FREQUENCY TRANSISTORS	
AUDIO TRANSISTORS	
SILICON-CONTROLLED RECTIFIERS	
POWER RECTIFIER SEMICONDUCTOR DIODES	
VACUUM TUBES	LEAST SENSITIVE

ELECTRONIC AND ELECTRICAL SYSTEM:

MOST SUSCEPTIBLE - COMPUTERS, TRANSISTORIZED POWER SUPPLIES, TRANSISTORIZED RECEIVERS, TRANSISTORIZED TRANSMITTERS, TRANSISTORIZED POWER SYSTEM CONTROLS.

SUSCEPTIBLE - ALL VACUUM TUBE EQUIPMENT INCLUDING TRANSMITTERS, RECEIVERS, TELETYPE TELEPHONES, POWER SUPPLIES, ALARMS, POWER SYSTEM CONTROL PANELS.

LEAST SUSCEPTIBLE - TRANSFORMERS, MOTORS, LAMPS, FILAMENT HEATERS, ROTARY CONVERTERS, HEAVY DUTY RELAYS, CIRCUIT BREAKERS, CIVIL DEFENSE RADIATION METERS, HAND-HELD WALKIE TALKIES, AM/FM RADIO RECEIVERS.

Considerable uncertainty exists as to how many AM broadcasting stations will be functional after an EMP attack. The prospects appear good that there will be adequate capability partly due to protective devices and measures taken by some stations as part of the Emergency Broadcast System (EBS) and partly due to the usual practice of retaining spare parts which would enable personnel to make repairs. Many stations maintain two transmitters and key stations have a back-up generator.[25] Also, all EBS stations are required to make EMP protection preparations.

An individual can take steps to protect electric or electronic equipment. The first measure is to disconnect the apparatus from the electrical outlet to prevent a voltage surge from flowing through the cord to the equipment. Any external antennas or ground wires should be disconnected for the same reason. Finally, a small item such as a AM/FM radio could be wrapped in aluminum foil. This will act as a Faraday shield creating a barrier to EMP.

It can be seen that it is possible to protect against EMP effects and that some preparations have been made. Yet, it is possible to imagine a huge portion of our electric and electronics systems becoming inoperable in a nuclear attack. These systems could be restored on a priority basis.

FIRES

As discussed earlier, one direct effect of a nuclear detonation is thermal radiation. Generally, any material that could be set on fire by a single match is potentially ignitable by the thermal pulse of a nuclear detonation.[26] Thus, it is unlikely that the siding of a house would ignite but exposed paper litter could.

Would firestorms occur in modern cities attacked by nuclear weapons? A definitive answer is not possible, yet much data indicates there would not be firestorms. The knowledge of blast - debris - fire interactions from nuclear detonations is not thoroughly understood. Fires could be started by the thermal pulse only to be extinguished by the blast wave. FEMA points out, "Since we now estimate that only 10% of the buildings will be ignited by a nuclear detonation, one of the criteria for firestorm conditions: that at least 50% be on fire initially, is not met."[27] Also, in most cities the concentration of buildings is too low to support a firestorm. According to the Department of Defense only about six U.S. cities meet the requirements which make the formation of a firestorm likely.[28]

The Office of Technology Assessment in their detailed study of nuclear war for Congress in 1979, studied hypothesized nuclear attacks on Detroit, Michigan, and Leningrad in the U.S.S.R. They concluded firestorms would not occur in these cities. "Although many fires will be started, only a small percentage of the buildings (in Detroit) are likely to continue to burn after the blast wave passes."[29] Secondary fires appear to be soft threats that can be locally controlled in the period after the detonation. For Leningrad the assessment is: "Buildings (except in the old part of the city) are unlikely to burn." "Apartment spacing is so great as to make fire spread unlikely, even though a few buildings would burn down."[30]

From the analysis of Hiroshima, Dresden, and other cases it has been estimated that in a nuclear attack upon a city, "the number of casualties caused directly by fire or its effects (including carbon monoxide poisoning) would probably be in the order of 1 - 4% of the population in the areas experiencing fires."[31]

It is interesting to compare the fire effects of the atomic bomb attacks against Japan with a conventional fire-bomb attack on Dresden, Germany in World War II. Dresden had 18% fire fatalities in the "at risk" population and a fire severity of 650 million BTU per square mile per second. Hiroshima had 3% fire fatalities (Nagasaki ½%). The Hiroshima and Nagasaki fire severity was 40 million BTU per square mile per second.[32]

In a nuclear attack, secondary fires could be minimized by having the utility companies close-off the supply of gas and electricity to residential and commercial areas before the attack. Thermal ignitions could be minimized by closing drapes and blinds or covering windows with other opaque materials followed by an immediate search for fires.[33]

Smoldering fires in destroyed buildings and rubble could result in great amounts of smoke, heat, and carbon monoxide. This would be a hazard to people in basements or simple fallout shelters. However, there is not so much danger if the shelter itself is not combustible.[34]

There are two other related hazards which must be considered. Perhaps nuclear war would ignite great forest regions causing a conflagration. This is not likely. Many chancy factors would have to occur; however, a summer or fall attack with a preceding long dry spell and high winds would greatly increase the risk. In order for forest fires to be started by detonations, the large forests must be near the area of intense blast from nuclear weapons. Since this is rare, dangerous mass forest fires or brush fires are unlikely.[35]

Finally, the light flash from a nuclear burst can cause "flashblindness" if an individual stares at the burst. Normally this would last for several minutes but is rarely permanent. There were many cases of flashblindness at Hiroshima and Nagasaki because people were unaware of the danger and of the necessity to take cover. However, there was one case in which there was permanent retinal burn.[36]

FALLOUT

Fallout from nuclear detonations has been studied extensively since the advent of nuclear weapons. However, it is not possible to predict the level of radiation intensity at a specified place and time. There are simply too many variables. Fallout patterns depend on size and type of weapon, whether ground burst or air burst, the weather, wind velocity, and distance from ground zero. Yet, it is possible to make some predictions based on studies of likely scenarios.

It is possible to state that radioactive fallout would be widespread; some communities would get heavy accumulations of radioactive fallout while other communities might get little or none. However, no area of the U.S. could be certain that it would be free of fallout.[37]

In examining the following nuclear war studies, bear in mind that today the average person in a lifetime receives an average dose of about 20R: 10R of ionizing radiation from nature and an equivalent amount from diagnostic radiology.[38] Also, for nuclear attack situations, recall that in order to limit exposure to low medical risk an individual should receive less than 150R in one week, or less than 200R in a month, or less than 300R in any four month period.[39] Of course it is possible for an individual to receive a larger dose and survive. (One example exists of a person with good medical care surviving a dose of 1,000R in a period of 106 days.)[40]

A typical study (published in 1976) of an all out nuclear attack (total of 6,559 megatons) on the U.S. made some predictions about fallout levels in the U.S. one year after the attack.[41]

Table 4.5
Area Dose-Rates One Year After a Hypothetical Attack

Dose-rate (R/hr)	Area (sq mi)	Cumulative Area (sq mi)	Percent of Area of Coterminous U.S.
0.1	108	108	0.004
0.01	347,000	347,000	11.7
0.001	1,089,000	1,436,000	48.5
0.0001	944,000	2,380,000	80.3
0.00001	274,000	2,654,000	89.5

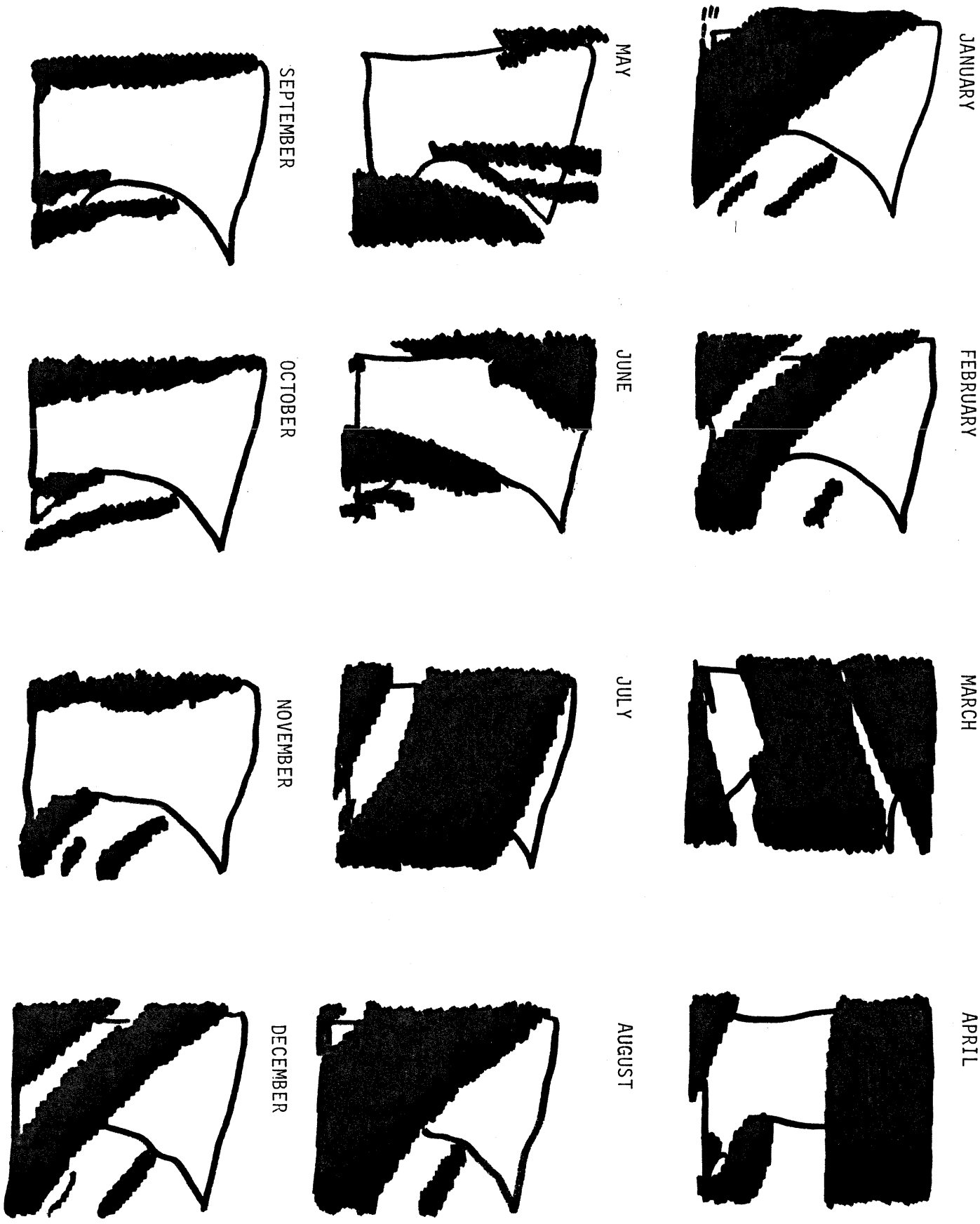
This study predicts one year after attack that about 88% of the U.S. land area would have a dose rate of 0.001 R/hr or less. This amounts to a

dose of 0.72 R/month and 8.6 R/year. Further, it is estimated that 99% of the U.S. would have a dose rate of 88R per year or less at this time. these rates would continue to decrease slowly with time.[42]

These data refer to fallout levels one year after the attack. Since most radioactive fission products decay rapidly, the most critical period will be the first two weeks after an attack. It is this period during which the radioactivity starts out extremely high and decreases rapidly. For example a rate of 100 R/hr will decrease to 1 R/hr in two days after a detonation, and decline still further to 0.1 R/hr after 2 weeks and to 0.01 R/hr after 100 days. Looking at the current Soviet arsenal and assuming an all-out attack with all detonations ground bursts (worst case) to maximize fallout for the study, it is estimated that 75% of the surface area of the U.S. would be covered by dangerous amounts of fallout.[43]

A very complex and thorough fallout study was carried out in 1981, by Leo Schmidt. A full attack upon the U.S. with 6,541 megatons of nuclear detonations was hypothesized and the maximum effective biological dose was estimated throughout the country (to create the maximum fallout picture all detonations were assumed to be ground bursts). The best projections of Soviet capabilities and targeting was used. Since fallout patterns vary with weather and wind patterns, the study divides the year into 12 monthly weather conditions upon which estimates are made. The estimates relevant to Minnesota follow:

FALLOUT MAPS OF MINNESOTA FOR A FULL ATTACK ON THE U.S. OF 6,541 MEGATONS



The light portions on the map refer to areas of relatively light fallout. People could survive here by taking shelter in home basements.[44] The light areas would experience an effective biological dose range of 0-2,500R from fallout. The average basement in Minnesota would reduce this range twenty times to a maximum biological dose between 1-125R. The dark areas would receive fallout in excess of 2,500R. The dark portions are areas of greater amounts of radioactive fallout. (Data in the study is much more detailed.) Minneapolis and Duluth are assumed to be extensively hit by nuclear weapons and suffer devastating blast effects. Yet, the main fallout danger for Minnesota would come from nuclear attacks on the military and missile sites located in the Dakotas.

Any structure, not hit by direct weapons effects, will provide some protection from ionizing radiation given off by radioactive fallout. Fallout particles tend to be deposited and accumulate on horizontal surfaces, roofs or the grass around the foundations of houses. Distance and shielding materials reduce the level of radiation. Denser material has better shielding properties than less dense substances. For example lead, steel, concrete, and dirt are better shielding materials than wood and plastic.

A typical basement provides a protection factor of twenty (reduces the level of radioactivity 20 times). Therefore, people located in a light map portion could survive in their basements without medical care. (This of course only applies if they are outside of the region of blast effects assumed for the Duluth and Minneapolis-St. Paul Metro areas. Also, the survivors would face other threats which will be described later.) Air filters would not be needed in fallout shelters to clean the air for breathing. The fallout particles of most importance are relatively coarse-grained (similar to fine sand) and tend to settle out of the air and remain where they fall.[45]

The Minnesotans located in the dark portion of the map would be subjected to very heavy amounts of fallout. In order for them to survive the fallout radiation, they would either have to know how to develop their home into a good fallout shelter or have access to a good public fallout

shelter. An improvised fallout shelter providing a good protection factor could be built in a basement in a few hours. An illustration of the process to create one type of improvised fallout shelter is given below. Any material could be stacked on top and on the sides to increase the shielding, however the denser the material the better shielding it will provide. Dirt would be a good material to fill the drawers and boxes with.



IMPROVISED FALLOUT SHELTER

Even without improvement many structures provide good fallout protection:

TYPICAL FALLOUT PROTECTION FACTORS
(as is, without shelter improvements)

Protection Factor	Structure
1,000 - 10,000	subway stations, tunnels
100 - 1,000	basements and sub-basements of large steel, masonry and concrete buildings
10 - 50	basements of single family residences
20 - 100	fourth and higher floors of buildings with "strong" walls[46]

Civil defense can help people survive radioactive fallout. Lacking access to radiation meters, survivors face a nightmare of uncertainties. Civil defense has distributed thousands of maintained instruments to communities across Minnesota for use in any radiological emergency. Also, instrument training programs have been in place for many years.

About two weeks after an attack, people could begin to emerge from shelter and spend an increasing number of hours working to survive. Areas with extremely high or low levels of radioactivity would be exceptions to this. Reliable fallout meters would also be invaluable during this recovery period. Unfortunately the natural reactions of people in an emergency (gather food, find better shelter, seek information from others, rescue others) could lead to higher casualties because of increased exposure to radioactive fallout. What is needed is instrumentation, trained personnel, an integrated plan, and communications. Civil defense can provide this.[47] Therefore, it can be seen that with existing buildings, the improvement of existing structures and the building of expedient shelters along with civil defense plans, preparations, and operations (including evacuation from target areas), most people in Minnesota and the United States could survive the hazard of radioactive fallout.

DRINKING WATER

Water is a critical necessity for human survival. Without drinking water, death follows in a matter of days. It can be surmised that in an area of direct effects the water system would be destroyed. In the region removed from direct effects, the water system will be intact and to a large part the water systems are powered by gravity. Radioactive fallout that lands on a water tank will not contaminate the water as long as the fallout is not deposited and dissolved in the water. Other sources such as deep wells, or covered reservoirs will be safe too.[48] Practically all of the fallout that lands on open water will settle to the bottom. Less than 2% of the fallout particles are soluable in water. The danger of drinking fallout-contaminated water could be greatly reduced by settling and filtration. A home-made soil filter could do the job.[49] As was the case in the Marshallese fallout incident, radioactive iodine would be a significant health threat in drinking water. Because of the rapid decay of radioactive iodine, this would be a concern for only a few weeks.[50] Stored supplies could be used in many cases during this period.

FOOD

As with drinking water, nuclear radiation that passes through food does not harm it. The danger would be the actual swallowing of radioactive fallout particles that happened to be on the food itself. Food contained in a contaminated can or package would be safe as long as the food could be removed without contaminating it. Fruits or vegetables could be made safe by washing, wiping, and peeling.[51]

Studies estimate that the majority of the nation's farm animals would be lost.[52] Yet, extensive areas of the U. S. would not receive enough fallout to kill grazing animals. These could serve as a source of food and breeding stock for national recovery. Experiments show that the offspring of severely irradiated animals are healthy and fertile.[53] Data indicates that some 70 days of processed food is on hand in communities ready for human consumption. Americans could get by on what most of the world eats now: grains, beans, and vegetables. One source estimates

enough grains and beans are in storage in this country to supply surviving Americans for about one year following a heavy nuclear attack.[54] Grain can be stored with little care and is nearly a complete food for human consumption.

Nearly all grain stored on farms and 50-70% of the grain stored off the farms would not be affected by a nuclear attack.[55] However, the same study estimates that 60% of the food processing plants would be destroyed.[56] Home-made processing methods are simple but not widely known.[57]

Most parts of the country are reasonably close to agricultural crops but some regions such as peninsular Florida, Northeastern U.S. and part of California are deficient in grain stocks. During the recovery period, large quantities of grain would have to be shipped in order to avoid massive starvation.[58] But enough fuel and transport should survive to deal with the problem.[59] A different study, PONAST II, concludes that nationally adequate food supplies would survive and distribution would be sufficient to meet the needs except for temporary local shortages.[60]

The critical factors in the recovery of agricultural production would probably be the supply of fuel, fertilizer and pesticides.[61] The U.S. is highly efficient agriculturally. Four percent of the population in farming produce enough food for the U.S. and for export. Enough calories and essential nutrients to provide for 100 million surviving Americans would be obtained from only about 16% of our 1974 production of corn, wheat, grain sorghum, and soybeans - if nothing else were produced.[62] Farm machinery and farm workers would not be targets. Priority allocations would substantially help to bring back high rates of production.[63]

Radioactive strontium and cesium can be dissolved and taken up by food producing vegetation. Since these isotopes have relatively long half lives they would pose a long-term health threat to humans via the food chain. This is not considered critical for crops grown a year after an attack. Farming might have to be temporarily abandoned in some areas. Scraping off the top layer of contaminated soil might be possible in

others. Also, most radioactive strontium and cesium would be locked up in glassy fallout particles too large and insoluble to pass through plant membranes and become incorporated in the plant.

PSYCHOLOGICAL EFFECTS

How would American society react to nuclear attack and its aftermath? One might speculate that people would roll up their sleeves and set about vigorously to rebuild, or a general depression might set in, with people concerned only with day to day survival.[64]

It is probable there would be a mixture of these forms of human behavior. However, it does seem reasonable that the social fabric would have a much better survival chance, if government continued to function and convinced Americans it had a workable plan of recovery. Disaster field studies in the U.S. show that under disaster conditions people have a heightened sense of concern for others and that mutual aid and acts of unselfishness are much more common than under normal conditions. Amazing toughness and resiliency are common in coping with the destructive effects of disasters.[65] The Delphi Technique was used in one study to query in isolation many psychology and sociology experts. The findings: "No collapse of society. Fear would be the greatest threat to recovery and communications the way to deal with it."[66]

GENETIC AND BIRTH EFFECTS

Ionizing radiation can affect the sex cells and cause mutations. Some of the victims at Hiroshima who received large doses of radiation became sterile. Most of these people died as a result of radiation sickness or injuries. However, of the surviving victims who had been made temporarily sterile, some later produced normal children.[67] According to the committee examining atomic bomb survivors, one-third of those examined were made temporarily sterile. There were only a few cases of men being permanently sterile.[68]

It is also known that children are more susceptible to radiation damage than adults. Fetuses are the most sensitive portion of the general

population. Most pregnant women survivors of the atomic attack on Japan, receiving a large enough dose to cause radiation sickness symptoms, had a miscarriage as a consequence. For those who survived and later gave birth, there was an increased incidence of malformation - 18.5% in the exposed group compared to 11% in controls (the controls were other Japanese women giving birth in the hard year following World War II).[69] Small children exposed to large doses of radiation at Hiroshima were adversely affected (the younger the child the worse the effect). The manifested problems were growth retardation (shorter and lighter than normal) and a higher than expected number of severely mentally retarded.[70]

What about the irradiated survivors who later produced offspring? The scientists studying this problem concluded in 1981, "Fortunately, investigations to date have revealed no harmful genetic effects in either the first filial generation (F1) or the second filial generation (F2), but further investigations and studies on atomic bomb illness must be continued for several generations to come.[71] A thirty-year study by the National Academy of Sciences (1977) of genetic abnormalities at Hiroshima and Nagasaki discovered no significant differences between the birth defect rate in these cities versus other Japanese cities.[72] In conclusion, no long-term genetic hazards have been associated and discovered in the studies of A-bomb survivors and offspring.[73]

A similar result has been seen in the case of fallout irradiation of the Marshallese survivors. From 1956 to 1962, 24 children have been born of exposed parents. All are normal.

It is believed that a massive nuclear war would have adverse genetic effects, though. The National Academy of Science in a 1977 report forecast that a large-scale nuclear war would cause temporary damage to the human gene pool. They estimated a rise in birth defects from 60 per 1,000 births to 61 per 1,000 births.[74] The PONAST II study estimated 40,000 to 70,000 genetic deaths (mutations resulting in death of the fetus) annually as a result of a nuclear war. Congenital malformations in the first year after the attack were estimated at 110,000 over and above the normal 45,000 that could be expected.[75]

CANCER

It is commonly known that radiation exposure increases the risk of cancer. However, the cancer would not be manifested until many years later.

In their study for Congress, the Office of Technology Assessment indicated that a radiation dose of 50 rems generally produces no short-term effects. However, if a large population were exposed to 50 rems, somewhere between 0.4% and 2.5% would later be expected to develop fatal cancer as a result.[76] A risk estimate for large wartime radiation doses indicates that for every 100 people receiving 100 R each, one more cancer death would be expected as compared to normal peacetime conditions.[77]

In Japan, about 5,700 A-bomb survivors were heavily irradiated. 15 to 25 years after the war, a total of 47 of these had died of cancer compared with a normal cancer death total of 30.[78] In a study of a large group of 109,000 survivors, the leukemia rate jumped from an incidence of one leukemia case in 1945 to a high of 19 leukemias in 1951. The leukemia rate has declined since then, but was still higher than the normal more than 25 years later.[79] The rate of lung cancer among the exposed in Japan has been almost twice the national average.[80]

The studies of a large-scale nuclear attack upon the U.S. indicates the cancer threat would be significant. The long term radiation hazards would result in bone cancers, leukemia, and other cancers. In the 15-20 years after an attack, an additional 20,000 cases per year of leukemia could be expected. An equal number of miscellaneous cancers would be added for 30 to 50 years. This would increase an individual's risk of getting cancer in a single year by 4 in 10,000. For perspective, one faces a risk of dying of 4 in 10,000 by traveling by car a distance of 24,000 miles in a year.[81]

A recent (1983) study out of Oak Ridge National Laboratory estimated for a 5,000 Megaton attack on the U.S. (all surface bursts): "The cancer death rate would peak at about 15 years. At that time, the total cancer death rate would be slightly more than twice the current rate." The

average loss of life expectancy as a result of radiation-induced cancers averaged 423 days per person.[82]

Nuclear war would create a heavy burden of cancer deaths. Yet, it can be said that the carcinogenic effects of nuclear war are not of sufficient magnitude to significantly influence the overall survival of the exposed population.[83]

EPIDEMICS

The large-scale death, injury, and destruction possible in a nuclear war create massive medical problems. Medical care and facilities, drug inventories, standards of living, and nutrition would all decline precipitously. A statement from the book, The Final Epidemic, is not hopeless but objective: "While no existing data prove that catastrophic epidemics will occur in the post-attack period, the matter is one of overwhelming importance and uncertainty. What is certain is that infection will pose a substantial threat to health and recovery for all those injured by blast, heat, and radiation, and that the resources to grapple with this threat will be inadequate."[84]

Obviously the medical situation would be grim. Yet, civil defense plans and preparations could significantly reduce the death and suffering a nuclear attack would cause.

If a surprise attack "out of the blue" is assumed, most of the country's medical personnel could be lost because of the concentration of medical service in metropolitan risk areas. On the other hand, with improved civil defense (including crisis evacuation) medical personnel and medical supplies could be relocated and provided with shelter protection. It is estimated that 60% to 70% of the doctors are in high-risk areas. If three-fourths of these were relocated during the crisis period, 250,000 doctors would survive in the host areas after the attack.[85]

It is known that people with symptoms of radiation sickness are more susceptible to infection; therefore, they should be isolated for their protection as much as practical. Experiments with animals and clinical

data, however, indicate that individuals irradiated but lacking the symptoms of radiation injury do not experience a reduction in resistance to infection.[86]

Controlling the spread of communicable disease would be vital. The critical factors which civil defense planning could come to bear upon include organic waste disposal, fly control, water treatment, pharmaceuticals, communication networks, and organized geographical units. Also, the British Medical Association points out that as high a standard of personal and food handling sanitation as is possible in a nuclear emergency be maintained. It would be critically important.[87]

Consider for example, the aspect of water purification. Contaminated water supplies could cause the spread of diseases such as dysentery, typhoid, and hepatitis. In some areas, water treatment facilities will survive undamaged so that it would be important to maintain their functioning. In other areas, portable water purification equipment might prove adequate.[88] In the worst cases, water could be disinfected by boiling or by adding a household bleach solution. (Household bleach that contains only sodium hypochlorite as its active ingredient may be used for this purpose in emergencies.)[89]

A study by Staackman, et.al., 1970, estimated that as much as 80% of the drug manufacturing capability could be destroyed in a large attack, but production could be expanded in the post-attack period to adequately meet the requirements.[90] The now declassified PONAST II study estimated that one-third of the needed drugs could be supplied in the first year, but expanding production could meet 100% of the pre-attack level in the second year.[91]

Furthermore, great epidemic diseases (bubonic plague, cholera, smallpox, typhus, yellow fever) do not exist in the U. S. or most countries and have few reservoirs from which such epidemics could arise and spread. Knowledge is the most important factor which could serve to mitigate an epidemic - it would not be destroyed by a nuclear attack.[92] Great epidemics need not and probably will not occur.

ECOLOGICAL EFFECTS

Ozone is a form of oxygen composed of three oxygen atoms rather than the common molecule found in nature which is composed of two. Ozone in the upper atmosphere screens out part of th ultraviolet radiation from the sun. In 1975, the National Academy of Sciences in its report, "Long-Term Worldwide Effects of Multiple Nuclear Weapons Detonations" studied the problem of ozone depletion. They estimated that a total of 10,000 MT of detonations in the northern hemisphere could result in a maximum reduction of ozone in the range of 30% to 70%. This would gradually replenish itself to 10% of normal in 5 to 7 years.[93]

If a large ozone reduction did take place, Dr. Bruce Clayton, a plant ecologist, believes that the effects on terrestrial life would be manageable and temporary. Humans would have a greater risk of sunburn and skin cancer, but could protect themselves by wearing clothing and staying out of the sun during the middle of the day. Some crops would be sensitive to increased ultraviolet radiation but others would not.[94] (For example, peas, beans, tomatoes, and onions are sensitive; wheat, corn, rye, and soybeans are not.)

Our crop capacity could decrease as a result of ozone depletion, yet U.S. agricultural surplus capacity and a switch to more resistant crops could allow the U.S. to meet its needs until the situation improved.

On the other hand, some experts believe that the worst case estimate of ozone depletion will never occur. In the years 1961 - 62, the U.S. and Soviet Union detonated over 300 MT of nuclear devices in the atmosphere as part of their weapons tests. A world-wide network of stations monitored the levels of ozone in the atmosphere. No evidence of decreasing ozone levels was observed. Rather, a slight rise in the level of ozone was measured.[95]

More recent analysis suggests that nuclear war could have less significant effects on the ozone layer than the 1975 study suggests. Since then the trend in nuclear weapons has been towards a greater number of smaller

yield weapons. This has been the case because greater missile accuracy means that a smaller yield will be needed to destroy a target. Also, smaller nuclear weapons are more efficient in creating blast effects than larger weapons.

Recent analysis at Lawrence Livermore Laboratory indicates that smaller nuclear weapons would not affect the ozone layer as much as the larger weapons in the 1975 study because of the limits of the cloud height from the detonation.

For important ozone effects, at least one thousand nuclear detonations larger than five megatons are needed to push the weapons effects above 80,000 feet. It is doubtful these large weapons exist. Most Soviet weapons are about one megaton in size and U.S. weapons are much smaller. Also, the trend towards smaller nuclear weapons is continuing.[96]

The 1975 National Academy of Sciences (NAS) study concluded that it was not possible to predict for certain the long-term ecological effects of nuclear war. However, a report for the Defense Civil Preparedness Agency points out that weapons testing does not indicate permanent ecological damage: "For example, some of the atolls in the South Pacific have experienced repeated direct effects and fallout from weapons tests comparable to the worst that could occur in a nuclear war. ...the tropical ecosystem has survived and recovered."[97]

An Oak Ridge National Laboratory study in 1969 stated, "a reasonable conclusion, therefore, is that the long-term ecological effects would not be severe enough to prohibit or seriously delay recovery."[98] The study looked at postulated catastrophes: fire, erosion, flooding, pest outbreaks, disease epidemics and ecological disturbances. Dr. Robert Ayres, a researcher for the study, concluded, "We have not found any of these mechanisms to be plausible in terms of any reasonable definition of catastrophe."[99] It seems possible that a nuclear war would not produce more stress on the balance of nature than nature has already withstood: cutting and/or burning most of the original forests, tilling the prairies, irrigating and reclaiming desert lands, damming and polluting the

rivers, eliminating certain species and introducing others, flooding valleys, spreading great amounts of chemical pollutants, and burning huge amounts of hydrocarbons in the atmosphere. Nature also unleashes huge amounts of energy within the biosphere. The average hurricane will dissipate an amount of energy equivalent to about 100 MT of nuclear detonations.[100]

Finally, prior to the test-ban treaty of 1963, about 1,000 megatons of nuclear detonations took place in the atmosphere without apparent, significant ecological damage.[101] This does not rule out ecological damage from a larger scale nuclear war, but at least our experience does not forebode great ecological damage.

One ominous theory that needs to be considered at this time is called the TTAPS study (the first letter of each author's name). It predicts a dark nuclear winter might occur following a nuclear war. As a result of smoke and debris being injected into the atmosphere from a nuclear war, sunlight reaching the earth would decrease and bring about reductions of land temperatures-in the worst case estimate to as low as -13 degrees Fahrenheit.[102]

The National Academy of Sciences had looked into the problem of a temperature decrease in a nuclear war in 1975. They estimated a drop in temperature of about 1 degree Fahrenheit. NAS assumed that debris from nuclear detonations was like volcanic debris. The famous Krakatoa volcanic eruption of 1885 was estimated to inject about 15 billion cubic meters of earth into the atmosphere. This is about equivalent to the amount that 3,000 1 Megaton surface bursts would inject into the atmosphere. Because a mix of surface and air bursts would be used in a nuclear attack, 3,000 MT of surface bursts is within the range of what might occur in a large nuclear attack on the U.S. No world-wide ecological effects were known to exist due to this volcanic eruption. The temperature of the earth may have dropped slightly. Other than that, the sunsets around the world were observed to be redder as a result of increased scattering by soil particles.

The TTAPS study is a more sophisticated estimate of the atmospheric effects of nuclear war than the earlier NAS study. Yet, it leaves many uncertainties because of speculative assumptions, incomplete data, and a limited model. Unfortunately, the message presented in the media did not give this impression. The scientific community must now begin the process of questioning, criticism, and refinement.

The TTAPS study is a pioneering attempt to address an important national question. Obviously, nuclear war would be a great world tragedy without even considering possible nuclear winter effects. But, the matter is of such national importance that it merits early examination by the most qualified experts in atmospherics, fire sciences, and nuclear detonations. However, the national civil preparedness program must have continuity and cannot be given a major shift in focus unless the need to do so is significant and without major uncertainties.

The concluding statement of the TTAPS study puts it well:

"Our estimates of the physical and chemical impacts of nuclear war are necessarily uncertain because we have used one dimensional models, because the data base is incomplete, and because the problem is not amenable to experimental investigation. We are also unable to forecast the detailed nature of the changes in atmospheric dynamics and meteorology implied by our nuclear war scenarios, nor the effect of such changes on the maintenance or dispersal of the initiating dust and smoke clouds. Nevertheless, the magnitudes of the first-order effects are so large, and the implications so serious, that we hope the scientific issues raised here will be vigorously and critically examined."[103]

RECOVERY POSSIBILITIES

The effects of a large nuclear attack on the U.S. would be devastating. Large numbers of business executives, government officials, medical specialists, scientists, educators, and associated institutions would be lost. The Office of Technology Assessment points out: "Structures and resources that would be destroyed in seconds or hours might not be

rebuilt for years, or even decades. People who would die in seconds or in weeks might not be replaced in a demographic sense for several generations. Political, social, and economic changes arising from immediate post-attack disruption would probably prove in some significant respects to be irreversible."[104] Even countries free from attack would suffer. Various underdeveloped countries depend on outside agricultural and manufactured products.

FEMA has estimated that one-third of Soviet weapons are aimed to maximize economic damage. They projected the GNP dropping from 100% to 60% on the day of the attack and continuing to a low of 40%.[105]

The PONAST II study estimated the destruction of manufacturing capacity:[106]

SEVERE DAMAGE (destroyed)	54%
MODERATE DAMAGE (1/2 assumed repairable)	19%
SURVIVING AND USEABLE	27%

They estimated that surviving industrial capacity would allow for a standard of living similar to the level of the mid 1930's. This would be expected to increase. The sixth year of recovery would approximate 1965 and the seventh year a 1970 standard of living.[107]

Many problems would have to be faced in a recovery effort. The labor force would be severely reduced. Yet, it would probably be sufficient to operate the surviving productive capacity. Shortages could be expected in some skills.[108] Housing needs might be met by doubling up, using congregate space in surviving structures (churches, schools, factories), evacuation to less damaged areas, emergency repairs and new construction.[109]

An estimated 60% to 80% of the current trucking capacity could survive a large attack provided appropriate measures were taken during the crisis phase before an attack.[110]

Motor vehicles, aircraft, rail, and inland water transport would still exist but transportation centers would probably be lost in most cases. It is possible to by-pass such centers by circuituous routing.[111] In the PONAST II study, local transportation was believed to be adequate for survival and recovery. However, availability of fuel was believed to be a critical problem.[112] 30% of the stored petroleum was estimated to survive, and the refining capability was reduced to 17%.[113] In another study, 80% of the U.S. crude oil refining capacity was estimated to be destroyed, or inoperative for several weeks after an attack.[114] Large amounts of petroleum would be destroyed. An estimated 2.27 billion gallons of diesel and fuel oil and 2.96 billion gallons of gasoline would survive in areas free of blast effects. This is probably adequate to carry the nation through the survival into the recovery stage if rationed and used judiciously.[115] The PONAST II study also analyzed recovery from the perspective of metropolitan areas. Some 230 SMSA (standard metropolitan statistical areas = economic and population centers) were studied in the nation. After 18 months all were deemed capable of again contributing to the nation:[116]

Time After Attack	# of Viable SMSA
3 months	50
6 months	90
18 months	230

Although the absolute level of materials and supplies would be greatly reduced in a nuclear attack, there would be a reduced population to use these stocks. According to the Office of Technology Assessment study, except for medicines there would probably not be widespread critical shortages of commodities.[117] Numerous economic models applied to economic recovery do not foresee insuperable barriers to economic recovery.[118] The PONAST II study concludes, "although damage was awesome, both sides (USSR/USA) are calculated to have survived and to be capable of recovery."[119]

But, national recovery will depend on a functioning government leadership with the appearance of self confidence, and the existence of a credible recovery program to restore production.[120] Other measures which could enhance recovery include civil protection, adequate pharmaceuticals, military dispersal, basic industrial survival, trade and financial service, economic management and guidance, and timely food distribution.[121]

Restoring production would be an immense task. Jack Greene, a civil defense expert, states that the most difficult barrier to recovery might prove to be post-attack management of the recovery. He sets forth the following priority actions:

> "Maintain communications; get essential transportation systems functioning; keep the agricultural industry going; avoid further deterioration or damage of idle production equipment or facilities; proscribe nonessential activities; mobilize manpower; re-establish the use of money; re-establish government operations."[122]

A tremendous quantity of equipment and parts would be destroyed because it would be located in target areas. Civil defense plans and activities could save some of this loss:

Crisis Preparations

- Remove records and management to safer locations
- Relocate valuable equipment and inventories
- Bury critical movable items
- Protect machine tools and special equipment
- Augment inventories of fuel, chemicals, and other stocks outside urban areas
- Accelerate production and safe stockpiling of essential survival items

- Provide shelter and alternate locations for work force and dependents

- Expand RADEF capabilities outside urban areas

- Mobilize post-attack control measures

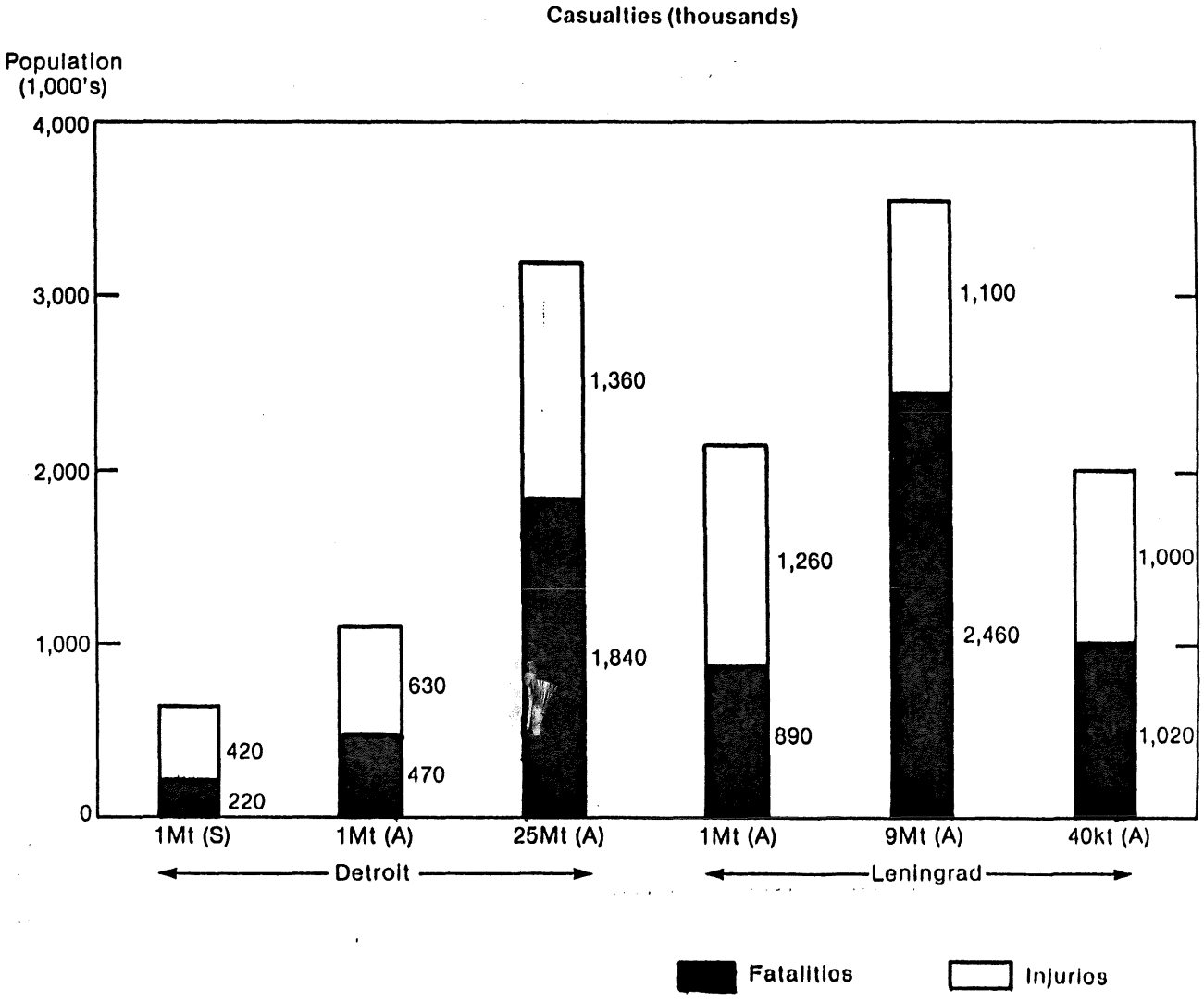
- Move vehicles from buildings likely to be destroyed by blast (If vehicles are parked in open less than half as much damage expected.)[123]

Even though the U.S./U.S.S.R. could probably recover in the years following a nuclear war, the superpowers must contemplate the probability that they would cease to be rich and powerful nations.[124]

CASUALTY ESTIMATES

1. Office of Technology Assessment Study - 1979

The OTA study estimated casualties in one American and one Soviet city for several different size attacks:[125]



The OTA hypothesized isolated attacks upon Detroit, Michigan, and Leningrad, U.S.S.R., using various size of weapons. The weapon detonations were either surface bursts (S) or air bursts (A). The 40 Kt(A) attack on Leningrad was an attack of 10 strategically placed 40 Kiloton air bursts. In using the above data for Detroit, the number of uninjured survivors can be obtained by subtracting the sum of the fatalities and injuries from 4.3 million, e.g., 4.3 million - (1.36 + 1.84 million) = 1.1 million uninjured survivors. 1 Mt equals an attack of a single one megaton weapon. The following assumptions apply for each of the scenarios:

The following are a list of the assumptions used by the OTA which may not be realistic but attempt to be illustrative:[126]

- "There is not warning. The populations have not evacuated or sought shelter, both of which measures could reduce casualties."

- "The detonations take place at night when most people are at their residences. This corresponds to the available census data about where people are, and indeed people are near their residences more than half the time."

- "There is clear weather, with visibility of 10 miles (16 km)."

- "The air bursts are at an altitude that maximizes the area of 30 psi or more overpressure. A higher height of burst would have increased the range of 5-psi overpressure (i.e. destruction of all residences) by up to 10 percent, at the cost of less damage to very hard structures near the center of the explosion."

- "No other cities are attacked, an assumption that allows for analyzing the extent of outside help that would be required, if it were available."[127]

There are three other points which can be added for a large attack on a metropolitan area - 1) many weapons will not arrive on target (estimated 1 in 5), 2) even fallout shelters may be useful in cities, and 3) there will be large numbers of people in need of emergency aid.[128]

The OTA also studied a large Soviet attack on U.S. military and economic targets (all-out nuclear war). A range of fatalities could be expected in the 30 days after the attack from a high of 155 - 165 million to a low of 20 - 55 million. This does not tabulate injuries to the survivors. OTA relied upon three other governmental studies.

Case 1:

Case 1 was a situation in which no warning or preparation occur before the nuclear attack. The average of the estimates (after 30 days) for these studies was 130 million American fatalities.

Case 2:

In case 2 the U.S. population was warned and had sufficient time to take shelter nearby. The average of the estimates in this case was 85 million American fatalities.

Case 3:

In case 3, the U.S. population had time to evacuate high-risk areas and then take shelter. The average of the estimates in this case was 35 million American fatalities.[129] Note that case 3 estimates 95 million more survivors than in case 1 in which there was no warning or preparations.

2. PONAST II

The PONAST II study was prepared by an interagency study group for the Joint Chiefs of Staff in 1973. It was a classified document for many years but is now open to the general public. An attack upon the U.S. of 6,800 megatons and also a spontaneous evacuation of 10% of the populace from large cities was assumed. The casualty estimates were as follows:

Fatalities	94 million (46%)
Survivors	109 million (54%)

Of the 109 million survivors, 35% (38 million) were estimated to be injured. About three-fourths of the fatalities and three-fifths of the injuries were caused by direct weapons effects.[130] Three factors were believed responsible for the high casualties: Large yield weapons, U.S. population concentration and co-location with industry, lack of effective civil protection programs.[131] The study estimates that had there been planned evacuations from high-risk areas the numbers of survivors could have been increased to 174 million.[132]

3. Oak Ridge National Laboratory

Another nuclear war study originated at Oak Ridge National Laboratory in 1976. It worked with a hypothetical nuclear attack of 6559 MT on th U.S. The study assumed that population relocation plans were put into operation and nearly 90 million people were relocated. Relocated people were assumed to be adequately protected from fallout radiation. Consequently, the study estimates that 90% of the U.S. population would survive through the attack period.[133] The following table also summarizes the post-attack survival of various sectors in the U.S.

Summary of Assessment of Postattack Survival of Sectors for Support for the Relocated Population

Section	Item	Estimated Survival
Communication	Telephones	Classified information.
	AM Radio Broadcast	At least two operating stations receivable at any location in U.S., and at least 100 million portable AM receivers.
	FM Radio Broadcast	Not estimated.
	CB Radios	4-6 million mobile units (1977).
	Public Safety Transmitters	0.5 to 1.5 million mobile units, 80-100 thousand fixed units.
	Industrial Services Transmitters	0.5 to 1.5 million mobile units, 90-110 thousand fixed units.
	Land Transportation Transmitters	0.8 to 1.2 million mobile units.
	Amateur and Disaster Radio Services	80 to 120 thousand fixed units.
Transportation	Automobiles	At least 60 million (over 60%).
	Buses (includes school buses)	200-240 thousand (50-60%).
	Trucks	11-16 million (50-75%).
	Train Locomotives	15-22 thousand (50-75%).
	Freight Train Cars	0.9 to 1.3 million (50-75%).

Summary of Assessment of Postattack Survival of Sectors for Support for the Relocated Population

Section	Item	Estimated Survival
	Aircraft (single engine)	59-88 thousand (50-75%) (at least 1000 airports with runways of 4000 feet or less will survive).
	Aircraft (twin engine or larger)	11-17 thousand (50-75%).
	Barges	11-17 thousand (50-75%) (usefulness limited because of destroyed locks and port facilities).
	Towboats	2-3 thousand (50-75%).
	Ships	3-4 hundred (50-75%).
	Pipelines	Most of the pipelines will survive but will not be able to function because of destroyed terminals and controls.
Petroleum	Gasoline, automotive	3.0 - 4.4 billion gallons (40-60%).
	Distillate fuel oil and diesel	2.3 - 3.4 billion gallons (40-60%).
	Aviation gasoline	15-25 million gallons.
	Refineries	80-100 refineries, having 20% pre-attack crude refining capacity.

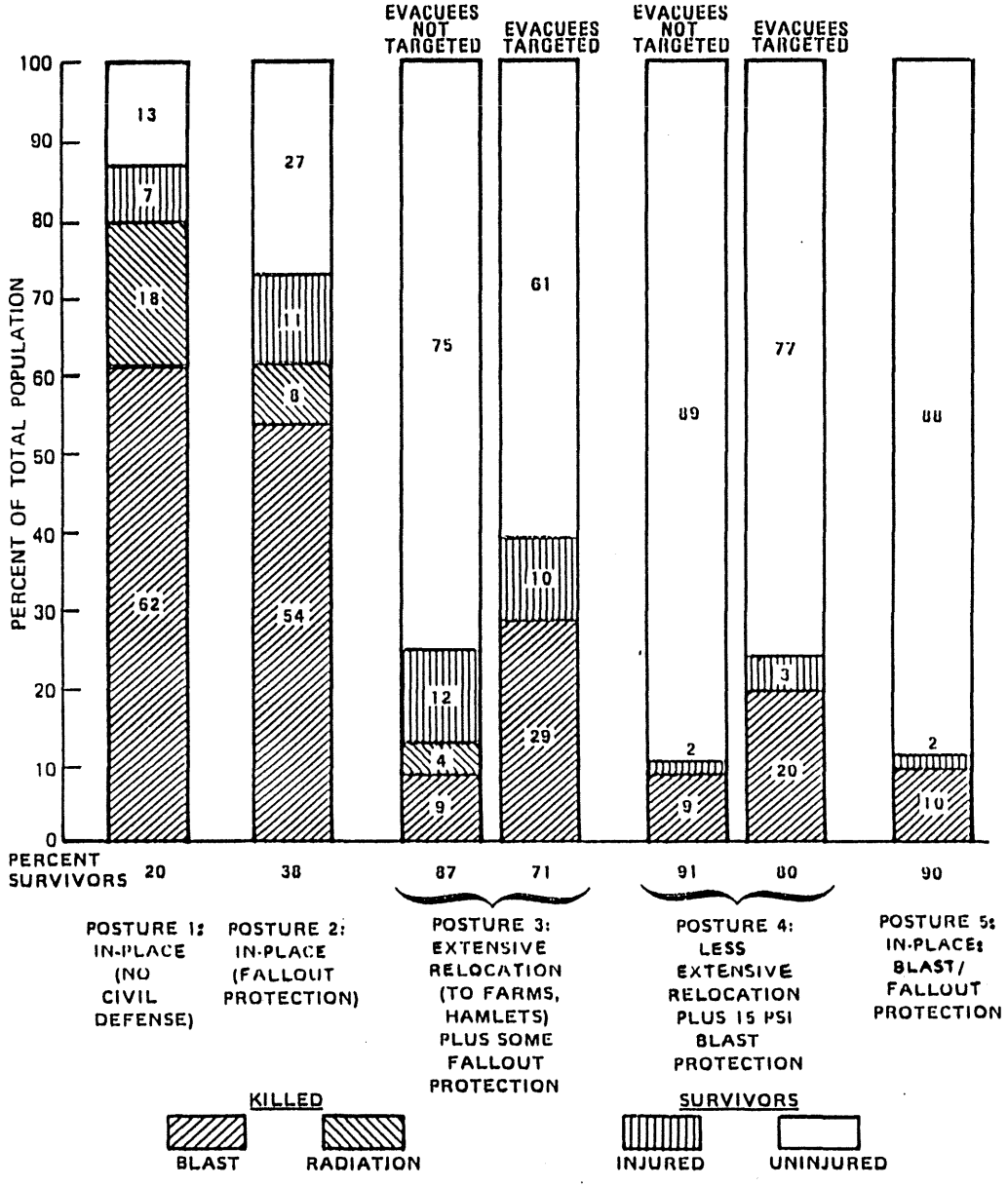
Summary of Assessment of Postattack Survival of Sectors for Support for the Relocated Population

Section	Item	Estimated Survival
Electrical Power	Power generation stations	1.4 - 2.1 thousand (40-60%).
	Transmission networks	13-14 thousand miles (90-95%) most of the power transmission net will survive but will not function for some time because of general damage by EMP and local blast and fire damage to substations.[134]

4. System Planning Corporation

The System Planning Corporation did a nuclear war study for DCPA in 1978 assuming a mid-1982 Soviet attack on the U.S. The attack on the U.S. is assumed to total about 6,000 MT and casualties are estimated for various civil defense postures:[135]

CASUALTY CALCULATIONS FOR ATTACK AGAINST MILITARY AND INDUSTRIAL FACILITIES, PLUS POPULATION



These estimates indicate that the current relocation planning could save millions of lives, and this is true even if the evacuees are targeted.

5. Boeing Corporation

The Boeing Corporation studied the situation of a U.S. preemptive strike upon the U.S.S.R. followed by Soviet retaliation against the United States. Such a Soviet strike aimed at maximizing fatalities by maximizing the amount of radioactive fallout was estimated to cause fatalities of 70% to 75% of the U.S. population (assuming no evacuations). Assuming full evacuation from target areas but no shelters in the evacuation areas, fatalities were expected to run about 30%. Assuming full evacuation and the use of expedient shelters in rural areas, the estimate of fatalities was about 13%.[136]

6. Defense Civil Preparedness Agency

Another nuclear attack study was made for the Defense Civil Preparedness Agency for a Soviet attack upon the U.S. taking place in 1979. The hypothetical attack was a mixture of counterforce and industrial targets. The study gives gross estimates of survival reflecting many years of research:

33 percent	Killed out right by direct weapon effects
17 percent	Killed by radioactive fallout
17 percent	Injured but not fatally by blast, thermal radiation or fallout
33 percent	Uninjured survivors[137]

Major changes in these figures were believed to be unlikely in the near future.

7. Criticism

A criticism of these casualty studies might be that they are out-dated. Unfortunately, they are the latest unclassified studies available for an attack on the United States. Because of recent trends, today there are greater number of warheads with smaller yields. Thus, there is a greater danger that more localities will be subjected to direct weapons effects. Overall, the threat from widespread fallout has decreased somewhat.[138]

Yet, the raw megatonnage (overall destructive power) of the strategic forces has remained about the same today as was the case in these earlier studies. The Congressional Budget Office estimated that by the mid-1980s the Soviet strategic force would consist of about 8,300 warheads of about 8,600 megatons in yield.[139] All of these warheads are not serviceable at any one time. Also, a certain percentage will prove to be unreliable. Using one estimate, about 6,000 megatons would be available at any one time to attack the U.S.[140] Also, consider that the Soviet Union cannot afford to launch all of its available warheads against the U.S. The Soviet Union has the longest border of any nation and each neighbor has various reasons to get back at the Soviet Union. Therefore, the U.S.S.R. would be forced to hold back a percentage of their nuclear arsenal as a deterrent.

One expert opinion is that the Soviet Union would have only 3390 megatons of raw yield to use against the U.S.[141]

Thus, these earlier studies have illustrative value because they are in the range of the total megatonnage the Soviet Union could use against the United States today. New studies need to be carried out and made public.

SOVIET CIVIL DEFENSE

Besides the U.S., other countries including Switzerland, Sweden, Denmark, Norway, England, France, China, and the Soviet Union also have civil defense programs in some stage of development. Switzerland, China and the Soviet Union have the most advanced programs in the world. Because of the adversarial relationship between the U.S. and U.S.S.R., it is important to consider the Russian civil defense system.

Soviet civil defense is a large, ongoing program, the goal of which is to protect the Soviet Union from enemy attack. The first order of priority for protection is the leadership, followed in order by the work force at key economic facilities and, lastly, the general population.[142] The U.S.S.R. has an extensive program to protect part of the population from blast. This is lacking in the U.S. As of 1978, blast shelters had been built for all of the Soviet leadership (approximately 110,000), between 12-24% of the essential work force and 10-20% of the general population. Plans call for the bulk of the urban population to be evacuated in 2 to 3 days in case of enemy attack.[143] According to Robert Kirshensteyn, former chief engineer of the Design Department of the Moscow Design Institute, the Soviet Union has now (1983) provided blast shelter for 50% of their working population.[144]

According to the CIA, "a publically recognized, highly structured, military-controlled civil defense organization exists at all levels of the Soviet government and economy..." The number of full-time civil defense personnel was estimated at more than 100,000.[145] Civil defense training is compulsory for all Soviet citizens.[146] Also a large shelter program exists. The subway systems of Moscow, Leningrad and other Soviet Cities have been designed with hermetically sealing doors to shelter many millions of people. Also, strict laws require that plans for the construction of new factories provide shelter for their workers.[147] The Soviet Union spends a great deal more than the U.S. does in the area of civil defense. It is possible to compare dollar costs of each country's program by converting Soviet civil defense

efforts into the amount a comparable U.S. program would cost. In the past decade the U.S. has spent about $900 million on civil defense as compared to the Soviet figure of $65 billion.

Some people question the effectiveness of the Soviet program. In 1978, the CIA estimated that under nuclear attack without civil defense preparations the Soviet Union would suffer 100 million casualties. With a few days for evacuation and shelter, this casualty figure could be reduced by half. With a week of pre-attack preparation, casualties could be reduced to the low tens of millions.[148] The former Chairman of the Joint Chiefs of Staff, General George Brown, stated that Soviet civil defense plans and preparations could under optimum conditions: 1) assure the survival of a large percentage of the Soviet leadership; 2) reduce prompt casualties of the urban population to a relatively small percentage; 3) give the Soviets the ability to distribute a subsistence level of supplies to the surviving population.[149] The idea that Soviet cities could be evacuated and the population sheltered while sustaining vital necessities has a historical basis. The U.S.S.R. successfully evacuated the population and entire vital industries in the face of the Nazi blitzkrieg in the summer of 1941.[150]

Why is it that over the years the U.S.S.R. has valued civil defense and accelerated preparations, while the U.S. has down played civil defense and reduced preparations? The core of the answer lies in the belief system of each superpower.

The American homeland has not within memory been invaded and occupied by an enemy. The desire to develop a huge conventional army to match the numbers of troops, tanks, artillery, armored personnel carriers, planes, etc. is lacking. It is not only lacking in the will to take billions of dollars from consumer and public welfare areas for this military build-up, but there is also great opposition to registering for a draft let alone drafting huge numbers to serve in the military.

It was possible to develop a technical solution to this human problem. The doctrine was called Mutual Assured Destruction (MAD). By creating

a large stockpile of nuclear warheads and the means to deliver them anywhere in the Soviet Union, U.S. planners developed a system aimed at preventing Soviet aggression. By necessity, the U.S.S.R. developed a similar nuclear system. According to U.S. ideology, neither side dares to implement adventurous foreign policies that risk a nuclear confrontation. The policy seeks to maintain the status quo. This being the case, what is the value of civil defense preparations for nuclear war in the face of Mutual Assured Destruction? In fact, it might undermine MAD. The Carter administration approached the U.S.S.R. during the Salt negotiations with specific proposals to do away with civil defense for this reason. The proposals were totally rejected by the Soviet Union.[151] Why?

The Soviet leaders do not belive in MAD.[152] They hold a different ideology. The belief system of communism maintains that capitalism is an economic system that is currently going through an evolutionary process of death and extinction. Because capitalism is based upon a small elite who control the power and wealth of a country by exploiting the working class, it will naturally be replaced by communism as the oppressed class becomes aware of their predicament. (The Soviets have no need to abandon this ideology given what has taken place and is occurring in Asia, Africa, and Central America.) From the communist standpoint all is well, except for one ominous obstacle. The capitalist nations, led by the U.S., may attempt to reverse this natural process by force of arms, driving the Soviet Union into a Third World War. Thus, the challenge from the Soviet perspective is not simply to maintain a status quo through MAD. Quite the contrary, the U.S.S.R. seeks to disrupt the status quo whenever possible to allow political evolution to occur and in the process increase their own power and influence.[153] If this process should lead the capitalist nations to war and even nuclear war, then the U.S.S.R. must be ready. This is the reason for the large conventional army and the large nuclear force. The aims of Soviet strategy are to restrain the U.S. from interfering with communism, to demonstrate that they could fight and survive a war if necessary, and to preclude the damage caused by an American nuclear

strike and thus negate U.S. deterrence.[154] Civil defense (CD) does not sit well with the U.S. strategy of MAD. It does work from the point of view of the U.S.S.R.

The current anti-nuclear, anti-civil defense movement popular in the U.S. seeks to convince the American public and the Soviet leaders that no one can survive nuclear war and therefore civil defense is worse than useless. Dr. Leon Goure' who served with U.S. military intelligence, the RAND Corporation and who is an expert in international studies described what he saw. The Soviet Union sends physicians and scientists to meet with the anti-CD groups. These Russian scientists reflect back the same sentiments as the anti-CD groups, affirming the "illusion of survivability."[155] This is totally at odds with Soviet CD policy, but if successful would make the U.S. more vulnerable to Soviet strategy.[156]

In conclusion, comparing Soviet and American civil defense efforts three salient points emerge:

- Soviet civil defense efforts are much greater than ours.
- Their level of effort has been increasing (or at least constant) for some time while ours has been generally decreasing.
- Their emphasis is on leadership, party, essential industry, and finally the population at large. Our emphasis is protection of the population.

Also, according to the CIA study, the Soviets almost certainly believe their present civil defense system would improve their ability to conduct military operations and would enhance the U.S.S.R.'s chances for survival following a nuclear exchange. They cannot, however, have confidence in the degree of protection their civil defenses would afford them given the many uncertainties attendant to a nuclear exchange.[157]

According to Paul Nitse, U.S. arms control negotiator, "The absence of the U.S. capability to protect its own population gives the Soviet

Union an asymmetrical possibility of holding the U.S. population as hostage to deter retaliation following a Soviet attack on U.S. forces." It also destabilizes the U.S. nuclear deterrent.[158]

Finally, Edward Teller estimates that fifty percent of the U.S. population would die in a nuclear attack. A civil defense program in the U.S. comparable to the Russian program could save 100 million more lives.[159]

ANTI-CIVIL DEFENSE MOVEMENT

"Wars are easy to start, expensive to continue and difficult to stop."[160] The last 38 years seem to indicate, hopefully, that nuclear war is perhaps an exception. The nuclear powers have successfully made great efforts to avoid war with another nuclear power because of the great respect for the destructiveness of nuclear weapons.

Yet, with the existance of nuclear weapons, there is a definite (hopefully small) probability they will be used. Unfortunately, even if all nuclear weapons were destroyed by treaty, there remains the possibility of nuclear war as long as nations have the knowledge and technology to rebuild the weapons rapidly if a conventional war developed.

At this time, there is a multi-faceted array of groups expressing concern about nuclear war. They remind us that nuclear war is destructive beyond historical precedence and that the resultant death and suffering are beyond human comprehension. "Nuclear war is not a solution. It is worse than any problem it might solve."[161] The important message for our world leaders is that they must not become complacent and must constantly seek actions and agreements that will promote peace. Even though the probability of nuclear war is small, the danger is great because of the magnitude of death and destruction which could result.

From the civil defense point of view, these efforts are laudable. Not only because they advocate peace, but also because they combat the apathy civil defense has tried to overcome for years. Emergency preparedness is most valued in time of emergency. However, some people in conjunction with their opposition to nuclear war have also adopted an anti-civil defense point of view. It is important for those interested in civil defense to understand this issue.

Most people who criticize civil defense give arguments against nuclear war, not against civil defense. The fact that devastation would be widespread, that immense environmental problems would exist, and that suffering and privation would be common are testament against nuclear

war not against civil defense. The tens of millions of people who could be saved by the civil defense system should not be denied that opportunity. In fact, we believe, it would be immoral to do so.

Some individuals have sought to propagate an unreasoning fear of radiation. This is especially easy with regard to nuclear weaponry. To allow fear to grow as the basis of our understanding is dangerous. We must not let fear lead us to believe that any measure taken to save lives in an attack is certain to be fruitless or even counterproductive.[162] Nuclear detonations could occur in the United States. Terror, a self-destructive emotion, is likely to occur if people don't know or are not aware of the possibilities of survival and recovery. There is much that could be done to increase the chances of survival.

Workers with disaster-related responsibilities cannot indulge in despair. First of all, the scientific and practical methods for protecting people from the direct effects of nuclear weapons and radioactive fallout are known; second, no insurmountable barrier to recovery has been proven to exist; third, we in the emergency services profession have been assigned the responsibility to help people survive in the event of nuclear detonations; fourth, if nuclear attack occurs, people will look to government for help and guidance.

Some of the issues raised revolve around simplistic solutions suggesting the choice is between the doomsday death of nuclear armagedon or some prescribed plan for peace. In reality, the question of peace/nuclear war is extremely complex. Slogans such as "Better Red than dead" are misleading because there are infinite possibilities besides either Red or dead. The civil defense measures which could save a great number of lives in the event of nuclear detonations are the same types of efforts that are needed in natural and technological disasters that occur frequently.

America has been an idealistic country since its inception. Idealism is good, but must be tempered by reality. In the context of enormous

problems, there is a special attraction to the assertion that only radical answers will suffice. The danger of focusing on utopian objectives is the turning away from practical and positive steps that can be taken now. Civil defense is practical.

Dare we, as Americans, adopt the simple solution of withdrawing into isolationism or advocating ideal worlds that do not exist? A nuclear war would be a world tragedy of unprecedented historical dimensions. But, it is because of this that we must think about it realistically and not idealistically. "The lessons of history clearly tell us that wars are not avoided by the adoption of idealistic assumptions."[163]

Some arguments against CD are quite down-to-earth and rational. The ultimate argument is that CD is useless because it is impossible to survive and recover in a nuclear war. If it were true it would be a powerful argument. Numerous studies have considered the long-term and short-term threats of nuclear war and no insurmountable barriers to survival or recovery have been proven to exist. To the contrary, research and study indicate that should nuclear war occur, the survivors would be more numerous and better off if civil defense plans and preparations have been made than if they have not.

This argument tends to be readily accepted by some because we are awed by a technology which we cannot understand. How can inadequate human beings stand against the power of science and technology? Yet, we are still superior to and are the masters of our technology. There are numerous examples of the tenacity of the spirit of the human race. On the eve of World War II, expert opinion was that mass strategic bombings of cities (such as later took place at London) would shatter the morale and the will to resist of the populace. Civil defense was developed as a successful counter to this threat. The bombings made the people more determined to prevail.

The small country of Vietnam had more tonnage of bombs dropped on it than was exploded during all of World War II. Yet, that civil war carried on for years and the side with minimum technology persevered.

The example of Leningrad during the German siege of World War II also provides perspective. Leningrad withstood the siege for nearly two and one-half years with almost no outside supply. No city in the U.S. experiences the severity of weather that winter brings to Leningrad. Yet, as Harrison Salisbury said in his book, The 900 days - The Siege of Leningrad: "Leningrad had survived without light, without heat, without bread, without water."[164]

Some people argue against civil defense saying that it increases the probability of nuclear war because it entails a war-fighting posture or psychology. Civil defense has never had this purpose. The thrust of the program is government's responsibility to protect its citizens from hazards of all types.[165] The Harvard Nuclear Study Group studied all facets of the issues of deterrence, peace, and nuclear war. Their conclusion: "all in all, the existence of a civil defense capability on one or both sides is unlikely to have a significant effect on the probability of a nuclear war."[166] The theory suggests that a president would be militarily adventurous and risk nuclear war because of the existence of civil defense preparations. A president knows civil defense capabilities and nuclear weapons effects. Even though civil defense preparations could save lives and reduce suffering, a nuclear war would still be the largest catastrophe the United States has ever faced. Many millions of Americans would die, suffering and hardship would be widespread, and the American industrial and economic base would be in shambles. Civil defense is not a solution to the problem of nuclear war, it is a partial insurance policy with a very high deductible.

The Russians, Chinese and others have had good civil defense programs for years. The U.S. has not considered this provocative and neither should anyone else.[167] The CIA study of Russian civil defense concluded: "We do not believe that the Soviet's present civil defense would embolden them deliberately to expose the U.S.S.R. to a higher risk of nuclear war."[168] Also, internationally, the right and responsibility of governments to prepare for the survival of its citizens in time of emergency is recognized. A Gallup survey of October 1982, found that

63 percent of adult Americans agreed that building up the U.S. civil defense system "would make nuclear war less likely because it would show the Soviets we are prepared."[169]

Civilian defense is humanitarian in nature. It has a humanitarian aim - to minimize loss, suffering, and death during times of disaster. Every government has the right and responsibility to protect its citizens with both military and civilian means.

The Geneva Conventions of 1977 (section 51 and 58) called for all nations to make preparations for the protection of their citizens from the effects of nuclear weapons including civil defense measures such as sanctuary for victims and evacuees, and preparations for medical response.[170] Dr. Gerald Looney, vice president of Doctors for Diaster Preparedness, believes that physicians are morally obligated to assist in preparing to help survivors of nuclear war. Dr. Max Klinghoffer of D.D.P. states, "...the conclusion that medical disaster planning for nuclear war is meaningless goes against all medical principles and logic."[171]

Civil defense can make nuclear war less likely by enhancing deterrence - making poor targets out of what are now good targets. Thus, the bottom line is that civil defense has the potential of saving millions of Americans in the unlikely, but not impossible, event of a nuclear attack upon the U.S.

Nuclear deterrence which has played a large part in preventing war between the two superpowers is fixed on the horns of a dilemma. On the one hand, our nuclear arsenals are too destructive to allow them to be used. On the other hand, not only must the U.S. develop the forces, doctrine, and will to use them, we must convince the Russians in advance, that we will use them.[172]

One dangerous aspect of the current anti-civil defense and anti-nuclear movement is that it puts pressure solely on the Western Democracies. Such broad-based popular movements could pressure the U.S. to reduce

civil defense and nuclear weaponry but would not affect the Soviet Union. Independent movements are not allowed in the U.S.S.R. nor is the leadership subject to public recall or change. Such efforts could undermine the existing deterrence which has served to prevent the escalation of numerous superpower crises.

Civil defense adds to the security of the United States in several ways. A national civil defense system:[173]

1. strengthens basic and extended deterrence by emphasizing the seriousness of the U.S. commitment to defend itself and retaliate;

2. aids the process of crisis management by reducing the possibility that the U.S.S.R. could blackmail the United States. (They are prepared for evacuation, sheltering, and long-term survival and we are not.);

3. significantly contributes to the survival and recovery of millions of Americans if war could not be avoided.

Nations are not attacked because they are prepared. The opposite is true. The leadership of the Soviet Union has proven to be cautious. They would not launch an attack upon the United States without a certainty of overwhelming superiority and success. Civil defense can contribute to the nonviolent deterrence of nuclear war.

When civil defense is mentioned in relation to nuclear war, it is almost always in the context of a total nuclear war using the entire world's arsenal. In reality, the threats are many and varied. The best argument for civil defense is that it is designed to operate over a range of emergencies and disasters.

The nation's emergency management system is composed of federal agencies, state agencies, and local groups. This national disaster preparedness network has the task of dealing with any natural or technological disaster that could occur in the U.S. The Integrated Emergency Management System (IEMS) is the name given to this approach. IEMS

recognizes that disaster preparedness has certain commonalities that can be applied to various disasters. Whether a region is faced with tornadoes, floods, toxic chemical accidents or nuclear power plant accidents, this emergency services network can be put into operation to meet the emergency. There are common elements in all disaster preparedness efforts. These include: a warning capability, command and control, communications, transportation, training, emergency evacuation, and protective sheltering. So with pre-planning and development, the disaster services community can have a capability to deal with many types of disasters.

Our emergency services network has a legal responsibility to aid Americans if a large nuclear war occurred. Now all of us realize that a major nuclear war would be the greatest catastrophe this nation could experience. Untold millions of Americans would die, the economy would be wrecked and society would be in dire straits. It would be beyond the capability of our civil defense system to prevent this.

All nations have a vital interest in preventing nuclear war. However, no one can guarantee that our nation will never experience nuclear attack. But, if it should occur, numerous studies and many years of research indicate that the survivors would be more numerous and better off if civil defense plans and preparations have been made than if they have not. The latest Federal Emergency Management Agency (FEMA) estimates, arrived at in conjunction with the Department of Defense (DOD) and other agencies, indicate that the civil defense system in a super-power nuclear conflict has a potential to double the number of survivors.

Hopefully, the probability of a nuclear war is remote. No one wants a nuclear war. Because of the mass destruction and death nuclear war could cause, there is no such thing as winning a nuclear war. The national well-being would be gravely injured. Our national leaders know this, and therefore one must assume the prevention of nuclear war is a top priority.

However, a total nuclear war is not the only threat and many believe it is not the most likely threat. Our military leaders tell us that limited nuclear war is more likely today than before because of the on-going trends in missile development and nuclear weaponry.

Also, given nuclear proliferation with many nations having nuclear weapons or on the verge of possessing them, the threat has never been greater that there will be a nuclear exchange not involving the U.S.: Argentina, Great Britain, France, India, Pakistan, Soviet Union, China, Israel, Iraq fit into this particular category. If nuclear attack occurred elsewhere, the U.S. could still receive dangerous levels of radioactive fallout in some areas. Would it be wise to dismantle the civil defense network? Should we junk the radiological instruments which have been maintained and prepositioned across the country? Should the programs to train civil defense personnel in radioactivity and radiological monitoring be abandoned? Should the program for protective sheltering be forgotten?

The U.S. could experience nuclear attack from a nation other than the U.S.S.R. Our nation has recently exchanged blows with Libya. The Libyan leader, Khaddafi, has a standing offer to buy nuclear weapons, and some believe he is backing Iraq's nuclear program. Would Khaddafi use nuclear weapons against Americans? Would a Khomeni? A recent newspaper article expressed the belief that this type of threat is more likely than a super-power nuclear conflict, because such a fanatical state would have less to lose, would be irrational, and could well be headed by an audacious blackmailer or kamikaze fanatic.

Civil defense has personnel, organization, planning, training, and expertise for such an eventuality. Should this be canceled? We believe the likelihood of such a tragic scenario occurring is greater if it is widely known that the capability to deal with it is lacking in the U.S.

Given the great numbers of nuclear warheads our own military maintains and transports, there is a chance of a functional or operational

accident. There is always the possibility of human error or the possibility that a responsible individual will lose control of his sanity. Not to have a national civil defense capability which could respond to this - to evacuate civilians or deal with widespread radioactive contamination of people and terrain would be scandalous and unforgiveable.

We live in an age in which terrorism is common. The scientific knowledge to build nuclear weapons is not beyond a competent physics student. It is possible, today, for a terrorist organization to build, steal, or buy a nuclear weapon. Internationally, the U.S. is the target of all sorts of fanatical groups.

Remembering the T.V. movie a year or so ago dramatizing a nuclear terroristic attack on Charleston, S.C., is it prudent for America to discard its planning and preparations to evacuate large metropolitan areas in an emergency? Granted, this is not an easy task. Some individuals assert that because of complications it would not be possible to evacuate everyone according to schedule. But, evacuation would occur more efficiently and rapidly if plans and preparations were made in advance than if they were not. To those additional individuals who would be saved as a result, it would make all the difference in the world.

This civil defense program, designed to operate in all of these types of emergencies involving nuclear detonations, is also integrated to serve in the event of nuclear power plant accidents or industrial and transportation emergencies involving radioactive materials. This radiological role is only one facet; the network is also set up to handle various natural and technological emergencies.

The current budget expenditure for the Integrated Emergency Management System nationally is 75 cents per person per year. Should we abandon the system and save 75 cents each next year?

The civil defense system and the measures that could save great numbers of lives in the event of nuclear detonations are the same types of

measures that are needed in natural and technological disasters that do occur frequently. Such humanitarian efforts to save lives and reduce human suffering are not only required by law, but also by morality and prudence. We in the disaster preparedness community can not afford to despair at the forms a disaster might take, because we have the responsibility to do all that we can if they occur.

CIVIL DEFENSE AND EMERGENCY PREPAREDNESS

In its early development, civil defense referred to a civil means of mitigating military attacks in order to protect a nation's population. For example, during World War II, the military means to protect the population from enemy bombers was to attempt to shoot them down using anti-aircraft guns or fighter planes. The civil defense response was to evacuate population, provide warnings, provide air-raid shelters and shelter needs, provide for search, rescue, fire control, etc. Although civil defense was only considered necessary during war, the advent of nuclear weapons and delivery systems necessitated some consideration be paid to civil defense during the 1950's.

Yet, in the absence of the threat of direct attack upon the U.S., the country was apathetic. The Berlin Crisis and the Cuban Missile Crisis presented stark realities and even the best leaders could not guarantee Americans would not be attacked by nuclear weapons. The Kennedy Administration became the champion of a great expansion of civil defense intended to save lives and protect the American public. President Kennedy had the greatest personal enthusiasm for civil defense. In Kennedy's words civil defense was, "insurance for the civil population in case of enemy miscalculation. It is insurance we trust will never be needed - but insurance we could never forgive ourselves for foregoing in the event of catastrophe."[174]

The amount of money spent in the early sixties remains the largest annual civil defense expenditures to date, despite the inflationary seventies.[175]

In the sixties, preparation for natural and technological disasters other than war became an important part of civil defense. Today's system, the Integrated Emergency Management System (IEMS), recognizes that many of the operations taken in the past to improve war-related civil defense capabilities also improved the capability to respond to peacetime emergencies. Thus, generic planning for disaster preparedness

involving warning, evacuation, sheltering, communications direction and control, continuity of government, resource management, law and order, food and medical supplies can be part of an emergency management program for fires, hazardous materials, tornadoes, floods, radiological accidents, hurricanes, earthquakes, and attack.

To simplify for illustrative purposes, the choice is not, "Does the American public want nuclear war or peace?"; for voting for peace will not guarantee that nuclear weapons will not be used against Americans. The choice is really to choose whether or not the government will work for peace. At the same time, the choice is whether or not the government will do civilian protection planning. Thus, the compound choices are:

1. Civil defense planning - NO / Peace planning - NO
2. Civil defense planning - YES / Peace planning - NO
3. Civil defense planning - NO / Peace planning - YES
4. Civil defense planning - YES / Peace planning - YES

This paper supports the belief that choice number 4 is the prudent and reasonable choice.

Obviously, peace efforts must be top priority and civil defense a much lower priority. But even the most peaceful and loving U.S. government cannot guarantee that the nations of the earth will forsake war. Civil defense could be a life saver in the disaster of war. Dr. Wayne Blanchard concludes from his history of civil defense: "First, contrary to an often repeated refrain, civil defense can work. Indeed, every government study of civil defense published during the years covered by Dr. Blanchard's study has indicated that civil defense measures can mean the difference in millions of lives saved in a nuclear attack."[176]

The reality of the situation is that we have some neighbors who have made threats against us - rather dire threats involving nuclear weapons. Now we have made similar threats of our own, but still, it is in everyone's best interest to live at peace with one another. When we

think about the ominous negative part of this relationship we become afraid. We do not want war and its consequences.

One way of dealing with this relationship is to imagine everything that is horrible, painful, and hopeless about a possible war with our neighbors and repeat it to ourselves to reinforce the idea that we never want it to happen. In other words, it must be so frightening that it will be unthinkable.

This approach would work if the choices were peace or war (happiness or hopelessness). But in the real world of complex relationships between nations, there are no simple - either this or that - answers to world problems. In fact, Hitler showed us that "peace at any price" can mean war.

A more rational approach to this relationship with our neighbors is to ask ourselves, "What is the worst thing that could happen in our relationship?" Obviously this would be a full nuclear attack upon us. Instead of pushing it away as unthinkable, let us think about it and study the magnitude of the disaster it would be. Then let us also make some prudent plans and preparations that could mitigate the death and suffering of this catastrophe to whatever degree is possible. Let us also maintain counterforce weapons to show our neighbors that we are sincere in our plan to defend ourselves.

At this point let us go to our neighbors and say that we have studied all of our choices. We have looked at the worst and we are not afraid of it. We are prepared to accept that heavy burden to maintain our lifestyle and freedom. But, we prefer a better relationship. Let us sit together and talk about our relationship. It is in our mutual good interest to see that the worst does not happen.

The American civil defense program is an inexpensive prudent program which plans and prepares to protect Americans in time of emergency from all causes. It is based on sound reasoning.

It is assumed that American policy constantly seeks cooperation, agreement, understanding and peace in international affairs. Despite the best efforts of the American government, there remains a possibility that nuclear weapons may be used against the U.S. by another nation or a terroristic group, or that nuclear weapons effects will reach the U.S. from a nuclear war exterior to the U.S. If this happens, almost all Americans will seek a means to protect themselves and their loved ones through measures such as evacuation.

Many years of research and study indicate that should a nuclear war occur, the survivors would be more numerous and better off if plans and preparations have been made than if they have not. Therefore, American government, under its responsibility to protect and defend its citizens, has provided leadership for survival and recovery.

Appropriate efforts will protect American lives. We know that ninety percent of the energy given off by a nuclear detonation is concentrated in the area of blast. This tremendous release of energy can destroy cities and make survival difficult. It is possible to construct blast shelters to protect individuals who live and work in the high-risk, target areas. But, because of the great amounts of energy released in nuclear detonations, blast shelters must be extensive and complex and are therefore costly. Although some nations (Soviet Russia and Switzerland) have chosen to build blast shelters for some civilians, our government has not.

But, since it has been estimated that only three percent of the land area of the U.S. would experience blast effects, another means of protecting civilians is possible. By evacuating people from a target area to an area that will only experience fallout radiation effects, the probability of survival is greatly increased. Would there be enough time for efficient evacuation? There certainly would not be if the U.S. experienced a "bolt out of the blue," all-out nuclear attack. However, experts agree this is not likely. The Soviets realize that a first strike by them will leave enough U.S. weapons to destroy a large portion of their military, economy and society. One cannot choose such

a catastrophe lightly. Therefore, it is most likely that nuclear weapons would only be used after a period of escalating crises resulting in conventional war and ultimately nuclear war.[177]

It would be possible for the Soviets to re-target the evacuated population but this would be difficult because of the dispersal of the population. Also, there is not evidence that population, per se, is an important Soviet target. The Russian attack priorities are ranked as follows:

#1 ICBM silos, SAC bases, SLMB (Submarine Launched Ballistic Missiles) bases and support systems.

#2 U.S. military installations.

#3 Industrial, transportation, and logistics facilities orientated towards military support.

#4 Other industrial, economic, and governmental centers.[178]

Therefore, evacuation could save lives. Once civilians have escaped the dire effects of nuclear blast, fallout shelters are the next most important necessity. In many cases residential basements (especially with several hours of improvements) would suffice. Also, national surveys have identified shelter spaces (Protection Factors of 40 or more) for millions of Americans. Great numbers of radiation dosimeters and survey meters are distributed throughout the nation and the training to use them has been going on for many years. The National Council on Radiation Protection is confident that these types of measures will save lives - "Enough is known about radiation physics and about the medical and biological effects of radiation to go far toward reducing radiation casualties, <u>if the knowledge is properly applied</u>."[179] This is one purpose of civil defense. Again an Oak Ridge National Laboratory study released in 1983 concludes, "Many millions of unprepared Americans would survive the very widespread danger from fallout and post-attack privations. Tens of millions of additional lives would be saved if even low-cost, realistic preparations were made."[180]

Is it a virtue to be naked in the wilderness? No, certainly it is not. It is always better to be knowledgeable, to plan, and to be prepared. The measures which could save an untold number of lives in the event of nuclear detonations are the same types of measures that are needed in the natural and technological disasters that do occur frequently.

Such humanitarian measures to save lives and reduce human suffering are required by law, by morality and by prudence. Social responsibility requires us to do all that we can, rather than despair at the forms that a nuclear disaster may take.

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