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ABSTRACT

Basic information about nuclear weapons is presented so that their effects can be meaningfully related to the defensive countermeasures which will be most effective against them. Major topics include: (1) Explosive power of nuclear weapons, (2) Major effects of nuclear explosions, (3) Two basic types of nuclear explosions, (4) Contrast between air and surface bursts, (5) Explosive power and destructiveness of different sizes of nuclear weapons, (6) Characteristics of a nuclear explosion, (7) The nature of fallout and its radiation, (8) Relationship between radiation and illness, (9) Review of the characteristics of fallout, (10) Detecting radiation, (11) Fallout shelters, (12) The National Shelter Program, (13) Types of Shelters, (14) Why a shelter is important, (15) Building your own fallout shelter, and (16) Stocking a shelter. Panel discussions and a test are included. (CK)

JUNE 1972

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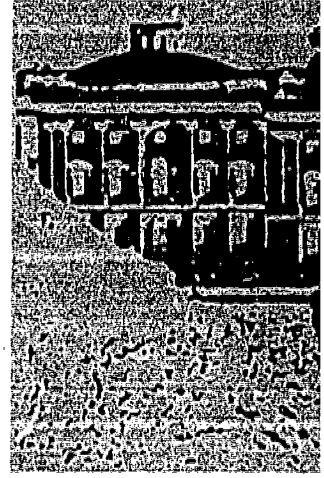

STAFF COL

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C I V I L D E F E N S E, U. S. A.

UNIT 2

NUCLEAR WEAPONS EFFECTS AND SHELTER

HS-6.2--June 1972

DEPARTMENT OF DEFENSE - DEFENSE CIVIL PREPAREDNESS AGENCY

C O N T E N T S

UNIT 2 - PANELS

INTRODUCTION TO UNIT 2 - PART 1:

EFFECTS OF NUCLEAR WEAPONS

Part 1 Purpose: To present basic information about nuclear weapons so that their effects can be meaningfully related to the defensive countermeasures which will be most effective against them.

For primitive man, fear and flight were appropriate reactions to natural threats. His only hope of survival in the face of fire, for example, was to flee. For modern man, however, fear and flight, accompanied as they usually are by a lack of knowledge, are totally inadequate responses. Modern man cannot run far enough fast enough to escape the man-made, "rational" threats with which he is faced.

Nuclear armaments are such a threat. We cannot deny their existence; we cannot talk them away; and there is no remote spot on this earth where we can go to avoid the influence of their presence in the world.

Are we trapped then? What can we do? We return to that all important word--knowledge. Knowledge gave us the fire department, with all of its specialized skills and equipment, which we use to fight the fires from which primitive man fled and knowledge can give us the answer to the nuclear threat.

Unit 1 gave you some basic general information about the nuclear threat and its relation to defense planning. It set the stage for what is to follow here. Unit 1 should have led you to the conclusion that civil defense planning is a necessary part of our overall military planning. You are probably already asking yourself the question which is the next logical step: "Okay, we ought to do something about civil defense, but what? What kind of civil defense posture should we have? The answer is based on specific information and data about nuclear weapons. Knowing what nuclear weapons can do must come before effective countermeasures to protect us from them can be designed and implemented. You will learn what they can do in Unit 2, Part 1.

NOTE: Rest Breaks - After Frame 33 and at the end of Part 1, Frame 63.

EXPLOSIVE POWER OF NUCLEAR WEAPONS

1. Read Panel 1 at the back of this book. Basing your answer upon the comparisons made in this panel, describe below the relative explosive power of conventional and nuclear weapons.

* _____

_____

---

22. Fallout is composed of earth and debris sucked up into the nuclear cloud. Consequently, the amount of fallout depends upon how close the fireball is to the ground. In fact, if the fireball does not touch the ground there may be no fallout. How severe (less severe/more severe) do you think the fallout would be for the following types of explosions?

	Severity of Fallout
Air	_____
Ground	_____

---

43. Check each description which you think is a major characteristic of fallout radiation (there may be more than one correct answer).

_____ 1. The gamma radiation of fallout does not penetrate most materials.
_____ 2. Any amount of radiation is always fatal.
_____ 3. It can damage living cells.
_____ 4. The gamma radiation of fallout is seldom fatal.
_____ 5. The gamma radiation of fallout is very penetrating.
_____ 6. The radiation level remains constant over time.
_____ 7. The radiation level decreases with time.
_____ 8. The gamma radiation of fallout may make exposed objects radioactive.
_____ 9. The gamma radiation of fallout cannot make other objects radioactive.

1a. *While many answers are possible, the point to be made is that nuclear weapons have far greater destructive power than do conventional weapons.

22a.

Severity of Fallout	
Air	Less severe
Ground	More severe

43a. The following are considered major characteristics of fallout radiation.

X 3. It can damage living cells.

X 5. The gamma radiation of fallout is very penetrating.

X 7. The radiation level decreases with time.

X 9. The gamma radiation of fallout cannot make other objects radioactive.

2. From the second example in Panel 1, you can see that the 20 kiloton (KT) bomb is the equivalent in explosive power of 20 thousand tons of _____. The explosive power of all nuclear weapons is measured in equivalent tons of _____.

---

23. Little or no debris is picked up by an air burst, but considerable dirt and debris are picked up by a ground burst. Therefore, fall-out will be heavier with a (ground/air) _____ burst.

---

44. Gamma radiation, like X-rays, can _____ steel and other solid materials.

2a. TNT

TNT

23a. ground

44a. penetrate

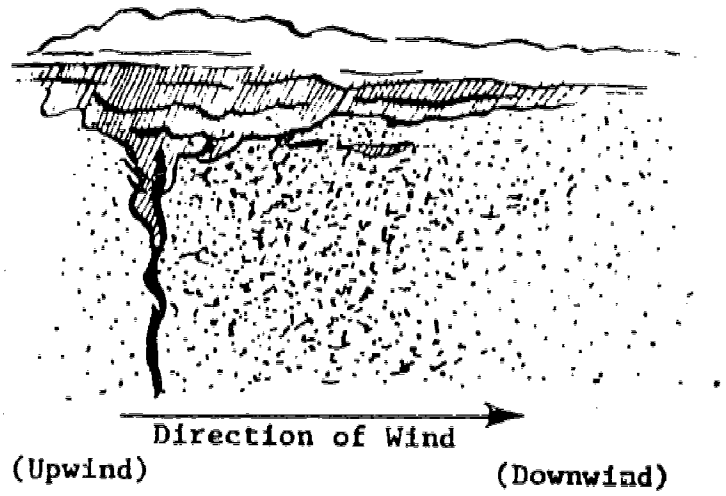
3. Almost 2,000,000 tons of explosives were dropped on Germany during World War II. A single 2-megaton bomb has about the same explosive power as all of these bombs. Its power is equivalent to the explosive power of (#) _____ tons of _____.

---

24. A sample pattern of fallout from a nuclear explosion is shown at the right. You can see that the heaviest fallout settles (where in relation to the center of the explosion?) * _____

_____

and that fallout travels in a(n) (upwind/downwind) _____ direction. The fallout is lighter as the distance from the center of the explosion _____.



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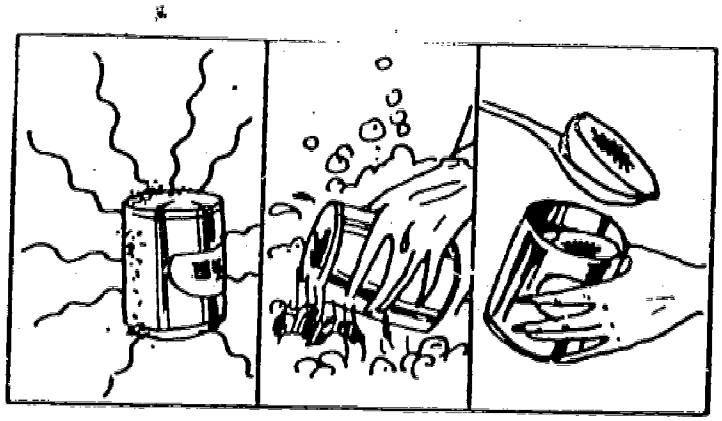
45. Although gamma radiation goes through objects (such as the can of fruit shown on the right), such radiation does not cause exposed objects to become radioactive. The can in the first picture here is covered with radioactive particles (fallout) and, therefore, (is/is not) _____ contaminated. However, after thoroughly washing the can, the fruit inside (is/is not) _____ safe to eat because * _____.



3a. 2,000,000 (2 million)

TNT (explosives)

24a. *near the center of the explosion (ground zero)

downwind

increases

45a. is

is

*fallout radiation does not cause objects to become radioactive.

4. The power of a megaton nuclear weapon is measured in terms of explosive power which is equivalent to that of (hundreds/thousands/millions) _____ of tons of TNT. A kiloton bomb is measured in terms of explosive power which is equivalent to that of _____ of tons of _____.

---

25. Descriptions of fallout effects are matched below with the different kinds of nuclear explosions. If the descriptions are matched correctly, copy them on the lines below. If they are incorrect, write the correct description on each line.

(1) Air burst -- moderate to heavy fallout

_____

(2) Ground burst -- little or no fallout

_____

---

46. If radioactive particles (fallout) settle on a can of food, the can is contaminated. The food inside the can is not _____, but has been exposed to radiation.

4a. millions

thousands

TNT

25a. You should have something like the following:

(1) Air burst -- little or no fallout

(2) Ground burst -- moderate to heavy fallout

46a. contaminated

5. The explosive power of nuclear weapons is measured in x _____

_____.

26. Fill in the following table indicating the position of the fireball relative to the ground and the comparative severity of each type of effect:

Type of Burst	Altitude of Fireball in Relation to Ground	Blast Effects	Shock Effects	Direct Heat and Initial Nuclear Radiation Effects	Early Fallout Effects
Air					
Ground					

47. All materials that the radioactive particles (fallout) settle on are _____. These materials (are/are not) _____ exposed to gamma radiation, but are not radioactive.

5a. *equivalent tons of TNT (i.e., the number of tons of TNT which have an equivalent explosive power)

26a.

Type of Burst	Altitude of Fireball in Relation to Ground	Blast Effects	Shock Effects	Direct Heat and Initial Nuclear Radiation Effects	Early Fallout Effects
Air	Fireball does not touch ground	More Severe	Less Severe	More Severe	Little or no Fallout
Ground	Fireball touches ground	Less Severe	More Severe	Less Severe	Moderate to Heavy Fallout

47a. contaminated

are

6. The major effects of nuclear explosions are shown in Panel 2. From this panel, you can see that the five major effects are:

1. _____
2. _____
3. _____
4. _____
5. _____

---

27. Look at Panel 4. This shows some of the effects of a 5 MT (megaton) blast at different distances from its center. Recall that a 5 MT blast has explosive power equivalent to that of (#) _____ tons of TNT. Check which of the following could be determined from this panel. (More than one.)

_____ 1. The approximate percentage of people killed.

_____ 2. The types of buildings which will be destroyed or damaged.

_____ 3. The number of buildings destroyed.

_____ 4. The maximum distance at which fires might be started by the heat radiation.

_____ 5. The approximate degree of damage.

---

48. If a sealed bag of apples was covered with radioactive particles (fallout), we would know that (place an "X" in the column(s) designating the proper description(s):

	Radioactive	Contaminated	Exposed
The particles are:			
The bag is:			
The apples are:			

6a. 1. Heat)
)
2. Initial nuclear radiation)
)
3. Blast) Any order
)
4. Shock)
)
5. Fallout)

27a. 5 million (5,000,000)

You should have marked the following:

__X__ 1. The approximate percentage of people killed.

__X__ 2. The types of buildings which will be destroyed or damaged.

__X__ 4. The maximum distance at which fires might be started by the heat radiation.

__X__ 5. The approximate degree of damage.

48a.

	Radioactive	Contaminated	Exposed
The particles are:	X		
The bag is:		X	X
The apples are:			X

7. Look again at Panel 2. Tremendous amounts of heat and initial nuclear radiation are released by a nuclear explosion. Charring and fires occur at great distances because of the intense _____. The initial nuclear radiation does no damage to most inanimate objects, but is very dangerous to _____.

---

28. Use Panel 4. The extent of destruction and casualties, as has been noted, depends upon the distance from *_____ _____. The greater the distance, the *_____ _____ the destruction and casualties.

---

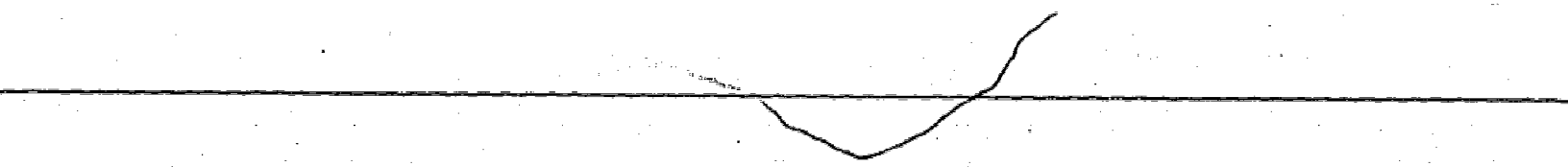
49. When atomic bombs were tested on the Nevada flats, they produced a great deal of radioactive material at the test area. However, this area could be used again because radiation decreases with time. Areas contaminated with fallout are also safe after a while because all types of fallout radiation *_____.

7a. heat

life (people, etc.)

28a. *ground zero (or, the center of the explosion)

*lighter



49a. *decrease with time

8. Continue with Panel 2. The shock effect is a concussion that is transmitted through the _____. The blast is a concussion that is transmitted through the _____.

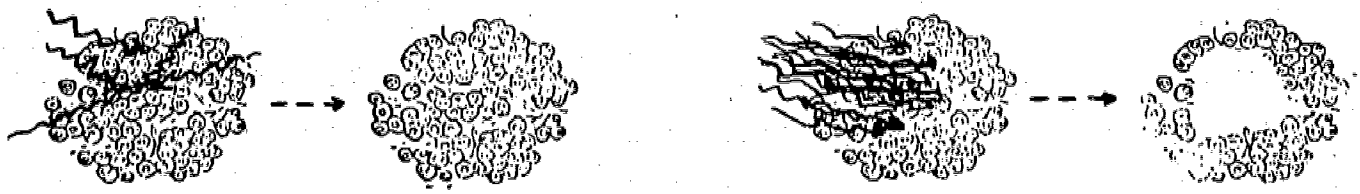
---

29. The effects in Panel 4 have been calculated for a(n) (air/ground) _____ explosion. From the note at the bottom of the panel, you can see that the radius of damage and the ignition radius are increased if *_____

_____.

---

50. All radiation damages cells in the body to some extent. The cells on the left, below, were hit with a small amount of radiation; few were damaged. The cells at the right, below, were subjected to a large amount of radiation; many died. Thus, if a person was not protected from heavy fallout radiation, he would probably die because the radiation would *_____.



8a. ground

air

29a. ground

*the burst is elevated to an altitude maximizing the reach of blast damage.

50a. *extensively damage the cells in his body.

9. In Panel 2 you can see that there are two sources of radiation. The radiation which first emanates from the fireball is called _____ _____ _____. Radiation also comes from the products of the explosion that drift to the ground after a period of time. This radioactive material is called _____.

---

30. Compare Panels 4 and 5. You can see that the radii of death and destruction are greater for the (#) _____ MT weapon than for the (#) _____ MT weapon.

---

51. Place a checkmark in front of each major characteristic of fallout radiation.

_____ 1. It does not penetrate most materials (gamma radiation).

_____ 2. It does damage to biological cells.

_____ 3. It decreases with time.

_____ 4. It is always fatal.

_____ 5. It is seldom fatal.

_____ 6. It frequently makes exposed objects radioactive.

_____ 7. It is very penetrating (gamma radiation).

_____ 8. It can contaminate the surface of exposed objects, but it cannot make exposed objects radioactive.

9a. initial nuclear radiation.

fallout

(As noted in Unit 1, the word "fallout" when used in this course always means radioactive fallout.)

30a. 25

5

51a. You should have marked the following:

_____ 2. It does damage to biological cells.

_____ 3. It decreases with time.

_____ 7. It is very penetrating (gamma radiation).

_____ 8. It can contaminate the surface of exposed objects, but it cannot make exposed objects radioactive.

10. On Panel 3 you can see that the two basic types of nuclear explosions are *_____ and * _____.

---

31. Look at Panels 4 and 5. Although a 25 MT weapon is five times as powerful as a 5 MT weapon (i.e., larger by a factor of 5), the increase in the corresponding radii of damage is a factor of about (check one):

1 ___ 1.7 ___ 2.8 ___ 4 ___

Now look at the areas of damage. If we compute the square miles contained in each of these areas (done by using an algebraic formula which allows us to figure the area of a circle when the radius of the circle is known), we find that they increase (approximately) from 28 to 79 square miles for the total destruction ring, from 79 to 200 for the severe damage, and from 200 to 615 for moderate damage. These are increased by a factor of about (#) _____.

---

52. As you might expect, there is a direct relationship between the amount of radiation received (the dose), measured in Roentgens (R), and the extent of illness. Exposures up to about 75 R do not cause serious illness. But exposures of 600 R and over result in _____ to nearly everyone so exposed.

10a. air)
) Either order
ground or surface)

31a. 1.7 X

3

52a. death

11. In Panel 3 you can clearly see that in a ground or surface burst the fireball touches the _____, but in an air burst the fireball *_____.

---

32. Which of the following best describes the relationship between the explosive power and the damage capability of different sizes of nuclear weapons (5 MT, 25 MT, etc.)?

_____ 1. The area and radius of damage increases by the same magnitude as the increase in power.

_____ 2. An increase in power results in a decrease in the area of destruction.

_____ 3. If the power is increased, the radius and area of destruction will increase, but the magnitude of this increase will be smaller.

_____ 4. Although the power may be increased, the area of damage changes little.

---

53. Some of the effects which may result from radiation are nausea, severe illness, and death. Because people have different resistances to radiation injury, some will resist illness better than others, but an increase in the total amount of radiation received, the dose, will always produce a(n) _____ in the percentage of people affected in a given way.

11a. ground

*is high enough above the ground that debris is not "sucked" up into it.

32a. __X__ 3. If the power is increased, the radius and area of destruction will increase, but the magnitude of this increase will be smaller.

53a. increase

12. Nuclear explosions may range from those occurring deep underground to those that occur at a high altitude. However, the kinds that are most dangerous to populations are those that are at or near the _____.

---

33. From the foregoing discussion, you can see that claims of "super bombs" with "five times the power of existing weapons":

_____ 1. are clearly not true.

_____ 2. are reason enough to abandon the civil defense concept.

_____ 3. are partly scare propaganda, because the destruction they cause does not increase in direct proportion to their power.

_____ 4. are proof that an area five times as large will be destroyed.

---

54. The dose of radiation received depends upon the intensity of the radiation and the time exposed. For example, if someone were exposed for five hours to a 100 R/hour source of radiation, he would receive a _____ of 500 R of radiation.

12a. ground

33a. X 3. are partly scare propaganda because the destruction they cause does not increase in direct proportion to their power.

THIS IS A GOOD PLACE TO TAKE A BREAK.

54a. dose

13. Panel 3 illustrates the results of heat, blast, and shock effects upon buildings at different distances from the two types of nuclear explosions. From the condition of the buildings, you can see that close to the explosion the effects of the two types are (much the same/different) _____.

CHARACTERISTICS OF A NUCLEAR EXPLOSION

34. You have learned something about what nuclear weapons can do. At this point, it would be useful for you to know the basic characteristics of a nuclear explosion. You have already learned some of them. List below the effects of a nuclear explosion that you have learned.

* _____

_____.

---

55. A. Match the effect that you think would result from short-term exposure with the dose.

Brief (4-Day) Radiation Dose in Roentgens	Effect on Humans
___ 1. 75-100	a. Death to almost everyone.
___ 2. 200	b. Brief nausea to some.
___ 3. 450	c. Largest dose that does not cause severe illness to most people.
___ 4. 600	d. Death to about 50%.

B. A dose between 200 R and 300 R over a few days would probably (kill you/make you very ill but with a good chance of recovery)

_____.

13a. much the same

34a. You should have listed:

*Heat and initial nuclear radiation, air blast, ground shock, and fallout.

55a. A. b 1.

c 2.

d 3.

a 4.

. . make you very ill, but with a good chance of recovery.

14. Looking at Panel 3 you are able to see that as the distance from ground zero increases, the magnitude of the effects of either an air burst or a ground burst (increases/decreases) _____.

---

35. Panel 6 provides a brief description of the general process of a nuclear explosion. Read this panel now. The next few frames are based upon it. When you finish reading, go on to the next frame.

---

56. Fill in the table below.

Brief (4-Day) Radiation Dose in Roentgens	Effect on Humans
1. 75-100	*
2. 200	*
3. 450	*
4. 600	*

14a. decreases

35a. Go on to the next frame.

56a.

Brief (4-Day) Radiation Dose in Roentgens	Effect on Humans
1. 75-100	* brief nausea in few
2. 200	* largest dose not causing severe illness in most
3. 450	* death to about 50%
4. 600	* death to most

15. Two things are directly related if, as one increases, the other also increases; two things are inversely related if, as one increases, the other decreases. The magnitude of effect of a nuclear explosion is (directly/inversely) _____ related to the _____ from ground zero.

---

36. From Panel 6 you can see that the following are dominant features of a nuclear explosion:

(1) The creation of a _____ which produces intense _____ and initial nuclear _____;

(2) The air _____ and ground _____;

(3) The inward and upward blowing _____ which form the _____ of the _____ cloud;

(4) The _____ of vaporized _____ on the dirt and debris to form a cloud of _____ _____;

(5) The settling of _____.

REVIEW

57. The explosive power of a 20-kiloton nuclear bomb is equivalent to that of (#) _____ tons of _____.

The explosive power of a 10-megaton bomb is equivalent to that of (#) _____ tons of _____.

15a. inversely

distance

36a. (1) fireball

heat (thermal)

radiation

(2) blast

shock

(3) after winds

stem

mushroom

(4) condensation

particles

radioactive particles

(5) fallout

57a. 20,000 (20 thousand) tons of TNT

10,000,000 (10 million) tons of TNT

16. Again studying Panel 3, you can see that as the distance from ground zero increases, the magnitude of the effects of the two types of bursts decreases at (about the same rate/different rates)

_____.

---

37. Below are five dominant features of a nuclear explosion. All but one have characteristic effects (harmful results). Match the features with the corresponding major effect (an effect may be used more than once).

Feature	Effect
_____ 1. Fireball: heat and initial nuclear radiation	a. Destruction and damage
	b. Death
_____ 2. Air blast	c. Sickness
_____ 3. Ground shock	d. Destruction by fire
_____ 4. Condensation of vaporized particles	e. No direct effects
_____ 5. Radioactive fallout	

Against which feature do you think protection is most possible and feasible? _____

---

58. You may use Panels 2 and 3 for the following:

In a ground burst, the fireball *_____. In comparison with the effects of an air burst, the blast effects for a ground burst are *_____; the shock effects are *_____; the heat and initial nuclear radiation effects are *_____; and fallout is *_____.

16a. different rates

37a. b, d 1.

a, b 2.

a, b 3.

e 4.

b, c 5.

fallout

58a. *touches the ground

*less severe

*more severe

*less severe

*moderate to heavy (or, more severe)

17. Use Panel 3.

As the distance increases from ground zero, the blast and heat effects of a ground burst decrease (faster/slower)_____ than for an air burst. This might be explained by (more than one):

_____ 1. The curvature of the earth.

_____ 2. The difference in distance from the fireball.

_____ 3. The weather conditions.

_____ 4. The interference of buildings and hills.

---

38. List below the dominant features of a nuclear explosion and any corresponding major effects (harmful results). Place an "X" in front of the effect against which protection is possible and feasible. You may use Panel 6 if you wish.

	Dominant Feature	Major Effects (If Any)
1.		
2.		
3.		
4.		
5.		

---

59. A comparison of Panels 4 and 5 shows that, although the power of a nuclear blast may be increased by a given magnitude, the radii and areas of death and destruction are increased *_____

_____.

17a. faster

X 1. The curvature of the earth.

X 3. The weather conditions.

X 4. The interference of buildings and hills.

38a. (The items below may be in any order.)

	Dominant Feature	Major Effects (If Any)
X	1. Heat and initial nuclear radiation	Destruction by fire, death
X	2. Air blast	Destruction, damage and death
	3. Ground shock	Destruction, damage and death
	4. Condensation of vaporized particles	No direct effects
X	5. Radioactive fallout	Sickness and death

59a. *by a smaller magnitude.

18. Topographical features (hills, valleys, buildings, etc.) would give you more protection from the (air/ground) _____ burst.

THE NATURE OF FALLOUT AND ITS RADIATION

39. Using Panel 6, select and copy the item below which is the best description of fallout from a low air burst.

(1) Heavy rocks that have been made radioactive.

(2) Water drops that contain dissolved radioactive materials.

(3) Small, solid particles that contain radioactive residues from the fireball.

_____

_____.

---

60. The following statements deal with the dominant features of a nuclear explosion and their harmful effects. The major effects caused by the nuclear fireball, with its intense _____ and initial _____ _____, are * _____. The concussions, that is, the air _____ and ground _____, cause extensive destruction.

18a. ground

39a. You should have written:

(3) Small, solid particles that contain radioactive residues from the fireball.

60a. heat

nuclear radiation

* fire and death

blast

shock

19. Since you would more likely be in a direct line of sight to the air burst, you would expect the blast effect to be (more/less) _____ severe with the air burst.

---

40. Although fallout particles vary some in size, they are generally small and solid. The particles of dirt or debris are coated or fused with radioactive residues from the fireball. Radioactive fallout, then, is composed of * _____

_____.

---

61. Fallout is composed of * _____

_____

Check each of the following which are major characteristics of the radiation from radioactive fallout.

_____ 1. It is stopped easily by the air.

_____ 2. It decreases with time.

_____ 3. It causes exposed objects to become radioactive.

_____ 4. It causes damage to biological cells.

_____ 5. The gamma radiation is very penetrating.

_____ 6. It is not dangerous to humans.

_____ 7. It can contaminate the surface of exposed objects, but it cannot cause exposed objects to become radioactive.

19a. more

40a. *small, solid particles that contain radioactive residues.

61a. *small, solid particles that contain radioactive residues from the fireball.

You should have marked the following:

X 2. It decreases with time.

X 4. It causes damage to biological cells.

X 5. The gamma radiation is very penetrating.

X 7. It can contaminate the surface of exposed objects, but it cannot cause exposed objects to become radioactive.

20. Like the blast effect, heat is transmitted better through the air than through the ground. Therefore, both the _____ and _____ effects and initial nuclear radiation from the fireball are more severe with a(n) _____ burst.

41. Fallout consists of * _____

_____.

62. The significance of a 200 R short-term dose of radiation is that it is * _____.

A 4-day dose of 450 R will * _____;

600 R will * _____.

20a. blast)
heat) Either order

air

41a. *small, solid particles that contain radioactive residues.

62a. *the largest dose that does not cause severe illness to most people.

*cause death to 50%

*cause death to almost everyone

21. Relate the overall effects of the different types of explosions by filling in the table below. Use the terms "less severe" and "more severe" to compare the effects of air and ground bursts.

Type	Blast Effects	Shock Effects	Direct Heat Effects
Air			
Ground			

42. Read Panel 7. Radioactive fallout emits different kinds of radiation, all of which are dangerous. The most penetrating type is gamma radiation. Therefore, the greatest danger would come from _____ radiation because of its ability to _____.

63. At this point you may be asking, "Those may be the effects of a nuclear weapon, but so what?" To see how you might be affected, write in the next blank the name of the facility or location closest to your community which might be a possible target (such as a major industry, military base, large population center, etc.) *_____
_____.
What is the distance of your community from this target? *_____ miles. Assume that a 5 MT bomb was dropped on the target (ground burst). Now use Panel 4 to estimate the extent of the damage and casualties in your community which resulted from blast and heat.

Extent of damage *_____

Casualties *_____

21a.

Type	Blast Effects	Shock Effects	Direct Heat Effects
Air	More Severe	Less Severe	More Severe
Ground	Less Severe	More Severe	Less Severe

NOTE: If you missed any of these, go back and review Panel 3 and Frames 13 through 20.

Return to the beginning of Unit 2 and continue with Frame 22.

42a. gamma

penetrate

Return to the beginning of Unit 2 and continue with Frame 43.

63a. PROGRAMMER'S COMMENT:

*If you live near a likely target, you should have found that extensive to moderate damage and casualties would result. There is the consideration also that you would not necessarily be safe even if you lived far away from a potential target. This was pointed out in Unit 1 and will be shown in greater detail in Part 2 of this unit.

END OF UNIT 2, PART 1. TAKE A SHORT BREAK AND CONTINUE WITH UNIT 2, PART 2, WHICH BEGINS ON PAGE 23.

INTRODUCTION TO UNIT 2 - PART 2:

SHELTER

Part 2 Purpose: To present (1) the need for and the basic concepts of shelter, (2) the National Shelter Program and its importance, and (3) the sources of information for home shelter construction and stocking.

Although peacetime usefulness of civil defense is stressed more and more, the objective of preparedness to meet the effects of nuclear attack has not diminished in importance. Knowledge about the nuclear threat and the effects of nuclear weapons has made it possible for our government to develop programs and plans for emergency operations in case of an attack. If one would assume that an attack was highly probable or certain, the importance of such programs would easily be seen. However, their role as a deterrent to an attack is less obvious. You have already learned how closely civil defense is tied in with other defense measures. Like those other systems of defense, civil defense programs, too, will be most successful if they never have to be used. This paradox of modern war is sometimes difficult for us to understand; yet we need not only to understand it but also to help others to grasp its full significance. For it is true that the better we plan for defense against nuclear weapons the less likely it is that our plan will ever need to be implemented.

This part of Unit 2 provides an answer to the question raised by Part 1, i.e., "What can be done to protect oneself against the effects of nuclear weapons?" Three factors which reduce the danger from radiation--time, distance, and shielding--are discussed. Emphasis is given to shelter as protection by shielding, including information on materials and their effectiveness. Consideration of the relative strengths of different materials which can be used for fallout shelters leads to the conclusion that good fallout protection in some instances can also mean good shelter from other dangers, such as blast effects, windstorms, and tornadoes.

The advantages of designing new buildings in such a way that fallout protection is provided at low additional cost is pointed out. It is hoped that all participants in this course, once they have learned these advantages, will then use their influence to assure that construction of public buildings in their areas follow such design practices.

The National Shelter Program is discussed in overview, as well as the expected results of that program in terms of total lives saved in the event of an all-out nuclear attack. Finally, various types of home shelters are described, and also information sources on construction and stocking of shelters are given.

NOTE: Rest Break - After Frame 30.

FALLOUT

1. In our earlier discussion of fallout, we noted that fallout consists of *_____, and that fallout radiation can be very dangerous to *_____.

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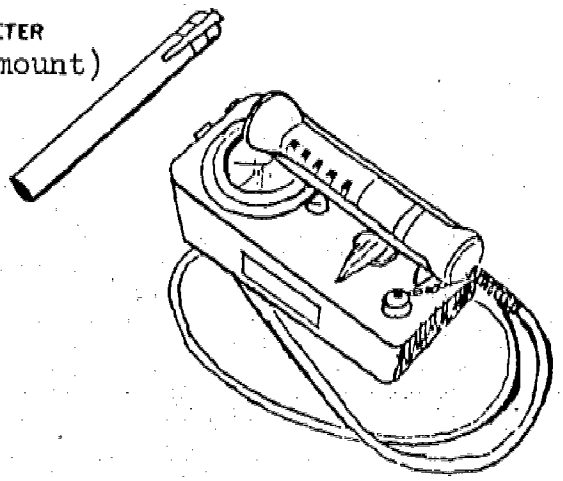
19. Look at the sketch on the right. Two special kinds of instruments are used for measuring _____. The dosimeter is used to _____ the total _____ of radiation; the survey meter (or ratemeter) is used to measure the _____ of radiation per unit time.



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37. From Panel 11, you can see that progress in locating, licensing, and marking fallout shelters is _____ _____. (Select your answer from the items below.)

(1) Going backwards.

(2) Standing still.

(3) Going forward.

1a. *small solid particles that contain radioactive residues from the fireball

*human life

19a. radiation

measure

dose

rate

37a. (3) Going forward.

2. Look at Panels 8 and 9. These panels illustrate fallout conditions based on two different (but actual) weather patterns, a spring day and a fall day. Although the patterns are entirely different, the major element that they have in common is that fallout of various intensities will cover about 75 percent of the country. Although for any given day, the fallout would probably cover only (#)_____% of the country, the particular areas covered are not defined beforehand; therefore, fallout actually threatens (10%/25%/50%/75%/100%) (#) _____ of the country.

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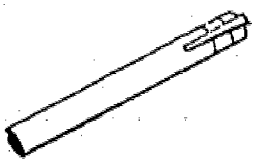
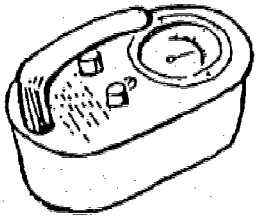
20. Use the choices below to specify the kind of instrument and its function next to the proper sketch below.

Choices: Dosimeter -- Survey Meter -- Measure total dose -- Measure dose rate

Instrument _____

Function _____





Instrument _____

Function _____

TYPES OF SHELTERS

38. Many communities have a Community Shelter Plan (CSP) which is a part of the Nationwide Fallout Shelter System. Your community may or may not have one, but if it does, the CSP will identify all buildings which have a public fallout shelter. It also will have assigned the residents of the community to particular shelters. If you are in doubt as to whether your community has such a plan, contact your Civil Defense Coordinator or your highest elected official for details. If your community is a part of the Nationwide Fallout Shelter System or has its own CSP, certain buildings will be identified with this sign:

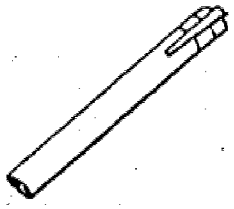
This sign is an indicator that the building is a public _____ _____.

2a. 75%

100%

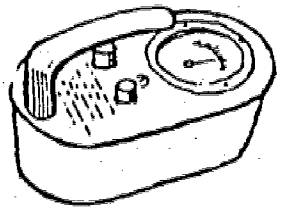
20a. Dosimeter

Measure total dose



Survey Meter

Measure dose rate



38a. fallout shelter

3. After studying Panels 8 and 9, do you think it would be likely that you would have to stay in a shelter in the area where you live after each of the assumed attacks?

Yes ___ No ___

The probability of fallout threatening your area is (#) _____%.

---

21. The two kinds of instruments used for measuring radiation and their functions are:

Instrument	Function
_____	_____
_____	_____

---

39. If you were in a strange community or in your own community and you saw this sign on a building, you would know that this building was:

a _____ fallout shelter.

If you were in an unfamiliar community and you saw no signs on any of the buildings, to locate the nearest community fallout shelter, you should contact the _____ _____ Coordinator for the community, or the office of the highest elected official.

3a. Your answer would almost have to be: Yes X

It is clear from the panels that in most areas residents would have at least some days of shelter occupancy after an attack, while in other areas they should have quite a few days of shelter occupancy.

100% (Recall that fallout threatens the entire country.)

21a.

Instrument	Function
Dosimeter	Measures total dose
Survey Meter	Measures dose rate

39a. (a) community (or public)

Civil Defense

4. In the event of a full-scale nuclear attack, fallout of various intensities will:

(1) probably cover about (#) _____% of the country;

(2) threaten (#) _____% of the country.

FALLOUT SHELTERS

22. There is no way to ensure that the _____ spent near a radioactive source will be negligible or that you can stay a safe _____ from the source; however, advance efforts can be made to provide some form of _____.

---

40. An important part of your local Community Shelter Plan may be assistance to the contractor during the construction phase of public buildings. It is possible to construct a building so that it will serve as a very effective shelter once completed. The costs are minimal over normal construction costs and there are additional benefits to be gained from this type of "slanted" construction ("slanted" toward being a good shelter). For example, schools which are built "slanted" toward being good shelters normally will have fewer external openings, less glass area, and more solid construction. Check the following factors which this type of construction would help eliminate.

_____ (1) Glass breakage.

_____ (2) Noise pollution.

_____ (3) Vandalism.

_____ (4) Frequent repair costs.

4a. 75%

100%

22a. time

distance

shielding

40a. <u>All</u> of these problems would be reduced by following a "slanted" plan during construction.

5. In the event of a nuclear explosion, many factors can be involved in determining the extent and location of the fallout area and the level of radiation for a given location. Which, if any, of the following do you think would be a factor? Check them.

_____ (1) Size, shape, and density of the fallout particles.

_____ (2) Snow and rain.

_____ (3) Altitude of the burst.

_____ (4) Atmospheric conditions and winds.

_____ (5) Power and design of the bomb.

_____ (6) Nature of the ground surface at the point of burst.

---

23. Fallout shelters basically protect you from radiation by putting heavy walls between you and the fallout particles, thus utilizing the principle of _____.

---

41. In addition, a building which has been slanted toward being a good fallout shelter has other advantages. How well would such a building function as a shelter in the event of severe windstorm or tornado, as opposed to a building which was not slanted? *_____

_____.

5a. All of the items listed are important factors.

23a. shielding

41a. *It would function better as a shelter against severe windstorm or tornado.

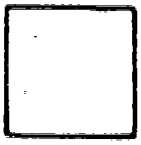
6. Recall that an air burst generally creates (more/less) _____ fallout than a surface burst; the amount of fallout thus depends in part upon the * _____ of the burst.

---

24. The most important consideration when constructing a fallout shelter is the density of the material which you are placing between yourself and the radioactive fallout. As a general rule, the more dense the material, the better. The density of two different materials can be compared by weighing a block of each of the materials, both blocks being of the same physical dimensions. The block which weighs the most has the most density. Based on what you know about the comparative weights of different materials, number the blocks below in order of their density.

(Number 1 would be the most dense; number 4 the least dense.)

_____Concrete



_____Styrafoam

_____Lead

_____Wood

---

42. An on-going program of architect training and technical assistance for incorporating fallout radiation protection in buildings is conducted by the Office of Civil Defense (OCD). Communities may obtain assistance in the area of slanting techniques through the Professional Advisory Service Centers of OCD. Therefore, help is available, and if you are, or can be in any way, influential in the design or construction of any public building (schools, auditoriums, etc.), it (would/would not) _____ be to the advantage of the community for you to suggest that the building be slanted for use as a community fallout shelter.

6a. less

*altitude

24a. 2 Concrete 4 Styrafoam 1 Lead 3 Wood

42a. would

7. Fallout particles can be carried long distances by a strong _____, or they can be carried to the ground by precipitation such as *_____. Note that one of the major reasons for the different fallout patterns in Panels 8 and 9 is the difference in _____ direction.

---

25. The best shielding material for a fallout shelter will be the one which is made of the (least dense/most dense)_____ material.

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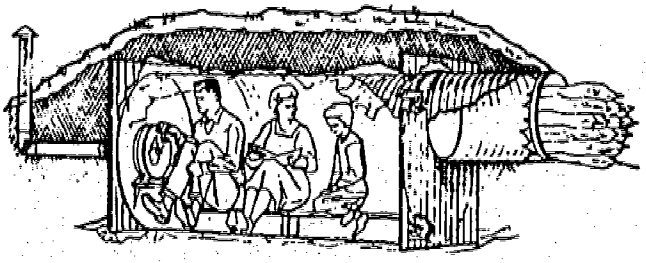
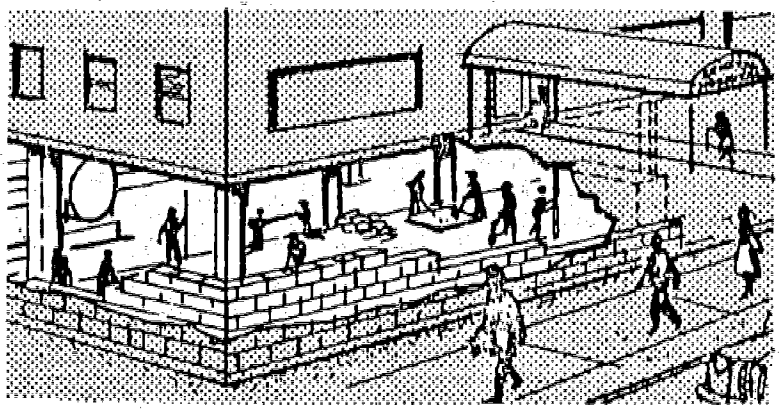
43. To this point under our consideration of the types of fallout shelters, we have focussed on the community shelter. From our earlier mention of the Home Fallout Protection Surveys, you already know there is yet another type of shelter which you might use in the event of a nuclear attack or a natural disaster. That is the shelter which is designed to be used by only one family at a time, and it is called a family shelter. Identify each of the shelters pictured below by writing the correct type below each picture.





A._____ B._____

7a. wind

*rain, snow

wind

25a. most dense

43a. A. Family (or Home) Shelter

B. Community (or Public) Shelter

8. If fallout particles are large and heavy, they will usually fall:

_____ close to the blast.

_____ a long distance from the blast.

Therefore, the amount of the fallout in a given area depends to some extent upon the wind and the *_____ of the particles.

---

26. Number the following blocks of material in order of their effectiveness as a material for construction of a fallout shelter (base your evaluation on their density):

___Steel

___Wood

___Lead

___Concrete

___Earth

---

44. If you live in a city and are close to public buildings, you will most likely use a _____ shelter in the event of a nuclear attack or a natural disaster requiring this type of shelter. If you live in the suburbs or in a rural area, you will most likely use a _____ shelter.

8a. __X__ close to the blast

*size (or density, etc.)

26a. __2__ Steel __5__ Wood __1__ Lead __3__ Concrete __4__ Earth

---

44a. community (or public)

family (or home)

9. From which kind of ground surface do you think a nuclear blast would draw the most material for fallout? (Check one.)

_____ A surface of rock.

_____ A surface of dirt and sand.

Because there is a difference, it is clear that the amount of fallout from a surface blast depends upon the nature of the *_____.

---

27. Lead has the most density. However, it is not very practical, from the standpoint of cost or construction techniques, to build a fallout shelter from lead. But return to the list of materials in the last frame and see what was second best and third best. List them below.

2nd best: _____

3rd best: _____

WHY IS A SHELTER IMPORTANT?

45. At this point you may be asking yourself one or more questions. Why is a shelter important? Why should I know where the nearest community shelter is? Why should I construct a family shelter in my home? Will it really help? The answer to the last question is a decided "YES!" Look at Panel 12. This panel depicts anticipated loss of life following a nuclear attack against the United States that might occur in 1975. Each column shows the predicted results under different conditions. For example, the first column, labeled "No Shelter," indicates the number of lives that would be lost in the absence of an effective shelter program, assuming the population is at home. In this case, (#) _____ lives would be lost.

9a. X A surface of dirt and sand.

*ground surface at the point of blast.

27a. 2nd best: steel

3rd best: concrete

45a. 104 million lives would be lost.

10. Circle the factors that help to determine the extent and location of a fallout area. (Read carefully.)

(1) Snow and rain.

(2) Size, shape, and density of fallout particles.

(3) Speed of the bomb when it explodes.

(4) Sunspot activity.

(5) Altitude of the burst.

(6) Nature of the ground surface at the point of burst.

(7) Atmospheric conditions and winds.

---

28. Steel and concrete are often used in the construction of buildings located in the business sections of cities, so many of these buildings (would/would not) _____ be effective as fallout shelters.

---

46. The third vertical column of Panel 12, labeled "Full Fallout Shelter," assumes that 10 percent of the population would fail to use the shelters at all and that others would improperly use them (e.g., late entrance and/or early exit). Under these conditions, our graph indicates that a total of (#) _____ lives would be lost, but (#) _____ lives would be saved by the shelters, nevertheless.

10a. (1) Snow and rain.

(2) Size, shape, and density of fallout particles.

(5) Altitude of the burst.

(6) Nature of the ground surface at the point of burst.

(7) Atmospheric conditions and winds.

28a. would

46a. 49 million (lives lost)

55 million (lives saved)

11. Now that we know some of the important facts about the dangers of radiation from fallout, how can we protect ourselves from it? Look at Panel 10. You can see that protection from external radiation exposure is a combination of three things: _____, _____, and _____.

---

29. In addition to providing effective shielding from fallout, there is another benefit which may be gained from the use of steel and concrete in building construction. For example, a shelter so constructed (would/would not) _____ tend to be very strong structurally. Based on this information, would you say that such a shelter has or has not the possibility of also functioning as a shelter from blast effects, or from natural disasters such as windstorms or tornadoes?

_____

---

47. The graph could carry the projection farther to the use of blast shelters also. But, we've made our point. The use of fallout shelters alone would save approximately 55 million lives in the event of an all out nuclear attack on the populated areas of the United States. That fact certainly makes it worthwhile for you to know where shelter is available to you. And it also certainly makes it worthwhile for you to build your own family fallout shelter, if you need to do that. Let's consider your own situation right now.

Do you know where you would go to community shelter in case of an attack? ( ) Yes ( ) No

Do you live in an area where you should consider building your own family fallout shelter? ( ) Yes ( ) No

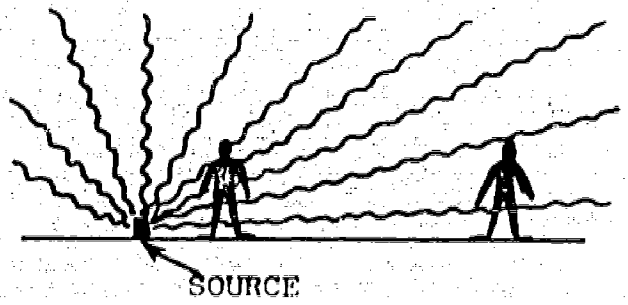
Does your community ever experience weather conditions which would require the use of such a shelter, e.g., heavy windstorms or tornadoes? ( ) Yes ( ) No

11a. distance)
time) Any order
shielding)

29a. would (tend to be very strong structurally)
has (possibility of also functioning as a shelter from blast effects, or from natural disasters such as windstorms or tornadoes.)

47a. PROGRAMMER'S NOTE: Only you can check your answers to this frame; however, your answers should have indicated a need for action on your part, or they indicated that you are already prepared, in which case you are to be congratulated. You must be the judge of whether or not you need to take further action.

12. As shown in the illustration here, the farther away you are from a source of radiation, the less radiation you will receive. This is the protection principle of _____.



30. There are factors other than the materials of which a building is made that must be considered in the selection of a building for a shelter. How the building is constructed; the size and number of windows and other external openings; whether or not the doors and windows are inset; the type of roof construction; and many other factors determine the overall effectiveness of a building as a shelter.

Do you think the average citizen is able to select the best building to be used as a fallout shelter? ( ) Yes ( ) No

Why or why not? _____

_____.

BUILDING YOUR OWN FALLOUT SHELTER

48. There are many plans available for building your own family fallout shelter. The plans call for simple construction which you can complete with basic carpentry or masonry skills. The required shielding materials used in construction of the shelter could cost as little as $100 to $200. They might also be somewhat higher than that, depending upon the type of construction, the shelter plan selected, etc. If you are in the process of building a house, or are contemplating doing so, you should consider including the necessary construction for a shelter. As with public buildings, this process is called "_____," because the house is intentionally designed so that portions of it can function effectively as a fallout shelter.

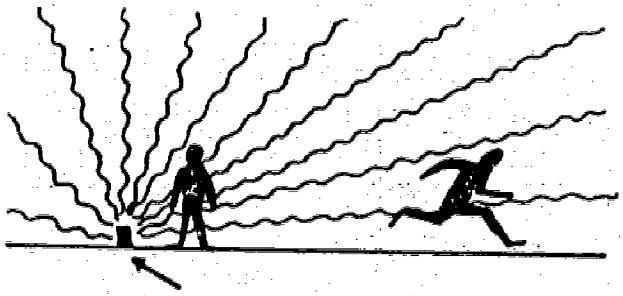
12a. distance

30a. PROGRAMMER'S NOTE: You should have checked "No." Unless he has made a study of the factors involved, and of architectural design and construction methods, the average citizen is not knowledgeable enough to select the best fallout shelter. In addition, he may not have the time to make that kind of a decision when a fallout shelter is needed.

THIS IS A GOOD PLACE TO TAKE A BREAK.

48a. "slanting"

13. As shown in this drawing, if you move away from a radiation source, you will receive less radiation than if you stay near it. By doing this, you will spend less _____ near the source.



THE NATIONAL SHELTER PROGRAM

31. Recognizing that the average citizen needs help in determining which buildings in his area would or would not be good fallout shelters, the Federal Government has undertaken a program designed to locate and identify public fallout shelters which already exist in our country. Read Panel 11 carefully.

With respect to fallout shelters, the National Shelter Program is concerned primarily with the (physical characteristics/staffing) _____ of those shelters.

49. If you decide to build a permanent shelter in the basement of an already completed house, you might consider one of three readily available plans.

Ceiling Modification Plan A--This plan calls for obtaining overhead protection by screwing plywood sheets securely to the joists and then filling the spaces between joists with bricks or concrete blocks. You may or may not need to add an extra beam or a screw-jack column to support the weight. You may or may not have to add optional walls.

Ceiling Modification Plan B--This plan shows you how to add extra joists into the ceiling in part of the basement to support the added weight of the shielding material. You will have to add two interior walls.

Concrete Block or Brick Shelter Plan C--Made of concrete blocks or bricks this shelter is located in a corner of your basement and can be used as a storage room or for other useful purposes in non-emergency periods.

To order any of these plans, please order by name from Civil Defense, Army Publications Center, 2800 Eastern Blvd. (Middle River), Baltimore, Maryland. The plans will be sent to you without charge. All of these plans are for permanent _____ _____ _____ to be built in a home which has a _____.

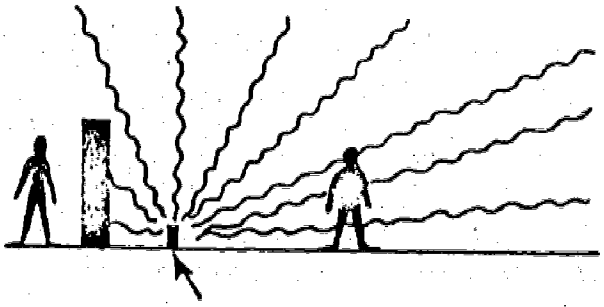
13a. time

31a. physical characteristics (e.g., location, marking, etc.)

49a. family fallout shelters

basement

14. Look at the sketch on the right. If you place a heavy object between you and the source of radiation, you are applying the protection principle of _____.



32. Use Panel 11. For a community fallout shelter to meet federal criteria, space within a building which is suitable for shelter must be located and an agreement (a license) must be signed by the owner of the building that it may be used for public shelter. Then, in order to permit people to find the shelter, it must be marked with a distinctive sign. Thus, _____, _____, and _____ shelters throughout the United States are all a part of the National Shelter Program.

50. Plans are also available without charge from the same source for "pre-planned" basement shelters. This type of shelter does not require a permanent installation. Rather, it relies on having the components for a quickly-constructed shelter stored in or near the basement ready for use, if needed. The plans which are available for these types of shelters are:

Preplanned Snack Bar Shelter Plan D--This plan shows you how to construct an attractive snack bar from concrete blocks or bricks in one corner of your basement. In time of emergency, the snack bar is quickly converted into a fallout shelter by lowering a strong, hinged false ceiling so that it rests on the snack bar. When the false ceiling is lowered into place the hollow sections of it can then be filled with bricks or concrete blocks. The plans also show how to keep these bricks and blocks available in the form of furniture or room dividers.

Preplanned Tilt-up Storage Unit Plan E--This storage unit is hinged to the wall at the top and the bottom; it then swings up to rest on a wall of concrete blocks or bricks which you have constructed by using materials stored expressly for these purposes.

As with the permanent shelter plans, you may obtain these plans without cost from: * _____

_____.

14a. shielding

32a. locating

licensing

marking

50a. *Civil Defense
Army Publications Center
2800 Eastern Blvd. (Middle River)
Baltimore, Maryland 21221

15. Protection from external radiation exposure is a combination of three things: _____, _____, and _____.

33. Look at Panel 11. In order to permit responsible officials to have up-to-date information on the availability of fallout shelters, an important part of the National Shelter Program is that of keeping _____ _____ data _____.

51. In addition, many kinds of improvised shelters can be constructed using materials normally found around a home or specially stored for just such an emergency. For information concerning the construction of the improvised shelter, see the citizen's handbook on nuclear attack and natural disaster entitled, In Time of Emergency. This book is available from your local Civil Defense Office, if you do not already have a copy.

Information on this type of shelter may be obtained from your local Civil Defense Office (at high cost/inexpensively/at no cost)

_____.

15a. time)
distance) Any order
shielding)

33a. fallout shelter
current

51a. at no cost

DETECTING RADIATION

16. For the reason shown in this sketch, special instruments are required to determine the amount of radiation present in an area. Fallout radiation (can/cannot) _____ be detected by the human senses; it can be detected by radiation measuring * _____.

34. Another function of the National Shelter Program is to locate additional fallout shelter spaces through the updating process. As indicated in Panel 11, these new spaces must either be adequate as they are or have what are called "_____ _____."

STOCKING THE SHELTER

52. Within the shelter, there should be adequate supplies of food and water to sustain the inhabitants for a period of at least two weeks. Some community shelters have been stocked with emergency supplies, and you won't be required to take food and water to these shelters. However, many community shelters may not be stocked, and if you use one that isn't, you may be required to bring your own supplies. If you use a home shelter, it may be either prestocked, or you may stock it from your kitchen cupboard shelves at the last minute before the emergency. Whichever method you use, it is suggested that you have enough food and water available to sustain your family for (how long?) _____.

16a. cannot

*instruments.

34a. "improvable deficiencies"

52a. two weeks (at least)

17. Special radiation-measuring _____ must be used to detect fallout radiation, because it cannot be seen, felt or detected by any of the human _____.

35. There are still some areas in the United States which do not have enough public fallout shelter spaces for their population. As we have already noted, the average citizen does not know on his own whether he has suitable fallout shelter space in his home or not. Therefore, Home Fallout Shelter Surveys (by states) are being done by the Office of Civil Defense, as necessary and possible. These surveys consist of three steps (See Panel 11):

1. *_____
2. *_____
3. *_____

53. In addition to food and water, you will also need to bring along other supplies. The handbook In Time Of Emergency will provide you with the information you need to prepare your home shelter. For example, it tells you the amount of water you will need for your family and how it should be stored or obtained from the pipes in your house, or how to purify any suspicious water that may contain bacteria. The basic rule for water is that you should have one quart per day for each member of your family. For your family, how many gallons does this mean you would need to take into the shelter with you? (#) _____

17a. instruments

senses

35a. 1. *Collect data from home occupants on the type of house, materials used in construction, and depth of basement.

2. *Compute the protection factor of the home.

3. *Advise home occupants of the fallout protection which their homes provide, and if necessary, tell them how to improve the radiation shielding.

53a. Check your answer in the chart below.

Number in Shelter:	1	2	3	4	5	6
Gallons Required:	$3\frac{1}{2}$	7	$10\frac{1}{2}$	14	$17\frac{1}{2}$	21

18. Fallout radiation cannot be detected by * _____.

It can only be detected by * _____.

36. Of the following items, circle those which are major operational elements of the National Shelter Program.

(1) Licensing shelters.

(2) Identifying suitable shelter spaces.

(3) Marking shelters.

(4) Locating shelter spaces with improvable deficiencies.

(5) Keeping shelter data current.

54. For further information concerning shelters, their use, construction, or how to stock them, consult the handbook In Time Of Emergency, or ask your Civil Defense Coordinator or your highest elected official, for additional information.

END OF UNIT 2.

18a. *the human senses.

*radiation-measuring instruments.

36a. (1) Licensing shelters.

(2) Identifying suitable shelter spaces.

(3) Marking shelters.

(4) Locating shelter spaces with improvable deficiencies.

(5) Keeping shelter data current.

54a. Take a rest break, and then do the Unit 2 Test, Page 59.

PANEL 1

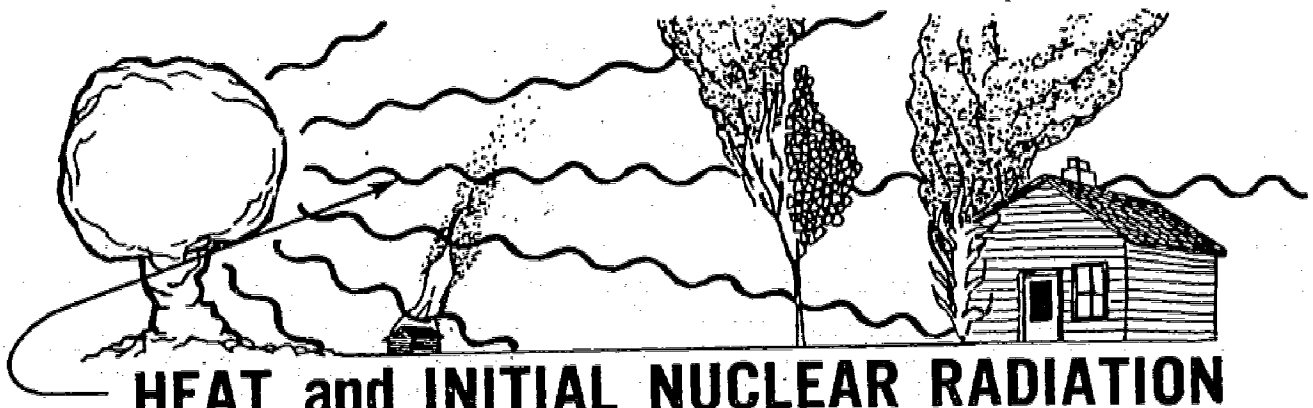
THE STORY OF TWO RAIDS

1. In the largest mass air raid on England in World War II, 437 aircraft attacked Coventry, England. They dropped 394 tons of high-explosive bombs, 56 tons of incendiary bombs, and 127 parachute bombs. The results? Three hundred and eighty persons were killed, 800 were injured, and extensive damage was done.

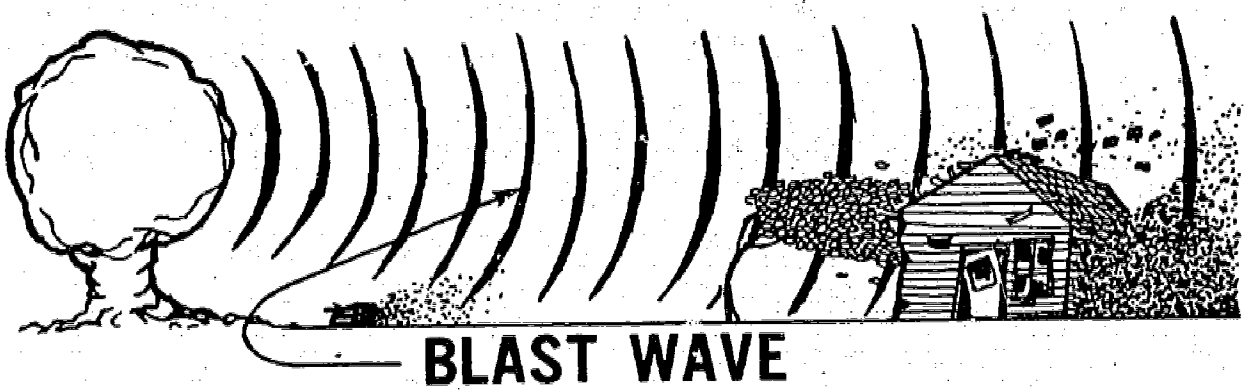
2. Three aircraft flew over Hiroshima; only one bomb was dropped, a 20-kiloton atomic bomb, equivalent in explosive power to 20 thousand tons of TNT. (This is a small bomb by today's standards.) The toll? About 70,000 persons killed, about 70,000 injured, 62,000 buildings obliterated, and 4.7 square miles of the city destroyed.

PANEL 2

MAJOR EFFECTS OF A NUCLEAR EXPLOSION



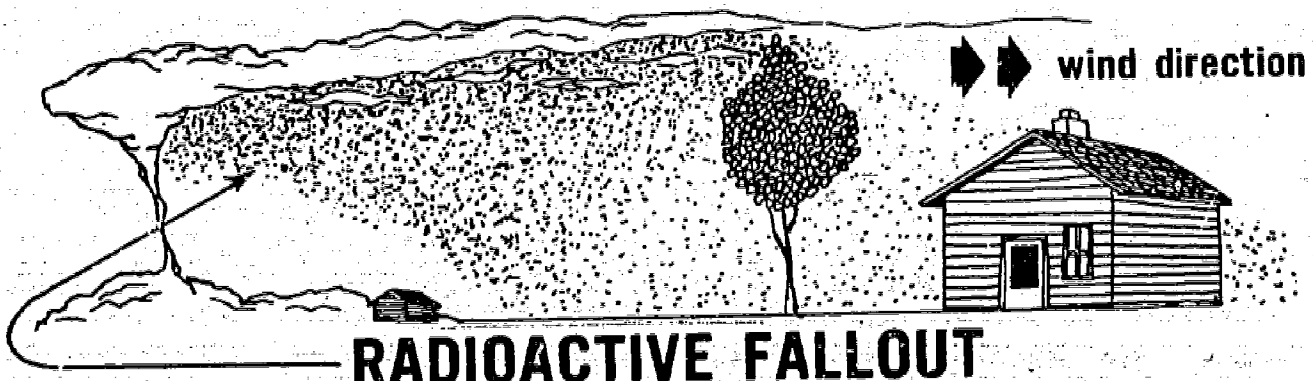
HEAT and INITIAL NUCLEAR RADIATION



BLAST WAVE

earth's surface

SHOCK WAVE



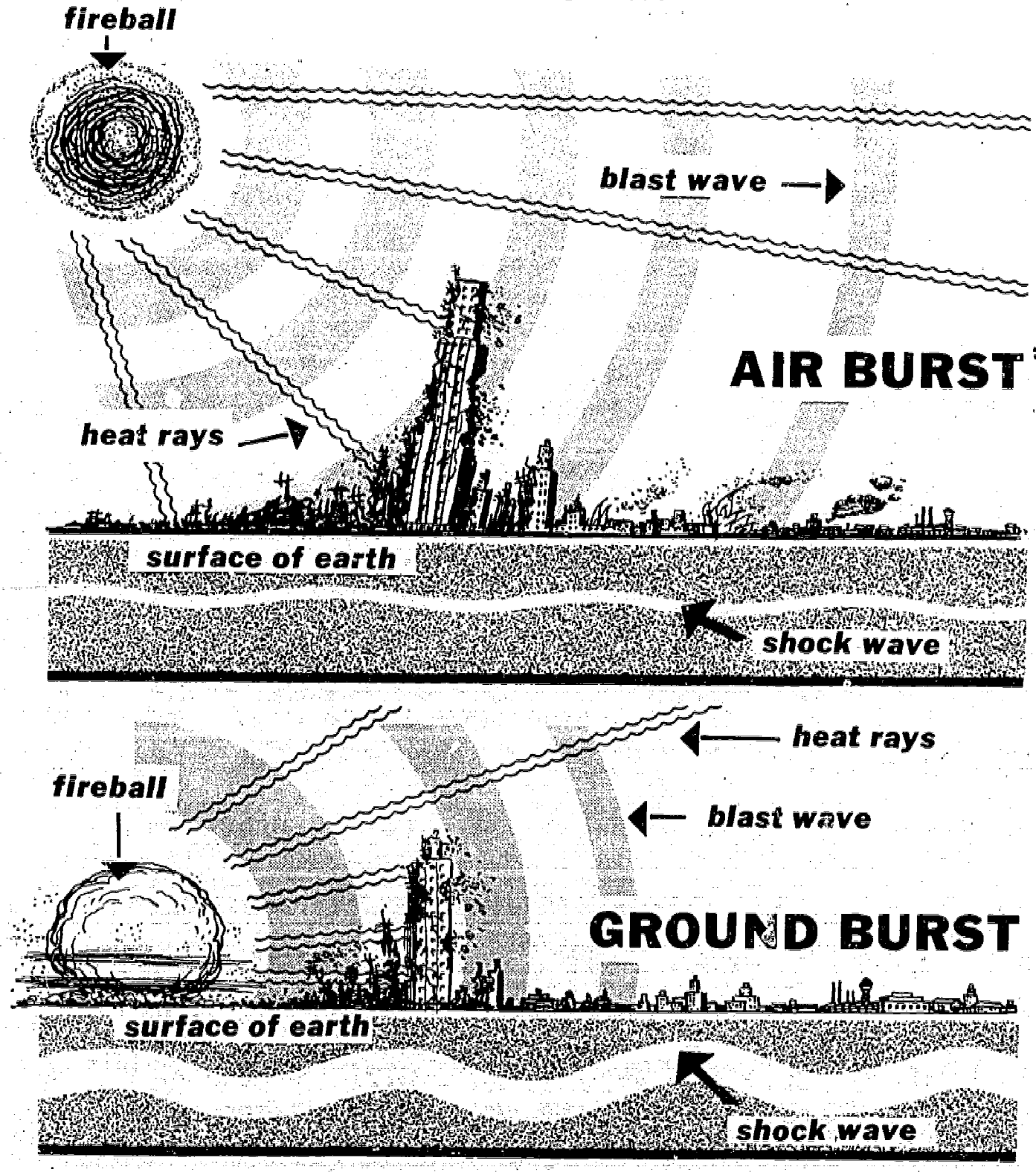
wind direction

RADIOACTIVE FALLOUT

(results in residual nuclear radiation)

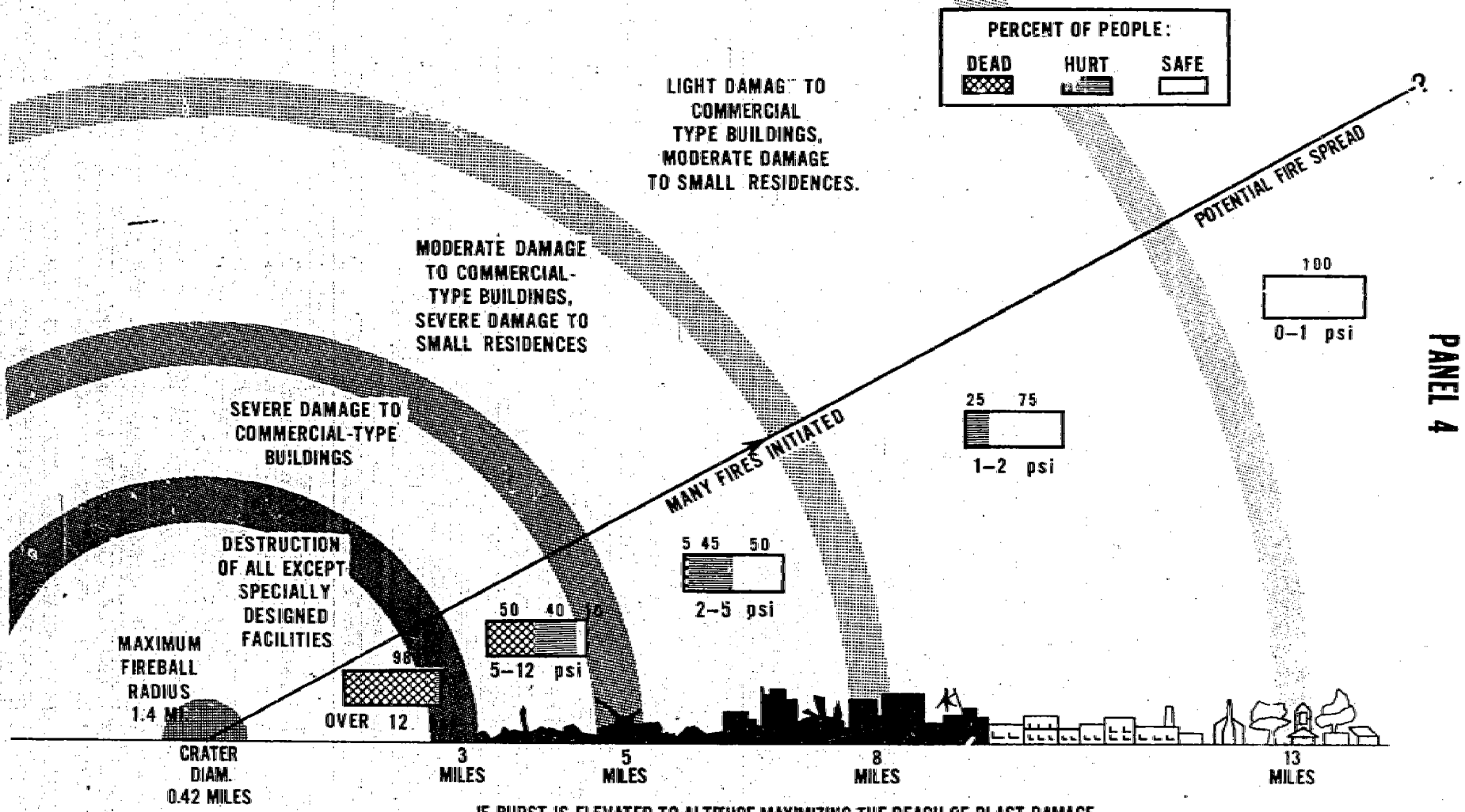
PANEL 3

THE TWO TYPES OF NUCLEAR EXPLOSIONS AND A COMPARISON OF THEIR EFFECTS



*The effects of an air burst depend upon the power and altitude of the burst. The most destructive height for a 20 KT weapon is about 2,000 feet; for a 1 MT weapon, it would be about 6,500 feet, etc.

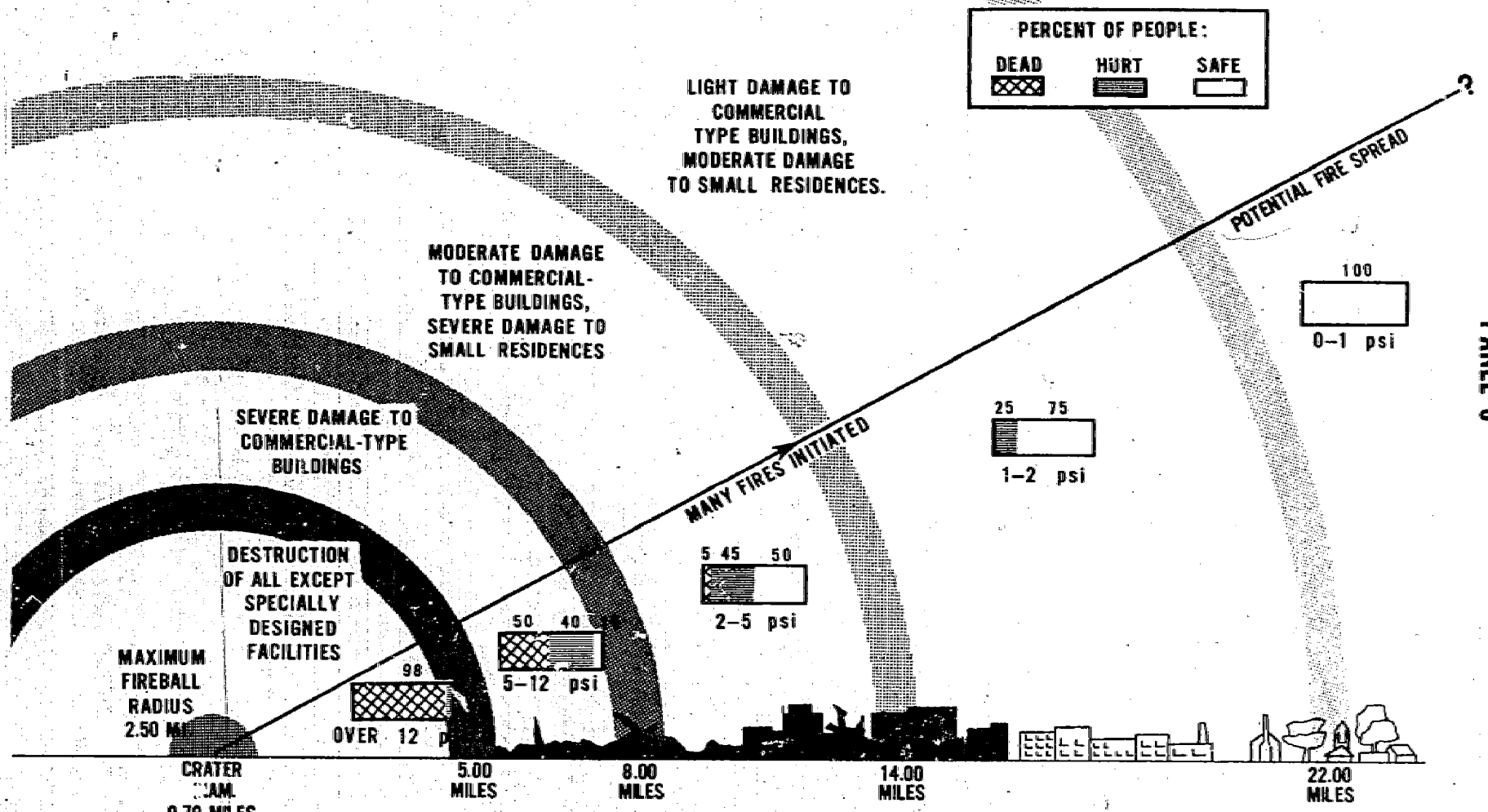
DIRECT EFFECTS OF 5 MT. BLAST
(SURFACE BURST)



PANEL 4

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.

DIRECT EFFECTS OF 25 MT. BLAST
(SURFACE BURST)

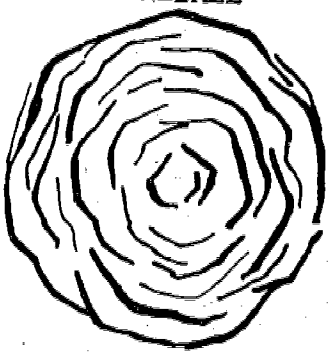


IF BURST IS ELEVATED TO ALTITUDE MAXIMIZING THE REACH OF BLAST DAMAGE, MODERATE DAMAGE FROM BLAST AND INITIAL FIRES ON A CLEAR DAY ARE EXTENDED FROM 14 MILES TO 22 MILES.

PANEL 5

PANEL 6

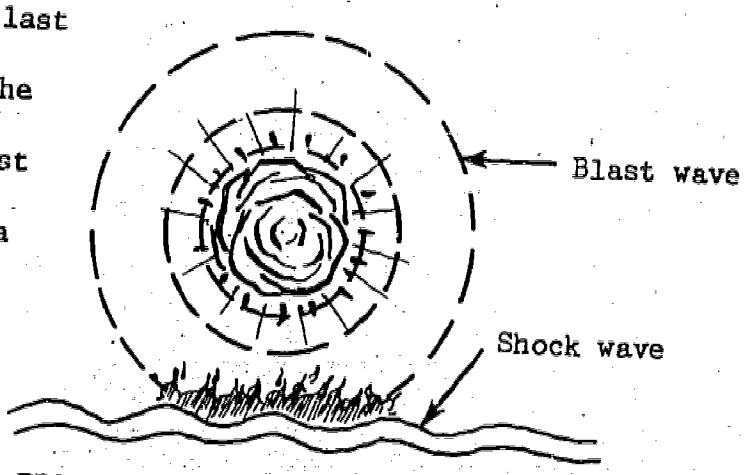
NUCLEAR EXPLOSION
(LOW AIR BURST)



HEAT AND INITIAL
NUCLEAR RADIATION

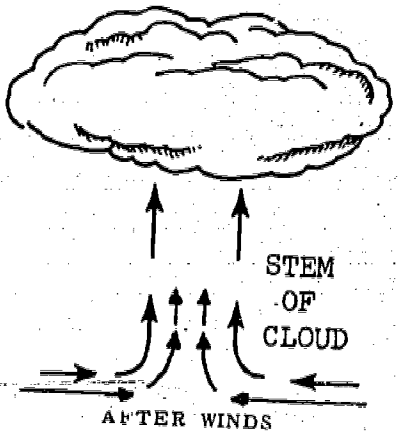
STAGE 1

The explosion is initiated by the union of pieces of nuclear material to produce the explosive critical mass. The nuclear reaction creates a fireball and produces a fantastic amount of heat which chars and ignites any combustibles within range, and initial nuclear radiation which can be fatal but which, because of its limited range, can be dropped from consideration (Stage 1). The fireball rapidly expands, pushing the air in front of it, creating a powerful blast wave that levels everything near the center of the explosion. This blast wave hits the ground and sets off a powerful ground shock that is much like an earthquake (Stage 2).



PROGRESS OF BLAST AND SHOCK WAVES

STAGE 2



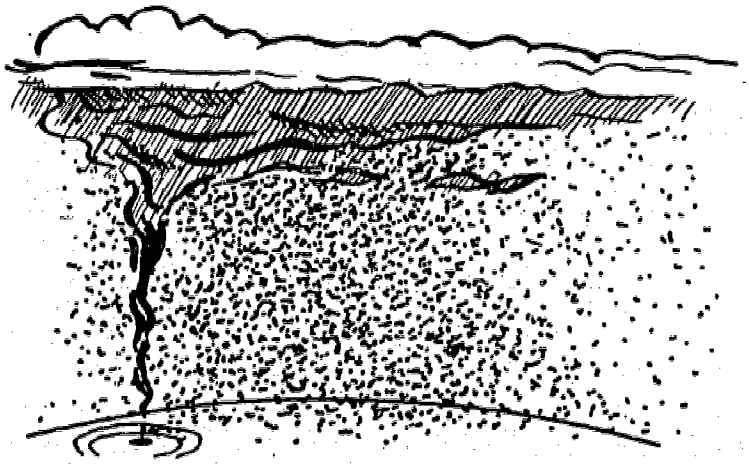
FORMATION OF STEM
OF MUSHROOM CLOUD

STAGE 3

Following the initial explosion, the fireball rises rapidly, producing strong "after winds" blowing inward and upward (Stage 3) which are similar to the updraft in a chimney. These winds, and the dirt and debris they pick up, form the stem of the mushroom cloud that is developed in Stage 4.

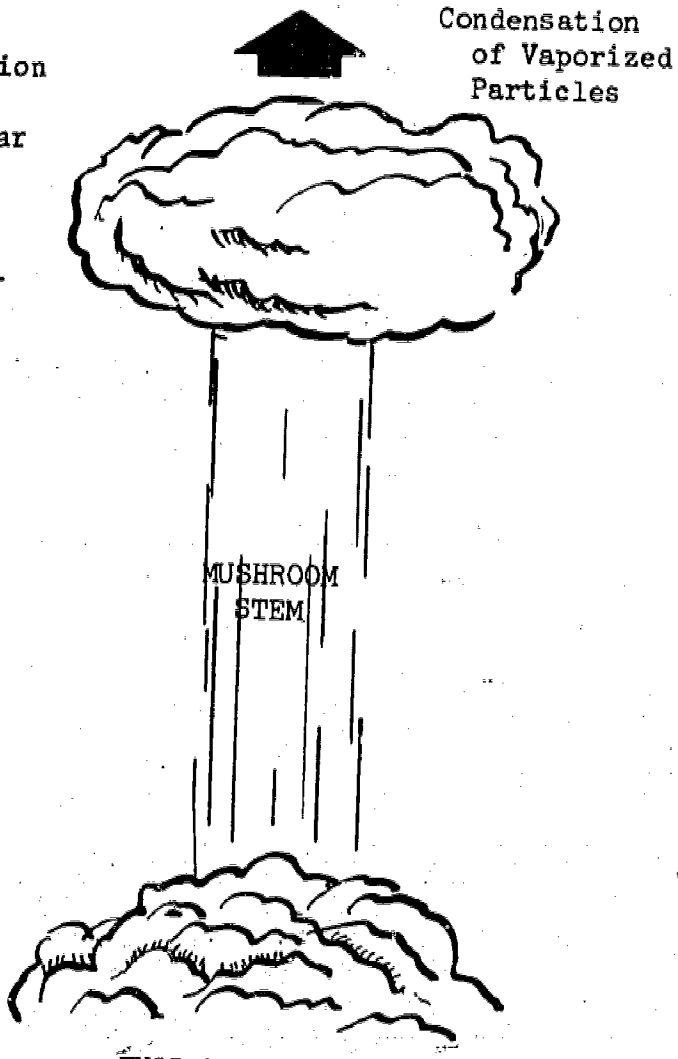
PANEL 6 (Continued)

As the fireball rises, there is condensation of the vaporized particles from the nuclear weapon on the dirt and debris, to form a cloud of small, solid, and highly radioactive particles (Stage 4). This cloud is dispersed by the winds at high altitudes. The particles then settle to earth as radioactive fallout (Stage 5).



FALLOUT

STAGE 5



FULL DEVELOPMENT OF MUSHROOM CLOUD

STAGE 4

PANEL 7

RADIOACTIVITY - RADIATION - CONTAMINATION

Radioactivity

The essential difference between atoms of different elements lies in the number of protons in the nucleus. A hydrogen atom, for example, contains only 1 proton; a helium atom has 2 protons; and a uranium atom has 92 protons. Although all the nuclei of a given element contain the same number of protons, they may have different numbers of neutrons. The resulting atomic species, which have identical atomic numbers but which differ in their masses, are called "isotopes" of the particular element.

Radioactivity is the process whereby isotopes of certain elements spontaneously emit particles and/or rays from the nuclei of their atoms. Some elements are naturally radioactive, whereas others can be made artificially radioactive by bombarding the nuclei. Significant initial radiation from a nuclear explosion includes gamma radiation and neutrons. Significant later radiation (fallout) includes gamma rays and beta particles. Beta particles are high-speed electrons, and gamma rays are similar to X-rays although usually more penetrating than X-rays.

Natural radioactivity is characterized by the ability of certain types of atomic nuclei to decay spontaneously, giving off alpha, beta, or gamma radiations, or combinations of these.

In a nuclear explosion, various isotopes of many normally stable elements can be created. Although most are radioactive, they produce beta and gamma radiation; none produce alpha.

Exposure to Radiation

When large amounts of radiation are absorbed by the body in short periods of time, sickness and death may result. In general, the effects of radiation exposure stay with people and accumulate over a period of time. Few people get sick who have been exposed to 100 Roentgens or less. Exposure to more than 300 Roentgens over a period of a few days will cause sickness and may cause death. And death is expected to ensue for almost everyone who receives an exposure of 600 Roentgens over a period of a few days. The effects of similar exposures over a period of months or years are still under study, though in general, even a fairly large dose of radiation absorbed over months or years is not as dangerous as when absorbed over a few days. In the former case, the body is able to repair much of the cell damage as it occurs.

PANEL 7 (Continued)

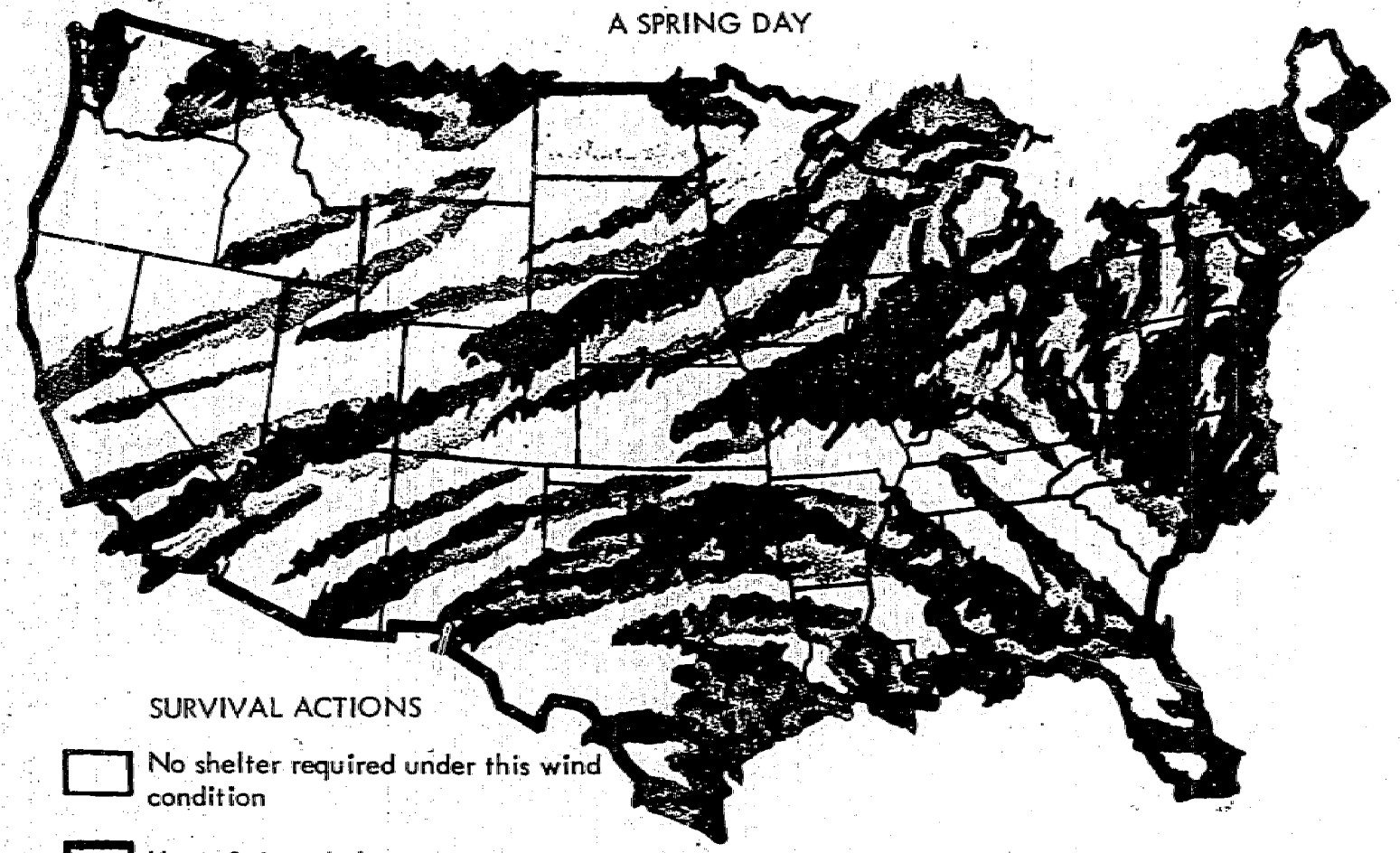
Contamination

Contamination is the deposit of radioactive material on the surfaces of structures, area, objects, or people following a nuclear explosion.

Contamination could be caused by fallout material settling on persons outdoors while fallout was descending. It could also be caused by persons getting fallout material on themselves if they entered a very dusty area after fallout was down.

Decontamination is the reduction or removal of contaminating radioactive fallout from a structure, area, object, or person.

FALLOUT CONDITIONS FROM A RANDOM ASSUMED ATTACK AGAINST A WIDE RANGE OF TARGETS: MILITARY, INDUSTRIAL AND POPULATION



PANEL 8

FALLOUT CONDITIONS FROM A RANDOM ASSUMED ATTACK AGAINST A WIDE RANGE OF TARGETS: MILITARY, INDUSTRIAL AND POPULATION

A FALL DAY

SURVIVAL ACTIONS

- No shelter required under this wind condition
- Up to 2 days shelter occupancy
- 2 days to 1 week shelter occupancy
- 1 week to 2 weeks shelter occupancy followed by decontamination in exceptional areas