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CIVIL DEFENSE. SECOND EDITION

P. T. Egorov, et al

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CIVIL DEFENSE

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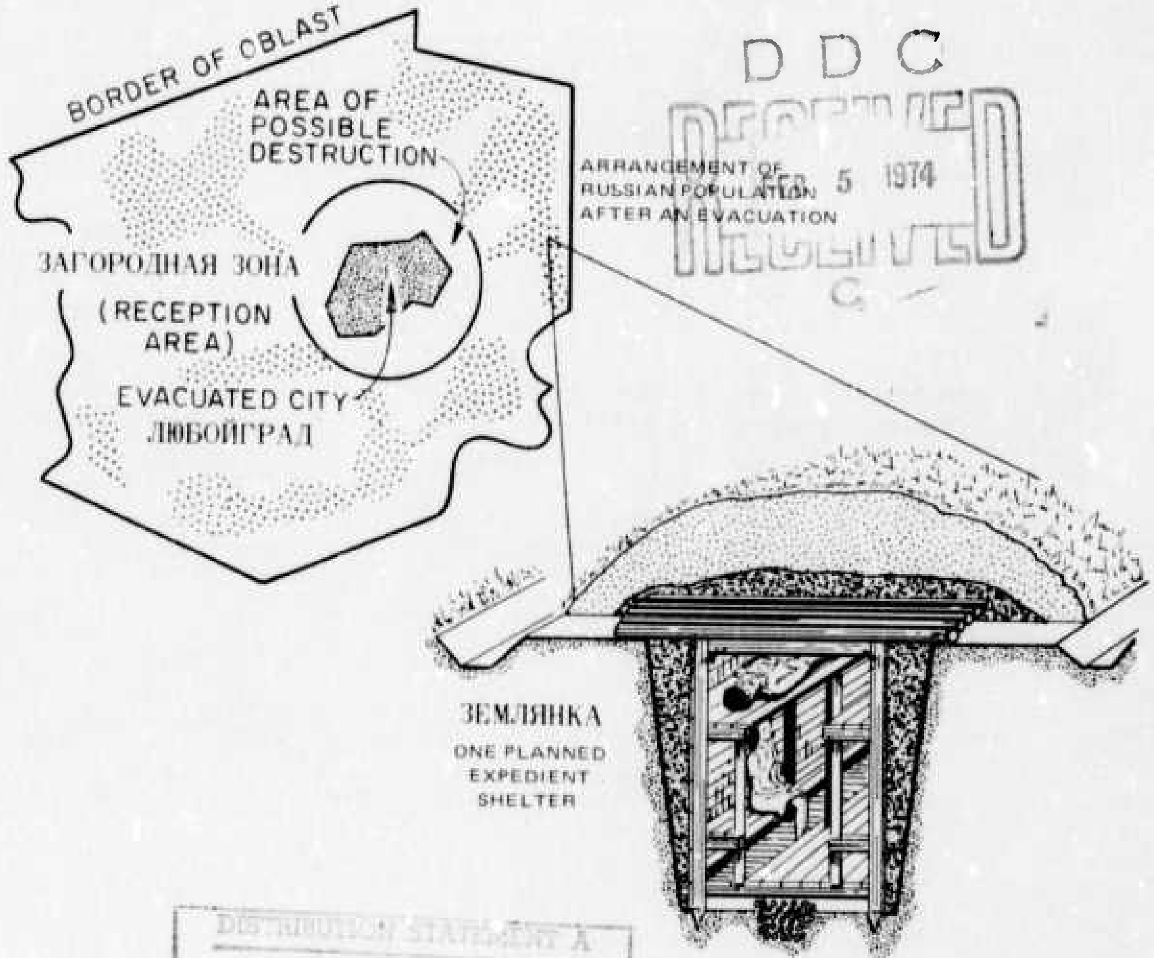

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CIVIL DEFENSE

(Grazhdanskaya Oborona)

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*This Table of Contents is a somewhat extended version of the Soviet one.

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U.S. Editors' Preface

THE IMPORTANCE OF CIVIL DEFENSE IN THE SOVIET UNION

There is considerable evidence that civil defense in the Soviet Union — in contrast to civil defense in the United States — is a major component of national defense capabilities. In support of this statement we cite the following examples:

1. It is endorsed by Marshal A. Grechko, Defense Minister of the USSR and Politburo member.[1]
2. With the appointment of its present head, A. T. Altunin, in 1972, the position of Civil Defense Chief of the USSR was upgraded to that of a deputy minister of defense.[2]
3. Its strengthening was called for by L. I. Brezhnev at the 23rd Party Congress.[3]
4. Its importance as a means of saving the worker, on whom production (and thus the state itself) depends, was recognized by Lenin (p. 45).
5. Civil defense instruction for the entire population is required by law.[4]

OVERALL OBJECTIVES OF SOVIET CIVIL DEFENSE

Essentially, the objectives of the Soviet civil defense program are fourfold:

1. to protect the population from weapons of mass destruction;
2. to increase the stability of vital industries so that they could continue to function in wartime;
3. to protect crops and livestock from nuclear, chemical, and biological weapons;
4. to perform rescue and emergency-reclamation operations in stricken areas.

WHY WE HAVE TRANSLATED THIS SOVIET CIVIL DEFENSE HANDBOOK

In 1971 we published a translation[5] of *Grazhdanskaya Oborona (Civil Defense)* (Moscow, 1969), a Russian handbook which deals primarily with the protection of people, livestock, and crops from the effects of nuclear, chemical, and biological weapons. This newer (1970) handbook, also entitled *Grazhdanskaya Oborona (Civil Defense)*, is concerned not only with protecting the population, but also with protecting and strengthening essential industries so that a larger fraction of them could continue production after a nuclear attack. Performing rescue and emergency-repair work in stricken areas is likewise given increased emphasis. Moreover, the procedures for evacuation and dispersal, discussed in the 1969 handbook, are described in even greater detail in this newer one.

There is little question that the Soviet Union has the most comprehensive and detailed evacuation-dispersal plan in the world. We believe that the description of this plan in the handbook, together with Soviet plans to protect industries and perform rescue-repair work, make *Civil Defense* (1970) a valuable resource to all interested in the U.S. civil defense program. We believe that this handbook would also be of interest to active defense planners and researchers, because not only does the present Soviet CD program reflect the Soviet theories on the nature of possible future threats to them, but also reveals, by implication, the kinds of threats that they themselves could present in the event of an escalating crisis.

PROTECTING THE POPULATION

The central feature of the Soviet civil defense program is its comprehensive dispersal-evacuation plan. According to this plan, the personnel, both operational and supervisory, of essential industries are to be

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dispersed with their families to small towns, villages, and collective farms outside the anticipated blast areas around the cities and other nuclear targets. The zones in which these towns, villages, and farms lie are selected on the basis of being far enough away from target areas to be safe from the blast effects of nuclear weapons, but near enough that the workers and staff members could commute to work inside anticipated blast areas – a round-trip travel distance of no longer than 4 to 5 hr (p. 46). Retired people, educators, and workers in nonessential industries, and sometimes light industries as well, would be *evacuated* from large cities to rural areas, where they would remain until the crisis subsided. Both evacuated and dispersed persons would be quartered with the rural residents and would be protected from fallout in high-protection-factor expedient shelters, which they would help their rural hosts to construct or improve.

According to estimates in chapter 3 of this manual, "...in a nuclear rocket attack the losses to the population in a large unprotected city may constitute 90% ... whereas in case of a timely and complete dispersal and evacuation ... the losses may be reduced to several percent of the total population" (p. 46).

The employees subject to dispersal would go on a two-shift system and continue production during the crisis, with blast and fallout shelters provided for the on-duty shift at its place of work. Should attack occur, the off-duty shift would then advance in formations to its stricken facility to perform rescue and emergency-repair operations or, if its own facility were undamaged, to a damaged neighboring one. Employees are trained for this purpose at their place of work and organized into reconnaissance teams, fire-fighting brigades, rescue units, repair crews, etc.

Thus, saving people is the primary goal of the Soviet civil defense program. The Soviet method of achieving it is to evacuate and disperse the urban population to rural areas, safeguard the people and their food supply, and rescue the injured.

INCREASING THE OPERATIONAL STABILITY OF VITAL INDUSTRIES

Second only to protecting people in the Soviet civil defense scheme is increasing the operational stability of vital industries and maintaining production. It is the purpose of this handbook to indicate, step by step, how these objectives are to be accomplished. Moreover, this handbook itself helps to further industrial preparedness. As the Foreword indicates, it is designed to be used in conjunction with CD instruction programs for Soviet students of engineering-technological and liberal arts colleges (p. xxiii). In addition to instructing future factory staff members in CD, other measures to increase the operational stability of industrial facilities in wartime include:

1. special emphasis on saving the workers, on whom the operation of such facilities depends;
2. the dispersion (already accomplished) of four-fifths of all newly constructed industrial projects in small and medium-sized towns in accordance with the 8th Five-Year Plan;[6]
3. the reduction of the vulnerability of each vital facility *in situ* (see chapter 6).

THE "WHY" OF SOVIET CIVIL DEFENSE

Anyone even scanning this substantial English translation, *Civil Defense* (1970), or its predecessor, *Civil Defense* (1969), may well ask: What are the reasons for the Soviets' serious concern over civil defense?

Vivid memories of World War II provide one reason. The enormous losses suffered by the USSR in World War II continue to be cited today. According to Soviet estimates, these losses include 20 million people (including "innocent citizens who were murdered and tortured by the Nazis on occupied Soviet territory, ... workers of the Soviet rear who perished as a result of the blockade of cities and aerial bombardment, [and] hundreds and thousands of people ... exterminated in German concentration camps"), 1710 towns and urban-type settlements, more than 70,000 villages and hamlets, 32,000 industrial enterprises, 93,000 collective farms, and 1,876 state farms – a loss of 30% of the national wealth of the land.[7] There are many retired officers and soldiers dubbed "heroes of the Soviet Union" who experienced the horrors of World War II firsthand and who are closely associated with the current Soviet civil defense program.

But it is not only a backward look that contributes to the importance of Soviet civil defense today; it is the Soviet view of a future war as well. Soviets cite statistics to show that in succeeding wars the civilian population bears ever heavier losses. Thus, in World War I only 5% of the 10 million killed were civilians; in World War II, 48% of the 50 million; and in the Korean War 84% of the lives lost.[8] In a future war the Soviets believe that the enemy would launch a nuclear attack not only on strategic facilities, administrative-political centers, and weapons factories, but also on industrial plants, large cities, and rear areas (p. 3). In such a war, the purpose would be to inflict large-scale losses "not only ... on the armed forces, but also – if necessary – on the civilian population," one of the main goals being to "destroy the morale of the population." Moreover, the "military leaders of the aggressive war blocs would attempt to suppress the activities of the resisting state, destroy the political leadership of the country, undermine its military-economic potential, forestall the production of armaments, and seize the strategic initiative in the war" (p. 1).

Chemical and biological weapons would be used along with nuclear weapons because these kinds of weapons make possible "a clandestine attack on the enemy, thus eliminating the threat of an immediate retaliatory strike." "Regions of high population density [might] be struck first by nuclear missiles," causing "an enormous number of casualties among the civilians" (p. 3).

Although Soviet defensive missile forces are regarded as a "reliable means" of protection, "it is not possible to guarantee that some of the enemy rockets will not penetrate . . . ." Significant reduction in population losses may be achieved under such circumstances only by instituting a comprehensive system of CD measures. It is for this reason that "CD assumes an important place in the national defense capability, constituting one of its major components" (p. 4).

Observers of the most current relations between the U.S. and the Soviet Union – especially if they read only U.S. newspapers – might well ask, "But hasn't the sunny climate of detente dampened the zealousness of the Soviet civil defense effort?" Not if we take seriously the words of Marshal A. Grechko, Defense Minister and Politburo member of the Soviet Union, in his report to the Fifth All-Army Conference of Party Organization Secretaries on March 27, 1973: In spite of "the peace program advanced by the 24th CPSU Congress and the practical activity of the CPSU committee and Soviet government to carry it out, . . . the antipopular class nature of imperialism remains unchanged. It has not and will not renounce its aggressive aims. As before, due to imperialism, acute crises are arising in the world, able at any moment to shake the entire system of world relations. . . . Were the imperialists to unleash another world war, . . . we are firmly convinced that victory in this war would go to us – to the socialist social system."[9]

Soviet civil defense planners want to leave as little as possible to chance. They publish such manuals as this one, devoted to various aspects of civil defense.[10] The purpose of this handbook primarily is to tell how the stability of vital industries may be increased so that they may continue to function in wartime. Additional detailed highlights of the 12 chapters are outlined below.

FOREWORD AND INTRODUCTION

The *Foreword* and *Introduction* provide the context for the civil defense program in general and this handbook in particular: "In view of the arms race and the aggressive policy of the imperialist states, the Communist Party and the Soviet government have worked relentlessly to strengthen the defense capabilities of our country and to improve civil defense" (p. xxiii).

The Soviet Union and its socialist allies are cast as peace-loving and good, rigidly adhering to "Leninist principles of peaceful coexistence with nations of different social structure," introducing "a broad and workable disarmament program," and doing "everything possible to maintain peace" (p. xxv). In contrast, the "aggressive imperialist circles . . . the ruling class of the U.S.A., in particular," is cast as aggressive and bad, "conducting a policy of aggression, maintaining an enormous army itself," forcing "its allies in the aggressive bloc to spend a large portion of their budgets in preparing for a new world war," and "set[ting] up a warlike network of aggression – NATO, CENTO, and SEATO – designed to subject the people of the allied countries to U.S. influence and use them in the interest of aggression, especially against the Soviet Union and other Socialist countries" (p. xxv). The "increase in imperialist aggression and reactionary activity" is attributed to "the deepening crisis of capitalism."

In the light of such "aggression," the Soviet armed forces "will continue to equip themselves at a high scientific and technical level, . . . maintain . . . preparedness accordingly to restrain any aggressor," and devote "considerable attention . . . to improving civil defense, which is of continually increasing importance."

CHAPTER 1. CIVIL DEFENSE IN A NUCLEAR ROCKET WAR

The first chapter, as already mentioned, describes the character of possible future wars. It also presents an overview of the Soviet civil defense program.

The *basic goals of Soviet civil defense* are to protect the population, ensure the stability of the economy in wartime, and conduct rescue and emergency-restoration operations at sites of destruction (p. 4). Since advance preparation is necessary, a federal system of appropriate civil defense measures has been inaugurated.

Protection of the population is to be achieved by:

1. early warning of impending attack;

2. dispersal and evacuation of the population;
3. individual means of protection (gas masks, respirators, and protective clothing);
4. construction of shelters for the elements of the population remaining in the cities and radiation protection for those in the outlying areas;
5. reserve supplies of food, water, and medicine in the outlying areas;
6. chemical and biological weapon monitoring stations, reconnaissance teams, and lab control;
7. CD instruction for the entire population;
8. advance preparation of plans and equipment;
9. sanitary, preventive, and antiepidemic measures;
10. preparation and execution of rescue operations in centers of destruction.

Preparing the national economy (vital industries and services) for stable operation under conditions of attack is achieved by:

1. ensuring the reliability of power, gas, and water supplies and creating reserves of raw materials and fuels, spare parts, etc.;
2. improving production processes and providing automatic shutdown when a facility is made inoperative;
3. constructing and equipping shelters in installations and plants and preparing mines as shelters;
4. providing for relocation of vital workers to the outlying zones within commuting distance to their factories;
5. creating protective structures for administrative units;
6. preparing CD formations to perform rescue-restoration work;
7. preparing a plant for immediate switchover to a "basic operational system" (the reduction of plant activities to a range of operations feasible under threat of attack) (p. 6).

Civil defense is organized throughout the entire USSR on a "territorial-industrial" basis. It is under the jurisdiction of the Council of Ministers (and directly under the Ministry of Defense) and is led by the Chief of Civil Defense of the USSR, who is also a deputy defense minister.

The responsibility of organizing and executing CD measures falls to the ministries of the 15 republics, the executive committees of the Councils of Workers' Deputies (equivalent to our county and city governments), and the directors of plants, schools, and other establishments and institutions. Party organs and party organizations exercise control, once the CD measures have been enacted by the ministers, "governors," "mayors," directors, and other appropriate authorities.

The civil defense services which support the civil defense measures of cities are based on the already existing municipal service departments. For example, the transport service is based on the Transport Administration Division, the service for maintaining public order on the militia, the power service on the Department of Power Supply, the fire-fighting service on the municipal fire department, the medical service on the municipal health department, etc. (pp. 8–9). In each case the chief of the service (e.g., the fire chief, head of the medical service, etc.) is in charge of the civil defense functions of his service.

In a national economic facility (factory, establishment) "CD is structured on the 'production principle.' In other words, CD units are set up to function during wartime on the basis of workshop, manufacturing unit, work shift, and work team, and in accordance with the special features of the industry" (p. 13). These plant shifts – work units, work teams, etc., which carry on the essential activities of the plant – make up the civil defense rescue squads, reconnaissance teams, and fire-fighting units.

CHAPTER 2. CHARACTERISTICS OF WEAPONS OF MASS DESTRUCTION

The second chapter describes the characteristics of nuclear weapons and the effects of the explosion of these weapons in the immediate vicinity and at various distances, with regard to the size of the weapon and the conditions under which it was detonated (in the air, at ground level, underground, or underwater). The shock wave, thermal radiation, initial nuclear radiation, and fallout are all described in considerable detail, as well as their effects on people, buildings of various materials and types of construction, blast shelters, fallout shelters, utility systems, and electrical communication lines. Secondary damaging effects of a nuclear blast are also discussed (p. 35). They include, for example, the electromagnetic fields, which generate surges in underground lines, high-wire lines, and radio station antennas and cause damage to insulation and electrical and radio equipment.

A *chemical weapon* is defined as "a toxic material (TM) and the means by which it is delivered" (p. 38). The characteristics and effects of such weapons are described, along with the methods of applying them and the danger areas of chemical contamination which result from their use.

A *biological weapon* is defined as "a pathogenic microbe or toxin intended to injure people, animals, plants, and food supplies, as well as the material with which these are applied" (p. 41). The concept "biological weapon" may include the vectors (insects, ticks) of these microbes and toxins, and also agricultural pests and other biological agents. The classification of microbes into bacteria, viruses, rickettsia, and fungi is given, together with the characteristics of and diseases caused by each class. Biological weapons are applied by aerosol and by vector via rockets, airborne bombs, artillery shells, packets thrown from planes, special equipment for spraying or vaporizing, and sabotage.

CHAPTER 3. METHODS OF PROTECTING THE POPULATION BY DISPERSAL AND EVACUATION

Chapter 3 deals with the dispersal and evacuation of people from cities and their reception and relocation outside the blast areas around cities and other likely targets. It is a detailed chapter, explaining the rationale for removing the urban population from the cities, the precedent for evacuation set during World War II, the feasibility of dispersal and evacuation today, the present plans for accomplishing them if the government decrees, the personnel responsible for carrying out these plans, the means by which the population is notified of the onset of evacuation and dispersal, and the part played by the Party in the whole process.

The rationale for evacuation and dispersal in a period of escalating crisis is simple: (1) Should nuclear weapons be used, major cities and industrial and administrative centers would be attacked; (2) at least 55% of the Soviet population lives in cities (p. 45); (3) therefore, relocating these people in the country can reduce the potential loss of 90% of an unprotected urban population to only "several percent of the total" (p. 46).

The most important element of the population to protect, according to Lenin, is "the worker," the "primary productive factor of all humanity. . . . If he survives, we can save . . . and restore everything . . . but we shall perish if we are not able to save him" (p. 45). The means by which this most valuable resource, the worker, is to be saved is dispersal. *Dispersal* is defined as "an organized departure from the major cities and the distribution in the outer zone of workers and employees of national industrial enterprises that continue to function within these cities in wartime" (p. 46). Also subject to dispersal are "people who . . . operate the city" (e.g., utility workers). "These people must all work within the city but return to the outer zone to rest."

The "outer zone" itself is defined as "the territory between the external border of the area of possible destruction of the city and the border of the region comparable to a state. The boundaries of the zone of possible destruction must be established in relation to the importance of the city and the size of the population." Below is our diagram of the "outer zone," based on Soviet figures in the 1969 handbook, *Civil Defense.*

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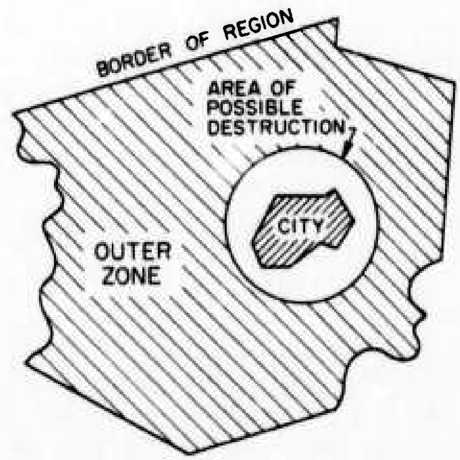

Evacuation refers to the removal from a large city of that portion of the population which does not work in vital industries, and also of those urban enterprises – educational and scientific institutions, etc. – which could be transferred along with their staffs to agricultural areas (p. 46).

The dispersed population would have to be located near enough to the city to commute there and back within 4 to 5 hr, and those workers commuting by train "no further than 5 km from a railroad station." The dispersed workers continue production, working in two 12-hr shifts. While the on-shift group is at work in the city, the off-shift group contains, on standby, the rescue crews, fire fighters, and reconnaissance teams that will march in formations to their own facility if this facility should be attacked.

The responsibility for preparing for dispersal and evacuation falls to the CD staff of each city or region or facility and to special evacuation commissions organized in city and regional executive committees of the Councils of Workers' Deputies (comparable to local and county governments), as well as at industrial enterprises, educational institutions, and housing offices. Evacuation commissions are subject to the control of the civil defense chiefs and work in close cooperation with the civil defense staffs. The composition of the evacuation commissions and of the staffs of the evacuation-collection points, where the people convene for departure by train, motor vehicles, boat, etc., is described in detail, as is the composition of the various committees that receive and distribute the people at the rural end.

The intricate details of the plans for evacuation and dispersal, including such aspects as billeting the urban population among the rural hosts, supplying the transportation for getting them there, assembling them in small groups to be brought to transport terminals, and processing them along the way, are all spelled out in myriad detail. Also designated are plans for meeting the material needs of the evacuees and dispersed persons — food, water, and other essential items, medical services, and even the assignment of jobs to evacuees. The order for dispersal and evacuation is given by the government — first to the various CD staffs, then to the managements of enterprises, offices, and other organizations, and finally to the general population (p. 53).

Closely connected with all aspects of dispersal and evacuation is the political work of the Party. The purpose of "Party-political work" is to disseminate knowledge of CD among the population by "visual aids, . . . oral addresses, the press, radio, TV, and movies, . . . to prepare the people psychologically and strengthen their morale for the . . . grim experiences [of] . . . war," and to maintain morale during the dispersal-evacuation process itself (p. 54). Party-political workers are therefore expected to be very much on the scene not only during peacetime, but also "in the period of threat of enemy attack," during which time they are in the thick of things at the evacuation-collection points, in transit to the rural areas, and in the resettlement zones.

CHAPTER 4. INDIVIDUAL MEANS OF PROTECTION

This chapter describes the devices available for protecting the respiratory system and the skin against toxic, radioactive, and biologically harmful materials. The most important device is the gas mask, of which there are two categories: (1) the filter-type mask, which purifies the air before respiration by removing most of the foreign materials harmful to man, and (2) the air-supplied mask, which makes possible "completely self-contained respiration . . . by providing oxygen in the apparatus itself and by purifying exhaled air to remove gaseous carbon dioxide and moisture" (p. 56).

The filter-type mask, intended for general use, is available in five models and comes in five sizes. In addition, since the 1969 handbook, a baby's protective chamber has been designed for infants up to 1.5 years old and is described in this 1970 handbook (p. 60). Detailed instructions are given on how to select, fit, and check the gas mask and also on how to use and care for it.

The air-supplied gas mask is also described, as are dust-protective respirators used to protect the respiratory organs from harmful aerosols (pp. 64–69).

Special clothing for protecting the skin is made to cover the entire body and is available in "protective ensembles" that include, for example, coverall (or jacket and trousers), rubber gloves, boots, and head covering (pp. 69–71). Rules are given for what to wear under such clothing under various temperature conditions. In addition to the manufactured clothing, improvised skin protection devices are described (pp. 72–73).

CHAPTER 5. PROTECTIVE CIVIL DEFENSE CONSTRUCTION

This chapter is devoted to civil defense shelters — the types, designs, interior arrangements, and equipment, including air supply system, water supply and sewer systems, electrical power, and heating supply, and also means to protect the air intake and exhaust openings from weapons damage. Instructions are given on how to adapt a basement as a shelter, construct a simplified filter system, and build detached fallout shelters of various types of construction and materials. Designs for simple expedient shelters that the population itself can construct under threat of enemy attack are provided, as well as methods of adapting mines as shelters. Finally, rules for shelter use and directions for shelter maintenance are given.

Shelters are first divided into four general categories: (1) blast shelters with industrially manufactured filtering equipment, (2) blast shelters with rugged, expedient filter equipment, (3) fallout shelters prepared in peacetime (both specially built structures and modified buildings), and (4) expedient shelters constructed of available materials during a crisis. Shelters are also classified in accordance with their protective properties, capacity, location, and filtering equipment. Attention is given to the construction of dual-use shelters which can serve specific peacetime as well as wartime purposes.

The filter ventilation unit of a shelter is described in depth with diagrams, for example, of the dust filter, the adsorption filter, and the antiexplosion mechanism to protect the air supply and filter equipment from blast damage. Even such details as the handle of the "butterfly valve" and the electric blower duct are indicated in the drawings (p. 80).

Building instructions with diagrams are given for a number of types of fallout shelters, including, for example, a shelter of unnotched construction for 40 persons (pp. 88–90), a trench-type shelter (p. 91), a dugout (pp. 91–92), and two fascine shelters (pp. 92–93): one in clay ground covered by cane-reed arched fascines and one in sandy soil made of annular brushwood fascines.* [Fascines are reeds or brush tied into bundles.]

CHAPTER 6. TECHNOLOGICAL CIVIL DEFENSE MEASURES TO INCREASE THE CONTINUOUS OPERATION OF NATIONAL ECONOMIC INSTALLATIONS [FACILITIES]

This chapter, as its title suggests, describes specific measures for increasing the "operational stability" of vital installations so that they could continue to function in wartime. The necessity for taking such measures is explained at the beginning of the chapter: "To wreck the enemy's economy has always been the purpose of war" (p. 100). Therefore, "nuclear strikes . . . on national economic facilities" are to be expected in a major war (p. 100). The decision as to what CD measures a specific facility should take is based on a calculation of the probable degree of damage it would sustain in the light of its own importance or its proximity to a city or other potential target (p. 101).

It is assumed that "cities and industrial sites [in general] will be the target of nuclear attack"; but, since it is not possible to know in advance which cities and industrial sites would be selected, "it is necessary to take CD measures in all cities, all population centers, and every economic center." These measures include such national ones as "gradually . . . developing industry in undeveloped regions and limiting the construction of new plants in highly industrialized regions." Other urban planning measures which take into account civil defense include "reducing the building density of urban regions and creating satellite cities, constructing wide major thoroughfares, creating greenbelts, constructing artificial reservoirs, developing suburban zones, and building a network of highways around the city (p. 102). These measures are all discussed in detail.

Planning new towns and renewing existing ones with an eye toward CD are two important civil defense objectives; increasing the "operational stability" of already existing national economic facilities is a third such objective. If the operational stability of a given facility is to be increased, its present operational stability must be evaluated. A facility's operational stability is distinguished from its "survivability." The survivability of a facility is determined by the capability of its buildings and structures to withstand the destructive forces of a nuclear blast. Its operational stability is its capability not only to withstand these forces but also to "maintain production as planned" (p. 105). Thus, an evaluation of a facility's operational stability takes into account the "possibility of continuing work by workers and employees, as well as the possibility of operating the facility in the event of [a partial] breakdown, through cooperation with other plants and suppliers of raw materials."

The assessment of the overall survivability of a facility includes the facility's capability to withstand the entire range of weapons effects from a nuclear strike. Such an evaluation begins with "determining the location of the facility relative to that of the anticipated strike" and goes on to include the capability of the facility to withstand the shock wave (pp. 105–106), the thermal pulse (pp. 106–108), initial nuclear radiation and radioactive contamination (pp. 108–109), the second-

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*The successes of groups of untrained Americans in building Russian-type shelters under simulated crisis conditions[11,12] have demonstrated the practicality of the Soviet designs on two important counts: (1) they can be constructed within the 72-hr period which the Russians allow for evacuation and dispersal and (2) they utilize widely available materials, especially growing trees and plants. However, their specified provisions for natural or forced ventilation would not provide enough cooling air to maintain nonlethal effective temperatures inside many of these Russian shelters if they were fully occupied for a day or more during warm or hot weather.[13,14] Furthermore, the habitability of Russian shelters, as described in successive publications, seems to be decreasing over the years – apparently as a result of increasing pressures on Russian civil defense technologists to provide inexpensive protection against the whole range of dangers from nuclear, biological, and chemical war. For example, a comprehensive Russian handbook[15] recently translated at ORNL emphasizes more strongly than ever the airtight sealing of all shelter openings except the small ventilation ducts. These ducts are sized ". . . on the basis of 10 square centimeters (intake) for each person . . . ," with the exhaust duct proportionally small. These are scarcely larger than the vent holes in an Eskimo's igloo! And unlike numerous earlier Soviet publications available to us, this 1972 handbook specifies the installation of fabric or straw filters in the small intake ducts, even of shelters dependent on natural ventilation. One may conclude that the Moscow civil defense authorities, like their counterparts in several other countries, have not thoroughly tested some of the shelters that they are instructing tens of millions of their fellow citizens to be ready to bet their lives on.

ary damaging effects of the weapons (p. 110), and contamination from chemical and biological weapons which could affect the personnel (p. 110).

Once the survivability of both a facility and its operations is estimated, technical engineering measures to increase the survivability of industrial buildings, structures, equipment, and communications systems can be taken. Such measures are most effective and economical when a new facility is planned and built. For currently productive national economic facilities, technical engineering measures to increase stability are geared to specific conditions. However, some general measures which can be applied to any installation include:

1. safeguarding workers and employees from weapons of mass destruction;
2. increasing the administrative survivability of the civil defense [capabilities] of the facility;
3. increasing the survivability of buildings and structures;
4. protecting costly and unique equipment;
5. increasing the survivability of the electrical power supply and also the gas, steam, and water supply;
6. increasing the survivability of utility networks [systems];
7. preventing fires;
8. placing the individual components of production in underground structures;
9. ensuring protection from radioactive, chemical, and biological contamination;
10. increasing the survivability of the supply of technical materials" (p. 111).

Chapter 6 describes these measures in considerable detail.

CHAPTER 7. CIVIL DEFENSE PLANNING

Every national economic facility must have a "civil defense plan," a written document containing all the basic civil defense measures to protect plant personnel, increase the operational stability of the facility during wartime, and administer the civil defense formations "in all stages of their operations" (p. 121). Chapter 7 describes a prototype civil defense plan and also the procedure for developing, checking, and correcting it – a responsibility of the CD chief of each national economic facility and his staff.

"The feasibility of the plan" is emphasized as "the most important thing." Therefore, "only carefully studied, actual concrete data regarding local conditions are reflected in the plan" (p. 122). The basic requirements of the plan include "a complete yet concise presentation, accurate calculations of the time required to complete CD measures, and the economic expediency of these measures, as well as their realism and compatibility with the overall CD plan of the [city] staff superiors" (p. 122).

The overall plan actually consists of many subsidiary ones, which include plans for:

1. dispersing the workers and employees, together with their families, to the outer zone and resettling them in villages and other rural areas;
2. designating plant shelters for the on-shift workers and employees;
3. converting the facility to a basic (limited) regimen according to defense needs;
4. providing plant personnel with individual means of protection;
5. organizing administration, warning, and communications at the facility;
6. performing urgent emergency-restoration work at the facility;
7. protecting food supplies, forage, and water supplies from radioactive and toxic materials and biological agents.

CHAPTER 8. CONDUCT OF THE POPULATION UNDER THE THREAT OF ENEMY ATTACK AND IN RESPONSE TO CIVIL DEFENSE SIGNALS

As the title suggests, the two major sections that comprise this chapter are devoted to specific measures to be taken by the population in response to (1) threat of attack and (2) the eight civil defense signals.

It is on the decision of the government that the population is warned of impending enemy attack (p. 127). The announcement is made directly over radio networks, television channels, and other facilities. Upon this announcement, all CD systems are put on combat readiness, and the following basic measures are taken:

1. all administrative posts, warning systems, communications, reconnaissance units, observation posts, and laboratory control facilities are put on full combat alert;
2. individual means of protection are issued;
3. blast and fallout shelters are made ready for workers on plant shifts which expect to continue production;

4. the command service is organized, and provision is made for maintaining public order on evacuation routes, on travel routes for advancing civil defense forces, and in populated regions;
5. dispersal is accomplished, and shelter is provided in outer zones for workers and employees of installations which will continue, or temporarily interrupt, their production activities in wartime;
6. persons and institutions subject to evacuation (rather than dispersal) are removed to predesignated rural areas;
7. reconnaissance is organized along with the relocation of formations into the outer zone, and civil defense forces and facilities are set up to carry out rescue and urgent emergency-restoration work;
8. mass cover (fallout shelters) is built for the entire population of small cities and rural areas
9. evacuation is organized from large cities, as well as removal and distribution of material goods into the outer zones;
10. food products, forage, and water are protected everywhere from radioactive, chemical, and biological contamination;
11. farm animals and plants are protected.

The first section of the chapter spells out each of these measures in more detail.

The second section lists (p. 131) and describes the eight CD signals and indicates the rules of conduct for the population upon hearing each one of them under varying conditions. The eight signals are:

- Air alert
- Close protective shelters
- All clear
- Threat of radioactive contamination
- Radioactive contamination
- Chemical attack
- Biological contamination
- Threat of flooding

On hearing the "air alert" signal, for example, all citizens are categorically advised to take refuge in blast shelters or fallout shelters or to make use of the protective features of the terrain "since it is dangerous to stay at home, especially in a multistory house" (p. 131). However, since "what a person does depends on where he is," specific instractions are given for people at home, on the way to the shelter, at work, on a city bus, in a department store (or movie), etc.

There are detailed instructions of what to do in a variety of situations, including, for example, when a shelter is damaged by blast or by fire or when the degree of radioactive contamination is "dangerous" or "strong" or "moderate." There are also instructions on how to decontaminate water by various methods and to use dosimetric instruments to verify that decontamination of food and water is completed, on how to move through contaminated territory when necessary, on how to remove toxic materials from the skin and treat the decontaminated skin area with a liquid from the antichemical kit, and on how to behave in a quarantined area.

CHAPTER 9. RADIATION DETECTORS, CHEMICAL SURVEY METERS, AND DOSIMETRIC CONTROL INSTRUMENTS

Chapter 9 describes the various instruments used to detect and measure radioactivity and to detect and identify toxic materials. The designation, classification, and operating principles of these instruments are discussed in considerable technical detail. Dosimetric instruments, for example, are classified into two basic groups in accordance with their purpose: (1) radiation survey meters, which include activity detectors and roentgenometers, and (2) instruments for exposure dose monitoring, which include radiometers and dosimeters.

The photographic, chemical, scintillation, and ionization methods of detecting and measuring radioactivity are examined. Not only are radiation survey instruments and dosimetric monitors discussed in detail with the help of schematic diagrams, but also explicit instructions for using the specific instruments are given.

Toxic materials in the air, on the ground, or on an object are detected by chemical survey instruments and gas detectors or by analysis of samples in a chemical laboratory. The use of chemical survey instruments makes it possible to identify toxic materials on the basis of the color changes of indicators reacting to these materials (p. 152). The intensity of the color indicates the approximate concentration of the toxic material. Three models of such instruments are examined in detail: the army chemical surveying instrument, the chemical surveying instrument, and the semiautomatic chemical surveying instrument.

CHAPTER 10. ORGANIZING AND CONDUCTING RECONNAISSANCE AT A NATIONAL ECONOMIC FACILITY IN A CENTER OF MASS DESTRUCTION

Reconnaissance is described in this chapter as "the most important means" of enabling the CD formations to accomplish their missions (p. 158). The mission of reconnaissance itself is essentially data gathering. It is to determine the levels of radioactive chemical, and biological contamination in a given area; the location and condition of obstructed blast shelters and fallout shelters; the degree of damage to buildings, engineering systems, and communication lines; and the location of conflagration zones — in short, to provide all the information needed to determine the extent and priorities of necessary rescue and emergency-repair operations, as well as the means for accomplishing them.

According to the means used to gather data, reconnaissance is classified as air, river (or sea), and ground (p. 159). It is the ground reconnaissance, however, which addresses itself to the majority of the problems and which is performed by the civilian CD reconnaissance formations, the military CD reconnaissance units, and by meteorological and sanitary-epidemiological stations and observation posts.

Reconnaissance operations take place over a broad geographical area, including the dispersal-evacuation routes, the evacuated areas, the settlement areas in the outer zone, the travel routes along which CD formations advance to centers of destruction, and the centers of destruction themselves. Reconnaissance groups, which generally consist of three to five teams of three to four persons in each team, are established at the national economic facilities and are recruited from the CD staffs and the plant personnel. Such groups are equipped with means to conduct reconnaissance (e.g., radiation detectors and chemical survey meters), as well as individual means of protection, communications, and transportation.

Civil defense chiefs, their staffs, and service personnel at national economic facilities are responsible for organizing reconnaissance (p. 160). The immediate superior officer for all reconnaissance measures is the reconnaissance chief, who is also assistant chief of staff to the CD chief (commander). The reconnaissance groups of a facility usually operate on behalf of that facility but occasionally serve a higher-level CD staff (p. 161), for example, the CD staff of a city.

Specialized reconnaissance groups and teams are created within the appropriate specialized formations to obtain precise data in a given field of reconnaissance — for example, radiation, chemical, fire, engineering, medical, biological, and veterinary (p. 163). Each of these specialized fields of reconnaissance is described in detail.

CHAPTER 11. RESCUE AND URGENT EMERGENCY-RESTORATION WORK

Chapter 11 is both comprehensive and detailed, covering all aspects of rescue and emergency-repair operations: (1) the CD formations that perform the rescue and repair work, the equipment they use, and the procedure to ensure their protection by removing them to the outer zone on threat of attack; (2) the services and equipment which support the rescue-repair forces; (3) the role of the CD chief and staff of the facility in organizing and conducting rescue repair work; (4) the rescue and repair operations themselves and the specific methods of conducting all aspects of them; and (5) the role of political Party work in rescue-repair operations.

The first section of the chapter begins with a review of the composition of the CD formations (discussed earlier in the handbook). It goes on to describe the equipment used by these formations, including the vehicles and machinery for removing debris and for hoisting, hauling, and transporting loads (excavators, tractors, bulldozers, cranes, winches, etc.), the metal-cutting equipment, and the water-pumping machinery, and concludes with a description of the dispersal plan, whereby the CD formations are transported to the outer region on threat of attack.

The second section of chapter 11 describes the various services which support the formations in their rescue-repair operations and indicates which group provides each service (e.g., medical support is provided by the facility's medical unit, fire fighting by the fire department, etc.). In addition to medical and fire fighting, these services include antiradiation and antichemical, material and technical, engineering, and transportation.

While the organization of the CD staff at a national economic facility is discussed in chapter 1, the third section of chapter 11 defines the specific duties and responsibilities of the CD chief and his staff with regard to the rescue-repair operation. These include organizing the rescue-repair work, evaluating radiation conditions, supervising the rescue and repair work, and ensuring that task force replacements of formations and subdivisions are carried out smoothly.

The fourth section of chapter 11 gets down to the essential details of the rescue and repair operations themselves: reconnoitering the center of destruction, isolating and extinguishing fires, clearing paths and making passageways through ruins, and rescuing victims from destroyed or obstructed blast shelters and fallout shelters, from under debris, and from burning and partially destroyed buildings. In this regard, specific instructions with diagrams are given for such operations as making an opening in a shelter roof with a manual drill, clearing an obstructed shelter with an excavator, and making an opening in a shelter wall. There are also sections on giving first aid to victims, helping people escape from contaminated or flooded areas, and decontaminating persons, clothing, and equipment.

Emergency-repair operations that are treated fully in chapter 11 include reinforcing or demolishing buildings which interfere with rescue work, repairing damaged power, water supply, gas, and sewer lines, and restoring damaged communications lines.

The necessity of maintaining a high "morale" and "combat readiness" in the face of the "extremely great danger" (p. 193) entailed in doing rescue-repair work is recognized by Soviet CD planners. To promote this "high morale" and a spirit of "self-sacrifice" in "defending the Socialist Motherland," the Communist Party conducts "political Party work" (p. 193). This work, conducted at the local Party level and by the Party committee of each facility, includes, in addition to building and sustaining morale, improving the caliber of CD staff work and of services, educating and training the formation personnel, and helping the commanders and CD chiefs at all levels to improve CD. Whether a threat of enemy attack has been announced or an order given to disperse the workers and service personnel to the outer zone or whether the time has come to advance the formations to a center of destruction, the Party workers are on hand to expedite the proceedings and to bolster the courage of formations and casualties.

CHAPTER 12. TRAINING THE POPULATION IN CIVIL DEFENSE

Chapter 12 restates the basic objectives of CD training at national economic facilities: to instruct the working population in (1) the principles of CD and the practical methods of protection against weapons of mass destruction, (2) the CD structure of their own facility, (3) the conduct of rescue and emergency-repair operations in centers of destruction, (4) methods for continuously improving the protection of the workers, and (5) measures to increase the operational stability of the facility in wartime (p. 196).

According to chapter 12, the population is divided into four categories for training purposes. The first category includes children in the first five grades of school* (p. 196). These students receive 15 hr of annual instruction, which includes field exercises, movies, and filmstrips designed to impart practical skills. Children also receive CD instruction in Pioneer camps [which are summer camps comparable to our Boy Scout and Girl Scout camps].

The secondary category includes workers, other plant personnel, collective farmers,† and unemployed persons (p. 197). In addition to instruction in methods of protection against weapons of mass destruction, people in this category also learn the specifics of conducting rescue-repair operations. The CD chiefs — usually the directors of the national economic facilities, collective farms, institutions, etc. — are responsible for instructing their workers. Training of citizens who are not employed (homemakers, retired persons, invalids) is the responsibility of the local CD units and the municipal, rural, and regional CD supervisors.

*According to Major General F. Klimenko, an experimental program was started in November 1970, whereby the students of the first four grades in selected schools received special CD instruction. Its "goal was to determine the most acceptable forms and methods of instruction, as well as the time required by young school children to assimilate the proposed amount of knowledge and skill." As a result of this experimental program, all Soviet children now start to study CD in the second grade. This training is reinforced in the summer Pioneer camps. However, they do not resume their CD studies in public schools until they reach grade 5 [Klimenko, "The Primary Stage of CD Training," *Narodnoye Obrazovaniye* (September 1971)]. Klimenko's article, which states that CD training in so low a grade as the second is an innovation, is contrary to the statement in this chapter that children receive CD training in the first five grades of school. However, two articles in the Soviet publication, *Military Knowledge*, support Klimenko in their statement that CD in 1968 was taught only in elementary grades 5, 6, and 7 ("Civil Defense Training Program for Students in the Fifth, Sixth, and Seventh Grade," and A. A. Sychev, "Study and Expand Experience . . . ," both in *Voyennyyee Znaniya*, No. 9 [Moscow 1968]).

†In accordance with the new Soviet CD training program — ratified by the USSR Chief of CD in 1972 and inaugurated in 1973 — the working population is divided into four basic groups to permit specialized training in each category: (1) CD leadership personnel, the chiefs of the services, and engineering technical personnel, (2) command personnel of the nonmilitary formations, (3) production and clerical workers and farmers who are members of formations, and (4) persons not in formations. The first two groups receive command training each year at their place of work and once every three years at CD schools. The first group undergoes a total of 35 hr of training annually in accordance with a program which is specially developed at each facility. The second group receives 36 to 44 hr — the 20-hr minimum, which is studied by the entire population, plus 16 to 24 hr of additional training. In addition to being trained themselves, these commanders, service chiefs, and specialists provide specialized instruction to the personnel of their own formations. This training includes special tactical studies and exercises which develop practical skills. [See M. Muradyan, "The Civil Duty of Each Citizen," *Kommunist* (Yerevan, 24 March 1973); S. Kuzovatkin, "To a New Level," *Sovetskiy Patriot* (Moscow, 14 March 1973); and M. Ponomarev, "The Alarm Signal," *Kommunist Tadzhikistana* [Dushanbe, 16 March 1973).]

The third category includes students in the ninth and tenth grades of public schools, in professional and technical schools, and in universities (p. 197). Ninth and tenth graders learn, for example, how to conduct themselves in response to CD signals, administer first aid, treat the sick, protect food and water, and decontaminate clothing, equipment, and people. Male students in the special secondary schools are trained to become junior supervisors of CD units at their schools in accordance with their specialized training, while female students are taught sanitary squad work. Students in professional and technical schools receive specialized CD training on the basis of their major field of study. All such students study defense against weapons of mass destruction and how to use and operate radiation and chemical reconnaissance instruments. Students in a program of two years or more also study measures to increase the operational stability of national economic facilities in wartime and gain skill in reconnaissance and observation post activities. Students of institutes of higher learning (universities, colleges) are trained to be members of CD staffs at the national economic facilities and future formation commanders.

The fourth category into which the population is divided for CD instruction includes the intermediate supervisory personnel of national economic facilities, collective farms, governmental organizations, trade institutions, public utilities, cafeterias, and community services (p. 198). These supervisors are trained to work with the population and CD personnel and to direct the formations in conducting rescue and emergency-repair work.

The second section of chapter 12 describes in detail the various programs for teaching the four categories and the course material used in each. The third section is devoted to the qualifications for teaching CD. These include, among other things, adequate training for the job and loyalty to the Communist Party. The fourth section deals with the organization and planning of CD combat training at the national economic facilities. The purpose of this combat training is to continuously increase the level of combat readiness.

Section 5 describes the training program for CD teachers and the development of teaching materials, and section 6 discusses each of the methods and forms of teaching. These include lectures, class problems, exercises, seminars, conferences, field trips, news reports, discussions, exhibits and demonstrations, tactical exercises, and practical sessions.

Section 7 concludes the chapter with a discussion of the various channels and methods of spreading CD information. Such channels include the Communist Party, trade unions, and Young Communist League branches at national economic facilities. Civil defense knowledge can be extended via CD exhibits, meetings, movies, and interviews with teachers and workers on local radio stations.

QUESTIONS NOT ADDRESSED IN THIS HANDBOOK

There are a number of questions which neither this handbook nor its predecessor that we published[5] has chosen to address. For example:

1. How many blast shelter spaces are available for people in cities?
2. To what extent are food and medical supplies stockpiled and available for civil defense use?
3. How many fallout spaces presently exist in the countryside and how many must be built during a crisis?
4. Under what circumstances would the order for evacuation be given?

A FEW WORDS ON THE TRANSLATION OF THIS TEXT

The Soviet text was first very roughly translated and then corrected and edited into grammatical and idiomatic English. While it is not a word-for-word translation, we have attempted to render an accurate transmission of each idea, neither omitting nor adding. The Russian text has only a very few footnotes. Those that do appear are printed at the bottom of the page with an asterisk beside them. With these few exceptions the footnotes in the text are editorial, explanatory material written by us, the U.S. editors. Brackets [] are used to denote such footnotes, as well as all other editorial insertions that have been made. Parentheses ( ) are used to denote Soviet insertions included in the original. To facilitate reader understanding, where Russian metric units occur, we have in some instances placed the appropriate English unit values beside them in brackets.

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Cresson H. Kearny
Conrad V. Chester

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Foreword

In view of the arms race and the aggressive policy of the imperialist states, the Communist Party and the Soviet government have worked relentlessly to strengthen the defense capabilities of our country and to improve civil defense. Civil defense is a system of national defense measures directed toward protecting the population, creating necessary conditions for maintaining operational stability of the national economy in wartime, and, if the enemy uses weapons of mass destruction, performing rescue and urgent emergency-restoration work.

In view of the above, the fundamental responsibilities of the higher educational institutions [see note *] with regard to their "civil defense" courses are [1] to train the students — the future specialists — in the methods of protection against weapons of mass destruction, [2] to create practical civil defense measures to be taken both in peacetime and in wartime at the national economic sites, and [3] to enable the military instructors to fulfill their training obligations [at these institutions of higher learning].

[*An institution of higher education is any institute or technical school or trade school above the high school level, with the exception of the university, which is not included in this category.]

The present manual is written in conjunction with a program for preparing students in institutes of higher learning by means of a course in "civil defense" and is intended for Soviet students of engineering-technological and liberal arts colleges. In addition, it may also be used by students of other institutions of higher learning in a general course on this subject.

The following civil defense instructors participated in the preparation of this handbook: P. T. Yegorov, professor and candidate [see note †] of military sciences [Chaps. 1, 2 (Sects. 1 and 2), 6, 8, and 11] and I. A. Shlyakhov [Chap. 2 (Sects. 3 and 4), 3, 4, 5, 9, and 10] — both instructors at the Moscow Highway Institute — and Dean N. I. Alabin (Chaps. 7 and 12) of the Moscow Technical Institute of Light Industry and Candidate of Military Sciences. G. A. Karpov, Deputy Chief of the Ministry of Secondary Specialized Education of the USSR, was responsible for overall supervision.

[†The "candidate" degree is equivalent to a high-ranking scientific degree, but is not given by a university or college, but by an institute — primarily a research institute or an institute of specialized training. Many people have both a university degree and a candidate degree.]

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Introduction

The Communist Party of the Soviet Union and the Soviet government, rigidly adhering to Leninist principles of peaceful coexistence with nations of a different social structure, have done everything possible to maintain peace. The international policies conducted by the Soviet Union are determined by the socialist character of our country. Since an integral part of the struggle is to strengthen universal peace and international security, the Soviet government has introduced a broad and workable disarmament program. However, in contrast to the approach of the Soviet Union and other socialist countries of solving international problems by peaceful means, the aggressive imperialist circles seek to increase international tensions. The ruling class of the U.S.A., in particular, is conducting a policy of aggression.

The United States of America not only maintains an enormous army itself, but also forces its allies in the aggressive bloc to spend a large portion of their budgets in preparing for a new world war. The capitalist world has set up a warlike network of aggression — NATO, SENTO, and SEATO — designed to subject the people of these allied countries to U.S. influence and use them in the interests of aggression, especially against the Soviet Union and other socialist countries.

As pointed out by the 23rd Congress of the CPSU [Communist Party of the Soviet Union], the past few years have been characterized by an increase in imperialist aggression and reactionary activity. The deepening crisis of capitalism, the accentuation of its contradictions, has strengthened imperialist adventurism and increased its danger for the people, for world affairs, and for social progress. The imperialist aggressors have been escalating their subversive activities against socialist countries and states standing in the way of capitalistic development.

United States imperialists, having assumed the role of world policeman, are the major reactionary force at the present time. The U.S. aggressors are conducting a criminal war against the Vietnamese people and are crudely interfering in the internal affairs of many countries and peoples of Africa, Asia, and Latin America. The alliance between the U.S.A. and the Federal Republic of Germany is extremely dangerous to international relations. The imperialist predators are achieving militarization of the economy on a gigantic scale and are preparing for thermonuclear war via the armaments race.

On the basis of a profound Marxist analysis of contemporary international conditions, the Communist Party of the Soviet Union has concluded that the danger of attack by imperialists on the USSR and other socialist countries is currently increasing, and the countries of the socialist block must play a basic role in defending the peace. "Thus," as stated in the fiscal report of the 23rd Party Congress of the CPSU Central Committee, "the Communist Party of the USSR will make tireless efforts to strengthen the defense capabilities of our nation and to consolidate our military alliances with other socialist countries. Our Party sees its duty as maintaining a high level of awareness on the part of the Soviet people of the intrigues of the enemies of peace and will do everything possible, if they attempt to disturb the peace, to prevent being taken by surprise, to ensure that retribution will inevitably and without delay overtake the enemy."*

To these ends, our glorious armed forces are equipping, and will continue to equip, themselves at a high scientific and technical level and will maintain our preparedness accordingly to restrain any aggressors. Considerable attention will also be devoted to improving civil defense, which is of continually increasing importance.

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*Fiscal Report of the 23rd Convention, L. I. Brezhnev, in *Pravda*, 30 March 1966.

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1. Civil Defense in a Nuclear Rocket War

1.1 THE CHARACTER OF POSSIBLE FUTURE WARS

The events of the past few years have clearly shown that the imperialist camp, particularly the United States of America, is preparing itself for dangerous offensives against humanity — a world war using weapons of mass destruction. While preparing to unleash the new world war, the military theoreticians of the imperialist states developed their own lawless doctrine, which attaches great importance to the element of surprise in conjunction with massive employment of nuclear weapons.

It was stated in official documents of the Pentagon that "from now on, surprise would be the key to victory." For this reason, initiating a war with a nuclear rocket strike has acquired a special significance which could prove to be decisive. At the very beginning of a war, the armed struggle would be led by forces and facilities that are in combat-readiness in peacetime. The enemy's basic operation at the onset of a war could be a general nuclear attack which would inflict high-power nuclear strikes on our strategic facilities, administrative-political centers, weapons factories, and government facilities.

It is assumed that the attack would be carried out with all available means for delivering nuclear weapons to the designated targets. Moreover, the military leaders of the aggressive war blocs would attempt to suppress the activities of the resisting state, destroy the political leadership of the country, undermine its military-economic potential, forestall the production of armaments, and seize the strategic initiative in the war.

Intercontinental missiles and aircraft, strategically deployed, play an important role in the fulfillment of these tasks: to reach designated targets with nuclear weapons. Reliance is placed on intercontinental missiles because their warheads are only slightly vulnerable to means of antiaircraft defense. Since these missiles are capable of reaching their targets with enormous speed and of carrying nuclear warheads with tremendous power, it is nuclear missiles that the United States of America is accumulating in its arsenal. Figure 1 shows the strategic missiles of the United States of America.

According to statements of American military leaders, there are about 1000 "Minutemen" missiles in the U.S. and 41 submarines carrying "Polaris" missiles with 16

ORNL DWG 73 4637

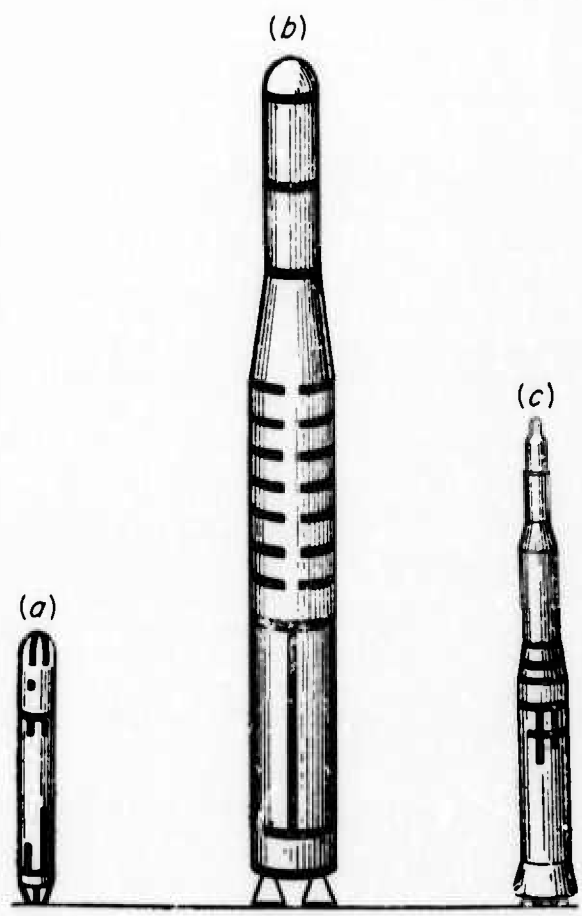

Fig. 1. Strategic rockets of the USA: (*a*) "Polaris"; (*b*) "Titan"; (*c*) "Minuteman."

such missiles on each vessel. Table 1 gives data on strategic missiles in the U.S.

The strategic aircraft includes both heavy- and medium-weight bombers. Heavy U.S. bombers include the B-52 (Fig. 2*a*), medium-weight bombers include the B-58 (Fig. 2*b*).

England is armed with the medium-weight bombers "Vulcan" B-2 (Fig. 2*c*) and "Victor" B-2 (Fig. 2*d*). Table 2 gives data on U.S. and English bombers.

Bombers may carry nuclear bombs and rockets of the "air-to-surface" class with nuclear warheads. The use of airborne missiles enables aircraft to carry out nuclear strikes at great distances without exposing the aircraft to destruction by antiaircraft weaponry. The heavy B-52 bomber is armed with "Hound Dog" air rockets [cruise missiles] (Fig. 3). English medium-weight bombers are armed with "Blue Steel" rockets (see Table 1).

Nuclear weapons are the most powerful of all known means of massive destruction. The payload of nuclear ammunition is ten thousand times greater than that of the largest explosive [nonnuclear] airborne bombs. The effects of nuclear weapons are multiply destructive, causing trauma, burns, and radiation damage.

At the present time, a huge supply of nuclear ammunition has accumulated in the world. According to calculations of foreign specialists, the combined nuclear power in all countries comes to 300,000 to 400,000 megatons, which is equivalent to about 80 tons for each person on earth.

Table 1. Technical tactical data of U.S. strategic missiles

Name of Missile	Engine	Maximum diam (m)	Length (m)	Initial weight (tons) [metric]	Maximum speed (km/hr)	Maximum height (km)	Maximum range (km)	Flight time at full range (min)	Power of warhead (megaton)
				Surface-to-surface					
Titan	ZZhRD	3.0	31.4	136.0	28,000	1300	23,000	50	10
Minuteman-2	ZPRD	1.8	18.0	33.0	26,000	1270	11,100	35	2.0
Polaris A-3	2PRD	1.37	9.52	15.8	20,000	1000	4,600	20	1.0
Poseidon (in planning stage)	2PRD	1.67	10.3	27.0	22,000	1100	5,000	21	2.0
				Air-to-surface					
Hound Dog	TRD	3.7	13.0	4.5	2,500		1,100		1.0
Blue Steel (England)	ZhPD	4.0	10.7	7.0	2,000		320		1.0

Table 2. Technical tactical data of the strategic bombers of the U.S. and England

	Name	Engine	Engine thrust (tons) [metric]	Crew personnel	Flight weight (tons)	Bomb load (tons)	Maximum speed (km/hr)	Maximum altitude in flight (km)	Practical operating range (km)
U.S.	Heavy bomber "Stratofortress" B-52	8TRD	8 × 6.800	6	200	10	1050	17	6400
	Medium bomber "Hustler" B-58	4TRD	4 × 6.800	3	86	4.5	2200	20	3000
England	"Vulcan" B-2	4TRD	4 × 7.700	5	90	4.5	1100	17	3500
	Medium bomber "Victor" B-2	4TRD	4 × 7.700	5	78	4.5	1100	17	3000

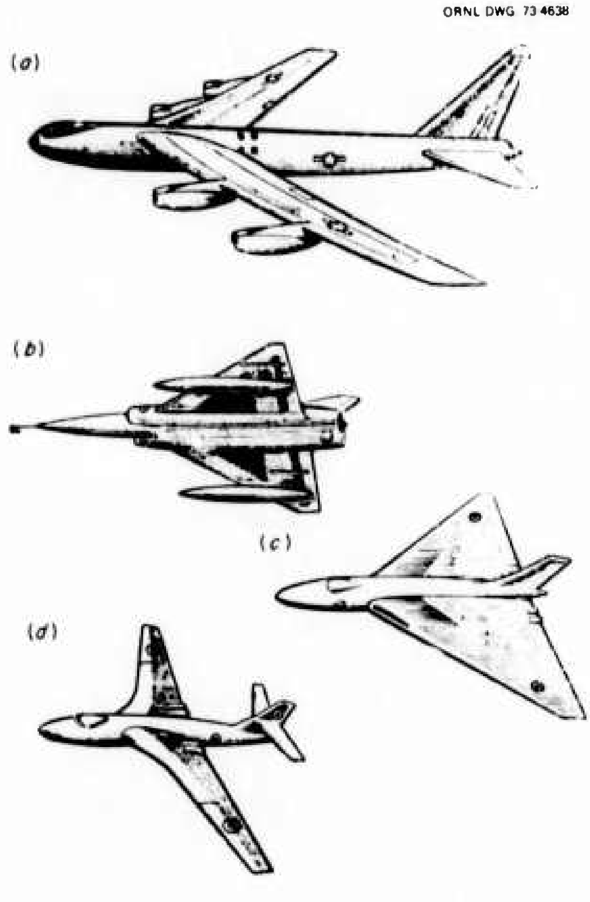

Fig. 2. Strategic bombers of the USA and England.

Considering the availability of nuclear weapons to attack and destroy, one may conclude that a future war unleashed by the imperialists would, unlike past wars, be of a nuclear missile nature. This means that delivery would be by missile, and the primary tool of destruction would be nuclear weapons.

In addition to nuclear weapons, chemical and biological weapons (CBW) might find wide application. The imperialists are preparing to use chemical and biological weapons in conjunction with other means of destruction. It is thought that the military characteristics of these types of weapons make it possible to carry out a clandestine attack on the enemy, thus eliminating the threat of an immediate retaliatory strike.*

The war, if unleashed by the aggressors with weapons of mass destruction, would have its own special characteristics. It would take place over a wide area and

Fig. 3. "Hound Dog" air rocket [cruise missile].

would actively involve most of the world's countries and peoples within a short period of time. It would be a war of two opposing systems: socialism and imperialism. It would be an armed encounter with specific goals. A nuclear missile war would be intercontinental, because now it is technically possible to strike at any continent – to transmit military force from one continent to another by means of accumulated strategic weapons.

The targets of destruction are not only weapons centers, but also areas deep within the rear areas of enemy territory, as well as administrative-political centers, industrial plants, and large cities. Destroying the morale of the population is one of the main goals of such a war; thus, in modern warfare there is no real distinction between the front and the rear.

Weapons of mass destruction are used not only to inflict large-scale losses on the armed forces, but also – if considered necessary – on the civilian population. Moreover, the greatest losses may be in densely populated areas, where industrial centers are usually located.

An analysis of the character of future wars leads to the conclusion that regions of high population density may be struck first by nuclear missiles. These strikes may destroy cities, industrial targets, and transportation and may also cause an enormous number of casualties among the population. Thus, the problem of defending the population and the material resources of our country and its industrial-political and strategic centers from the effects of nuclear weapons has become one of the most important concerns of modern warfare.

A reliable means of safeguarding our borders and the main military strength of the Armed Forces is the Strategic Missile Forces, equipped with first-class intercontinental ballistic missiles. Thanks to the relentless efforts of the Party and the government, in a relatively short time the missile forces have been converted into a powerful shield against the cunning intent of the enemy. Immediate destruction of the enemy's means of attack is effected by antimissile and antiaircraft defense. Soviet antiaircraft defense forces, coupled with military air forces, ground forces, and the navy, reliably protect our country from enemy strikes.

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*D. Rothchild, *The Weapons of Tomorrow*, translated from the English, Military Publications, 1966.

However, it is not possible to guarantee that some of the enemy rockets will not penetrate our antimissile defense. Significant reduction in population losses may be achieved in this case only by instituting a comprehensive system of civil defense measures. Thus, civil defense assumes an important place in the national defense capability, constituting one of its major components. Defending the population from weapons of mass destruction is its main task.

Preserving the nation's means of production, ensuring economic stability, and preserving the material and technical resources are matters of paramount importance. Thus, under modern conditions, civil defense has become a factor of strategic importance. To a considerable degree, the success of civil defense measures predetermines the viability and the stability of the country.

1.2 CIVILIAN DEFENSE PROBLEMS

Civil defense (CD) is based on a system of federal defense measures aimed at protecting the population, creating conditions for maintaining a stable economy in time of war, and — if the enemy uses weapons of mass destruction — conducting urgent emergency rebuilding operations.

The basic goals in civil defense are:

1. protecting the population from weapons of mass destruction:
2. preparing the national means of production for economic stability under conditions of enemy attack;
3. conducting urgent rescue, emergency restoration operations at sites of destruction.

Carrying out these tasks requires advance preparation of a system of measures and civil defense planning activities.

1.2.1 Protecting the Population from Weapons of Mass Destruction

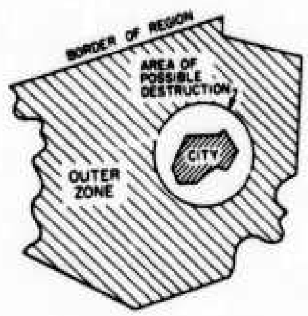
Weapons of mass destruction have various damaging effects, which necessitate a system of defensive measures. Protection against weapons of mass destruction may be achieved with a system of means and methods to be employed under different conditions. No single measure, no one method of defense, will safeguard the people from destruction by nuclear, chemical, and biological weapons.

Protection of the population from weapons of mass destruction can be achieved by:

1. early warning of the population against the danger of enemy attack;
2. decentralization of labor and service enterprises of large cities into outlying areas by evacuation from the cities into rural areas where there are no manufacturing, medical, children's, scientific-research, or educational institutes;
3. individual means of protection for the entire population;
4. construction of shelter and housing for the population remaining in the cities after evacuation; the provision of protection against radiation for the population in the outer zones [see note *] ; and the evacuation of the population;
5. defense food supplies, water and the creation of reserve supplies, medical goods, and other essential items in dispersal and evacuation zones;
6. the organization of radiation and CBW monitoring stations, reconnaissance, and laboratory control;
7. necessary general instructions to the population on methods of protection from weapons of mass destruction;
8. preparation and equipment for the development of civil defense;
9. execution of sanitation, preventive, and anti-epidemic measures;
10. preparation and execution of rescue operations in centers of destruction.

Let us examine some basic practical measures for protecting the people from weapons of mass destruction.

[*"Outer zone" or "outlying zone" is used by the Russians in Chapter 3 to mean "the territory between the external border of the area of possible destruction of the city and the border of the region [area, republic]. The boundaries of the zone of possible destruction must be established in relation to the importance of the city and the size of the population."]



To warn the people in time about the danger of impending enemy attack, it is necessary to set up a warning system and maintain a state of constant readiness. The warning is given by civil defense staffs, which use electric sirens set up in the city; industrial and transport whistles; and television and radio channels (loudspeakers) set up on streets, in homes, and in apartments. In addition, electrically powered sirens, local radio units, and radio channels, as well as factory whistles installed in workshops, are used at industrial sites. Various other means of communication, including radio and telephone, are used to warn supervisory personnel.

Protecting the population against weapons of mass destruction is achieved by dispersal and evacuation in conjunction with the use of protective shelters and individual means of protection. Dispersal of workers and employees [see note*] and evacuation of the population from large cities into the outer zones is an effective means of defense, carried out to help the maximum possible number of people escape from a probable enemy strike. To accomplish dispersal and evacuation, it is necessary to carefully plan these measures, prepare designated regions, and organize security in every respect. The assured availability of transport for dispersal and evacuation is of great importance; thus, the use of transportation must be carefully planned and implemented in peacetime.

Protection against radioactive, biological, and chemical contamination is also achieved through the use of individual defense means (gas masks, respirators, and protective clothing). Thus, it is not only very important to safeguard industrial production, but also to teach the entire population in advance to use the simplest possible means of protecting the skin and the lungs.

The construction and utilization of [blast] shelters to protect workers and employees remaining in the city and fallout shelters in places where dispersal and evacuation have taken place guarantee [the availability of] cover [see note †] for the people in case of enemy attack. Existing shelters, cover, and other structures are used for workers and employees who continue their industrial activities, ensuring protection from all injurious factors of a nuclear blast.

[*"Workers" refers to the category of personnel that we would call wage-earners; "employees," to the category of personnel that we would call "salaried."]

[†"Cover" is sometimes used by the Russians to refer generally to protection from both blast effects and fallout; however, it is used much more frequently to mean a fallout shelter. "A shelter," on the other hand, usually denotes a blast shelter.]

For the evacuated population in the outer zones, the greatest danger is from radioactive, chemical, and biological contamination. Thus, fallout shelters, built by the people themselves, are used in dispersal and evacuation areas. Preparation for their construction is carried out beforehand so that the types of shelter and available construction materials are known in advance.

The protection of food supplies and water and the creation of reserve supplies and the basic essentials of life are necessary to ensure survival of the population. Thus, all these measures must be planned and prepared in peacetime. In addition, the people must be aware of the simplest means of protecting food products and water in their homes.

Organizing radiation, chemical, and biological monitoring and laboratory control entails warning the people about the danger of contamination. The Meteorological Service constantly monitors the condition of the air, following the course of radioactive, chemical, and biological contamination. Special observation posts are set up at places of dispersal and evacuation during wartime to warn the people of dangers.

Organizing civil defense and instructing the people, workers, and employees about protective measures against weapons of mass destruction are accomplished by individuals with experience in dealing with complex situations and with knowledge of how to apply defense measures. Community instruction is organized and executed by civil defense chiefs and their staffs, business leaders, institutional and educational establishments, collective farms, state farms, and housing-service offices (government housing offices).

Among the other defense measures, preventive treatment and avoiding or reducing the effects of radioactivity, toxic agents, and biological weapons on the people are very important. Establishing sanitation, preventive, and antiepidemic measures is assigned to the civil defense medical services which make use of medical defense facilities. To carry out medical measures it is necessary to plan in advance the operation of medical institutions, to train medical personnel, to accumulate medical supplies, and to prepare sites for the medical facilities.

1.2.2 Preparing the National Economy [Essential Industries and Services] for Stability of Operations Under Conditions of an Attack

Ensuring the stability of the national economy under conditions of enemy attack is a complex problem, the solution of which depends on the character of the individual installations and services. To solve this problem it is necessary to carefully plan and execute a whole complex of measures.

Stability of operation of national economic establishments during wartime is achieved by:

1. ensuring the reliability of power, gas, and water supplies; creating reserves of raw material and fuel;
2. improving technological production processes, guaranteeing automatic shutdown when a plant, district, or facility is made inoperative;
3. constructing and equipping shelters in installations and plants for employees and workers, primarily according to the number of shifts, and preparing mine shafts and mines as shelters;
4. preparing bases in outer zones for the relocation of scientific-research, construction, and other establishments that are to be evacuated from large cities in order to continue operation in war time;
5. creating protective structures for administrative units;
6. constantly preparing [civil] defense formations [see note *] to carry out rescue and emergency restoration work with consideration of the special features of each plant;
7. performing organizational and engineering-technical work to prepare a plant for changeover to a basic work regimen, providing a series of defense measures for workers and employees, stockpiling material goods and special equipment, preparing to operate with emergency supplies of power and water, providing for fire prevention, and inaugurating other measures in accordance with the nature of production.

The principal measure to ensure the operational stability of establishments and plants in the event of enemy attack is the complete conversion of these sites to the "basic operational system" for civil defense. The "basic operational system" of an establishment or plant refers to the organization of plant operations under threat of attack (as ordered by civil defense signals) to ensure a reduction of losses, should the enemy employ weapons of mass destruction.

[*The civil defense "formation" is the basic unit of Soviet civil defense. A "formation" consists of specially trained and equipped civil defense personnel, prepared to go into centers of destruction after a nuclear strike and conduct reconnaissance operations and perform massive rescue and emergency restoration work. A formation usually refers collectively to a number of highly specialized "groups," "squads," "units," "brigade," or "teams." Most large plants and other large establishments organize and train their own formations.]

Converting these facilities to a "basic operational system" expedites the reduction of plant activities to a range of operations that are feasible while under the threat of attack (proclaimed by civil defense signals). The [emergency] measures are carried out [including] the prevention of fires, explosions, and other problems of a secondary nature (short circuits, destruction of the liquid fuel tanks, etc.). Thus, these plants which must continue certain of their operations, even after the air alert signal has been sounded, are converted to a reduced operating regimen. The workers and employees remaining in the plant take cover individually and make use of other protective measures. In case of radioactive, chemical, and biological contamination, workers and employees take the necessary protective measures. In addition to converting these units to a "basic operating regime," technological measures must be taken to increase the operational stability of an enterprise and ensure the protection of workers and employees.

1.2.3 Performing Rescue and Emergency Restoration Work at Sites of Destruction

Antiaircraft and antimissile defenses notwithstanding, it is still impossible to completely exclude the possibility of nuclear strikes on cities. Therefore, performing rescue operations is one of the vital tasks of civil defense. Thus, civil defense must be ready to immediately go to the rescue of nuclear blast victims.

After the enemy has inflicted nuclear or other strikes, the main task of civil defense is to rescue people in centers of destruction. The rescue work and the emergency restoration operations necessary for its achievement must be executed by trained personnel, specialized brigades, and [military] civil defense troops [see note *]. To carry out rescue operations and emergency rebuilding work at centers of destruction, it is necessary to do the following:

1. organize civil defense units of workers and employees, collective farm workers, and teaching personnel and prepare them to work in centers of destruction;
2. equip civil defense personnel with individual means of protection, other equipment, and various techniques;
3. plan the activities of civil defense personnel well before the threat of enemy attack and the need to

[*It is expected that civilian civil defense formations and military civil defense units would work side by side in performing reconnaissance and rescue-repair operations in centers of destruction as soon after nuclear attack as possible.]

perform rescue and emergency reclamation work at the centers of destruction;

4. verify and specify civil defense plans for instruction of units under conditions simulating those of wartime;
5. create civil defense formations in a short period of time; establish them in large cities and in other zones; distribute them in previously designated zones and prepare them to carry out rescue operations;
6. organize the line of command and clearly establish the authority of civil defense personnel when performing rescue operations.

The success of rescue personnel working in centers of destruction depends on the preparedness of civil defense units to organize rapidly and execute rescue and urgent restoration work.

Thus, by preparing the defense of the cities, population points, and units of the national economy in advance, executing defense measures, and instructing the entire population on how to protect themselves against weapons of mass destruction, it is possible not only to reduce the number of casualties but also to preserve material and cultural values and to guarantee the uninterrupted work in rear [areas].

1.3 ORGANIZATIONAL STRUCTURE OF CIVIL DEFENSE

1.3.1 General Principles of Civil Defense Organization

The Communist Party and the Soviet government pursue a policy of peace, while at the same time relentlessly working to strengthen the defense capability of our country and to improve national defense. Since civil defense is an integral part of national defense, it is organized according to the following basic principles:

1. Civil defense is organized in all territories of the USSR on a territorial-industrial basis. Defense measures and preparations for performing rescue operations are conducted everywhere.
2. Civil defense is organized by agencies of Soviet authority and by directors and managers of departments, plants, institutions, educational establishments, collective farms, and state farms. The responsibility for executing civil defense measures and the constant readiness of Civil defense forces and facilities for action falls to the Soviet Ministers of the United Autonomous Republics, ministry administrators, office and organizational managers, executive committees of Soviets [Councils] of workers' Deputies, as well as to plant managers and leaders of establishments and educational institutions.
3. The supervision of civil defense in outer regions is carried out by chairmen of executive committees of Soviets [Councils] of Workers' Deputies, who are [also] civil defense chiefs.
4. Civil defense is based on the material and human resources of the entire Soviet Union.
5. Organization of civil defense is provided for by the well-thought-out coordination of centralized and decentralized governmental forces and civil defense staffs.
6. Civil defense in the USSR is not only a system of nationwide defense measures, but is also a matter of public concern. Every Soviet citizen is required actively to participate in carrying out civil defense measures, fulfilling an obligation to defend the homeland.
7. Party organs and Party organizations exercise control after civil defense measures have been enacted by ministers, offices, national economy officials, establishments, and educational institutions.

1.3.2 Organization of Civil Defense in Cities

In cities and in populated areas, civil defense is organized by civil defense chiefs. The civil defense chief in the city is the chairman of the Municipal Executive Committee of the Council of Workers' Deputies. Supervision of civil defense in the city is carried out by the staff of employees (Fig. 4).

The civil defense staff of the city is the governing organ of civil defense. The [civil defense] chief of staff reports to the civil defense head [the administrative head] in the city and serves as his first deputy. The chief of staff has the right to issue decrees and orders in the name of the city civil defense head. [In other words, the civil defense chief, like the chief of police or the fire chief, is directly responsible to the city's administrative head, comparable, say, to a U.S. mayor.]

Civil defense services. Municipal civil defense services are created to support civil defense measures, to prepare and formulate civil defense, and to direct its work in centers of destruction. The following civil defense services may be created in the city: communications, maintenance of public order, fire fighting, medical, engineering, communal-technical, protection of animals

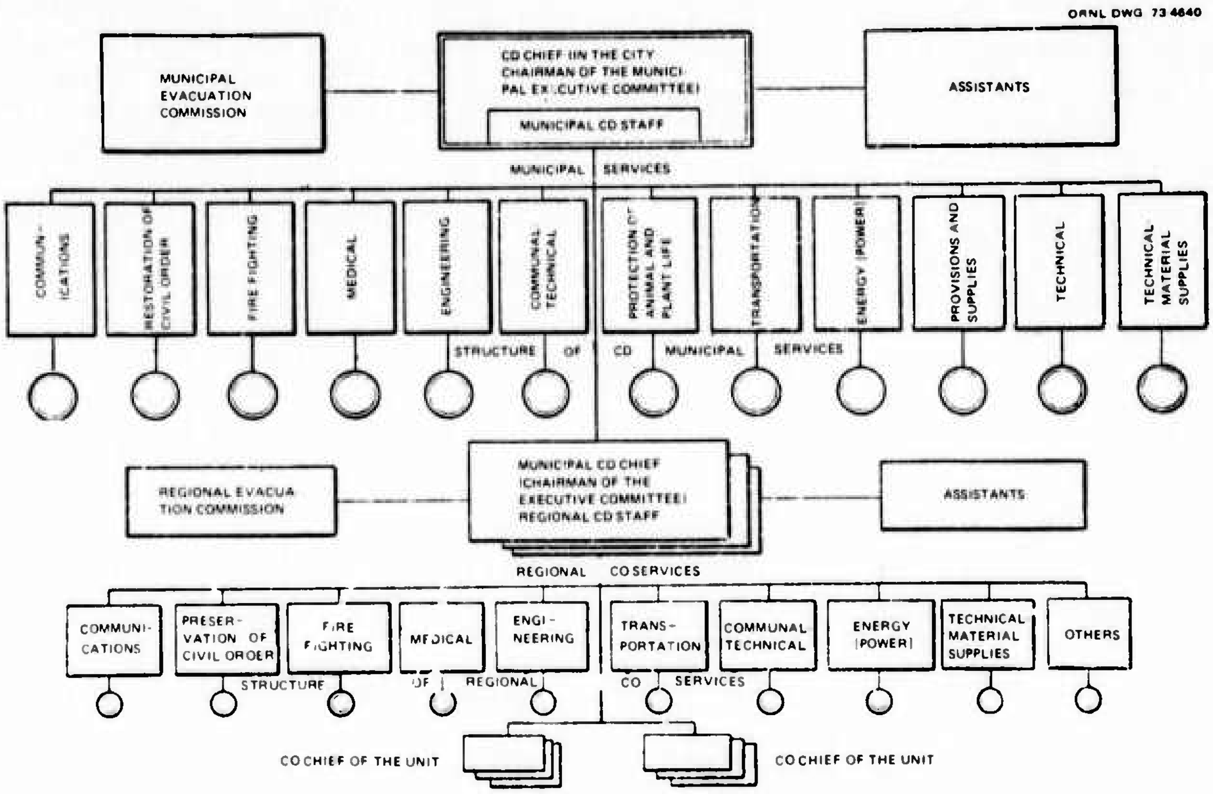


Fig. 4. Diagram of municipal CD organization.

and plants, transportation, energy, provisions and supplies, technical, material-technical supplies, etc.

The communications service is built on the administrative base (division) of municipal communications. The chief of this service is the communications administrator. Efficient communications ensure early warning of the population and municipal officials of the threat of nuclear attack, the danger of radioactive contamination, and the use of chemical and biological weapons by the enemy. This service ensures reliable communications among CD municipal and regional chiefs, sectors of the civilian economy, and officials of the service. It is entrusted with resolving system difficulties and arranging communications between centers of destruction.

The service for maintaining public order is based on the municipal administration division of the militia. The chief of the service is the chief of militia administration. This service is devoted to the maintenance of public order and ensures that all decrees of the Executive Committee of the Council of Workers' Deputies which pertain to civil defense have been carried out by installations and factories, organizations, institutions, and by the people; it regulates traffic on highways and on routes of population evacuation; it controls panic and also guards state property and the personal property of citizens; it isolates centers of destruction (contamination).

The fire-fighting service works through the municipal fire station. It organizes preventive and fire-fighting measures and assures their completion, establishes fire-fighting training, and instructs and supplies fire-fighting personnel. When a fire occurs, this service locates, contains, and extinguishes it, as well as rescues people from burning buildings and structures.

The medical service is based on the municipal health department; the chief of this department is also the chief of the medical service. In peacetime, the medical service operates a whole system of medical evacuation and antiepidemic programs; it organizes training for the service; it conducts special instruction for personnel of the service; it selects and equips the accommodations for the establishment of medical stations in wartime; it provides for the stockpiling of medical sanitation supplies. In wartime the medical service is entrusted with the responsibility of rendering medical aid to the injured [and of assuring] their reception at medical facilities, their decontamination treatment, their evacuation into suburban zones, and their medical treatment.

In addition, the municipal medical service is concerned with the disposition of the sick that are evacuated from medical and preventive-medicine facilities into rural areas; it provides expert advice on water, food products, and food raw materials and administers medical aid to the evacuated population.

The engineering service is based on the municipal housing service. It is concerned with facilities in danger of collapse, as well as with the collapse of poorly constructed buildings and edifices, and the extrication of people from destroyed buildings, blast shelters, and fallout shelters. The service is organized to train and instruct CD personnel. In peacetime, the municipal engineering service is concerned with problems of building shelters and seeing that they are used correctly. When the threat of attack arises, the service supervises construction of blast shelters and fallout shelters for the people.

The organization of the communal-technical service is based on the communal services department of the Council of Workers' Deputies in order to localize and eliminate damage done to utility and communal systems in centers of destruction. In case of radioactive, chemical, or biological contamination, the service is responsible for the decontamination of the territory, installations, equipment, clothing, and footwear and also decontamination procedures for the people. The municipal communal-technical service prepares individual protective facilities and communal facilities (bathing, shower bath, mechanized laundry facilities) for decontamination treatment of the people and for decontaminating clothing and footwear. In addition, the service prepares to use communal techniques, available in the city, for decontaminating the territory (spray washing, scouring, and sand spreading).

The animal and plant life protection service is based on the Agricultural and Veterinary Administration, experimental stations, tree planting trusts, and other establishments.

This service is entrusted with organizing and executing measures to protect animal and plant life, water sources, food supplies, and forage against contamination; it gives veterinary aid to contaminated animals and provides special treatment; it decontaminates stock breeding farms, forage, and water; it checks meat and dairy products and determines the advisability of using the meat of slaughtered animals for food; it slaughters and utilizes injured animals; it declares meat unfit for consumption; it establishes reserves of vaccines and veterinary supplies; it organizes antiepidemic measures and combats destructive insects on agricultural plants.

The transport service is based on the Transport Administration Division and other municipal organizations and facilities concerned with transportation. This service provides for the transportation of evacuated and dispersed workers and employees into the outer areas. If the enemy should use weapons of mass destruction, the service organizes transportation of trained personnel to the centers of destruction, evacuates the injured to medical facilities, and transports food products, essential items, and other material goods necessary for carrying out rescue and urgent emergency reconstruction work. In addition, the transport service checks into the technical condition of the means of transportation and its correct use and maintenance. If the transport system is contaminated with radioactive, chemical, or biological agents, the service organizes decontamination at Transportation Decontamination Stations or Decontamination Areas.

The power service is based on the Department of Power Supply and is designated to prepare in advance for the uninterrupted supply of electrical energy to manufacturing plants and transportation under conditions of enemy attack and to ensure normal operation during a blackout. After elimination of the aftereffects of enemy attack, the power service clears away damaged elements of the electrical supply network and restores service.

The provisions and supplies service is organized in the Administrative Department of Commerce and Food Supplies and is responsible for planning and conducting measures to protect food products, consumable raw materials, and industrial commodities; it secures food products and essential items for the injured and evacuated population; organizes the feeding of personnel and of the population working at centers of destruction; selects samples of food products and essential commodities and conducts tests in the chemical laboratories of the medical service; decontaminates food products and essential supplies; and reprocesses or disposes of contaminated food supplies and industrial goods not suitable for decontamination. The service sets up food and supply stations in rural areas.

The technical service is based on the "agricultural-technical" associations, maintenance agencies (repair shops and vehicle maintenance stations), and establishments and is responsible for the proper maintenance, operation, evacuation, and repair of vehicles, mechanical equipment, and other technical facilities in the civil defense system.

The material-technical supply service is based on the Municipal Planning and Supply Organization and provides CD personnel working in centers of destruction with all types of construction materials, decontamination and washing equipment, reserve equipment and automobile parts, and fuel and lubricants, as well as water for human consumption and technical use. In outlying zones the service equips warehouses and bases and organizes the water supply and the mobile auto-repair units.

In addition to the enumerated services, other services may be organized if the need arises and supportive agencies exist.

The service chiefs are the department directors of offices and organizations which support the service. To guarantee the supervision and administration of service facilities and human resources, staffs composed of a number of workers in those institutions are appointed as service chiefs.

1.3.3 Organization of Civil Defense in Urban Districts

In all urban districts, civil defense is organized by the civil defense head of the district. Civil Defense heads in urban districts are chairmen of the Executive Committees of Councils of Workers' Deputies in these districts. They strive to solve civil defense problems as fully as possible within strictly determined time limits, consistent with national economic planning.

The civil defense head of the urban district sets up a district evacuation commission to organize dispersed workers and employees and to evacuate the people into the outer zones. As a rule, the chairman of the evacuation commission is the Deputy Chairman of the District Executive Committee. The civil defense head of the urban district supervises civil defense through a staff and officials.

The civil defense staffs of the urban district, in addition to regular staff workers, are supplemented by persons working on executive committees of these districts and other organizations; these people serve on civil defense district staffs without being exempt from their usual jobs.

The following civil defense services may be set up in urban districts in the presence of supportive organizations: communications, protection, public order, fire fighting, medical, engineering, communal services, power supply, transportation, material-technical supply, and others, depending on local conditions. The district services organize groups for special purposes and supervise instruction.

1.3.4 Organization of Civil Defense in Rural Areas

Civil defense chiefs of rural regions are chairmen of the Executive Committees of Soviets [Councils] of Workers' Deputies in these regions. They are responsible for the execution of civil defense measures to the fullest extent within a strictly determined time schedule in conjunction with national economic plans. In rural regions, the regional civil defense (CD) chief sets up a commission for the reception and relocation of people evacuated from the cities and urban institutions and organizations. The chairman of this commission is usually the Deputy Chairman of the Executive Committee. Supervision of civil defense in the [rural] region is the responsibility of a CD staff and regional CD employees.

The following civil defense services may be set up in rural areas; communnications, protection, public order, fire fighting, medical, communal-technical, auto transport, protection of animals and plant life, supply of food and other essential items, etc. The responsibilities of these services are similar to those of the municipal services. The special feature of the rural area medical service is that it receives and distributes medical and protective facilities and provides for the sick.

The service for the protection of animal and plant life is based on veterinary facilities and experimental stations. It organizes and trains personnel; takes measures to protect animal and plant life, water sources, and forage against contamination; gives veterinary assistance to injured animals; makes special preparations for and decontaminates livestock farms, forage, and water; checks meat and dairy products and determines the advisability of using slaughtered animals as food; organizes the slaughter and utilization of injured animals; assures a reserve supply of vaccines and veterinary supplies; takes measures against animal sickness; and combats pests on agricultural plants.

1.3.5 Organization of Civil Defense in Units [Establishments] of the National Economy

Civil defense exists at all levels of the national economy to prepare the people in advance for defense against nuclear, chemical, and biological weapons, to assure minimal losses if the enemy should use weapons of mass destruction; to create conditions which increase the operational stability of enterprises and industrial plants in time of war and the prompt performance of rescue and emergency restoration work.

The basic tasks of CD at this level are:

1. developing measures to protect workers, employees, and their families who reside with them in worker settlements near the plant, primarily from chemical and biological weapons,
2. developing measures to increase the operational stability of industrial, power, transport, and communications installations in wartime;
3. ensuring the uninterrupted supervision of services and training and the reliable operation of warning and communications systems;
4. creating, equipping, and preparing civil defense formations and maintaining them in a constant state of combat readiness;
5. generally instructing workers, employees, and their families in defense measures against weapons of mass destruction;
6. ensuring protection of provisions and water supply sources from radioactive, chemical, and biological contamination;
7. carrying out rescue and emergency reclamation work at centers of destruction.

The CD chief of an installation (plant, organization, establishment, and educational institution) is its director, responsible for the organization and the condition of civil defense and for the constant readiness of its forces and facilities to carry out rescue and urgent restoration work. He and his staff are subordinate to the appropriate officials of the ministry (department) in which the installation is located. In large installations the CD chief appoints his own deputies; each one is in charge of one of the following: dispersal of workers and employees, engineering-technical units, and material-technological supplies.

The CD staffs organized at the installations are composed largely of plant workers and staff members who continue to work at their usual jobs at the enterprise. The number of official workers on the staff is determined by the directors of the ministry in which the unit is located (Fig. 5).

The staff of large installations is organized as follows: the chief of staff, assistants in the areas of operational reconnaissance, combat training, and other specialities, at the discretion of the CD chief. Moreover, by decision of the Party, Komsomol [Young Communist League], and trade union committees, the staff may also include

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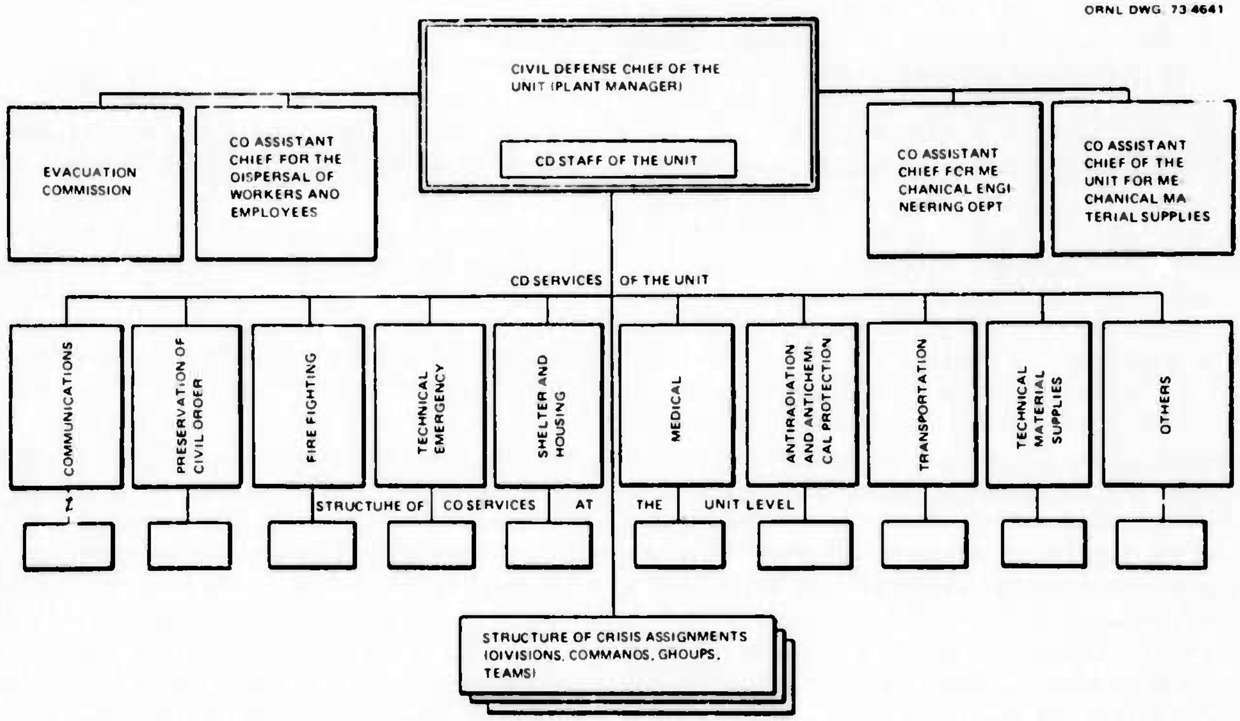

Fig. 5. Diagram of CD organization of a unit.

representatives of the Party, Young Communist League, and trade union as well as of other social agencies.

The CD staff, which operates under the CD chief of the unit, supervises the unit's CD programs. Specifically its functions are:

1. to organize and guarantee uninterrupted administration of civil defense;
2. to ensure early warning of workers, personnel, employees, and the population of worker settlements [the families of the staff and workers] of the threat of attack;
3. to develop CD plans for the unit and to see that they are executed;
4. to develop and carry out measures for the protection of workers, employees, and their families, as well as of industry, from nuclear, chemical, and biological weapons;
5. to organize the combat readiness of CD formations, to instruct workers and employees about protection from weapons of mass destruction, and to control the quality of that instruction;
6. to guarantee the constant readiness of civil defense forces and facilities.

The duties of the civil defense services of an installation. To assure the execution of civil defense measures, as well as the training of civil defense formations and their direction in the conduct of operations at centers of destruction, the following civil defense services are created: communications, protection of public order, fire fighting, emergency-technical, blast and fallout shelters, medical, antiradiation and antichemical protection, transport, material-technical supplies, and others. The number of services is determined by the CD chief of the installation [site]. Depending on the characteristics of the installation and the presence of a supportive organization, other civil defense services may be set up in addition to those enumerated.

The communications service is set up on the basis of the communications unit. The chief of this service is the chief of this communications unit. This service is responsible for assuring an early warning of administrative personnel, workers, employees, and their families to the threat of enemy attack. This service must also organize communications and maintain them in a state of constant readiness. In addition, the communications service must resolve difficulties in the networks and in communication facilities located at the centers of destruction. To ensure a state of constant combat readiness, command and observation posts are provided with all means of warning and communication.

The service for maintaining public order is based on the Section of Departmental Protection. The chief of the service is also the chief in charge of protection of the installation. The service for the protection of public order provides reliable protection of the site and of public order during the threat of enemy attack and during the performance of rescue and emergency restoration operations; it assists in providing prompt cover in accordance with civil defense signals; it supervises the blackout system.

The fire-fighting service is organized as a subsection of the official fire department; the chief of the service is the chief of the fire department. This service designs fire prevention measures and assures their execution; guarantees constant readiness of service forces and facilities; locates and extinguishes fires; assists in antiradiation and antichemical protection by decontaminating affected regions.

The emergency-technical service is based on the production or technical section of the division of the chief mechanic; the chief of the service is the chief of the supportive division which sets up the service. This service plans and executes preventive measures which increase the stability of the basic installations and sets up special engineering and communications systems in the event of enemy attack. It undertakes emergency operations to locate and eliminate trouble in the systems, in communications, and in installations at the site. In addition, this service clears away obstructions and rescues people.

The shelter and housing service is based on the Principal Construction Department, the Communal Housing Department, and the Building Guild, the chief of the service is the chief of the supportive department which created the service. This service is concerned with computing housing expenses for workers, employees, and the other people who work in the settlements; preparing shelter and assuring its proper use; organizing the construction of fallout shelters; guaranteeing the prompt completion of [blast] shelters and fallout shelters in accordance with civil defense instructions. In addition, this service participates in rescue operations when shelters and housing collapse.

The medical service is organized by medical centers, medical and sanitation sections, and outpatient clinics. The chief of the medical service is the chief of the medical center, sanitation section, or outpatient clinic. The medical service assures the constant readiness of medical personnel; plans and conducts hygenic and preventive measures; provides medical assistance to victims and evacuates them to medical facilities; executes sanitation measures in destroyed areas; concerns itself with the medical care of workers and members of their families at dispersal sites.

The antiradiation and antichemical protection service is based on chemical laboratories and plants; the chief of the service is the chief of the laboratory or the chemical plant. This service develops and completes measures for the protection of workers, employees, water supply sources, food units, and supply warehouses from radioactive and toxic substances; organizes and prepares antiradiation and antichemical training and facilities; is in charge of individual means of defense and collective defense facilities and special techniques; organizes posts for radioactive and chemical observation and performs dosimetric checks of personnel; attempts to rectify effects of radioactive and chemical contamination.

The material-technical supply service is organized by the material technical supply department of the area. The chief of the service is the chief of the department. This service plans material and technical supply; at the same time, it supplies personnel with all types of equipment and provisions; it assembles repair technicians and various supplies, arranges their transportation to work stations and maintains records of these activities; it secures provisions and essential items for workers and employees in the area and at dispersal sites.

The transportation service is based on the transportation departments and garages of the unit. The chief of the service is the chief of the department or of the garage. This service plans and implements measures to guarantee that the dispersed workers and employees will be transported to their places of work; organizes the transportation of brigades and equipment to the center of destruction; prepares transportation for the conveyance of workers and employees, and for the evacuation of the injured, as well as for other civil defense objectives; decontaminates transportation vehicles.

The CD service is not organized for small installations [plants, enterprises] of the civilian economy but is entrusted to a department of the installation in question.

Structure of civil defense units. The structure of civil defense consists of divisions, commands, groups, and sections with various assignments, composed of all able-bodied men and women of the country and trained in the execution of defense measures and in rescue and emergency restoration work at centers of mass destruction, as well as in areas of natural disasters and catastrophes. The CD structure is set up in peacetime. It encompasses personnel, transportation, technology, equipment, material, and property. However, men with draft notices, pregnant women, and women with children up to eight years of age are not included in the structure.

The CD structure is organized according to special programs, which are subdivided into crisis assignments and special assignments. The crisis structure involves performance of rescue work, generally in those establishments in which it was set up. The degree of structuring is determined by the CD staff of the unit, with the approval of the CD staff of the region (city), and is then affirmed by the CD chief of the unit. Rescue divisions (commands, groups) pertain to the CD crisis structure.

The structure of special assignments involves specialized tasks in the civil defense system and includes the training organization for civil defense employees.

Establishments, organizations, and communications facilities; public health, transportation, commerce and material-technical supply; veterinary and agrotechnical institutions; and war production activities which will continue to function in war time pretty much as they do in peacetime may be asked to help solve civil defense problems within their existing structure.

Structure of civil defense in industry. In industry, civil defense is structured on the "production principle." In other words, civil defense units are set up to function during wartime on the basis of workshop, manufacturing unit, work shift, and work team, and in accordance with the special features of the industry. The special skills of the workers and the equipment and techniques that are available are also taken into account in the organization of civil defense. Thus, the entire working population of the plant is organized into CD units and subunits within the workshops, shifts, and various areas of production.

These plant shifts — work units, work teams, manufacturing units, etc., which carry on the essential activities of the plant — make up the CD rescue division, commands, and teams, the fundamental units on which CD in industry is based. The rescue divisions (Fig. 6) are responsible for rescuing people from beneath the rubble of destroyed shelters and buildings, removing them from centers of destruction, and giving them first aid. When these tasks have been completed, the rescue workers usually assist engineering and technical workers with their special assignments.

In addition to rescue brigades, the following are organized in industrial concerns:

1. Reconnaissance groups (teams) (Fig. 7), comprised of workers and employees in each production shift, who may be quickly organized to reconnoiter with

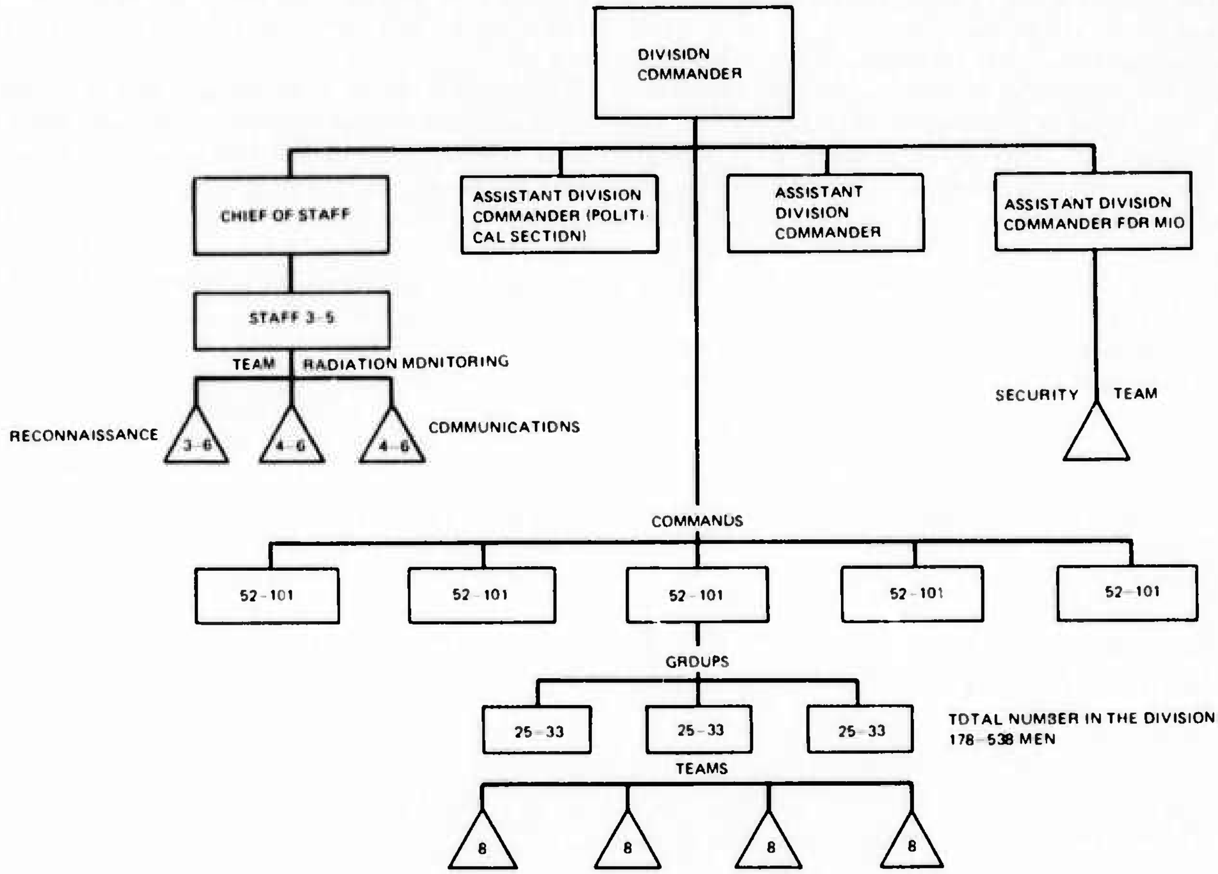

Fig. 6. Organizational chart of the CD rescue division of a unit.

the use of special equipment in dispersal areas, on advance march routes, and in centers of destruction.

2. Observations posts for monitoring radioactivity in air, water, precipitation, and soil in the area of laboratories and other facilities; communications groups (teams) in each shift of the radio unit, communications station, and main power sections; communications groups, including communications teams, equipped with motorcycles, Mopeds, automobiles, and technical means of communication.
3. Decontamination squads (Fig. 8) and decontamination posts in the plant medical stations (dispensaries) and also in shifts at plants where the workers are mainly women (these people are designated to provide first aid at centers of destruction and to evacuate the injured to first-aid stations).
4. Technical emergency teams and groups in the main mechanical, power, and technological departments,

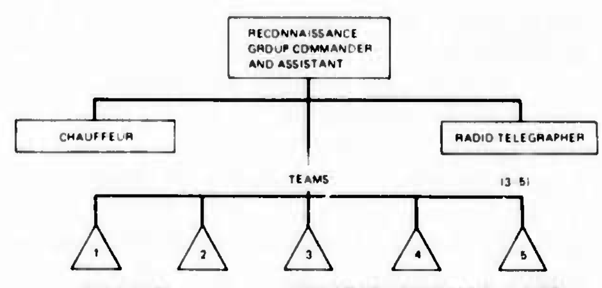

Fig. 7. Diagram of the organization of a reconnaissance group.

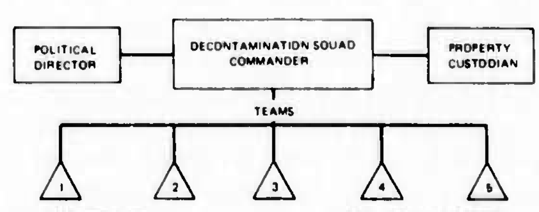

Fig. 8. Organizational diagram of a decontamination squad.

as well as in plant shifts and production sections where workers and employees are involved with engineering systems and communications. Their duties are to construct shelters, prepare and equip underground facilities to shelter the people, clear away rubble, and search for shelters and recover the wounded from them.

5. Fire-fighting commands (detachments) in each shift based on the volunteer fire brigade.
6. Decontamination commands (groups) based on the welfare and the janitorial services of the plant and making use of available communal and decontamination techniques.
7. Stationary laundry and clothing decontamination centers, based on decontamination stations, baths, and showers.
8. Commands (groups) for preservation of public order, based on the departmental militia and the volunteer people's brigade.
9. Groups (teams) for maintaining [blast] shelters and fallout shelters, based on the Main Building, Communal Housing, and Public Works Departments (the number of teams must correspond to the number of existing shelters).
10. Transportation commands, based on the Transportation Work Department and Garages.
11. Mobile food stations and water-carrying units, based on the labor supply departments and plant food and cafeteria departments.
12. Military mine-rescue sections and subsections in the mining industry are utilized for CD training in wartime and are provided with special equipment.

Structure of civil defense in plants and in communications, transportation, and power supply organizations. In addition to the abovementioned services, communications, transportation, and power supply organizations serve as the basis for the following special groups:

1. emergency recovery and technical emergency commands, based on supply line agencies, electrical stations, communications units, radio and telegraph stations, railroad junctions and stations, and sea, river, and air ports;
2. communications commands to ensure communications between the chief administrator, based on the communications office, telegraph office, post office, and training establishments (on the decision of the local Soviet agencies, the personnel of the communications command may include former school teachers);
3. motor-vehicle fleets, based on the motor-vehicle industry.

Structure of civil defense in construction companies. The following CD personnel are appointed in construction and construction-assembly organizations with these special assignments:

1. engineering reconnaissance groups, based on the administration of the construction organization;
2. engineering divisions (units) based on construction, enterprises, building maintenance organizations, and construction-assembly companies;
3. sections (units) for mechanizing work, operating as independent units within the companies, enterprises, and organizations;
4. road and bridge repair and reconstruction sections, operating within road construction and bridge construction combines, enterprises, and companies. These people must repair, restore, and maintain roads and highway facilities which are obstructed and must prepare detours on access routes to permit rescue operations;
5. technical-emergency command, based on combines and administrations for the construction of national oil and gas lines, irrigation canals, water reservoirs, and hydroelectric plants.

Structure of civil defense in institutions and administrative-governmental organizations. If suitable bases are available, governmental institutions and organizations and scientific research and planning organizations organize rescue divisions (commands, groups), reconnaissance groups (teams), communications groups (teams), sanitation squads (posts), fire-fighting commands (detachments), technical emergency groups (teams), commands (groups) for the preservation of public order, and units for servicing [blast] shelters and fallout shelters.

1.3.6 Organization of Civil Defense in Educational Institutions

The CD chief of the educational institution (university, technical school, school) is the rector (director) of the educational institution. In large universities with a large number of teachers and students, civil defense may be organized in the same way as it is for large national industrial plants. A staff and CD employees may be set up in such universities. An evacuation commission is set up to plan for the effective dispersal and evacuation of personnel and is headed by one of the assistant university directors. The CD staff includes official university employees who continue to do their usual work. In universities with a small enrollment the CD chief may appoint an official CD staff from the employees of the institute, in which case they hold dual positions.

All civil defense measures in an educational institution are executed in accordance with the orders of the rector (director) by official workers in the departments of the educational institution.

Structure of civil defense in higher and middle [secondary] educational institutions. The CD structure in educational institutions consists of divisions, commands, groups, and teams. Teachers and university employees are included in the structure. The commander of the structure is appointed by the permanent staff of the educational institution. Colleges and secondary schools recruit personnel and set up crisis training for special civil defense assignments in the educational institution.

Institutions of higher learning must set up rescue divisions (command groups), sanitation squads and sanitation posts composed of students and the regular staff, technical emergency groups (teams), groups (teams) for servicing blast and fallout shelters, which are to be supplemented by administrative personnel; and teams (groups) for the preservation of public order, which are supplemented by student members of the national volunteer services.

During their university years each study group (class) receives a course in civil defense, in accordance with the curriculum and included in the program of the educational institution, as a part of their training on the subject. At the school, each class may have its place in the CD structure in accordance with the overall program of instruction at the university.

Technical schools, secondary schools, and vocational colleges should organize rescue teams (groups), sanitation squads (teams) and sanitation posts, and commands (groups) for the preservation of public order, supplemented by alumni groups, faculty members, and administration personnel.

2. Characteristics of Weapons of Mass Destruction (According to Data of the Foreign Press)

2.1 NUCLEAR WEAPONS

Nuclear weapons are munitions based on the release of internal nuclear energy resulting from an explosive nuclear reaction: fission, or fusion, or [fission and fusion] occurs at the same time. Depending on the means for obtaining nuclear energy, a munition is classified as either nuclear or thermonuclear (hydrogen).

Nuclear weapons include airborne bombs, artillery shells, rocket warheads, naval torpedoes, subsurface bombs, and mines (nuclear land mines). Nuclear weapons are characterized by great power and diverse destructive capabilities, determined by the effects of the shock wave, thermal radiation, penetrating radiation [initial nuclear radiation], and radioactive contamination [fallout radiation].

Nuclear weapons are the most powerful of all known means of destruction. The power of nuclear weaponry is measured by TNT (trinitrotoluene) equivalents. The TNT equivalent is the weight of ordinary explosives (trotyl) with an explosive energy equal to that of the given nuclear weapon. The TNT equivalent is measured in tons, kilotons (1 kiloton = 1000 tons [tons of TNT] or megatons (1 megaton = 1 million tons [tons of TNT]).

According to its power, nuclear munitions are classified provisionally as:

low: up to 15 kilotons;

medium: 15–100 kilotons;

large-scale: 100–500 kilotons;

super: greater than 500 kilotons.

2.1.1 Conditions of Nuclear Explosions

Nuclear bursts may be produced in the air, at ground (water) level, underground, and underwater. Accordingly, a distinction is made between high-altitude, air, ground (water), underground, and underwater bursts.

The center of the burst is the point where the explosion occurs or the center where the fireball is located (Fig. 9). The epicenter [ground zero] of the explosion is the [vertical] projection of the center of the burst to ground level.

A high-altitude burst is a blast which occurs at an altitude of more than 30 km to destroy a rocket, spacecraft, or other projectile.

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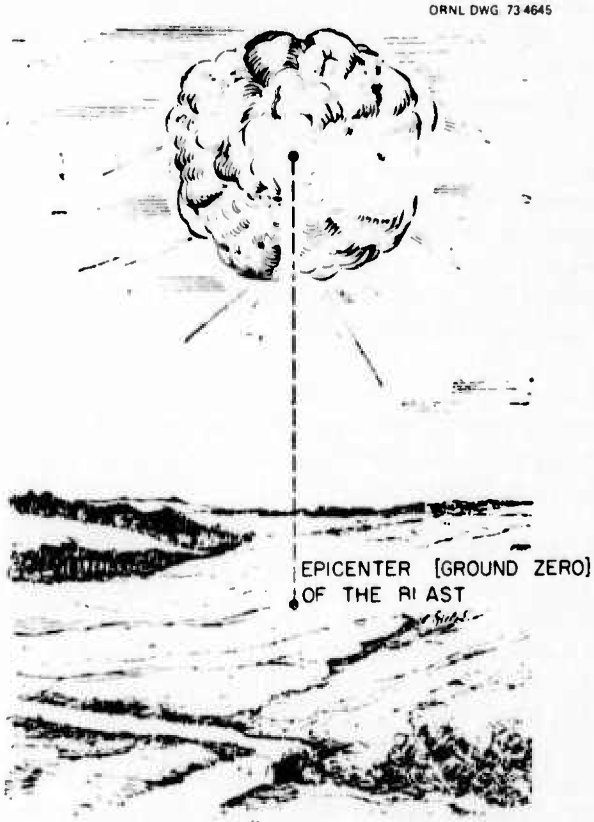

Fig. 9. Center and epicenter of a nuclear blast.

Air bursts are explosions in which the luminous part [fireball] does not touch ground level. Depending on the power of the weapon, the altitude to which the cloud rises can fluctuate between several hundred meters and a few kilometers. An air burst is accompanied by a bright flash, after which the fireball forms, rapidly growing in size and rising upward. After a few seconds the fireball is transformed into a round dark-brown cloud with fire-brightened gaps.

At this time a column of dust extends from the ground to the cloud, rising from the epicenter of the burst. In the case of a high-altitude [air] burst, the pillar of dust rising from the ground does not reach the cloud, which assumes its characteristic toroid form (Fig. 10*a*). The size and the altitude of the radioactive cloud depend on the power of the burst. In the case of a nuclear explosion, it may reach an altitude of 10 to 20 km, but in the case of a thermonuclear explosion, it may reach an altitude of 20 to 40 km. Gradually the radioactive cloud loses its characteristic shape, moves in the direction of the wind, and is dispersed.

An air burst causes destruction by means of a shock wave, thermal radiation, and initial nuclear radiation. Radioactive contamination of an area in the case of an air burst is almost nil since the radioactive products of the blast are lifted with the fireball to very great altitude and are not combined with surface particles.

A surface burst is an explosion on the surface of the earth or at an altitude above it so that the luminous part [fireball] touches the ground and, as a rule, has a hemispherical shape. The fireball increases in size and cools, detaches from the ground, grows dark, and is transformed into a round cloud which, trailing its pillar of dust [stem] behind, assumes its characteristic mushroom shape in a few minutes.

In the case of a surface burst, a crater is formed, the size depending on the power of the explosion and the type of surface. The diameter of the crater, formed of dry sand and clay particles, may be determined according to the formula

$$D = 38\sqrt[3]{q},$$

where D is the diameter of the crater in meters and q is the power of the explosion in kilotons. According to this formula, with explosive power $q = 1$ kiloton, $D = 38$ m; when $q = 1$ megaton, $D = 380$ m. The depth of the crater equals from $\frac{1}{6}$ to $\frac{1}{10}$ D.

At the site of the explosion, the ground melts and is covered with a layer of slag; as a result, a huge amount of vaporized soil is drawn into the cloud, giving it its dark color (Fig. 10*b*).

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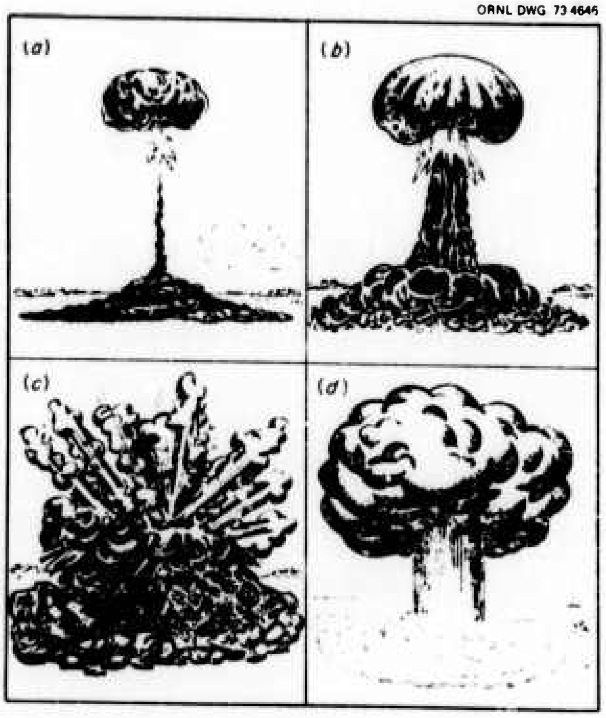

Fig. 10. Types of nuclear bursts: (*a*) air; (*b*) surface; (*c*) underground; (*d*) underwater.

The radius of destruction of the shock wave, thermal radiation, and initial nuclear radiation of a surface burst is less than an air burst. The characteristic feature of a surface burst is a high degree of radioactive contamination in the area of the explosion, as well as in the area over which the radioactive cloud moves.

A surface burst over water is an explosion over the surface of water or at an altitude where the fireball reaches the water surface. A column of water rises under the force of the shock wave, but, on the water surface at the epicenter of the blast, a depression is formed which causes the formation of divergent concentric waves when it is filled in. A large quantity of water vapor is drawn up into the cloud, forming under the effect of thermal radiation. When the cloud cools, the vapor condenses, and drops of water fall in the form of radioactive rain, highly contaminating the water in the area of the explosion and in the direction that the cloud is moving.

The destructive factors in the case of a water surface burst are the shock wave [in the air] and the shock wave which forms on the surface of the water. The effects of thermal radiation and initial nuclear radiation are greatly decreased because of the shielding effect of the large mass of water vapor.

An underground burst is an explosion occurring below the surface of the earth. When there is an underground burst, a large amount of soil is projected to a height of several kilometers and a deep crater, which is larger than the one after a surface burst, is formed at the site of the explosion (Fig. 10*c*).

The basic destructive factor of underground nuclear explosions is the compression wave propagated underground. In contrast to a shock wave [in air], longitudinal and transverse seismic waves are generated in the ground, and the shock wave [in the ground] does not have a clearly defined front. The propagation velocity of the seismic waves in the ground depends on earth conditions and may reach 5 to 10 km/sec. The destruction of underground structures as a result of the effect of the compression wave in the ground is similar to destruction due to earthquakes. Thermal radiation and initial nuclear radiation are absorbed in the ground. An underground explosion causes a high degree of radioactive contamination in the area around the epicenter of the explosion.

An underwater burst is an explosion which occurs under the water at a depth which may fluctuate widely. In the case of an underwater burst, a column composed entirely of water rises to the top of the large cloud (Fig. 10*d*). The diameter of the water pillar reaches a few hundred meters, and the height reaches several kilometers, depending on the power and depth of the explosion. When the water column falls, a strong, concentrically divergent wave forms at its base, which is called the base surge.

The basic destructive factor of an underwater burst is the shock wave in the water, the so-called slick, which has a propagation velocity equal to the speed of sound in water, that is, about 1500 m/sec. In view of the high density and low compressibility of water, the pressure at the front of the shock wave at equal distances is greater than in air. However, when encountering an obstacle, the pressure at the front of the shock wave increases only slightly. The duration of overpressure in the water is also shorter than in the air.

The shock destroys the below-water structures of ships and various hydroelectric structure.

Thermal radiation and initial nuclear radiation in the case of an underwater burst are absorbed by the water mass and by water vapor. An underwater burst causes a high degree of radioactive contamination in the water. When an explosion occurs near the shore, the contaminated water is projected onto the shore by the base wave, which inundates the shore and causes a high degree of contamination to material located there.

2.1.2 Destructive Factors of a Nuclear Explosion

The destructive factors of a nuclear blast are the shock wave, thermal radiation, initial nuclear radiation, and radioactive contamination [fallout].

The energy release of a nuclear blast depends on the type of explosion and the conditions under which it occurs. After an atmospheric explosion, the shock wave generates about 50% of the energy of the explosion, thermal radiation 35%, initial nuclear radiation 5%, and the remaining 10% is present as radioactive contamination [fallout].

Shock wave in air. A shock wave in air constitutes an area of suddenly compressed air propagated in all directions from the center of the explosion at supersonic speeds. The source of the shock wave is a high-pressure zone in the center of the explosion, amounting to billions of atmospheres. The products of the explosion tend to expand, compressing the layer of surrounding air. In turn, this compressed air mass expands and transmits the pressure to adjoining layers. Thus the pressure is rapidly transmitted from layer to layer, forming a shock wave.

The outermost compressed air layer, characterized by a marked increase in pressure, is called the shock wave front. The shock wave front, moving rapidly away from the fireball, resembles a moving wall of highly compressed air. The thickness of the compressed air layer is constantly increasing due to the inclusion of new air masses with the increasing effective radius of the shock wave.

In the immediate vicinity of the explosion center, the speed of the shock wave exceeds the speed of sound several times. The speed of the shock wave gradually decreases, and its pressure is reduced with increasing distance from the center. The velocity and the distance to which the shock wave is propagated depend on the force of the explosion; the more powerful the explosion, the greater the speed and the larger the radius of propagation of the shock wave. Nevertheless, the action radius of the shock wave is affected by the topographic relief of the area, meteorological conditions, and the wind.

Along with rapid propagation of the shock wave front, air particles are compressed into layers in the direction of shock wave expansion. Air moves behind the shock wave front at supersonic speeds and takes on hurricane force.

The direction and the speed of air movement behind the shock wave front are subject to change. When the front reaches any point on the surface of the earth,

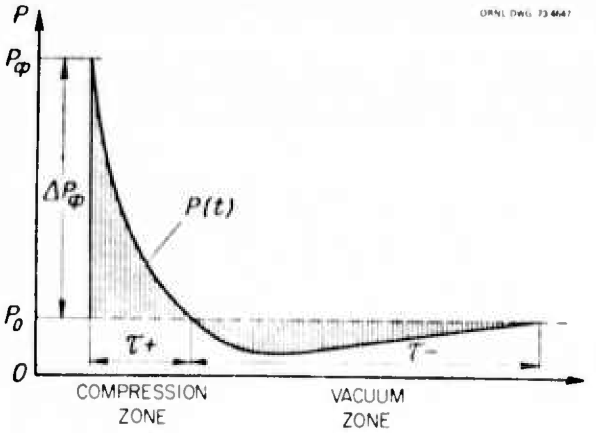

Fig. 11. Pressure changes according to time at any point on the surface of the earth when the shock wave passes through it.

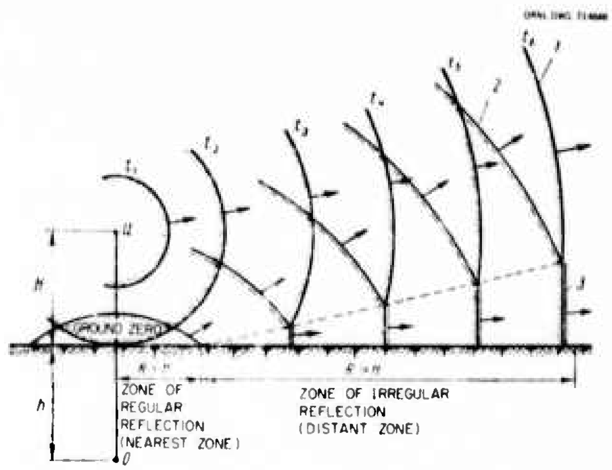

Fig. 12. Propagation of the blast wave; 1-incident wave; 2-reflected wave; 3-Mach stem wave.

there is an instantaneous increase in overpressure and temperature at that point, and the air begins to move perpendicularly to the shock wave. Subsequently, as the shock wave advances, the pressure behind the front drops below ambient pressure, and the wind direction reverses; the resulting [partial] vacuum follows the zone of compression, that is, the front (Fig. 11). In addition to the change in pressure, there is also a change in temperature. Temperature increases in the compression zone but drops in the vacuum zone. However, the temperature change and the rarefaction of the air are not as important as the overpressure.

The character of the effect of the wave depends on the nature of the explosion. When a shock wave in the air is produced, a spherical shock wave is formed; in the nearest zone, that is, at a distance shorter than the height of the explosion ($R < H$), it descends and is called the incident shock wave (Fig. 12). Upon reaching the surface of the earth, the shock wave is immediately reflected, forming a reflected wave. Due to the slowing down of the air particles and the interaction of the incident and reflected waves, the overpressure is multiplied. This nearest zone is called the zone of regular reflection.

In a zone at a distance greater than the height of the blast ($R > H$), the reflected wave is propagated in the air, which is heated and compressed by the passage of the incident wave. Thus, the velocity of the reflected wave is greater than that of the incident wave. As a result of this, the incident and reflected waves combine, forming the Mach stem wave which has a pressure 4 to 5 times greater than the pressure of the front of the incident wave. The Mach stem wave is propagated along the surface of the earth (see Fig. 12).

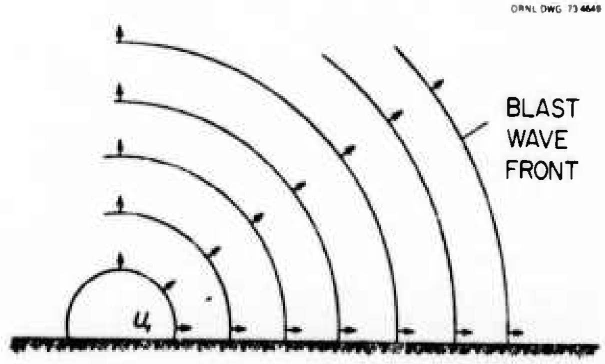

Fig. 13. Propagation of the blast wave in the case of a surface burst.

The zone in which generation and propagation of the Mach stem wave is observed is called the distant zone or the Mach region. Thus, the damaging effect in the immediate vicinity of the shock wave resulting from an air burst is determined by the pressure of the reflected wave, while in the Mach zone it is determined by the pressure of the Mach stem wave.

A surface burst results in a wave with the shape of a continuously enlarging hemisphere, which spreads parallel to the surface of the earth (Fig. 13) and does not have as complex a pattern as does the wave from an air burst.

A boundary can be defined at a determined distance from the center of a surface burst at which the overpressure in the blast wave front will be equal to that of an air burst of equal power. The overpressure will be greater closer to the center of a surface burst than is the case at the same distance of an air burst. Farther from this boundary, in a surface burst the overpressure will be less than in an air burst of the same power.

The radius of destruction of the blast wave from a surface burst is about 20% smaller than the radius of destruction of an air burst of the same power [see footnote *]. The basic parameters determining the destructive effect of a blast wave are overpressure, dynamic air pressure, and duration of action of the overpressure (duration of action of the compression phase).

The destructive effect of a shock wave is determined mainly by the overpressure. The overpressure (ΔP_{ϕ}) is the difference between ambient air pressure ahead of the wave front and the peak pressure within the shock wave front. It is measured in kg/cm^2 or in kn/m^2 (1 kn/m^2 $\approx$ 0.01 kg/cm^2).

The dynamic air pressure (ΔP_{sec}) is the dynamic load created by the air flow. The dynamic pressure is measured in kg/cm^2, as is overpressure. The air pressure depends on the velocity and the density of the air behind the wave front and is closely related to the value of the maximum overpressure of the shock wave. The dynamic air pressure is most significant at overpressures above 0.5 kg/cm^2 [7.35 psi].

The duration of action of overpressure (τ+) (effective duration of the compression phase) is measured in seconds. The more prolonged the action of the blast wave, the greater its destructive effect. The effective duration of the compression phase increases with the increasing power of the explosion.

Effect of the blast wave on people. Immediate injury of people by the blast wave occurs as a result of the effect of the overpressure and the dynamic air pressure. The shock wave envelops a person almost instantaneously and compresses the person from all sides. An instantaneous increase in pressure the moment the shock wave arrives is perceived as a sudden blow. The dynamic air pressure has a projecting effect and can knock a person down, causing injury.

An indirect injury is an injury sustained from fragments of buildings, trees, and other objects which are displaced under the effect of the dynamic air pressure.

The effects of the blast wave are sudden, damaging external organs, causing contusions, that is, injuries of varying degrees of seriousness; these can be classified as: *Light*, caused by overpressures from 0.2 to 0.4 kg/cm^2 [3–6 psi] and characterized by bruises, sprains, temporarily impaired hearing, and general contusions; *moderate*, occurring at overpressure of 0.4 to 0.6 kg/cm^2 [6–9 psi] and characterized by serious contusions of all organs, damage to the hearing organs, bleeding from the nose and ears, and serious contusions of the extremities; *serious*, occurring at overpressures of 0.6 to 1.0 kg/cm^2 [9–14.7 psi] and characterized by serious contusions of all organs, serious fractures of the extremities, and heavy bleeding from the nose and ears; *very serious*, observed at overpressures higher than 1 kg/cm^2 [14.7 psi]. These injuries may be fatal.

The radius of destruction from the blast wave of a nuclear explosion and the types of injuries depend on the power of the explosion. The radius of destruction to people from building fragments, especially glass fragments, blown out under overpressures of 0.02 to 0.07 kg/cm^2 [0.3–1.0 psi] may increase the radius of immediate destruction from the blast wave.

In our discussion of shielding oneself from the blast wave, we include the direct effect of the blast wave as well as its indirect effect. To protect oneself from a blast wave, it is necessary to have underground structures — shelters which can be depended upon to withstand the effect of the blast wave. Other cover is used in the absence of shelters, such as underground mines, shafts, natural cover, and the relief of the terrain.

The protective nature of the terrain depends on the size and the characteristics of topographic relief relative to the blast. The pressure of the blast wave decreases on slopes facing away from the center of the blast, and thus its destructive effect is reduced. In general, it can be assumed that on the rear of slopes having an angle up to 30° the pressure of the blast wave is decreased up to 5 to 15%, and on an angle of more than 30°, up to 15 to 30%.

The protective features of ditches, washed-out hollows, ravines, and gullies depend on their orientation with relation to the propagation of the shock wave, their depths, and their widths. Ditches, washed-out hollows, ravines, and gullies extending in the direction of shock wave propagation increase its destructive effect. If such relief patterns are situated perpendicular to the direction of shock wave propagation, then they greatly attenuate its destructive effect. For example, at the bottom of a hollow, the pressure may be 2 to 3 times less than in the front of a passing wave. The degree to which the pressure is diminished increases as the hollow becomes deeper and narrower.

[* This is equivalent to stating that the area covered by destructive effects of a given intensity caused by a surface burst is 64% of the corresponding area covered by an air burst of the same sized weapon.]

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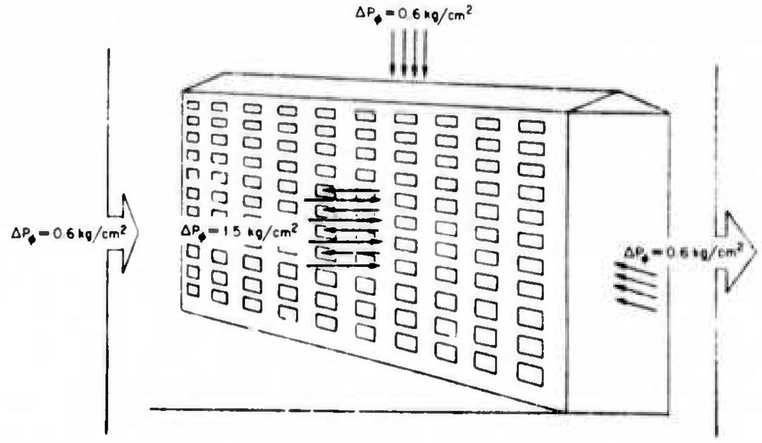

Fig. 14. Effect of a blast wave on a building.

Large topographic forms offer the best shelter — hills, ravines, and canyons of large dimensions. However, small features, such as hills, depressions, and sinkholes, are capable of attenuating the effect of shock waves.

Effect of a blast wave on buildings and structures. This depends on the magnitude of the overpressure and the dynamic pressure of the air moving behind the front of the shock wave. The overpressure of the shock wave and the dynamic air pressure exerted on a structure cause its destruction.

While the wave is freely expanding without encountering resistance, it creates a load, which changes with time, equal to the overpressure of the passing blast wave. When the shock wave encounters an obstacle, it is reflected (forming a reflected pressure Δp_{refl}) and decelerates the mass of moving air, so that the overpressure increases two to eight times. As a result, the obstacle undergoes an impact of tremendous force, which is increased due to the reflected pressure. Reflected pressure can be calculated according to the formula

$$\Delta p_{\text{refl}} = 2\Delta p_{\Phi} + \frac{6\Delta p_{\Phi}^2}{\Delta p_{\Phi} + 7p_0}$$

where

Δp_{refl} = reflected pressure,

Δp_{Φ} = overpressure at the shock wave front,

p_0 = ambient pressure.

For example, if a blast wave encounters a house in its path, the impact occurring on the wall becomes the center of impact. If the overpressure is 0.5 kg/cm² [7 psi], the wall of the house sustains a pressure of 5 t/m^2. If the overpressure increases eight times, the wall will undergo an impact of 40 t/m^2 at the initial moment. Then the blast wave begins to be deflected around the house, exerting pressure on the side walls and on the top, and then on the rear wall. As a result, the house is enveloped with a high pressure and compressed from all sides (Fig. 14); however, the wall facing the blast is subjected to the highest pressure. The effect of the blast wave when bypassing and surrounding the building is a complex interaction of currents, flowing around the building on the top and the sides, creating vortices and high-pressure zones. Figure 15 shows the shock wave deflected around a vertical obstacle when the shock wave is reflected by the surface of the earth behind the obstacle. The shock wave deflected around a building from the sides creates an increased pressure when the two flows meet (Fig. 16). The reflected pressure on the front wall is attenuated in proportion to the extent to which the wave is deflected around the building.

The effect of the overpressure and of the dynamic air pressure when a blast wave destroys a building may vary according to the construction of the building, its size, and its position relative to the direction of travel of the blast wave.

A large building with a large wall area is primarily destroyed by the effect of the initial instantaneous impact, developing as a result of shock wave reflection. This is because the shock wave requires a certain amount of time for deflection, causing a relatively long-term effect of reflected pressure from the shock wave.

Residential buildings with brick walls are less stable and are completely destroyed with an overpressure of

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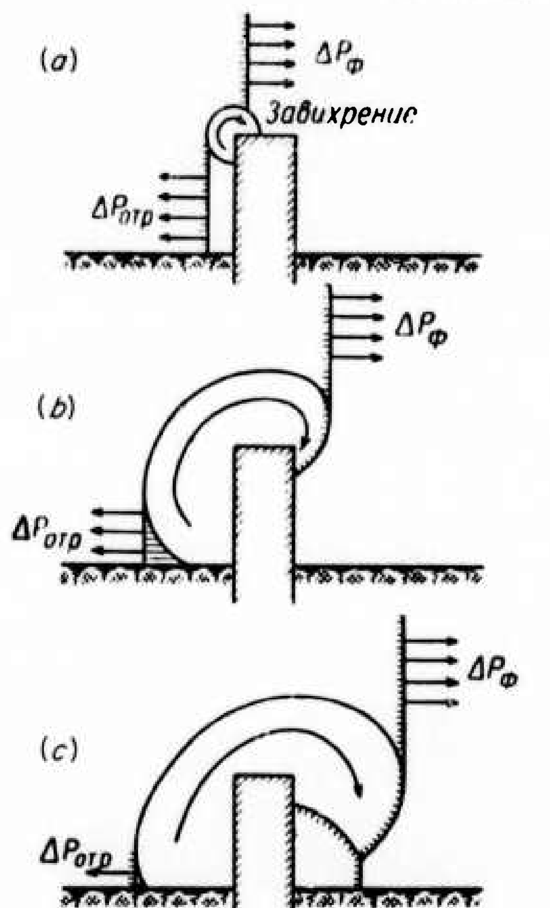

Fig. 15. A blast wave engulfing a vertical obstacle. (*a*) The front reaches the obstacle and exerts full reflected pressure; (*b*) the front passes by the obstacle and partially exerts reflected pressure; (*c*) the effect of reflected pressure ceases, but behind the obstacle the blast wave is reflected from the earth's surface.

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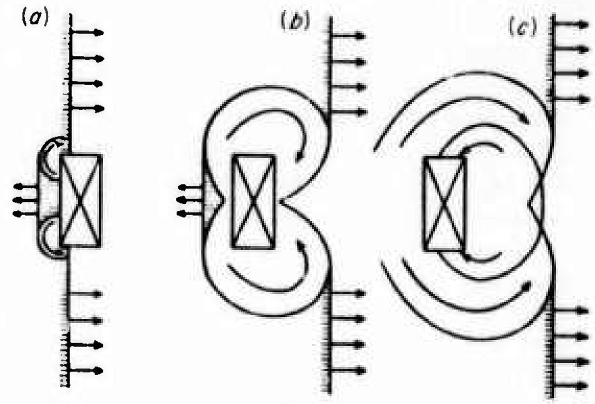

Fig. 16. Blast wave circumventing an obstacle (plan view). (*a*) The blast wave reaches the obstacle, reflected pressure is created, and circumvention begins; (*b*) the front passes by the obstacle and two flows are set in motion in the rear; (*c*) the front moves further and a high-pressure zone is formed behind the obstacle due to the collision of the two flows.

the blast wave equal to 0.3 to 0.4 kg/cm^2 [4–6 psi], but wooden structures are completely destroyed at a pressure of 0.1 to 0.2 kg/cm^2 [2–3 psi].

Among aboveground buildings and structures, the most stable are monolithic iron-steel structures, buildings with a metal framework, and buildings with an antiseismic design, which are completely destroyed when the overpressure of the shock wave equals 0.5 to 0.8 kg/cm^2 [7–12 psi].

The presence of apertures in walls (windows, doors) has an influence on the destruction of buildings and structures since the wave, easily destroying them, penetrates quickly into the building, and the reflected pressure [outside] is compensated by the overpressure within. Complete destruction of the glass in different buildings occurs when the pressure of the blast wave front reaches 0.02 to 0.07 kg/cm^2 [0.3–1.0 psi], while partial destruction occurs at 0.01 to 0.02 kg/cm^2 [0.15–0.29 psi].

A special characteristic of the effect of a wave is its ability to penetrate [blast] shelters, fallout shelters, and other buildings through ventilation openings and vent pipes and its ability to create damage inside, as well as to injure people. When a wave penetrates a building, the temperature quickly rises to a level which may kill people. To avoid this in [blast] shelters and fallout shelters, all openings are sealed, and the air vents are equipped with shock-attenuating devices.

The wave is quickly deflected around high structures of small area (telegraph poles, factory smokestacks, well derricks, and other [such] structures), since they are less likely to generate a reflected wave. For these structures, the destructive effect of the blast wave is determined by the effect of the dynamic air pressure. Such structures, designed to counteract the effect of wind load, are destroyed by the effect of the dynamic air pressure.

Metal oil-well derricks are more stable than industrial buildings. They lose stability and collapse under somewhat higher pressure. The weaker elements of a derrick are the anchor bracings on the supports, the pipe connections, and the shaft braces.

A cracking plant is still more stable than oil derricks; the weakest elements in metal cracking-plant components are the annular reinforced-concrete base supports. Urban reinforced concrete and metal bridges are very stable since they have a small surface and are less susceptible to the dynamic air pressure. The buildings of power-plants are destroyed at the same blast wave pressures as multistory brick buildings.

Home furnaces are put out of commission at a blast wave pressure somewhat greater than the pressure which completely destroys industrial buildings. The first parts of home furnaces to be destroyed are the air-water pipes, the structure itself, and the stoker.

Structures which are sunk deep in the ground are less susceptible to the effects of a blast wave, since the shock wave does not encounter an obstacle during travel and no pressure increase occurs by reflection of the shock wave. Underground municipal utility networks are rather stable against the effect of a blast wave. Housing development buildings are generally destroyed and wells are also damaged. Blast shelters and fallout shelters sunken into the ground can withstand a rather high-pressure blast wave. Depending on the load created by the blast wave, buildings and structures sustain damage of varying degrees.

A. Stone, reinforced-concrete, wood-frame, and frameless residential, administrative, and industrial buildings

1. Complete destruction is characterized by destruction and collapse of one or more of the walls and by a high degree of deformation or collapse of the roof. Fragments fall into rubble within the periphery of the building and around it. Restoration of destroyed buildings is impossible.

2. Heavy damage is characterized by destruction of parts of the walls and ceilings of the lower floors and basements, making future use of the premises impossible or inexpedient.

3. Moderate damage is characterized by destruction of most builtin parts: inside partitions, doors, windows, and ceilings; appearance of cracks in walls and the destruction of attic ceilings and individual sections of upper floors. The basement is preserved and is suitable for temporary use after rubble is removed from the entrances. Rubble does not accumulate around the building, but individual fragments of the structure may be thrown a considerable distance. Restoration is possible in the course of major repairs.

4. Slight damage is characterized by destruction of windows, doors, and thin partitions and the appearance of cracks in walls of the upper stories. The basement and lower floors remain intact and are suitable for temporary use. Restoration is possible in the course of major repair work.

B. Blast shelters and fallout shelters of substantial constructions

1. Complete destruction is characterized by destruction of basic protective structures, entrances, protective doors, and inside equipment. Restoration and future use are completely impossible.

2. Heavy damage is characterized by partial damage to the basic shelter structure, entrances, doors, and protective equipment. Restoration and future use are impossible.

3. Moderate damage is characterized by destruction of entrances and displacement and deformation of basic structural elements. Renewed use of the structure is possible after repair.

4. Slight damage is characterized by partial destruction or collapse of entrances and damage to supporting and safety structures. The building is suitable for use after clearing the entrances.

C. Fallout shelter constructed under threat of attack

1. Complete destruction is characterized by destruction of the roof beams, collapse of the room to the ground, and fallen ceiling parts. Restoration and prolonged use of the building are impossible.

2. Heavy damage is characterized by considerable damage to the roof beams and partial collapse of the walls. Future use is impossible.

3. Moderate damage is characterized by partial damage to roof beams and destruction of entrances, doors, and door frames. Future use of the building is possible after repair.

4. Slight damage is characterized by partial destruction of entrances and parts of the building adjoining them and considerable displacement and deformation of ceilings. The building is suitable for future use.

D. Utility systems, electric communication lines, and interconnections

1. Complete destruction is characterized by broken cables and destruction of pipe lines and high-tension poles over wide areas.

2. Heavy damage is characterized by broken cables and partial damage to pipe lines and high-tension wire poles in localized areas.

3. Moderate damage is characterized by localized broken and deformed cables and pipe lines and deformation and damage to individual high-tension

poles and electro-communication lines and junctions.

4. Light damage is characterized by slight deformation of individual networks and line sections.

The overpressure values causing damage of varying degrees to buildings and structures are listed in Table 3.

The extent of damage in a city depends on the design of the buildings and their number of stories, their density, and [the overall] urban design, because one building may shield others, that is, a building standing near the center of the blast may absorb the impact of the blast wave and reduce its effect on buildings farther away. However, the shielding effect is noticeable only on building densities of 50%. In this case, the overpressure of the blast wave on the buildings may be 20 to 40% less than on a building standing in an unprotected area at the same distance from the center of the blast. If the building density is less than 30%, the screening effect is insignificant and has practically no value.

Table 4 gives the distances [from ground zero] at which [the listed] overpressures in the front of the shock wave may occur.

Thermal radiation. The thermal radiation of a nuclear explosion consists of radiation in the ultraviolet, infrared, and visible regions. In the first fractions of a second after the appearance of the flash, the temperature increases millions of degrees and ultraviolet radiation prevails; as the fireball cools, visible and infrared radiation is emitted.

The source of thermal radiation is the luminous area consisting of incandescent gaseous products of the explosion and air heated to a high temperature. In the first moment that the fireball emerges, its temperature reaches 8,000 to 10,000°C, gradually dropping to 1,000 to 2,000°C. After this time, thermal radiation ceases.

The duration of emission of thermal radiation depends on the yield of the explosion and may continue from a fraction of a second to several seconds. In a blast of a nuclear charge with a yield of 20 kilotons, thermal radiation persists for 3 sec; in a thermonuclear charge of 1 megaton, 10 sec; in a charge of 10 megatons, up to 22 sec. The maximum dimensions of the luminous area and of the duration of thermal radiation increase along with an increase in explosive power.

The basic parameter characterizing thermal radiation is the thermal pulse. The thermal pulse is the quantity

Table 3.

Type of buildings and structures	Overpressure (kg/cm^2) [psi]				
	Complete	Heavy	Moderate	Light	Damage
Building with a steel frame	0.8 [11.4]	0.5 [7.1]	0.3 [4.3]	0.2 [2.8]	0.05 [0.7]
Brick building of a few stories	0.45 [6.4]	0.35 [5.0]	0.25 [3.5]	0.15 [2.1]	0.05 [0.7]
Brick building of many stories	0.4 [5.7]	0.3 [4.3]	0.2 [2.8]	0.1 [1.4]	0.05 [0.7]
Wooden building	0.3 [4.3]	0.22 [3.1]	0.12 [1.7]	0.07 [1.0]	0.04 [0.6]
Underground water and gas lines	15 [213]	12 [170]	7.0 [99]	3.0 [43]	2.0 [28]
Covered manholes	15 [213]	10 [142]	3.0 [43]	2.0 [28]	1.2 [17]
Overhead communication lines	0.7 [9.9]		0.35 [5.0]		
Steel bridges with 30–45 m spans	2.5 [36]	2.0 [28]	1.5 [21]	1.0 [14]	0.5 [7.1]
Reinforced-concrete bridges with 25 m span	2 [28]	1.5 [21]	1.2 [17]	1.0 [14]	0.5 [7.1]
Highways with asphalt and concrete surfaces	40 [568]	30 [426]	10 [142]	3 [43]	1–2 [14–28]
Air fields	40 [568]	30 [426]	15 [213]	4 [57]	1–2 [14–28]

Table 4. [Metric units]

Weapon power, q (kilotons)	Overpressure, Δp (kg/cm^2)									
	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
	Distance from ground zero (km)									
20	0.6	0.7	0.8	0.85	0.9	1.0	1.1	1.5	2.0	3.2
	0.7	0.8	0.9	0.95	1.0	1.1	1.2	1.5	1.9	3.0
50	0.8	0.9	1.0	1.1	1.2	1.3	1.4	2.0	2.7	4.5
	1.0	1.1	1.2	1.25	1.3	1.4	1.5	2.0	2.6	4.2
100	1.0	1.2	1.3	1.4	1.6	1.7	2.1	2.6	3.8	6.5
	1.2	1.3	1.4	1.5	1.7	1.9	2.2	2.5	3.2	5.2
200	1.2	1.4	1.5	1.6	1.8	1.9	2.5	2.9	4.4	7.9
	1.5	1.6	1.7	1.8	2.0	2.2	2.6	3.0	3.8	6.4
500	1.7	1.9	2.0	2.3	2.6	3.0	3.4	4.2	6.0	11.5
	2.1	2.3	2.4	2.6	2.8	3.2	3.6	4.4	5.5	9.0
1,000	2.2	2.4	2.7	3.0	3.3	3.6	4.3	5.3	7.5	14.3
	2.9	3.0	3.4	3.5	3.6	4.0	4.5	5.4	7.0	11.2
2,000	2.7	3.0	3.3	3.6	4.2	4.6	5.6	6.8	9.5	18.0
	3.4	3.7	3.9	4.2	4.6	5.2	5.7	7.0	8.8	14.2
3,000	3.2	3.4	3.7	4.2	4.6	5.4	6.3	7.8	11.0	20.5
	4.0	4.2	4.5	4.8	5.2	5.7	6.5	8.0	10.1	16.2
5,000	3.7	4.2	4.4	5.0	5.6	6.5	7.6	9.2	13.0	24.0
	4.7	5.0	5.4	5.7	6.2	6.8	7.8	9.3	12.0	19.5
10,000	4.8	5.3	5.6	6.3	7.0	7.9	9.3	11.4	16.2	31.4
	6.9	6.3	6.7	7.2	7.7	8.5	9.6	11.6	15.3	24.5

[English units]

Weapon power, q (kilotons)	Overpressure, Δp (kg/cm^2)									
	14.2	12.8	11.4	9.9	8.5	7.1	6.7	4.3	2.8	1.4
	Distance from ground zero (miles)									
20	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.9	1.2	2.0
	0.4	0.5	0.6	0.6	0.6	0.7	0.7	0.9	1.2	1.8
50	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.2	1.7	2.8
	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.2	1.6	2.6
100	0.6	0.7	0.8	0.9	1.0	1.1	1.3	1.6	2.4	4.0
	0.7	0.8	0.9	0.9	1.0	1.2	1.4	1.6	2.0	3.2
200	0.7	0.9	0.9	1.0	1.1	1.2	1.6	1.8	2.7	5.0
	0.9	1.0	1.0	1.1	1.2	1.3	1.6	1.9	2.4	4.0
500	1.1	1.2	1.2	1.4	1.6	1.9	2.1	2.6	3.7	7.1
	1.3	1.4	1.5	1.6	1.7	2.0	2.2	2.7	3.4	5.6
1,000	1.4	1.5	1.7	1.9	2.0	2.2	2.7	3.3	4.7	8.9
	1.8	1.9	2.1	2.2	2.2	2.5	2.8	3.4	4.3	7.0
2,000	1.7	1.9	2.0	2.2	2.6	2.9	3.5	4.2	5.9	11.2
	2.1	2.3	2.4	2.6	2.9	3.2	3.5	4.3	5.5	8.8
3,000	2.0	2.1	2.3	2.6	2.9	3.4	4.0	4.8	6.8	12.7
	2.5	2.6	2.8	3.0	3.2	3.5	4.0	5.0	6.3	10.0
5,000	2.3	2.6	2.7	3.1	3.5	4.0	4.7	5.7	8.1	14.9
	2.9	3.1	3.3	3.5	3.9	4.2	4.8	5.8	7.5	12.1
10,000	3.0	3.3	3.5	3.9	4.3	4.9	5.8	7.1	10.1	19.5
	4.3	3.9	4.2	4.5	4.8	5.3	6.0	7.2	9.5	15.2

NOTE: The first values give the distances [from ground zero] for an air burst; the second values give the distances for a surface burst.

of energy incident on 1 cm^2 of a surface, perpendicular to the direction of propagation, during the whole interval of luminescence. The thermal pulse is measured in calories per square centimeter or in joules per square meter (cal/cm^2 or J/m^2).

The magnitude of the thermal pulse depends on the power and the type of blast, the distance from the center of the blast, and the degree of thermal radiation attenuation in the atmosphere. The thermal pulse decreases in proportion to the square of the distance from the center of the blast.

The energy of thermal radiation incident on the surfaces of an object is partially absorbed by the surface layer of the material and partially reflected from its surface; if the surface is transparent, then part of the energy is transmitted through the object. The absorbed thermal radiation is converted into thermal energy which causes the surface layer of the material to heat. Heating may be so great that carbonization or combustion of the heated material is possible, and softening or melting of noncombustibles may result.

Ignition of materials by thermal radiation depends on the distance, the type of blast, atmospheric conditions, and the nature of the materials. Atmospheric conditions have great influence on the ignition of materials.

In an air burst, the luminous area has the shape of a ball; thermal energy is absorbed less, and the effective radius of thermal radiation has a maximum value.

In a surface burst, the luminous area has the shape of a hemisphere, which rises above the surface of the earth and is transformed into a fireball. In this case, the main portion of the thermal pulse propagates almost parallel to the earth's surface or touches the ground at a very acute angle. Part of the thermal radiation is absorbed by the ground. The thermal pulse close to the blast site reaches enormous magnitudes. At distances from the blast site greater than the altitude to which the fireball ascends, the thermal pulse is less than in an air burst. This is true because in a surface burst a considerable part of the thermal energy is dissipated by melting the earth in the center of the blast.

Effect of thermal radiation on people. The effects of thermal radiation on people are burns on exposed skin and eye injuries. Depending on the magnitude of the thermal pulse, the burns may be classified into three degrees: *First degree burns* occur with thermal pulses of 2 to 4 cal/cm^2 and are characterized by surface damage to the skin, reddening, edema, and nausea; *second degree burns* occur with thermal pulses of 4 to 10 cal/cm^2 and are characterized by the formation of vesicular blisters on the skin; *third degree burns* occur with thermal pulses of 10 to 15 cal/cm^2 and are characterized by necrosis of the skin [localized death of skin cells] and open lesions.

The seriousness of injuries to people from thermal radiation depends not only on the degree of the burns, but on the extent of the surface area of the body that is injured. The effective radius of thermal radiation causing first, second, and third degree burns to people depends on the power of the nuclear explosion.

The degree of burns from thermal radiation on covered parts of the skin depends on the character of the clothing, its color, density, and thickness. People dressed in white, loose-fitting clothes or other lightly tinted clothes are usually burned less by thermal radiation than people dressed in dark-colored, tight-fitting clothes.

Burns can also be caused by fires resulting from thermal radiation. These burns cannot be distinguished from burns caused by thermal radiation.

There are three possible types of damage to the eyes caused by thermal radiation: (1) temporary blinding, which lasts for a few minutes; (2) burns on the fundus of the eye [part of the eye opposite the pupil], occurring at great distances, when looking straight into the blast; (3) burns on the cornea and eyelids, occurring at the same distances as skin burns. When the eyes are closed, temporary blinding and burns on the fundus of the eye are prevented. Various objects which create a shadow may serve as protection from thermal radiation, but the best results are obtained by the use of blast shelters and fallout shelters, which simultaneously provide protection from other damaging effects.

Effect of thermal radiation on buildings and structures. Depending on the nature of the material, thermal radiation causes melting, charring, and ignition which leads to fires and conflagrations in populated areas. At distances close to the center of the blast ($R < H$), the thermal radiation is incident vertically or at angles close to 90°, but at greater distances ($R > H$) it is incident at smaller angles, almost parallel to the earth's surface. In this case, thermal radiation goes through windows into rooms and may set household objects afire: rugs, curtains, upholstery, furniture, books, etc. (Fig. 17).

The effect of thermal radiation or of the blast wave in the city may cause individual or group fires, conflagrations, or fire storms involving many conflagrations.

An individual fire is a fire enveloping one house or a group of buildings. In a nuclear explosion, several individual fires may occur which may be transformed into group fires or conflagrations.

A group fire is a combination of individual fires resulting from a nuclear explosion enveloping more than 25% of the buildings in a given populated area.

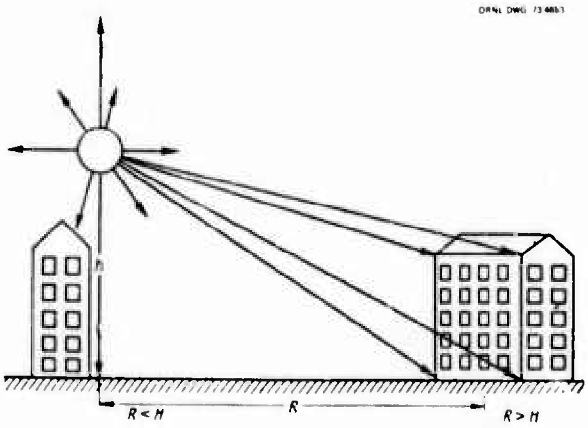

Fig. 17. Direction of thermal radiation for a nuclear blast: At $R<H$ the thermal radiation is directed onto the roof; at $R>H$ the thermal radiation penetrates through the window.

A conflagration is defined as a group fire which envelops more than 90% of the buildings. A fire storm is a special type of conflagration, so-called when the urban area (not less than 250 hectares) is enveloped by a conflagration with a strong (hurricane-like) wind blowing from all sides toward the center of the blast at a speed of 50 to 60 km/hr [31–37 mph] [see note *], because a powerful ascending draft develops in the center of the fire, creating conditions for a hurricane-like wind.

In August of 1945, a fire storm occurred in the city of Hiroshima which raged for 6 hr, as a result of an atomic bomb dropped by the United States. In consequence, a large part of the central city was completely destroyed by fire. About 60,000 homes were destroyed. Hurricane winds blowing toward the center of the blast for 2 to 3 hr reached speeds of 50 to 60 km/hr [see note]. Later, for about 6 hr, the velocity was reduced to that of a moderate wind.

Combatting fire storms is impossible; even high-power fire-fighting equipment cannot cope with the fire. Thus, it is extremely important to take all measures to prevent the development of a fire storm if the enemy uses nuclear weapons. The speed with which fires spread in a city depends on the character of the buildings and on wind speed. If the wind has a speed of 5 to 7 m/sec [11–16 mph], then the fire may spread in a city with brick buildings with a speed of 100 m/hr and more, and, in populated areas with flammable buildings, 120 to 300 m/hr. In rural areas, the fire spreads with a speed of 600 to 900 m/hr and more.

The presence of combustible materials around buildings is also very important. The following materials can be easily ignited by thermal radiation: tar paper, paper, straw, cane reeds, peat, wood, oil products, and other materials. In cities and in [other] populated areas where there are large quantities of such materials, group fires may break out due to the effect of thermal radiation. The ignition of materials by thermal radiation depends on their properties, thickness, and moisture content. The thermal pulse values causing ignition of various materials are listed in Table 5.

It is evident from Table 5 that in a blast with a power of 20 kilotons, thermal pulses are less intense than from a blast of 10 megatons. This is because the duration of thermal pulse is much longer from a blast of 10 megatons than from a blast of 20 kilotons. Table 6 shows the distances from the centers (ground zero) of

[*This is an obvious error, perhaps caused by not correctly converting wind velocities expressed in mph to km/hr.]

Table 5. Thermal pulse required for ignition

Materials	Thermal pulses (cal/cm^2) as a function of explosive power	
	20 kilotons	10 megatons
Newspaper	3	6
Dry weed	4	9
Sparse dry grass	5	10
Pine shavings (yellow)	5	12
Fallen leaves	6	12
Gray cotton cloth	8	16
Yellow broom	8	17
Fallen pine or spruce needles	8	18
Rubber-treated tarpaulin (gray)	15	28
Cottom cloth (white)	15	30
Coarse wool rug (gray)	16	35

Table 6. [Metric units]

Weapon power, q (kilotons)	Thermal pulse (cal/cm^2)											
	30	25	20	18	16	14	12	10	8	6	4	2
	Distance from ground zero (km)											
20	1.1	1.15	1.25	1.3	1.35	1.5	1.7	1.8	2.0	2.4	2.8	4.0
	0.7	0.75	0.8	0.85	0.9	1.0	1.1	1.2	1.3	1.4	1.7	2.7
50	1.8	2.0	2.2	2.3	2.5	2.7	3.0	3.2	3.5	4.2	5.0	6.5
	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.0	2.2	2.7	3.0
100	2.7	2.8	3.1	3.3	3.6	3.9	4.2	4.6	5.0	6.0	7.0	9.0
	1.5	1.6	1.9	2.0	2.1	2.2	2.4	2.7	3.0	3.4	4.2	6.0
200	3.2	3.4	3.7	4.0	4.3	4.7	5.8	6.9	8.0	9.0	10.0	11.0
	1.8	2.0	2.2	2.4	2.5	2.7	2.9	3.2	3.6	4.1	5.2	7.1
500	5.2	5.5	5.9	6.3	6.6	7.0	8.0	9.0	11.0	13.0	15.0	17.0
	2.8	3.0	3.2	3.6	3.8	4.1	4.4	4.8	5.4	6.1	8.1	10.4
1,000	7.7	8.6	8.8	9.0	10.0	11.2	13.6	14.8	15.8	16.6	18.6	26.8
	4.8	4.9	5.1	5.6	6.2	6.8	7.2	7.8	8.6	10.1	14.0	16.6
2,000	9.0	9.5	9.4	10.5	11.0	12.5	15.0	18.0	20.5	23.0	26.0	29.0
	5.3	5.7	5.9	6.4	7.0	7.5	8.4	8.7	10.0	11.3	14.7	18.2
5,000	13.0	13.8	14.5	15.6	16.5	17.5	20.0	23.0	26.0	29.5	33.0	37.0
	7.9	8.4	8.8	9.3	10.0	11.0	11.5	12.2	14.5	17.0	19.7	24.9
10,000	20.6	21.0	22.0	24.6	26.0	28.0	29.0	30.5	33.0	37.0	41.0	51.0
	12.8	13.2	14.0	15.0	16.0	17.0	18.0	19.0	23.0	27.0	29.0	37.0

[English units]

Weapon power, q (kilotons)	Thermal pulse (cal/cm^2)											
	30	25	20	18	16	14	12	10	8	6	4	2
	Distance from ground zero (miles)											
20	0.7	0.7	0.8	0.8	0.9	0.9	1.1	1.1	1.2	1.5	1.7	2.5
	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.1	1.7
50	1.1	1.2	1.4	1.4	1.6	1.7	1.9	2.0	2.1	2.6	3.1	4.0
	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.2	1.4	1.7	2.4
100	1.7	1.7	1.9	2.0	2.2	2.4	2.6	2.9	3.1	3.7	4.3	5.6
	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.7	1.9	2.1	2.6	3.7
200	2.0	2.1	2.3	2.5	2.7	2.9	3.6	4.3	5.0	5.6	6.2	6.8
	1.1	1.2	1.4	1.5	1.6	1.7	1.8	2.0	2.2	2.6	3.2	4.4
500	3.2	3.4	3.7	3.9	4.1	4.3	5.0	5.6	6.8	8.1	9.3	10.6
	1.7	1.9	2.0	2.2	2.4	2.6	2.7	3.0	3.4	3.8	5.0	6.5
1,000	4.8	5.3	5.5	5.6	6.2	7.0	8.5	9.2	9.8	10.3	11.6	16.7
	3.0	3.0	3.2	3.5	3.9	4.2	4.5	4.8	5.3	6.3	8.7	10.3
2,000	5.6	5.9	5.8	6.5	6.8	7.8	9.3	11.2	12.7	14.3	16.2	18.0
	3.3	3.5	3.7	4.0	4.3	4.7	5.2	5.4	6.2	7.0	9.1	11.3
5,000	8.1	8.6	9.0	9.6	10.9	10.9	12.4	14.3	16.2	18.3	20.5	23.0
	5.0	5.2	5.5	6.1	6.2	6.8	7.1	7.6	9.0	10.6	12.2	15.5
10,000	12.8	13.0	13.7	15.3	16.2	17.4	18.0	19.0	20.5	23.0	25.4	31.7
	8.0	8.2	8.7	9.3	9.9	10.6	11.2	11.8	14.3	16.8	18.0	23.0

NOTE: The first values give the distances [from ground zero] for an air burst; the second values give the distances for a surface burst.

the blast [area] at which thermal pulses of different intensities occur for [different power] surface and air bursts.

The spreading of fires in the city depends on fire-resistant properties of the buildings, their density, local topography, weather conditions, and the distances from the center of the blast.

The building density has an especially great influence on the spreading of fires. The smaller the builtup density, the lower the probability of a fire spreading from one building to another. Figure 18 is a curve expressing in percentages the probability of fire spreading as a function of the distances between buildings.

It is evident from the graph that if the distance between buildings is 15 m, in 50 cases out of 100 the fire will spread to the next building. At distances between the buildings of 90 m, there was zero probability of a fire jumping from one building to another.

Local topography also has an influence on the spreading of fires in a city. The total area of the fires caused by the atomic blast in Nagasaki was four times less than the area of fires in Hiroshima, because the spreading of fires in Nagasaki was hindered by the hilly nature of the area. In Hiroshima, which is built on flat terrain, there were no such impediments. In addition to the relief of the locality, the presence of water obstacles and green areas which modify the effect of the fire and impede its propagation are also very important.

The time of year and the meteorological conditions also have a great influence on the spreading of fires. In bright summer weather, favorable conditions are created for the spreading of fires. Rain, fog, and snowfall attenuate thermal radiation and consequently inhibit the formation of group fires. In industrialized cities, the atmosphere contains large quantities of dust and smoke, forming smog which attenuates thermal radiation. The execution of preventive measures has great importance for preventing group fires.

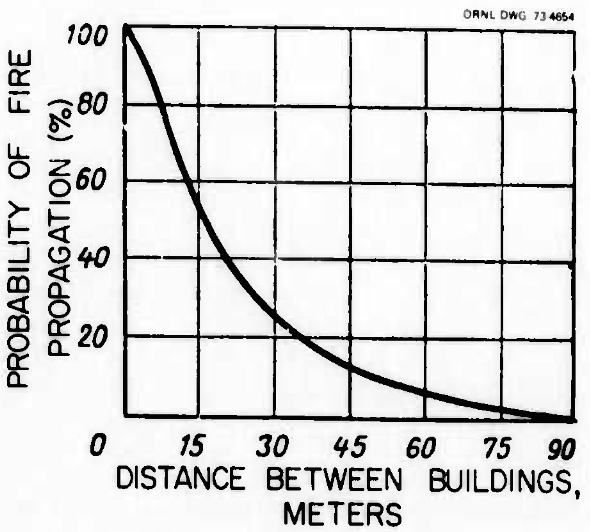

Fig. 18. Probability of fire propagation as a function of the distance between buildings.

As a result of thermal radiation, large forest fires may break out due to the combustion of dry leaves, grass, and dry wood. The propagation of fires in forests depends on the season and meteorological conditions. Coniferous forests in dry summer weather present a particularly great hazard. As a rule, deciduous forests, especially when the leaves have not yet fallen, burn less rapidly and with less intensity than coniferous forests.

The radius of action of thermal radiation is greater than the radius of action of the blast wave. Thus, with a nuclear blast with a power of 1 megaton, the radius of action of the blast wave is 11 km [6.8 miles], and the radius of action of thermal radiation is 17 km [10.5 miles]. Thermal radiation is propagated far beyond the limits of the zone of action of the blast wave.

Initial nuclear radiation. Initial nuclear radiation is a flux of gamma rays and neutrons emitted from the center of a nuclear blast. The source of the initial nuclear radiation is a nuclear reaction and radioactive decay of nuclear fission products. The duration of the effect of initial nuclear radiation does not exceed 10 to 15 sec from the moment of the blast. After this, the decay of short-lived fission fragments formed as a result of the nuclear reaction terminates. In addition, the radioactive cloud rises to great heights, and radiation is absorbed by the mass of air and does not reach the surface of the earth.

Initial nuclear radiation is characterized by absorbed dosage, that is, the amount of energy from the radiation absorbed per unit volume of irradiated media. The exposure dose is a measure of the total amount of ionization that the quantity of gamma rays and neutrons can produce in the air volume. The ionization process consists in knocking out electrons from electron shells of atoms. Due to this, the uncharged atoms, are converted to variously charged particles, ions.

Initial nuclear radiation is the total flux of gamma radiation and neutrons. Gamma radiation, making up the greater part of initial nuclear radiation, is produced immediately at the moment of detonation, in the process of the explosive nuclear reaction, as well as after the blast as a result of radiative neutron capture by the nuclei of atoms of various elements. The duration of gamma radiation is 10 to 15 sec. The unit for measuring a gamma-radiation dose is the roentgen, the special international physical dose unit (amount of energy).

A roentgen is the amount of gamma radiation which, at a temperature of 0°C and a pressure of 760 mm in 1 cm^3 of dry air, produces 1 billion ion pairs (more precisely 2.08×10^9). The roentgen is designated by the letter R. One thousandth part of a roentgen bears the designation milliroentgen and is abbreviated mR.

The neutron flux produced in a nuclear explosion contains fast and slow neutrons which affect living organisms differently. The neutron fraction in a total dose of initial nuclear radiation is smaller than the gamma-ray fraction. It increases somewhat with a decrease in the power of the nuclear blast. The basic source of neutrons in a nuclear blast is the nuclear chain reaction. The neutron flux radiates in fractions of a second after the blast and can cause artificially induced radiation in metal objects on the ground. Induced radioactivity is observed only in the zone directly adjacent to the blast site.

The radiation dose in a neutron flux is measured by a special unit, the roentgen equivalent mammal (rem). The rem is the dose of neutrons with a biological effect equivalent to 1 R gamma radiation.

The harmful effect of initial nuclear radiation on humans is called irradiation, which has a harmful biological effect on living cells of organisms. This harmful effect stems from the fact that gamma rays and neutrons ionize the molecules of living cells. This ionization disrupts the normal activity of cells and in large doses leads to their destruction. The cells lose their power to undergo mitosis; as a result the individual develops radiation sickness.

The effect of initial nuclear radiation on human beings depends on the radiation dose and the exposure time. A single exposure dose of up to 50 R in the course of 4 days and nights, as well as a continuous dose of up to 100 R over 10 days, will not cause pathological symptoms and is not considered dangerous; doses above 100 R cause radiation sickness.

There are three degrees of radiation sickness, depending on the exposure dose: first (light), second (moderate), and third (serious).

First degree radiation sickness is produced by a total dose of 100 to 200 R. The latency period lasts from two to three weeks, when general condition becomes poor with asthenia, nausea, vertigo, and intermittent fever. The white blood cell count decreases. First degree radiation sickness is curable.

Second degree radiation sickness is produced by a total exposure dose of 200 to 300 R. The latency period lasts about one week, after which pathological symptoms appear, like those from first degree radiation sickness, but of greater severity. With good medical treatment, recovery takes about 1½ to 2 months.

Third degree radiation sickness is produced by a total exposure dose of 300 to 500 R. The latency period is reduced to a few hours. The symptoms are more severe; with active medical treatment, recovery takes several months.

An exposure dose greater than 500 R is usually considered fatal.

The dosages of initial nuclear radiation depend on the type and power of the blast and the distance from the center of the explosion. Table 7 gives the radii at which different initial nuclear radiation doses are delivered by explosions of varying force. It is evident from Table 7 that the harmful radius of initial nuclear radiation is much smaller than the radii of destruction of blast waves and thermal radiation (see Tables 4 and 6).

Initial nuclear radiation does not have a noticeable effect on most objects. However, the glass of optical instruments may darken due to its effects, and photographic film in sealed cartridges may become exposed.

Various materials which attenuate gamma rays and neutrons also protect against initial nuclear radiation.

Table 7.

Dose (R)	Radius (km) [miles] TNT equivalent				
	20 kilotons	100 kilotons	1 megaton	5 megatons	10 megatons
500	1.2 [0.7]	1.8 [1.1]	2.4 [1.5]	3.0 [1.9]	3.4 [2.1]
300	1.4 [0.9]	1.9 [1.1]	2.6 [1.6]	3.2 [2.0]	3.6 [2.2]
200	1.5 [0.9]	2.0 [1.2]	2.8 [1.7]	3.4 [2.1]	3.0 [2.4]
100	1.6 [1.0]	2.1 [1.3]	3.0 [1.9]	3.6 [2.2]	4.2 [2.6]

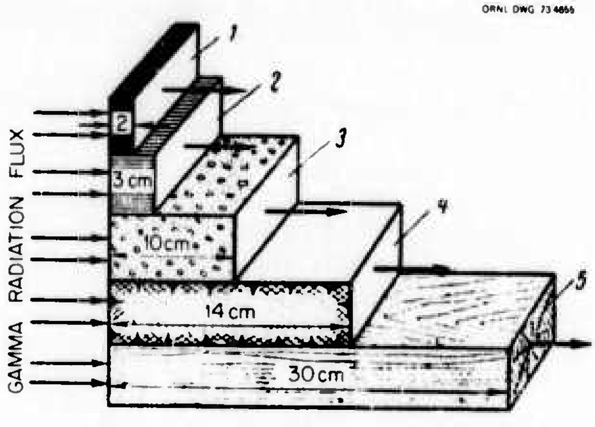

Fig. 19. Relative half-value layer of gamma rays, for different materials: 1 = lead; 2 = steel; 3 = concrete; 4 = soil; 5 = wood.

The degree of gamma-ray attenuation depends on the nature of the materials and the thickness of the absorbing layer. Gamma-ray attenuation is described by the half-value layer, which depends on the density of the materials.

The half-value thickness is the layer of a substance which reduces the intensity of incident gamma radiation by a factor of 2 (Fig. 19). The thickness of this layer is determined according to the formula

$$d_{h\text{-}v} = 23/\rho ,$$

where

$d_{h\text{-}v}$ = the half-value thickness of the layer, cm;

ρ = the density of the material, g/cm³;

23 = the half-value thickness of the water layer, cm.

The half-value thicknesses of various materials for gamma rays and neutrons [of initial nuclear radiation] are listed in Table 8.

Table 8.

Material	Density, ρ (g/cm³) [lb/ft³]	Half-value thickness (cm) [in.]	
		Gamma rays	Neutrons
Lead	11.3 [705.1]	2 [0.8]	9 [3.5]
Steel	7.8 [486.7]	3 [1.2]	5 [2.0]
Concrete	2.3 [143.5]	10 [3.9]	12 [4.7]
Earth	1.6 [99.8]	14 [5.5]	12 [4.7]
Wood	0.7 [43.7]	30 [11.8]	10 [3.9]

It is clear from Table 8 that gamma rays and neutrons are attenuated by materials to a different degree. For more prevalent building materials (concrete and earth), the half-value thicknesses are almost identical, permitting calculations [using] only [the values] for gamma radiation.

To guarantee the effective protection of people from initial radiation, it is necessary to consider its attenuation in protective buildings. The attenuation of initial radiation is otherwise called the shielding coefficient of a building and is designated by the letter K. The shielding coefficient K of a building shows how many times a given building attenuates penetrating radiation. It is determined according to the formula

$$K = \frac{h}{2^{d_{h\text{-}v}}} ,$$

where h is the thickness of the shielding material in centimeters and $d_{h\text{-}v}$ is the half-value thickness in centimeters. The shielding coefficient of a blast shelter amounts to 500 to 1000 or more.

Radioactive contamination [fallout]. Radioactive contamination of land, water, and the atmosphere occurs as a result of fallout of radioactive materials from the cloud of a nuclear explosion. The sources of radioactive materials are: (1) fission products of a nuclear burst, emitting beta and gamma rays; (2) radioactive materials of unfissioned fractions of a nuclear charge (^{235}U or ^{239}Pu), emitting alpha, beta, and gamma rays; (3) radioactive materials produced in earth by neutrons (induced radiation). Under the effect of neutrons, silicon, sodium, and magnesium atoms in the earth become radioactive and emit beta and gamma rays.

However, induced radiation in the ground and radioactive materials of the unfissioned portion of a nuclear charge comprise an insignificant part of all radioactive materials formed in a nuclear blast. Thus, the basic source of radioactive materials is fallout from the radioactive cloud resulting from the nuclear blast. These are a mixture of a large number of isotopes of various chemical elements formed by the nuclear fission process and the radioactive decay of these isotopes. During fission of the nuclei of ^{235}U and ^{239}Pu, about 200 isotopes of 36 different elements are formed.

Properties of radioactive materials. Fallout radiation from the cloud of a nuclear blast has no features that the senses can detect: color, taste, or smell. With long half-lives, they emit alpha, beta, and gamma rays during decay. These emissions have different properties.

Alpha rays are high-speed helium nuclei consisting of two protons and two neutrons. The escape velocity of an alpha particle reaches 20,000 km/sec, and its mean free path length in air does not exceed 10 cm. A sheet of paper or [ordinary] clothing is sufficient to absorb alpha particles. Alpha-active particles are dangerous when they penetrate an organism because the alpha rays emitted by them cause strong molecular ionization which damages the internal organs.

Beta rays are fast electrons with velocities up to 250,000 km/sec and mean free path lengths in air of up to about 10 m. The ionizing power of beta particles is 100 times lower than that of alpha particles, but their penetrating power is greater; thicker absorbers are required for them. An aluminum sheet of 1 mm thickness effectively shields against beta rays. Beta-active materials are dangerous when they fall on the skin and reach the internal organs, since irradiation of internal organs is much more dangerous than external irradiation.

Gamma rays are electromagnetic rays with a wavelength of 3×10^{-9} cm and a velocity of 300,000 km/sec; their mean free path length in air attains 100 m. The ionizing power of gamma rays is 1000 times weaker than that of alpha rays; however, gamma rays are highly penetrating, and much thicker materials are needed to attenuate them. Thus, gamma rays are more dangerous.

Spontaneous disintegration and conversion of all nuclei of a given element does not take place chaotically but according to the law of radioactive decay. The length of its half-life is used to describe the radioactive disintegration of an element. The half-life T is the time during which one-half of the atoms which existed at the start of the interval disintegrate. The half-life of a given radionuclide is always the same and cannot be changed by any external influence. If we assume N_0 to be the number of atoms, then after passage of one half-life the remaining half would equal $N_0/2$. The disintegration characteristics are shown in Fig. 20.

Depending on the characteristics of the radionuclides, the half-life of different isotopes may be from a fraction of a second to billions of years. For example, the half-life of ^{238}U is 4.5 billion years, ^{235}U 707 million years, ^{60}Co 5.3 years, and ^{3}H 12 years.

Radioactive contamination of an area is measured in roentgens per hour (R/hr) and is referred to as the radiation level. The radiation level indicates the exposure dose which a person in a contaminated area may receive in a unit of time (hour). An area is considered contaminated if the radiation level is 0.5 R/hr and higher.

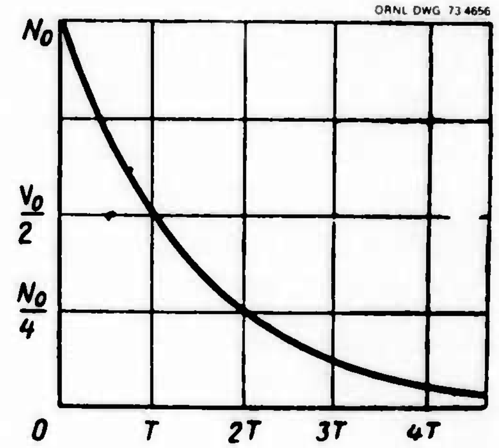

Fig. 20. Law of radiation decay: T = half-life, N_0 = number of atoms at start of half-life.

Contamination of objects equipment, and human skin is measured in milliroentgens per hour (mR/hr) or in beta decays per minute on 1 cm^2 of area (beta decays/min $\times$ cm^2). Contamination of food supplies is measured in milliroentgens per hour, in beta decays per minute on 1 cm^2 of the surface of the product, or in beta decays per minute per gram of the product. Contamination of water is measured in volumetric units in milliroentgens per hour and in curies per liter (Ci/l). A curie is the quantity of a radioactive material in which 37 billion (3.7×10^{10}) atomic disintegrations occur per second; it describes the radioactivity of a given material.

The contamination of an area by radioactive material depends on the power and type of burst (air, surface, underground), the direction and force of the wind, the character of the area and the earth, and meteorological conditions. The degree of contamination in an area is determined primarily by the power of the blast. The more powerful the blast, the more radioactive products are formed, and the more the area is contaminated. In addition, the type of explosion is very important. Especially heavy contamination occurs with a surface burst.

The relief of the terrain and the soil conditions influence the uniformity of radioactive contamination. The degree of contamination of an area is approximately uniform only on a plain at equal distances from the blast center and from the axis of the cloud track in the absence of wind. On very broken ground, radioactive materials may be slowed down by slopes with sides exposed to the wind. In the city, radioactive contamination is distributed irregularly due to the irregularity of the buildings.

Meteorological conditions, especially precipitation, have a great influence on the radiation level in a given area. In a ground blast, the wind causes the contamination of a large territory, since large amounts of radioactive material are carried by the wind and then settle to the ground. Strong wind also increases the dissemination of radioactive material over a wide area. Because the radioactive cloud is transported by a strong wind to great distances from the site of the explosion, the radiation level at the blast site declines.

Cloudiness may lead to radioactive rain, increasing the radiation level. Radioactive material falling into rain clouds favors droplet formation, condensation, and rainfall. Rain promotes rapid precipitation of radioactive materials on the ground since raindrops entrap fine dust particles and carry them earthward. In addition, however, heavy rainfall after a blast washes the radioactive substances from the surface of the earth.

Snowfall, as well as rain, causes rapid fallout of radioactive material to the ground, and contamination of the area increases; but a large amount of snowfall after contamination forms a layer which attenuates the radioactivity.

Fog and humidity promote radioactive fallout, and contamination of the area increases.

Characteristically, the level of radioactive contamination drops steadily with time due to the decay of the radioactive fallout from the cloud of a nuclear explosion. A tenfold decrease in the radiation level is observed with a sevenfold increase in time. Thus, if the radiation level is defined as 100% at 1 hr after the nuclear blast, then after 7 hr it will amount to about 10%, 1% after 7^2 hr (49 hr, about 2 days and nights), and about 0.1% after 7^3 hr (343 hr, or about 2 weeks).

As an example, let us examine the regularity in the drop of the radiation level. When measured 1 hr after the blast, the radiation level was 1000 R/hr; after 1 hr, 1000 R/hr; after 7 hr, 100 R/hr; after 2 days and nights, 10 R/hr; after 2 weeks, 1 R/hr. Thus, two weeks are required for the radiation level to decrease from 1000 to 1 R/hr. This law of radioactivity decay permits us to determine the radiation level per unit of time (seven times per unit of time). Table 9 shows the radiation level at varying times after the blast.

Damage from radioactive materials involves two factors: contamination and human exposure. Within the contaminated area, people are exposed to gamma rays and contamination from radioactive materials settling on clothing and skin (external contamination) and also to radioactive materials which enter the body by ingestion of food and drink (internal contamination). Human contamination by radioactive material, as well as a prolonged residence time in a contaminated area, produces an exposure which may cause radiation sickness. Exposure doses causing radiation sickness are the same as those for initial nuclear radiation: a single dose greater than 50 R is considered dangerous.

Table 9.

Time after blast	Dose rate (R/hr)																				
30 min	2.3	4.5	9.1	13	18	23	45	68	91	114	136	182	227	456	546	681	908	1140			
1 hr	1.0	2.0	4.0	6.0	8.0	10	20	30	40	50	60	80	100	200	240	300	400	500	600	800	1000
1.5 hr	0.6	1.2	2.4	3.7	4.9	6.1	12	18	24	31	37	48	61	122	146	183	244	305	366	468	610
2 hr	0.4	0.9	1.8	2.6	3.5	4.4	8.7	13	18	22	26	35	44	87	105	131	175	219	266	350	437
3 hr	0.3	0.5	1.1	1.6	2.1	2.7	5.4	8.0	11	13	16	21	27	54	64.4	80	107	134	161	214	268
5 hr		0.3	0.6	0.9	1.2	1.5	2.9	4.4	5.8	7.3	8.7	12	15	29	35	44	58	73	87	116	145
7 hr			0.4	0.6	0.8	1.0	1.9	2.9	3.9	4.9	5.8	8	10	19	23	29	39	[illegible]	58	78	97
10 hr				0.4	0.5	0.6	1.3	1.9	2.5	3.2	3.8	5.1	6.4	13	15.4	19	25	32	38	51	64
15 hr					0.3	0.4	0.8	1.2	1.6	1.9	2.3	3.2	3.9	7.8	9.5	12	16	19	23	31	39
1 day							0.5	0.7	0.9	1.2	1.3	1.8	2.3	4.5	5.4	6.8	9.0	12	13	18	23
1.5 days							0.3	0.4	0.6	0.7	0.9	1.2	1.5	2.9	3.5	4.4	5.8	7.3	8.7	12	15
2 days									0.4	0.5	0.6	0.8	1.0	1.9	2.3	2.9	3.9	4.9	5.8	7.8	10
4 days												0.3	0.4	0.8	1.0	1.3	1.7	2.1	2.5	3.3	4.2
1 week														0.5	0.6	0.7	0.9	1.2	1.4	1.8	2.3
2 weeks																	0.3	0.4	0.5	0.6	0.8
4 weeks																				0.3	0.4

To protect people from radioactive contamination, hermetically sealed blast shelters and fallout shelters are built and equipped with filter systems.

Industrial buildings which will not interrupt their manufacturing activities under the threat of fallout are built to guarantee partial sealing in the case of contamination of the area and the air, considering the attenuation factor for fallout radiation of buildings and structures.

Individual protective devices are used to protect people from radioactive materials (gas masks, protective clothing), and the safe exposure period is monitored in a contaminated area to be sure that the dose does not exceed 50 R. After leaving the radioactive zone, it is necessary to remove the radioactive materials deposited on clothing and the skin, that is, proceed with sanitary measures and decontamination of clothing.

2.1.3 Secondary Damaging Effects

The damaging effects of a nuclear blast cause destruction and fires, which in turn may cause secondary damage; [for example] initial nuclear radiation generates electromagnetic waves which affect electronic instruments.

If petroleum-extracting and -refining equipment is damaged, fires and explosions are caused on a scale which may exceed the immediate effect of the nuclear blast. Damaged chemical plants may cause local contamination, while destruction of a hydroelectric installation may cause flooding of populated areas.

In addition, nuclear blasts create electromagnetic fields, which generate surges in underground lines and in high-wire lines and radio station antennas, and also generate radio waves propagated over a wide area. The induced current and voltage may be propagated by wires over a wide area and cause damage to insulation, electrical and radio equipment may burn out, and personal injuries may occur. It is necessary to expedite municipal technical defense measures to provide protection from secondary damage.

2.2 AREAS OF NUCLEAR DAMAGE AND ZONES OF RADIOACTIVE CONTAMINATION

An area of nuclear destruction is an area subjected to the direct effect of a nuclear blast. The boundary of such an area is arbitrarily defined as the line where the overpressure of the blast wave reaches 0.1 kg/cm^2 [~1.5 psi]. To determine the possible nature of the destruction and also the necessary amount of rescue and temporary emergency restoration work, an area of nuclear destruction is divided into four zones (Fig. 21).

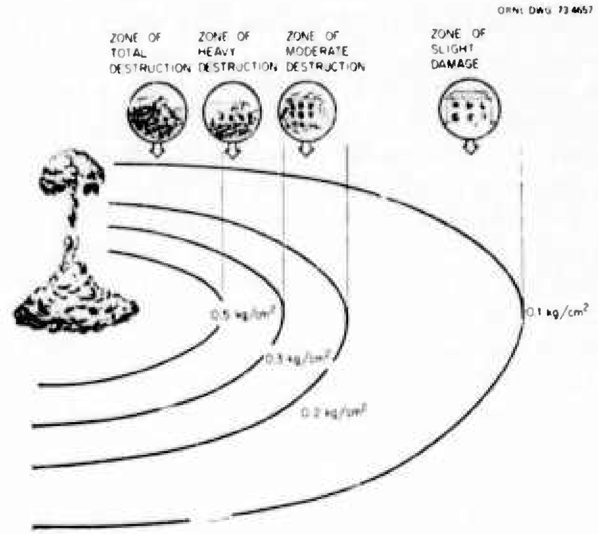

Fig. 21. Zones in an area of nuclear destruction.

The zone of complete destruction is characterized by an overpressure exceeding 0.5 kg/cm^2 [~7 psi] in the blast wave front. In this zone, residential and industrial buildings are completely destroyed; fallout shelters and some of the blast shelters located near ground zero are also destroyed. The majority of the blast shelters (up to 75%) and underground utility lines (up to 95%) remain undamaged. The streets are completely clogged due to the destruction of buildings. Entrances and exits of built-up shelters are blocked. Fires do not occur in zones of complete destruction; flames due to thermal radiation are prevented, because rubble is scattered and covers the burning structures. As a result the rubble only smolders, and fires as such do not occur. In zones of complete destruction, rescue work is carried out under complex conditions and involves clearing away the rubble, rescuing people from obstructed shelters, and particularly supplying air to shelters in which the filtering system has been destroyed.

A zone of heavy destruction is one in which the overpressure in a blast wave front amounts to 0.5 to 0.3 kg/cm^2 [7 to 4 psi]. In this zone the buildings and structures sustain heavy damage, but the shelters and the power lines remain intact. The majority of basement-type fallout shelters are also undamaged. A layer of rubble is formed as a result of damaged buildings. Conflagrations result from thermal radiation. The basic rescue work in this zone consists of clearing away the rubble and rescuing people from blocked blast shelters and fallout shelters and from destroyed and burning buildings.

The zone of moderate destruction is characterized by an overpressure in a blast wave front from 0.3 to 0.2 kg/cm² [4 to 3 psi]. In this zone, the buildings sustain moderate damage, while blast shelters and fallout shelters are completely undamaged. Local rubble is produced as a result of destroyed buildings.

The zone of slight destruction is characterized by an overpressure of 0.2 to 0.1 kg/cm² [3 to 1½ psi]. In this zone buildings sustain slight damage (partitions, doors, and windows are damaged); as a result isolated rubble may be present. Isolated fires may occur due to thermal radiation. The basic rescue work in this zone is to extinguish fires and rescue people from partially destroyed and burning buildings.

Beyond the zone of slight destruction, the shock wave is practically harmless to unprotected people. Buildings may undergo insignificant damage (damage to glass, roofs, and door and window frames). In addition, isolated fires may arise. People may experience slight injuries. Beyond the zone of slight damage, people are able to aid the injured and clear away the damage without assistance.

The area of destruction may be thought of as a circle and [its area] is calculated according to the formula

$$A = \pi R^2,$$

where R is the radius of destruction with an overpressure of 0.1 kg/cm² [1.5 psi], determined according to Table 4, or calculated.

Example: The radius of destruction (0.1 kg/cm² [1.5 psi]) of a 10 megaton nuclear weapon equals 25 km. We need to determine the area of destruction.

Solution:

$$\text{Area of destruction} = \pi R^2 = 3.14 \cdot 25^2 = 1962.5 \text{ km}^2 .$$

The area of the zone of nuclear destruction is determined according to the formula:

zone of complete destruction (area of a circle)

$$A_1 = \pi R_1^2 ,$$

zone of heavy destruction (area of a ring)

$$A_2 = \pi(R_2^2 - R_1^2) ;$$

zone of moderate damage (area of a ring)

$$A_3 = \pi(R_3^2 - R_2^2);$$

zone of slight damage (area of a ring)

$$A_4 = \pi(R_4^2 - R_3^2) .$$

The radius in which injury of people and destruction of buildings occur from the blast wave of a nuclear explosion may be determined with the aid of tables and graphs, as well as by the law of similarity of explosions.

2.2.1 Law of the Similarity of Explosions

As theoretical studies have shown, the radii of the zones of destruction and damage from a blast wave of nuclear and thermonuclear explosions of different force are proportional to the cube root of the ratio of TNT equivalents. Thus, for an approximate comparison of the radii of zones of destruction of a shock wave from nuclear blasts of varying powers, we may use the formula

$$\frac{R_2}{R_1} = \sqrt[3]{\frac{q_2}{q_1}} ,$$

where R_1 and R_2 are the radii of the zones of destruction in meters and q_1 and q_2 are the TNT equivalents in kilotons.

Example: The radius of slight damage in an air burst with a power of 20 kilotons is 3200 m. To determine the radius of destruction of a nuclear blast with a power of 10 megatons, substitute the known values in the formula referred to above:

$$R_2 = R_1 \sqrt[3]{\frac{q_2}{q_1}} = 3.2 \sqrt[3]{\frac{10{,}000{,}000}{20{,}000}} \cong 25 \text{ km [15 miles]} .$$

It is clear from this example that with a 1000-fold increase in the TNT equivalent of a nuclear bomb the radius of destruction increases 10 times. Thus, the area of nuclear destruction is characterized by:

1. massive injury to people and animals;
2. damage and destruction of surface buildings and structures;
3. partial damage, destruction, or collapse of CD shelters;
4. occurrence of individual and group fires and conflagrations;

5. continuous and scattered rubble in the streets, thoroughfares, and alleys;
6. massive damage to networks of the utility services;
7. formation of zones and bands of radioactive contamination from surface bursts.

2.2.2 Zones of Radioactive Contamination

Zones of radioactive contamination form in the center as well as beyond the limits of the area of nuclear destruction after surface bursts. A great quantity of radioactive products is formed by a nuclear explosion; these products are carried to great heights in the mushroom cloud. Part of the radioactive materials settles to the surface of the earth in the course of about 1 hr after the blast, forming a zone of contamination in the blast area, extended in the direction of the wind.

A radioactive cloud, formed by a surface burst, is transported by the wind. Radioactive materials fall from the cloud, leaving on the surface of the earth an invisible trail of radioactive contamination which follows the movement of the cloud. The trail may be visualized as drawn by the wind along a band of contamination of approximately elliptical shape. The imaginary line which can be drawn down its center is called the axis of the trail. The ellipse of contamination is characterized by length R and width L.

The size of the zone of radioactive contamination depends on the explosive power, wind velocity, meteorological conditions, and topography. The approximate dimensions of the band of contamination with a marginal dose rate of 0.5 R/hr and a wind velocity of 50 km/hr (31 mph) may be as follows: in a nuclear blast of 20-kiloton power, width 10 km [6.2 miles] and length 60 km [37 miles]; in a nuclear blast of 10-megaton power, width 60 km [37 miles] and length 800 km [496 miles].

Radioactive fallout continues for some time at each point in the contamination band, while the radioactive cloud passes over. Radioactive material contaminates the area irregularly, the strongest contamination being observed near ground zero of the blast, while lower radiation levels are found further from the blast site (Fig. 22).

Radioactive products of nuclear explosions do not settle immediately over the entire band, but do so gradually, with the forward movement of the cloud, and initiation of contamination depends on the wind velocity. For example, with a moderate wind velocity of 50 km/hr [31 mph] at a distance of 600 km [372 miles] from ground zero of the blast, radioactive fallout begins about 12 hr after the blast. After this time, the

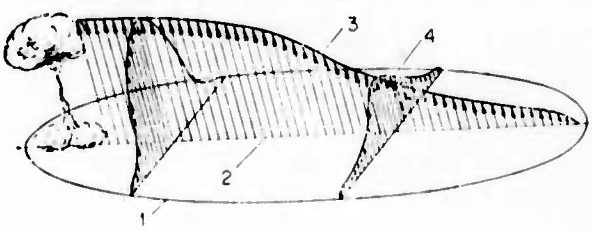

Fig. 22. Dose rate distribution along the trail of a radioactive cloud: 1 = track of the radioactive cloud; 2 = axis of the track; 3 = dose rate along the axis of the track; 4 = dose rate transverse to the track.

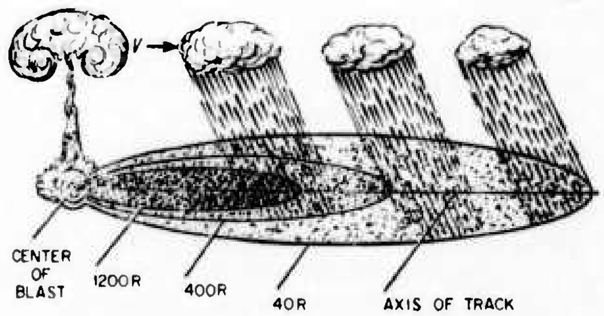

Fig. 23. Zones of radioactive contamination on terrain.

wind direction may change and with it the direction of cloud movement. The direction of the track of radioactive contamination also changes.

A zone of contamination is characterized by exposure doses and dose rates. A radiation dose from all of the fallout [infinity dose] D_∞ of the radioactive substances is taken as a basis. A person who stays in the open until all the radioactive material decays will receive such a dose. The zone of contamination can be arbitrarily divided into three zones (Fig. 23): zone A, moderate contamination; at the periphery the exposure dose is $D_\infty = 40$ R; the dose rate 1 hr after the blast is 8 R/hr, and after 10 hr it is 0.5 R/hr; zone B, high level contamination; at the periphery the exposure dose is $D_\infty = 400$ R; the dose rate 1 hr after the blast is 80 R/hr, and after 10 hr it is 5 R/hr; zone C, dangerous contamination; at the periphery the exposure dose is $D_\infty = 1200$ R; the dose rate 1 hr after the blast is 240 R/hr; after 10 hr it is 15 R/hr.

Thus the region of radioactive contamination presents a danger to people who may receive the maximum exposure dose and may be contaminated by radioactive materials if they do not take protective measures.

2.3 CHEMICAL WEAPONS

2.3.1 Characteristics of Chemical Weapons

A chemical weapon is a toxic material (TM) and the means by which it is delivered. The toxic materials, chemical compounds, are the primary active agents of a chemical weapon. The toxic material is distinguished from other harmful agents by its damaging characteristics. Such materials can penetrate with the air into buildings, dwellings, and production facilities, as well as into protective structures which are not hermetically sealed; they can be harmful to the occupants. They may retain their harmful effect in the air, on open terrain, and on various objects for a long period of time. Dispersed in large volumes of air and over wide areas, they affect all people within their range of potency who do not seek shelter facilities. Gaseous toxic materials can be propagated in the wind direction great distances from areas where the chemical weapons were directly applied.

The most important characteristic of toxic materials is their high toxicity, that is, their power to cause damage when they enter an organism in minimal doses. Injury from toxic material may occur as a result of breathing contaminated air; having it come in contact with the eyes, the skin, or clothing; ingesting contaminated food or water; or as a result of coming into contact, unprotected, with contaminated objects. But the toxic materials in the air can affect people only in so-called combat concentrations or densities.

The concentration is the amount of toxic material per unit volume of contaminated air, usually expressed in weight units, that is, milligrams of TM per liter of air, or in grams of TM per cubic meter of air. For example, a phosgene concentration of 0.5 mg/liter means that 1 liter of contaminated air contains 0.5 mg of phosgene. If the toxic material is sprayed on the ground in the form of liquid droplets, then its weight per unit of surface area is called the contamination density and is expressed in grams per square meter. For instance, a contamination density of 15 g/m^2 means that there is an average of 15 g of TM on one square meter of contaminated area.

The harmful effect of the toxic material on an organism may be local or general. In a local effect, the injury appears in areas where the organism has had direct contact with TM – on the skin, mucous membranes of the upper respiratory tract, eyes, respiratory system, and the digestive organs. In a general effect, the damage (toxic effect) usually appears after the toxic material has entered the blood stream, which carries it to other organs. The toxic material may enter the blood stream and cause general poisoning as a result of absorption from the skin (skin absorption toxicity) or from the respiratory organs (inhalation toxicity). General poisoning may result from ingestion of food and water which have been contaminated with toxic materials.

Local and general effects of toxic materials cannot be considered separately; these concepts are arbitrary to a certain degree. If the TM accumulates, a local process may become a general toxic process. However, a local effect is symptomatic primarily of a few toxic materials; in the case of other agents, general intoxication is produced. Simultaneous local and general effects are possible.

Toxic materials have definite physicochemical and toxic properties, a knowledge of which allows a more rational organization of chemical warfare protection of the population. Such properties as boiling and freezing points, volatility, specific gravity, solubility, and viscosity are of great practical importance. Knowledge of a given TM's boiling point, viscosity, and volatility make it possible to determine approximately how long that TM will survive at a certain place, that is, how long contamination will last. Solubility and specific gravity can be used to judge the degree of contamination of a liquid and the possibility of washing the TM from contaminated surfaces.

A knowledge of the chemical properties of poisonous substances makes it possible to select the means and methods for detecting (indicating) and decontaminating (neutralizing) TM. The properties of toxic materials are generally divided into groups for study according to functional stability relative to maintaining their toxic effects and the nature of the effect on the human organism. In the armies of capitalistic countries, TM are arbitrarily divided into persistent and nonpersistent.

The persistence of a TM is its power to retain its harmful effect for a determined period of time after it is used; this depends on the physical and chemical properties of the TM, the method with which it was applied, meteorological conditions, and the character of the territory where it was released. Persistent toxic materials retain their harmful effect for a few hours up to several days or even a week. They are modified little by air and humidity and evaporate very slowly. Nonpersistent toxic materials maintain their harmful effects on open terrain for several minutes and in sites of stagnant air (in basements, closed premises, ravines, etc.) for 10 min up to an hour and more.

2.3.2 Basic Characteristics of Toxic Materials

Toxic materials are divided into four groups according to the nature of the effect (toxic effect) on human organs: nerve-paralysis, skin abscesses, general toxicity, and suffocation. The TM classifications used in the armies of capitalistic countries are shown in Table 10. The basic properties of the toxic materials indicated above are given in Appendix 1.

Table 10.

Name of TM	Toxic effect	Stability
Sarin	Nerve paralysis	STM
Soman	Nerve paralysis	
V gases	Nerve paralysis	
Mustard gas	Skin irritant	
Prussic acid	General toxicity	UTM
Phosgene	Suffocation	

In the U.S., work is being carried out on a new type of TM, which is called the psychochemical TM. Only small doses (less than 0.001 mg) of these TM are required to incapacitate a human. The effect of the psychochemical TM on people is not fatal, but only psychological. People exposed to these TM become incapable of working for a period of time and lose their self-control. When psychochemical TM's are used, for example, diethylamides of lysergic acid, intoxication and depression set in after about 30 min, causing hallucinations. The effect of this TM lasts from 0.5 to 12 hr (Dr. Rothschild, *Tomorrow's Weapons*, Military Press, 1966) [see footnote *].

Tremorine and psilocybin have been described in the foreign press under the title "fear gases." When the effect of these TM was demonstrated in a cat which had inhaled the particular agent, it ran away from a mouse. In addition to the enumerated substances, in capitalistic countries there is a TM with a lacrimatory and an irritant action which is used to combat demonstrations and in colonial wars (U.S.A. in Vietnam).

2.3.3 Methods for Applying Toxic Materials

To contaminate national economic installations, the enemy may apply poisonous substances with the aid of bombers (bombs, VAP), rockets, and blimps. The bombers of the U.S.A. have aerial chemical bombs in their armaments (ACB) as well as aircraft spray tanks.

[*In the U.S., *Tomorrow's Weapons*, by J. R. Rothschild, McGraw-Hill, 1964.]

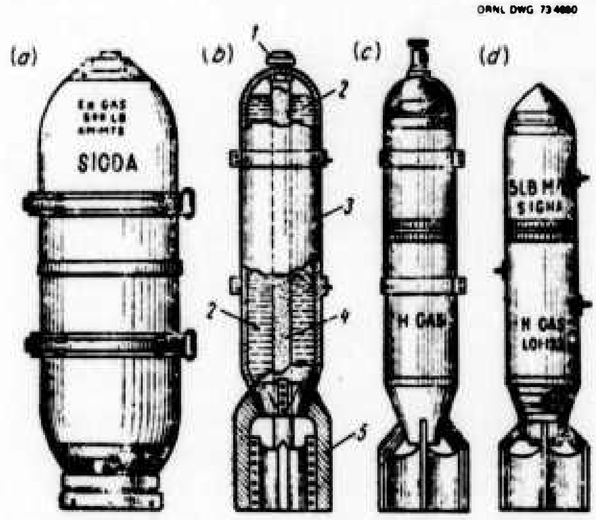

Fig. 24. Aerial chemical bombs: (*a*) Bombs armed with persistent TM; (*b,c,d*) bombs armed with nonpersistent TM. 1, fuse; 2, toxic material; 3, shell; 4, explosive; 5, stabilizer.

The size of U.S. airborne bombs ranges from 4.5 to 450 kg (Fig. 24). Depending on the type of fuse, the aerial chemical bombs may have a [direct] impact effect or a remote effect. The former explode upon contact with the ground or with other objects; the latter may explode at a preset altitude.

Chemical bombs may contain persistent as well as nonpersistent TM. Bombs armed with nonpersistent toxic materials are intended to injure people and contaminate the air; they are equipped with contact fuses. They explode when they strike the ground (or another target) and form a cloud of TM, which is dispersed by the wind over great distances.

Bombs with nonpersistent TM are usually large, 250 to 1000 kg [550–2200 lb], and produce a high concentration of toxic materials over a considerable area at the moment of explosion. For example, a 250-kg U.S. bomb armed with phosgene forms a cloud of contaminated air with a diameter of 50 m and a height of 10 m, with a very high TM concentration; the cloud is propagated by the wind at a dangerous concentration over a considerable distance; the crater usually retains an accumulation of incompletely vaporized TM, the vaporization of which may continue for an hour or more.

Bombs armed with persistent TM are intended to injure people as well as to contaminate the area and targets. Depending on the targets selected by the enemy, remote action bombs may be used. These bombs may be detonated at an altitude of 50 to 200 m, and the toxin will settle on the ground in the form of

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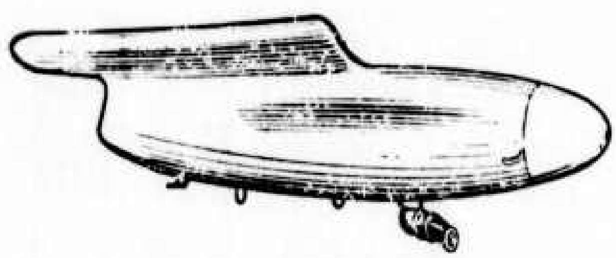

Fig. 25. Aircraft spray tanks (AST).

rain, contaminating the area and targets as well as the population. The size of the contaminated area depends on the size of the bomb, the quantity and quality of the TM, the altitude of the blast, and wind velocity. The size of such bombs may be 100 to 1000 kg. When a 250-kg bomb explodes at an altitude of 100 m, an area of about 5000 m^2 is contaminated with a TM density of 10 to 15 g/cm^2.

Aircraft spray tanks (Fig. 25) are thin-walled metal containers with a streamlined shape: their capacity is several hundred liters. Two to four, depending on the carrying capacity of the airplane and the capacity of the containers, are mounted on the wing surfaces or under the fuselage of aircraft. These cannisters contain TM which discharges from the container as soon as it is dropped and settles on the ground in droplet form: it contaminates the earth and injures unprotected personnel in the area.

The size of the contaminated area when aircraft spray tanks are used depends on the altitude and the flying speed of the aircraft, the duration of spraying, the amount of TM dispensed, and the wind velocity and direction.

Rockets, including ballistic missiles, may be used to apply toxic materials. The special features of this method of attack are the range of delivery and the surprise factor, in addition to which "one large rocket with TM can affect 30% of the people located in an area of about three square kilometers" (Dr. Rothschild, *Tomorrow's Weapons*, Military Press, 1966). [See footnote on page 39.]

2.3.4 Danger Areas of Chemical Contamination

A danger area of chemical contamination is an area subjected to the effects of TM, as a result of which people and animals may be injured. The size of the danger area of chemical contamination depends on the quantity of TM used, the type, the meteorological conditions, and the relief of the terrain.

Persistent TM may be used to form a danger area of chemical contamination. Such an area is capable of sustaining its harmful effect for an extended period of time. The possibility of contaminating an area from the air and consequently creating a danger area of chemical contamination is determined by U.S. specialists according to the lifting capacity of the airplane. By their calculations, one airplane carrying about 7 tons of chemical bombs armed with toxic materials with a nerve-paralyzing effect can create a lethal concentration of TM in an area of 250 km^2 [96 square miles].

If aircraft spray equipment is used, a low-flying plane at a speed of 480 km/hr equipped with two 30-gal (136.5-liter) aircraft spray tanks can contaminate a strip 270 to 360 m wide ("Colliers," September 27, 1953; "Passive Defense, Washington"). The width of the contaminated strip in this case depends on the wind (its velocity and direction) and on the altitude at which the TM was dispensed. Thus, U.S. aviation has the means to create a danger area of chemical contamination. These danger areas will be characterized by massive injury to unprotected people and animals due to contamination by toxic materials of objects, buildings, equipment, transportation, water sources, reservoirs, food supplies, and forage.

Vapors and aerosols are formed when the chemical weapon explodes; the TM's contaminate the air and create a "primary cloud" of contaminated air, which, propagated in the direction of the wind, is capable of injuring people in an area several times larger than the area directly affected by chemical weapons.

When the chemical weapon explodes, some of the TM settles on the ground and on objects in the form of drops (fogging) and when these evaporate a "secondary cloud" of contaminated air is formed which moves in the wind direction and can cause injury to people. Consequently, a danger area of chemical contamination includes territory which is damaged directly by dispersion of TM from weapons and also the territory on which TM vapor is dispersed in combat concentrations, that is, concentrations capable of causing injury to people.

The configuration and size of a danger area of chemical contamination depends on the type of TM substance, the type and quantity of the means of delivery, meteorological conditions, and the character of the terrain. This danger area can be divided into two zones: I, the zone directly contaminated by TM, and II, the zone into which TM vapors and aerosols are dispersed (Fig. 26). The size of zone II, that is, the zone into which TM vapors are dispersed, exceeds zone I several times, especially for such TM as sarin and

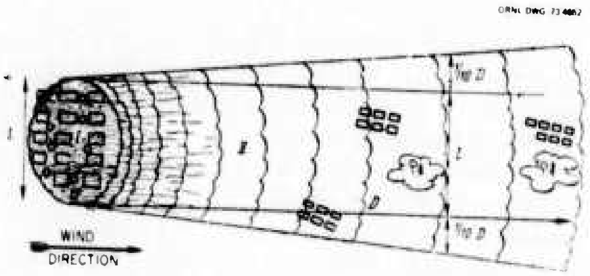

Fig. 26. Danger area of chemical contamination. D = length of TM propagation zone; 1 = width of the zone of direct contamination.

soman. If there is an inversion (and other favorable conditions for using TM), a dangerous concentration of sarin can be propagated for a distance of 15 to 20 km [9–12 miles].

In the case of chemical attack and formation of danger areas of chemical contamination, the basic conditions for guaranteeing functional stability of industrial plants would be to carefully seal production buildings and technological processes and to provide the workers with individual means of protection.

2.3.5 Influence of Meteorological Conditions and Topography on a Danger Area of Chemical Contamination

Meteorological conditions, the relief of the terrain, and the building density have a great influence on the condition of an area of chemical contamination. The temperature and the wind have an important influence on the evaporation rate of TM. When there is intense heating on the earth's surface and a low layer of air, mixing of the lower and upper atmospheric layers occurs and causes rapid dispersion of TM, which evaporates from the ground and objects, while the wind facilitates scattering of these vapors.

At low winter temperatures, TM evaporation will be insignificant; thus, local and material contamination will be more extensive. The vertical stability of the lower atmospheric layers influences the propagation velocity and the area of the TM vapors and thus the size of the secondary danger area of chemical contamination.

It is possible to distinguish three levels of stability in the surface layer of air: the first level is inversion (at which the lower layer of air is cooler than the upper); the second level is isothermal condition (characterized by the fact that the air temperature within 20 to 30 m from the ground is nearly uniform); the third level is convection, when the lower air layer is warmer than the upper layer and vertical mixing occurs. Inversions and isotherms contribute to maintaining a high TM concentration in the surface air layer; they facilitate the dispersal of contaminated air great distances from the contaminated area. Convection causes rapid dispersal of contaminated air, and air concentrations of TM vapors decrease rapidly.

The wind velocity influences the atmospheric TM concentration. With a gentle wind, contaminated air is dispersed slowly, and high concentrations are sustained longer; strong, gusty winds rapidly disperse the contaminated air. With an increase of wind velocity, the TM evaporated from the contaminated area also increases. Heavy rainfall washes the toxic materials from the soil and also lowers the contamination density in the area. Vegetation (underbrush, forests, thick grass), building density, and the relief of the terrain (ravines, gullies) facilitate stagnation of contaminated air and increase the duration of contamination of an area.

2.4 BIOLOGICAL WEAPONS

2.4.1 Concepts Concerning Pathogenic Microbes and Toxins

A biological weapon is a pathogenic microbe or toxin intended to injure people, animals, plants, and food supplies, as well as the material with which these are applied. The basis of the biological weapon is the pathogenic microbe and the toxins which are produced by some microbes. The concept "biological weapon" can be much wider, including not only pathogenic microbes and toxins but also their vectors (insects, ticks, rodents), agricultural pests, and other biological agents.

Depending on their structure and biological characteristics, microbes are classified into bacteria, viruses, rickettsia, and fungi. Bacteria are microorganisms of the plant kingdom, primarily unicellular, visible only under a microscope. Their size ranges from 0.05 to 5 μ [microns]. Under favorable conditions they multiply by simple division very rapidly – every 20 to 30 min. Bacteria are rapidly destroyed by light rays, disinfectants, and boiling. Some forms of bacteria (malignant anthrax, tetanus) are transformed into spores with great stability to the above-mentioned agents. Bacteria are resistant to low temperatures and freezing. Bacteria cause diseases such as bubonic plague, cholera, anthrax, etc.

Viruses are the smallest organisms, a hundred thousand times smaller than bacteria, and they can be detected only with the aid of an electronmicroscope.

Unlike bacteria, viruses multiply only in vivo. They are resistant to drying and freezing. Viruses are responsible for smallpox, yellow fever, etc.

In size and shape, rickettsia approximate some bacteria, but they reproduce and survive only in infected tissue. Rickettsia cause typhus, Q fever, and other diseases.

Fungi, just as bacteria, are in the plant kingdom, but have a more highly developed structure. The resistance of fungi to the effects of physicochemical factors is much higher; they are resistant to desiccation and sunlight.

Toxins are highly active poisons produced by some microbes, for example, by the organisms of botulism, tetanus, and diptheria. The toxins of these microbes are extremely potent and cause serious poisoning. In their most potent form, the toxins retain their potency for many weeks and even months. About a thousand pathogenic microbes are presently known which cause damage to people, animals, and plants. But according to information of the foreign press, they may all be used in a war in the capacity of biological weapons.

United States specialists have selected the following pathogens to destroy humans in a biological war:

1. Bubonic plague, malignant anthrax, melioidosis, brucellosis, tularemia, cholera;
2. Smallpox, equine encephalomyelytis, dengue fever, yellow fever, psittacosis;
3. Typhus, Q fever, Rocky Mountain spotted fever, tsutsugamushi disease;
4. Coccidial mycosis, nocardiosis, blastomycosis;
5. Botulism.

To destroy animals, U.S. specialists selected the following pathogens: hoof-and-mouth disease, large-horn cattle plague, pig plague, African swine plague, malignant anthrax, glanders, brucellosis, etc. To destroy agricultural plants, they may use agents of wheat rust, rice [pyriculariosis], potato phytophthora, and other diseases.

The destructive force of biological weapons depends on a series of factors: the biological properties of the pathogens, the living conditions of the people, immunity of the population (resistance to infection), level of sanitary conditions of the population, state of preventive medical treatment and antiepidemic decontamination facilities, the season, and other factors. The characteristics of the pathogenic microbes which may be used by the enemy are described in Appendix II.

If the enemy uses biological weapons to destroy the population, the following may result: inhalation of contaminated air; use of contaminated products and water; bites by infected insects and mites; invasion of mucous membranes and injured skin by microbes and toxins; contact with contaminated objects; personal contact with infected people and animals. With contamination by biological means, sickness does not appear at once; there is almost always a latency (incubation) period during which the disease is asymptomatic and the infected person is not disabled. The duration of the incubation period depends on the agent, the microbial invasion of the organism, and the general physical condition of the host. The latency period may last from 1 day up to 2 to 3 weeks.

Some pathogens (plague, cholera, smallpox) can be transmitted from infected to healthy individuals and by spreading rapidly can cause epidemics. It is very difficult to prove that biological weapons are being used and to identify the pathogen. It is reported in the U.S. press that no instruments currently exist with which it would be possible to determine when use of biological weapons was initiated. Thus, the basic method for determining the type of agent is analysis of specimens in the laboratory, which requires a great deal of time, sometimes as much as a whole day. All this makes it difficult to take the appropriate measures in time to forestall an epidemic.

2.4.2 Methods for the Application of Biological Weapons

There are different ways and mechanisms to infect people by biological agents. The enemy might use biological weapons in different ways in any season or at any time of the day. One of the most probable methods might be to contaminate the layers of the atmosphere near the ground with aerosols in the form of liquid or dry bacterial (viral, fungal, toxic) formulations.

Judging from the following considerations, the aerosol method is considered the most important by U.S. specialists: With this method it is possible to contaminate large areas, measuring tens, hundreds, or thousands of [square] kilometers. In the absence of protective measures, the aerosol method makes it possible to infect everyone in the zone of application. In this case, due to a large dose of pathogens invading the organism through the respiratory organs and the skin, it is possible for people to be infected even though they would ordinarily be immune. In addition, this method makes it possible to disperse agents of almost all infectious diseases, even those which are not transmitted through the air under ordinary conditions (for example, brucellosis, typhus, yellow fever, etc.).

It must be kept in mind that with the use of biological weapons contamination of people and farm animals and surrounding objects through the air can occur not only at the moment of biological attack, but for a long time afterward, for several hours and sometimes days. The possibility of such contamination is explained by the fact that the pathogens may retain their viability for a long time in the soil, on vegetation, and on the surface of various objects, and, in addition, [if] picked up by dust, they may create so-called secondary bacterial aerosols which are no less dangerous than the primary ones.

Biological pathogens can be disseminated among the human population and animals not only by aerosols, but also by vectors: insects, mites, and rodents. These disease-carrying vectors of infectious diseases can be easily cultivated in large quantities; they are infected and continue to survive as carriers of pathogenic microbes for a long period of time, sustaining the pathogens in their organism and transmitting them to people or animals. The life span of infected pathogenic vectors varies from a few weeks (mosquitos, fleas, flies, lice) up to several years (mites). Some vectors, mites for example, can transmit disease vectors to their progeny. These factors guarantee creation of persistent areas of contamination; this is also facilitated by the biological characteristics of insects and mites, used in active attacks on people and animals, and rodents, which also contaminate food sources and surrounding objects. To apply these biological weapons, the enemy may use rockets (Fig. 27*a*), airborne bombs (Fig. 27*b*), artillery shells and mines (Fig. 27*c*), packets (bags, boxes, containers) thrown from airplanes (Fig. 27*d*), special equipment for spraying or vaporizing (Fig. 27*e*), and sabotage (Fig. 27*f*) – [thus] contaminating air, water, and places where people gather, contaminating animals, and disseminating infected insects and mites to contaminate the population and their food products.

2.4.3 Indications of the Use of Biological Weapons

Indications of the use of biological weapons are as follows: the appearance of streaks of smoke or fog in the wake of moving aircraft (Fig. 28*a*), a dull sound of the explosion of the microbe-carrying weapon (Fig. 28*b*), the presence on terrain of special aerial bombs, shell, and other containers (Fig. 28*c*), the appearance of drops of liquid or powdery substances on the soil or other objects (Fig. 28*d*), the appearance of hosts of insects, mites, or rodents – unusual for a given place or a given season (Fig. 28*e*), and the occurrence of epidemic diseases in people and animals.

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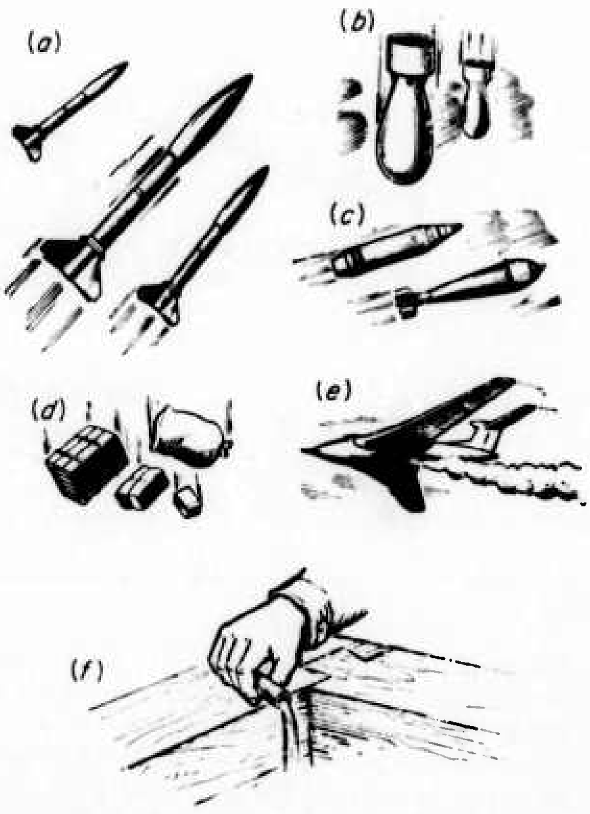

Fig. 27. Application of biological weapons.

Early detection of signs that the enemy has used biological weapons makes it possible in a short period of time to send qualified biological exploration teams to the contaminated region to determine the area of contamination and the nature of the pathogens, and thus to set up quarantines, if necessary, in time to control further attacks.

2.4.4 Focal Areas of Biological Contamination

A focal area of biological contamination is a territory exposed to the direct effect of biological media, creating the danger of spreading infectious diseases. Such a focal area may be produced by the use of pathogenic microbes which induce infectious diseases or of toxins injurious to human beings.

According to foreign specialists, the use of biological media is contemplated on targets deep in enemy territory: heavy industrial and administrative centers,

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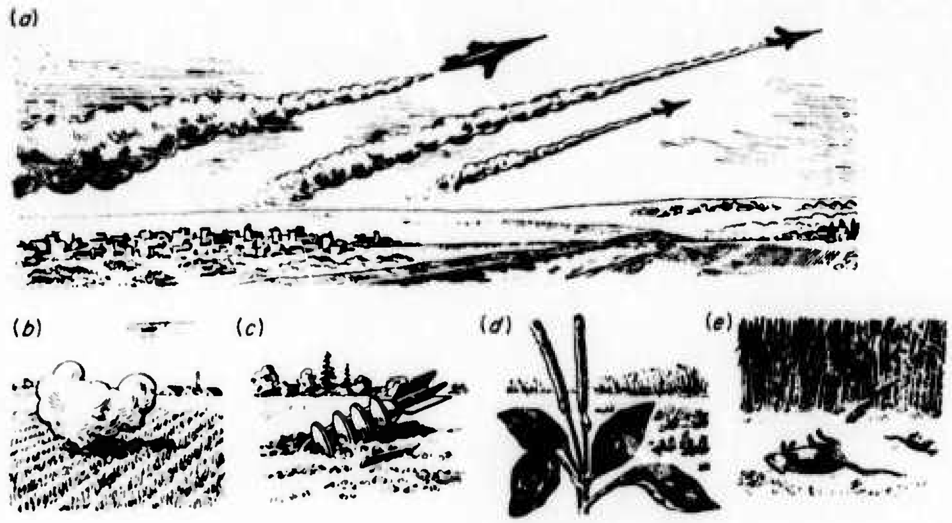

Fig. 28. Indications that biological weapons are being used.

railroad junctions, sea and river ports, and on large stores of agricultural products. The main danger of biological media used in war is the possibility of contaminating large territories. In their instructions in the use of chemical and biological weapons, the U.S. Army FM-3 (1962) points out that "with the use of one airplane or rocket it is possible to contaminate thousands of square kilometers in effective concentrations on enemy territory."

Biological media are used on targets in the rear areas to disrupt mobilization measures in the initial period of a war and to hamper deployment of armed forces by destroying troop contingents designated for movement to the front, as well as by destroying the urban and rural population subject to conscription into the army; to disorganize the rear of the country by creating a large number of contaminated areas and disrupting the normal operation of industrial plants and other national economic sites; to reduce the war-economy potential and create difficulties in the country by widespread transmission of infectious diseases; to infect food supplies and forage; to destroy agricultural animals and crops.

The size of the focal area of biological contamination depends on the type of munitions and the bacteriological formulations and their number and means of application, as well as meteorological conditions, how quickly the infections are detected, and on how promptly preventive treatment is given and decontamination measures are taken.

When bacterial formulations are released in the air, a bacterial cloud is formed consisting of minute particles of the formulation mixed with air. This cloud, moving irregularly with the wind, may settle on the ground, into water, onto plants, and on all objects, as well as on human and animal skin. If contamination occurs via the air and a large quantity of pathogens invade an organism, even inoculated people may be infected. Thus, a large number of people will require medical treatment in a hospital.

If biological media are applied by means of vectors, the size of the focal area of biological contamination is determined by the area where these disease carriers were dispersed. The special feature of this method of contamination is that insects and mites, as mentioned above, retain pathogens in their bodies from several weeks (fleas, mosquitos, and flies) to several years (mites).

Antiepidemic facilities of the CD medical service are organized on the periphery of the focal area of biological contamination, as determined by data from observation stations and reconnaissance teams and groups, as well as from meteorological and epidemiological public health stations. When a focal area of biological contamination is delineated by order of the CD chief of the area (republic, region), quarantine and observation are initiated.

3. Methods of Protecting the Population by Dispersal and Evacuation

3.1 ORGANIZATION AND PLANNING OF DISPERSAL AND EVACUATION

Should weapons of mass destruction be used, the enemy plans nuclear rocket attacks on the major cities and industrial and administrative centers that have defense importance. Industrial enterprises, transportation and communication centers, and other important objectives are usually concentrated in cities; at the same time, the cities contain large populations that work in these enterprises and that form the basis of productive capacity.

The fraction of the Soviet population living in cities is 55% (by 1967 data). Thus, the larger part of the population of our country lives in cities, many of which may become the targets of possible nuclear rocket attacks.

Under these conditions, civil defense takes on an especially important character, since its principal task is the defense of the population from weapons of mass destruction and the defense and conservation of the productive capacities of the state. V. I. Lenin once stressed: "The primary productive factor of all of humanity is the laboring man, the worker. If he survives, we can save everything and restore everything . . . but we shall perish if we are not able to save him" (V. I. Lenin, *Collected Works*, Vol. 38, p. 359).

During the Great Patriotic War [World War II], to remove productive capacity from areas of direct combat in our country, we transported entire enterprises, including their workers and employees, to the deep rear; that is, we evacuated industry. The evacuation of people, enterprises, and capital equipment was directed by the Soviet [Council] on Evacuation, which was organized by decision of the UCP(v) and by the Soviet of People's Commisssars of the 24th of June, 1941.

Under the direction of the government, all national departments and administrations organized special sections and commissions on evacuation. On-site the evacuations were supervised by Party and Soviet organs. A sequence of evacuation of enterprises, people, and capital assets was established.

The first enterprises to be evacuated were large ones with defense significance. (The evacuation included the workers, employees and their families, and the factory equipment.) From July through November 1941, over 1000 industrial enterprises moved into the interior of the country. Evacuation from the forward areas of the Don Basin, Stalingrad, and the northern Caucasus was conducted in the summer of 1942.

When evacuation took place, regions further than 1000 km from the front were inaccessible to the then current methods of attack. However, this evacuation was only partial in character, since a significant part of the population remained in the territory occupied by the German-fascist invaders.

Under conditions of a nuclear rocket war, civil defense must solve the problem of defending the population through a series of measures, which include dispersal and evacuation of people from cities that are likely to be targets of rocket attacks by the enemy. Evacuation should be made to areas outside the metropolitan areas, and the evacuees must be sheltered there in protective structures and also given individual means of protection.

The outer zone [see *] in this case means the territory between the external border of the area of possible destruction of the city and the border of the region [area, republic]. The boundaries of the zone of possible destruction must be established in relation to the importance of the city and the size of the population.

[*See drawing in footnote on page 4.]

3.2 THE CONCEPT OF DISPERSAL AND EVACUATION

Dispersal is the term used for an organized departure from the major cities and the distribution in the outer zone of workers and employees of national industrial enterprises that continue to function within these cities in wartime.

In addition to workers and employees of industrial enterprises, people who help operate the city should also be included in the category of those to be dispersed (for example, utility workers). These people must work within the city but return to the outer zone to rest.

Workers and employees of enterprises who are among those to be dispersed must, after relocation in the outer zone, go into the city in shifts for work at their enterprises and, upon completion of work, must return to the outer zone to rest.

Evacuation refers to the removal from a large city to the outer zone of that portion of the population which does not work in industrial enterprises within the city, and also the removal of the inhabitants of a zone of possible flooding into safe areas.

Some city enterprises should also be evacuated, including organizations, offices, and educational institutions whose activities during the war period can be transferred to agricultural areas.

Thus, those to be evacuated include the entire population not connected with enterprises that operate within the city in wartime, and also the staffs of administrative, scientific research, and educational institutions that would be evacuated for the duration of the war to the outer zone to continue their activities.

In the outer zone, the dispersed and evacuated population is located beyond the boundaries of the possible radius of destruction that would result from probable nuclear blows to the city, that is, at a safe distance from the city. This distance must be established in each specific case by the civil defense chief of the city.

The decision on where to locate the outer zone should take into account the distance that the essential workers would have to travel to and from the city each day. Round-trip travel time should not exceed 4 to 5 hr.

When the distribution of people in the dispersal areas is planned, it must be borne in mind that the dispersed workers and employees include not only the resting shift [off shift] of some enterprises, but also those civil defense formations responsible for rescue and repair operations at their enterprises. Thus, the dispersed workers and employees must be located no farther than 5 km from a railroad station or highway.

The evacuated population may be settled in areas that are farther from railroads and highways in their own regions and, in special cases, in areas of neighboring regions. [These regions roughly correspond to states.] (See Fig. 29.)

As a rule, dispersed workers and employees, as well as the evacuated population, would be billeted in the homes of the local population, whereas medical, trade, and other establishments would be distributed among tourist and sport facilities, schools, clubs, rest homes, sanitoriums, and nursing homes that are situated in the outer zone.

After completion of dispersal and evacuation, the only population left in the city would be the operating shift of workers, and employees of those enterprises that remain, and service personnel of the city. The rest of the city population is dispersed over a wide territory of agricultural lands.

These measures reduce the possibility of destruction of the dispersed workers and employees, as well as of the evacuated population, when nuclear attacks are made on the cities. Since only the operating shifts of enterprises must remain within the city, the problem of sheltering these people in shelters [blast shelters] at the enterprises, or very near them, is reduced. Under these circumstances, the requirements for shelters would be much lower than they would be if the entire city population were to be protected.

Calculations show that in case of a nuclear rocket attack the losses to the population in a large unprotected city may constitute 90% of the population, whereas in case of a timely and complete dispersal and evacuation of the population the losses may be reduced to several percent of the total population.

To make dispersal and evacuation measures effective and complete in the shortest possible time, such measures must be planned and prepared well ahead of time, while peace still exists. Under a socialist regime, the planned system of the national economy and the public ownership of land, houses, enterprises, and utilities provide favorable conditions for preparing evacuation regions to receive the city population.

3.2.1 Preparations for Dispersal and Evacuation

Preparations for dispersal and evacuation are made by the commanders of civil defense at all levels and their staffs. The dispersal of workers and employees and the evacuation of their families are conducted in accordance with industrial practices. For resettlement of workers, employees, and their families, the enterprises are assigned one or more adjacent populated points

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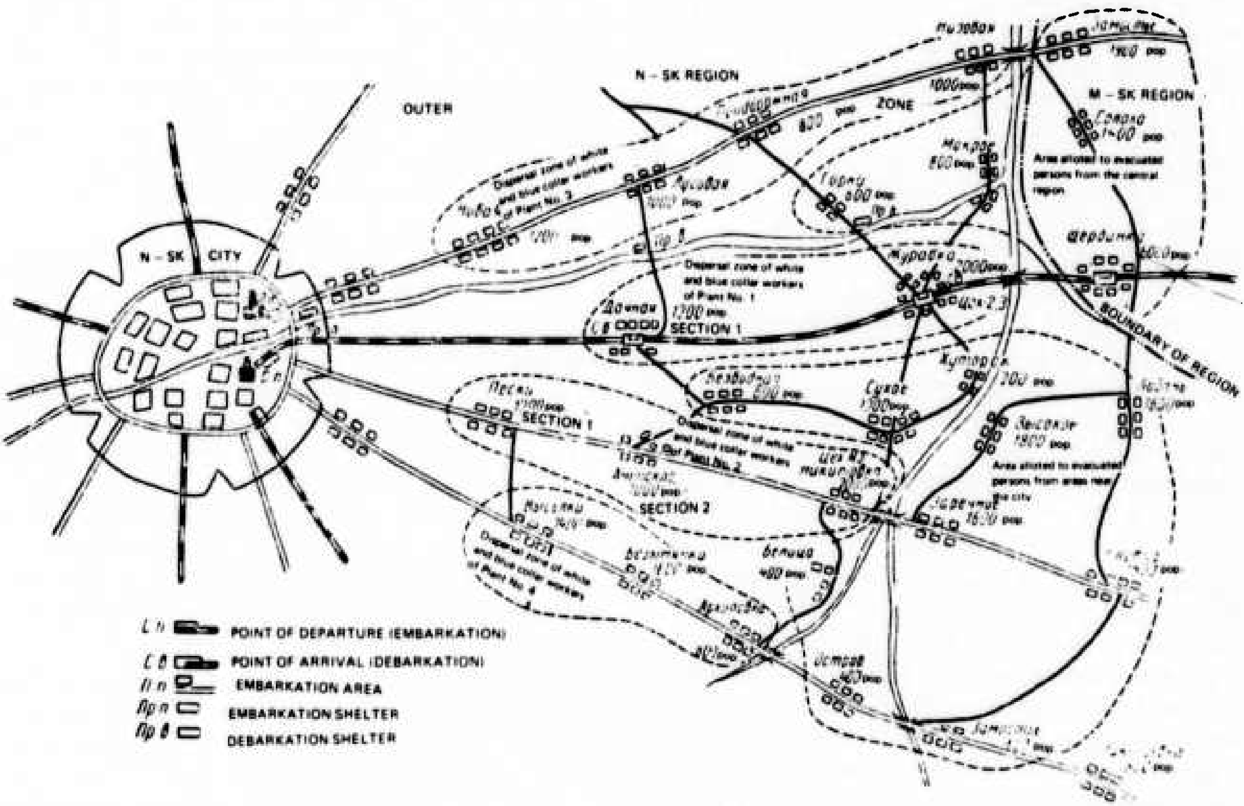

Fig. 29. Evacuation and dispersal areas.

(depending on the numbers of people to be resettled and the quantity of living space available). Under this principle the integrity of the enterprise is not disturbed: the workers and employees of one enterprise and the members of their families are resettled compactly, thus easing the tasks of collecting and transporting them for work in the city, of providing them with food and medical services, and of conducting Party-political work, mass-cultural work, and other measures in the areas of resettlement.

The population that is not connected with enterprises, offices, and educational institutions is evacuated on a territorial basis; that is, the population of each city district is resettled on the territory of one or two agricultural areas (depending on the numbers to be evacuated and the capacity of the agricultural area to absorb those resettled).

Preparations for and execution of dispersal and evacuation are the responsibility of the civil defense staff of each city or region or enterprise, and of special evacuation commissions organized in city and regional executive committees of Councils of Workers' Deputies, as well as at industrial enterprises, offices, educational institutions, and housing utilization offices (housing-unit management). Evacuation commissions are subject to the control of the Chief of Civil Defense and work in close cooperation with the civil defense staff. A city-district evacuation commission is created by decision of the respective executive committee of the Council of Workers' Deputies. The commission is composed of representatives from the Party and Soviet organizations, military headquarters, leading workers of planning organizations, trade organizations, health organizations, police organizations, educational organizations, social service organizations, and transport organizations.

The responsibilities of the city-district evacuation commission and of the civil defense staff of the city-district are: (1) registration of the population and of enterprises and organizations that are subject to dispersal and evacuation; (2) determination of regions for dispersal and evacuation and of their capacities for absorbing the population and offices and organizations; (3) the distribution in these regions of city districts, enterprises, offices, and other organizations; (4) a tabulation of means of transportation and its distribution over the various points from which dispersal and evacuation are to take place; (5) solution of the problems of material, technical, and other essential services for dispersal and evacuation; (6) the development, publication, and storage of evacuation documents and the supply of these documents to all evacuation organizations of the city; (7) the determination of time periods required for dispersal and evacuation.

In addition, the city evacuation commission conducts the selection and appointment of commanders of evacuation collection points and of evacuation commissions of city districts, and also prepares them for their work in dispersal and evacuation.

An evacuation commission is created at a given location upon the decision of the commander of civil defense of the location (for example, the director of the enterprise). The evacuation commission of the enterprise includes representatives of the Party committee, the management committee, the personnel committee, the staff and the civil defense staff of the enterprise, and heads of individual shops. The chairman of the evacuation commission of an enterprise is the deputy commander of the civil defense organization of the enterprise and deals with dispersal and evacuation. The basic work of the evacuation commission of the enterprise includes: (1) a tabulation of the number of workers, employees, and members of their families that will be dispersed and evacuated; (2) the preparation of areas for dispersal and evacuation and of the points of embarkation and debarkation of those evacuated; (3) organization of communications and interaction with the regional evacuation commission and the evacuation collection point.

The evacuation commission operates in cooperation with the civil defense staff of the enterprise.

Dispersal and evacuation are conducted through evacuation collection points that are created by the city-district evacuation commission.

The evacuation collection point is given a permanent number. These evacuation points are assigned the responsibility of alerting, collecting, registering, and preparing for departure the population that is to be dispersed and evacuated; organizing embarkation on various forms of transport and dispatching the transport to the outer regions; informing the population about the situation and the areas of distribution for those dispersed and evacuated; organizing shelter for the people at the evacuation collection point upon the signal "air alert"; notifying the evacuation commission of the numbers evacuated and dispersed to the outer zones within the time periods established.

The collection points for evacuation are organized in communal buildings (schools, clubs, etc.) near the point of embarkation designated for service to the collection points (near railroad stations or platforms, docks, parking areas for automobile transport). The locations for organizing evacuation collection points are fixed by the evacuation commission.

The staff of the evacuation collection point and the responsibilities of its members are listed in Appendices III and IIIA.

The commanders of the evacuation collection points are confirmed in their post by resolution of the city-district executive committees of the Councils of Workers' Deputies, upon recommendation by the chairman of the city-district evacuation committee. Such commanders must come from the management staff of enterprises, offices, and organizations from which evacuees will come to the respective collection points. Assistant commanders of the collection points are also chosen from the administrative staff, while the rest of the staff consists of workers and employees of those enterprises, offices, and organizations for which the collection points are intended.

The commander of the collection point organizes a file with working documents, which is kept at the enterprise, at the bureau, or at the Housing Utilization Office. In this file are placed instructions to the staff of the evacuation collection point, calculations prepared for the staff, a diagram of the collection point with a list of instructions on the distribution of all its elements, a listing of people subject to dispersal and evacuation, a diagram and data for their instructions, blanks for certifications of evacuation, graphs to show the times for start-up of transports of embarkation and the times for their departure, route listings for the commanders of automobile convoys or of railroad assemblies, tickets for embarkation, and other documents.

A definite number of people are assigned to each evacuation point, and places are assigned for dispersal of this population to the outer regions. Means of transportation are assigned, and the points of embarkation and debarkation and the routes for the means of transport from the assembly point to the reception point are designated.

As a rule, the operation of the evacuation collection point is planned so that the evacuees leave in only one type of transport: motor vehicle, train, or boat. The population that is to be dispersed and evacuated must be notified early enough concerning who goes where and when during the evacuation (after the government gives the order for dispersal and evacuation), what things and documents are to be taken, and in what order evacuation documents should be presented.

The times for people to come to the collection points are determined from the transport plan and their [projected] arrival at the embarkation point.

In agricultural regions the measures taken for reception and distribution of the evacuees are the responsibility of the commanders and staff of civil defense of the agricultural region and of collective and state farms. Commissions must be created to deal with the reception and distribution of the dispersed workers and employees and of the evacuated population. These commissions are created within the executive committees of the Council of Workers' Deputies of the agricultural region. Composition of the commissions must include representatives of the regional committee of the Communist Party of the Soviet Union, of the military command, of the staff and the operating civil defense personnel of the area, and of the collective and the State farms. The head of the commission is the assistant chairman of the regional executive committee.

The commissions prepare for the reception and distribution of those evacuated, as well as the organization of food supplies, living essentials, and medical and other services and supplies.

For the reception of the evacuees, the regional commission must organize evacuation reception points.

Composition of the evacuation reception points and the functional responsibilities are listed in Appendices IV and IVA.

The staff of an evacuation reception point is made up of representatives of Party and Soviet organizations. Evacuation reception points must be located near stations, docks, and other places where debarkation occurs. Representatives are selected by the regional commission, and the evacuees are distributed in accordance with the directives of the executive committee of the Council of Workers' Deputies of the region.

3.2.2 Planning the Dispersal and Evacuation

An actual dispersal of workers and employees and evacuation of the population to outer areas are effected upon the decision of the government of the USSR. Some basic data used to plan dispersal and evacuation of a city population are:

1. the total population living in the city; the number of enterprises, offices, educational institutions, scientific research institutes, and other organizations and enterprises; the number of workers and employees to be dispersed, together with the members of their families; the number of persons who are to be evacuated;
2. the number of settlements in the agricultural area and the number of buildings there that are suitable for sheltering people, offices, and enterprises; the medical service situation in the settlements;
3. the availability of railroad, automobile, and marine transportation and their throughput capacity; the number of railroad stations and platforms, docks and landing areas, and points of embarkation and debarkation; the condition of bridges; the possibility for increasing the capacities of roads and water transport ways;
4. the availability in the city and in the outer zones of medical facilities and personnel, medicines, and preventive medicines; the availability of medical treatment for the population at the collection points, over the evacuation route, and in the regions where dispersed people and evacuees are to be distributed;
5. availability of water supplies and their characteristics and the possibilities for creation of new water supplies;
6. availability and location of food stores; quantity and capacity of enterprises for feeding the community; availability of bakeries and bread factories and their production capacities; the possibility of organizing mobile feeding stations and methods for obtaining additional required foods;
7. availability of radioactive fallout shelters, their capacities, and shelter characteristics; availability of local construction materials for erection of radiation shelters; availability of individual shelters;
8. meteorological conditions characteristic of the area, the average prevailing winds; the possibilities of catastrophic flooding.

Of all the essential data listed, the most complicated is a listing of the people who are to be dispersed and evacuated. This work must be accomplished early enough, by the personnel departments of enterprises, housing administrations, and the passport desks of the police.

Having studied and evaluated the basic data, the city-district civil defense staff and the city-district evacuation commission develop plans for evacuation and dispersal, which are then approved by the commander of civil defense of the entire city or region. The plans must provide for the distribution of the city districts and the enterprises among the outer regions, the necessary number of evacuation collection points and the locations for them, the locations of the means of transportation for the evacuation, the organization of material, and technical and other necessary measures.

To the plan are attached the following: a text of the announcement about dispersal and evacuation; a map showing the dispersal and evacuation; instructions to the commanders of the evacuation collection points, the railroad train assembly, and the auto convoy.

The dispersal and evacuation map must indicate: the name of the enterprise, office, or organization; the numbers of the evacuation collection points; the transport that is assigned to them; the locations for embarkation and debarkation; the distribution points for those to be dispersed and evacuated to the outer zones; the time periods allotted for dispersal and evacuation; and those people responsible for the evacuation and dispersal.

The civil defense organizations (transport, militia, medical, food supplies, materiel, etc.), in cooperation with the civil defense staffs of the city or region, develop their own plans for dispersal and evacuation, which are appended to the general plan.

Extracts from the city or regional plan for dispersal and evacuation are delivered to the industrial enterprises and are limited to those passages that are pertinent to them.

Based on data of the city or regional plan, the civil defense staff of an enterprise and the evacuation commission work to prepare and execute the evacuation and dispersal.

Among the responsibilities of any given civil defense staff and of any given evacuation commission are the following: studies of the region for dispersal and evacuation, the routes for evacuation, the points of embarkation and debarkation; the organization of communications with the evacuation collection point, a listing of workers, employees, and members of their families who are to be evacuated and dispersed; a listing of the kinds of transport available; organization of the materials and other kinds of supplies. In addition, the civil defense staff and the evacuation commission of the location establish contact with the reception point of the evacuation commission of the agricultural region and confirm with it the number of settlements and the amount of living space that is available and suitable for distributing the evacuees; the order for reception and distribution of workers and employees of an enterprise and members of their families; possibilities for employment of the evacuated; food supplies; the food distribution network and the trade network; organization of the materiel and other forms of service; the availability of local transportation, etc.

When planning the distribution of the evacuees among the settlements, it is essential to avoid overcrowding. Approximate standards of distribution may be as follows: for each local inhabitant, there may be one to two evacuated people, or two to three square meters of living space for each person (that is, both local and evacuated).

Summaries of the preparatory work of the civil defense staff and the evacuation commission of the location are studied by the civil defense commander. He examines the proposals of the staff and makes decisions; based on these decisions, the civil defense staffs of the location form their plan for distribution and evacuation (see Chapter 7).

3.2.3 Supplying the Requisites for Evacuation and Dispersal

Supplying transport. Transportation for evacuation and dispersal applies to the movement of organizations, their workers, employees, and members of their families to the dispersal areas; transportation of the population to the evacuation region; transportation by shifts of workers and employees from dispersal regions to the city, to the enterprises for work, and back to the dispersal area for rest.

Transportation of dispersed workers, employees, and evacuees is effected by railroad, water, and automotive transport. The principal means are railroad and automotive transport.

The capacities of railroads for evacuation are determined by the command staff (sections) of the railroads, with the participation of representatives of the civil defense staff of the city or region. Together they develop various means for providing transportation, depending on the capacity of each section or tract, the number of people to be dispersed and evacuated, the numbers and times for transportation or working shifts to the enterprises (those that do not interrupt production in wartime), places for embarkation and debarkation, the capacities of the areas of distribution, and other conditions.

The management (departments) of the railroads makes up graphs of the transport movements and informs the city or regional civil defense staff of the number of trains (assemblies), the number of people that may be transported in each of them, stations (points) of embarkation and debarkation, and the times of departures. Requisite to calculating the departure times for trains during an evacuation is the reliable notification of the onset of dispersal and evacuation.

Information on these matters, as well as data on the capacities of other forms of transport, enables the urban civil defense staff to plan transportation of the population by various means.

During preparation for evacuation transport, sequences are developed for embarking and debarking people under conditions when cars must be loaded to maximum capacity and [for giving] the rules of conduct for the evacuees when embarking, when enroute, and when debarking. These are developed in cooperation with the managing staffs and commanders of railroad train assemblies.

Automotive transport is planned and organized by the commander of the motor pool of the city's civil defense organization, in accordance with notifications from the civil defense staffs of the various enterprises.

The commander of the motor pool determines the problems involved in providing transportation for evacuation and dispersal and makes them known to those responsible for executing the transport operations. These communications must indicate:

1. to whom, where, in what quantity, and under whose command the means of transportation may be released, the location and the purpose of the transports;
2. the sequence of steps and the time allocated for equipping the means of transportation for movement of people;
3. the routing of the transportation and the schedules for the trips;
4. the supply of fuel for automobiles and trucks and the supply of lubricants and spare parts;
5. places and sequences for maintenance operations for auto transport.

To ensure a centralized direction of the automotive transport and precise operation of the motor pools, a city must organize auto convoys, consisting of 20 to 30 automobiles. Commanders of the convoys are designated and dispatcher points organized. Automotive convoys are assigned specific routes and specific evacuation collection points so that each convoy operates, as a rule, over only one route.

Buses are also assigned to transport people, as are light and heavy trucks and specially equipped dump trucks.

After the directive (order) for dispersal and evacuation, an automotive convoy must report to the evacuation collection points at the designated time and, depending on the capacity of the embarkation point, go to the actual embarkation location either in one column or in groups of five to six vehicles.

When calculating automotive transport, it is essential to know the passenger capacity of the vehicles. Trucks and dump trucks must be equipped with seats for transporting people.

Representatives of the enterprise, offices, and organizations that are being evacuated must accompany the convoy from the evacuation collection point to the various distribution areas in the outer regions.

During the distribution of workers and employees of an enterprise, a commander of a shift that is being transported can designate one of his assistants to be in charge of the operation. This person is [then] responsible for the organization and rapid departure of a shift that has been resting, for its transportation to an outlying region, and for arranging for the nourishment and rest of the workers and employees, as well as for the timely delivery of the rested shift back to its place of work.

The continued smooth operation of the enterprise will depend to a large extent on the efficient and precise operation of the transportation.

Roads. Road service includes the organization and execution of measures to ensure uninterrupted transport along the automobile highways during an evacuation.

Automobile highways are subdivided into operating sections 150 to 200 km long.

To ensure uninterrupted transport during the period of evacuation, automobile highways must be equipped with repair points (based as far as possible on existing automotive enterprises) and stationary and portable fuel supplies. In addition, at places specified by the civil defense plan, stations and areas for decontamination of transport and points for medical processing must be established.

Among the primary responsibilities of the commander are: maintenance of the road and the structures along it; distribution of necessary signs and indicators; organization of emergency technical services; organization of guards and protection of the most important locations along the road; and also assistance to the police service in directing traffic and safety.

To maintain order at distribution and evacuation points, civil defense police functions are organized. Their responsibilities include traffic control and public safety along the evacuation routes, the implementation of specified measures, control over orderly traffic movement, and protection of the most important equipment along the road and of industrial enterprises.

For each section of the route a commandant is appointed. Tractors and other road equipment are allocated to him, particularly in areas that are difficult to cross.

Command posts are designated and outfitted, and check points are organized and staffed by personnel of public safety organizations, with the necessary means for transportation, communication, and chemical and radiation monitoring.

The command function is organized by the civil defense staff of the city or region. Direct control of this function is given to the commander of the public safety organizations of the city or region by the commanders of the routes (regions and crossing points) and the commanders of the command posts (the check points).

Measures for organization of the command function are reflected in the early development of plans by the staff. These plans indicate:

1. the purpose and the principal goals of the command staff, its strength, and the resources at its disposal;
2. the locations of command posts and traffic control posts; their composition; their equipment for transport, traffic control, and communications;
3. the composition and location of personnel and equipment of the command staff,
4. organization of communication and control;
5. areas and routes (sections of routes) over which the command staff is assigned authority by the headquarters staff.

Before the convoys of dispersed and evacuated people depart, the command staff is distributed over the routes that these convoys will take.

Material. Material requirements consist, first of all, of food and other essentials, together with their supply and distribution to the evacuated population.

The organization of supplies for the dispersed workers and employees and for their evacuated families is the responsibility of the deputy chief of civil defense for materials and technical supplies.

In cooperation with civil defense agencies of the city-district and of the agricultural region, he makes preparations for supplying, in the outer regions, the workers and employees of an enterprise and the members of their families, and also organizes the feeding of working shifts.

The supply of food to the evacuated population and of essentials to the outer zones is organized through local trading organizations, through the network of communal food supplies, and through community services. City trade enterprises and community service enterprises are transported to the outer areas simultaneously with the dispersal of workers and employees and the evacuation of the population, and are used to increase the capacity of the established network of supply in the outer evacuation region.

Enterprises, clinics, children's organizations, and educational institutions take with them into the outer zones their own supplies of food and means for organized feeding and supply through their own dining rooms and ORS [?]. The enterprises and organizations that do not have their own mess facilities, and all the rest of the population, are assigned for feeding to mess facilities at the points of distribution, or they obtain food through the trading network of the agricultural regions.

The feeding of working shifts of enterprises is organized through already existing or newly formed mess facilities. Food is supplied to dining rooms at locations by the food services and by the supply services of the city, or the city-district gathers, for this purpose, stores of foodstuffs within the limits of established standards.

The supply of drinking water in the outer zones is obtained mostly from artesian, drilled, or piped wells, and from other enclosed water supplies.

Medical service. Responsibilities of the medical service for dispersed workers and employees and the evacuated population include: medical aid for the sick and injured, their medical care in medical establishments; the timely execution of antiepidemic measures to prevent infectious epidemics; control of sanitary conditions at points of embarkation, debarkation, and eating stations, as well as in areas of temporary habitation and in areas where evacuated people are more permanently distributed.

Medical aid to dispersed workers and employees and to the evacuated population is conducted at collection points, embarkation points, stops, and points of debarkation and distribution, as well as at the enterprises themselves.

During a period of dispersal of workers and employees and the evacuation of the population, local or administrative enterprises make available, at the collection and embarkation points, medical personnel and organized medical care centers. The personnel of these centers is evacuated with the last convoy, that is, at the conclusion of the work of collection at the evacuation point.

At the places where the dispersed workers and employees and the evacuated population are distributed, medical care is organized by the medical services of the agricultural regions with the help of the personnel of the evacuated medical enterprises and of the medical organizations of industrial enterprises, and also of the local clinical and preventive-medicine organizations.

Part of the medical personnel is assigned to the staff of the mobile civil defense formations to give medical aid to members of the population who may have suffered in nuclear attacks on cities.

Supplies, as well as workers and employees of operating shifts, are organized at medical enterprises by the commander of medical services of the enterprise. Medical service is rendered through sanitation posts and nursing aid centers, which are set up well ahead of time for each shift. Medical attention by a doctor is administered through the clinical centers and through mobile clinics. Specialized medical aid and treatment in fixed locations are conducted in hospitals of the outer regions, while first aid to nonmobile sick is rendered in city hospitals. When infectious illness appears, suspected victims and those who have been in contact with them must immediately be isolated and evacuated by special transport to the nearest infectious illness hospital, with the implementation of strong measures for epidemic control.

In addition, during the period for sheltering the workers and employees, the medical groups and the personnel of sanitation posts (that operate on a shift basis) are uniformly distributed for first aid services among the defensive facilities.

3.2.4 Radiation and Chemical Defense

Radiation and chemical defense, under conditions of dispersal of workers and employees and evacuation of the population, consists of organizing radiation and chemical monitoring, of supplying individual and collective means of defense, and of providing health physics services.

Radiation and chemical defense of workers, employees, and the members of their families is organized and conducted both on-site in the city and in the dispersal and evacuation zones.

To accomplish this, the civil defense staff of the enterprise organizes radiation, chemical, and meteorological monitoring at the collection and reception points for evacuation, along the evacuation route, and at the evacuation sites in the outlying zone.

At the sites of the evacuation collection points, shielding shelters must be prepared in advance so that those being dispersed and evacuated can take shelter in case of an "air alert" signal. In the outlying zones, at the evacuation receiving stations, and in the areas where evacuees are quartered, on-site facilities (cellars, vegetable storage bins, etc.) that can also shelter the population must be prepared in advance.

When the dispersal and evacuation are announced, the civil defense staff begins to supervise the preparation of shelters at the enterprises and, in the areas of the evacuation collection points, the preparation of individual civil defense equipment and other antiradiation measures; it also checks on the state of readiness of shelters in the outlying area at the resettlement locations for workers, employees, and their families; organizes the preparation of the most simple means of individual protection and the construction of radiation shelters in the outlying zone, using for this purpose cellars, basements, mine shafts, mining diggings, and various structures that are below ground level.

At resettlement sites of workers and employees in the outlying zones, a continuous monitoring of the radiation situation is organized; also, a warning system is developed, as is a set of rules for the population to follow in case of radioactive contamination. In addition, there is organized study of civil defense signals and the actions to be taken under specific real conditions.

If a center of contamination does develop, the civil defense staff announces the measures and actions to be followed by workers and employees, depending on the situation.

3.2.5 Putting Dispersal and Evacuation into Effect

Sequence of announcements. Among the measures required for dispersal and evacuation, the means for informing the population are very important.

Dispersal and evacuation are initiated upon orders from the government. The various civil defense staffs receive such orders in a predetermined manner and then transmit them to the managements of enterprises, offices, and other organizations by means of radio broadcasts, television broadcasts, telephone, and messengers. The general population is notified through local radio broadcasts, as well as through enterprises, offices, educational institutions, rental offices, building superintendents' offices, and police establishments.

In the daytime, when radio relay stations are usually operating, as well as radio and television sets, the population can be notified quickly of orders for evacuation and dispersal. At night, when these devices are usually turned off, spreading the word becomes more complicated. If the situation demands immediate notification at night, then special automobiles equipped with public address systems may be sent into all regions of the city to waken the residents and transmit the orders to them. Telephone and street loudspeaker systems may also be used for this purpose, as well as the instructors of the evacuation collection points and the workers on night shifts at various enterprises.

Assembly and departure of evacuees and dispersed persons. After notification of the onset of dispersal and evacuation, the evacuation collection points start to operate at once and to assemble and route those being dispersed and evacuated.

Workers and employees must arrive at their collection points at the times designated for them. As a rule, the workers and employees to be dispersed are relocated in the outlying zone, together with their families. Thus, they all arrive together at the collection points.

If it is impossible to evacuate families as units, the dependents are moved to more distant regions; therefore, their times of arrival at the collection points may differ from those of the workers and employees.

Those who are dispersed and evacuated must take with them documents, money, and necessary items and food for two to three days. At the evacuation collection point the people are registered and obtain tickets for embarkation. On this ticket, the number of the convoy or train and the time and location for embarkation are indicated.

After registration and ticketing, the people are grouped according to their assigned railroad car or motor vehicle, under the direction of a deputy commander of the evacuation collection point and the commander of the train or convoy. At the appointed time these groups move out to the embarkation points.

The actual embarkation is supervised by the senior people of the railroad car or motor vehicle [truck, bus, or car]. Once embarked, the evacuees are not allowed to leave the railroad cars or motor vehicles without permission of the supervisors.

After arrival at the evacuation destination, debarkation takes place on order of the train or convoy commander, and the people then go to the evacuation reception point, where once more they are registered and assigned to settlements, to which they proceed in an organized manner.

In the cases of children, invalids, and the very old, their possessions must be moved by local transport. The places for distributing these people and their possessions are farther than 5 km from the evacuation collection point. The evacuees must be carried by the local transportation of the collective farms and state farms.

Party-political work during evacuation and dispersal. The successful execution of evacuation and dispersal depends to a significant extent on the morale and the political state of mind of the evacuees, and also on the level of Party-political work.

Party-political work is based on the Program and Directives of the CPSU (Communist Party of the Soviet Union), on the decision of the TsK CPSU (Central Committee of the Communist Party of the Soviet Union) and of the Soviet Government; on the orders and directives of the Military High Command and of the Commander of Civil Defense of the USSR; on the decisions, directives, and instructions of the TsK of the Communist Parties of the Union Republics, Regional Committees, District Committees, City Committees, and Borough Committees of the CPSU.

The specific contents of the Party-political work and the ways and means of its implementation under various conditions and situations are determined by the nature of the problem and by local conditions.

Party-political work is organized by city and borough committees of the CPSU, while at the sites themselves it is organized by the Party organizations of the enterprises, offices, and educational institutions.

Under the direction of Party organs, even in peacetime, propaganda must be conducted — knowledge of civil defense must be spread by means of both visual aids and oral addresses, the press, radio, TV, and movies. All of these means must propagate knowledge about ways to defend the population from weapons of mass destruction.

The purpose of the propaganda is to explain the measures and methods used to provide protection from weapons of mass destruction, to popularize civil defense and its problems, to make the entire population knowledgeably aware of the importance of civil defense measures under modern conditions, and to prepare the people psychologically and strengthen their morale for the difficulties and grim experiences that may occur if the imperialists unleash a war.

The rapid course of events that will be a characteristic of a nuclear rocket war will require a very fast reaction to events from both the civil defense forces and the entire population. One of the conditions for reducing losses among the population would be the early and smooth execution of dispersal and evacuation; thus, one of the most important problems is that of making clear to workers, employees, and the population all the measures that must be implemented for dispersal and evacuation, and the role and the place of each person in the execution of these measures.

In the period of threat of enemy attack, the Party committees of each enterprise must distribute Party-Komsomol [young Communist League] and trade-union activists among the evacuation collection points, trains, and convoys. The committees must provide these activists with all information; they must understand the importance of counteracting panic; they must inform those being evacuated of the rules of conduct at embarkation, in transit, and upon arrival. The Party committees must organize propaganda brigades for work in the resettlement areas, among those who are evacuated and dispersed; they must also organize lectures and discussions, show movies, give radio broadcasts, make bulletin boards, issue war communiques, and make propaganda posters.

Primary attention must be directed to explaining to the population the details and particulars of the actual situation, to fostering faith in the righteousness of our cause and in the certainty of victory over the enemy.

The problem of work placement at the evacuation locations has considerable significance, both economic and political. Thus, placing evacuees in jobs is one of the concerns of Party-political work.

4. Individual Means of Protection

4.1 DEVICES FOR PROTECTING THE RESPIRATORY SYSTEM

The individual means of protection include gas masks and devices for protecting the skin against toxic and radioactive, as well as biologically dangerous, materials.

The most important protective device is the gas mask. It is intended to protect the respiratory system, the face, and the eyes from the effects of toxic materials in any form (vapor, fog, gas, smoke, droplets), radioactive substances in the form of airborne radioactive dusts, and pathogenic microbes and toxins introduced into the air in the form of fogs (aerosols).

4.1.1 Basic Gas Mask Design

Gas masks can be classified, according to the type of protection they give, into two categories: filter and air-supplied types. In the filter-type gas masks, ambient air is purified before respiration by removing the majority of foreign materials that are harmful to man. In the air-supplied gas masks, completely self-contained respiration is made possible by providing oxygen in the apparatus itself and by purifying exhaled air to remove gaseous carbon dioxide and moisture.

Air-supplied gas masks (apparatus) have multiple protective characteristics, that is, they protect from all toxic materials, radioactive dust, and biological aerosols in any concentration. However, their essential disadvantages, besides being heavy and cumbersome, are their short service life and the comparative complexity of their design and use.

Thus, the filter-type gas mask has received the most widespread popularity and is the basic means for protecting the respiratory system. Before we begin to familiarize ourselves with models of protective devices for the respiratory system, let us briefly examine the principles on which these devices operate.

The removal of vapors and gases in the cartridges of filter-type gas masks occurs as a result of adsorption, chemisorption, and catalysis. Air is purified by the removal of radioactive dust, biological media, and toxic materials in the form of fog and smoke by filtration.

Adsorption is the retention of molecules of any substance on the surface of a solid due to forces of intermolecular attraction. A solid adsorbing any substance on its surface is called the adsorbent. The amount of substance adsorbed depends on the nature of the surface on which adsorption takes place. The more porous the adsorbent, the more readily the adsorption process takes place, and the greater the amount of adsorbate.

Carbon is the most suitable adsorbent in gas masks; it is highly porous and consequently has a large surface. But ordinary carbon does not have sufficient adsorptive power for toxic materials because most of its pores are filled with resinous materials, carbon dust, and combustion products. To increase the adsorptive power of carbon, it is subjected to a special activation treatment.

The activated carbon, in the form of small pellets or granules, is the basic component of a gas mask adsorbent. In contrast to untreated carbon, activated carbon has an enormous free surface; for example, 1 g of activated carbon has a free surface of about 800 m^2. Activated carbon adsorbs toxic materials of the sarin and yperite (mustard gas) type, etc., very well.

However, not all toxic materials can be trapped on the surface of activated carbon by the forces of intermolecular attraction alone; some gaseous toxins, for example, prussic acid, are capable of penetrating a layer of activated carbon and are not trapped by its pores. Purifying the air by removing such toxins is accomplished by chemisorption, that is, chemical conversion of toxic materials into nontoxic neutral substances. To this end, chemicals are added to the gas mask adsorbent. Toxic materials entering the gas mask react with these chemicals and are converted into innocuous materials.

The process of chemical interaction between the gases and the adsorbent usually takes place slowly, but in the gas filter cartridge it must take place in hundredths of a second because the rate of air flow through the adsorbent with inhalation is high, that is, about 1 m/sec. Therefore catalysts, that is, special chemical accelerators, are used to speed up the chemical reactions occurring in the gas mask. Thus, catalysts which accelerate the reactions of chemical adsorbents with toxic materials are a necessary part of the protective features of the gas filter cartridge.

In modern filter-type gas masks, this addition is achieved by a very thin layer of activated carbon which has the power to adsorb any known toxic material. The properties of the adsorbent may change depending on the composition of the catalyst, in particular, its adsorptive power for different toxic materials.

The process of adsorbing any toxic material on the surface of an adsorbent particle cannot go on indefinitely. After saturation of the adsorbent particle with toxins, which may occur at any moment, adsorption stops. However, gas mask protection does not stop because the time when the individual adsorbent particles will become saturated by toxins has been determined, as has the duration for which the entire gas adsorbent will guarantee protection from toxic materials, that is, the time at which the entire gas adsorbent layer will become saturated and the so-called breakthrough of toxic materials will take place. When the breakthrough occurs, the gas filter cartridge must be replaced [see footnote *].

Another process occurring in the gas filter cartridge is filtration, which protects the respiratory system from radioactive dust, toxic fumes and vapors, and biological media. Radioactive dust, biological aerosols, and toxic smokes and fumes consist of particles which, according to their size and quantity, may [*not*] be trapped on the surface of the adsorbent only by intermolecular forces. Thus, for protection against these materials an aerosol or so-called smoke filter is used in the gas mask.

Filtering cardboard is used in modern gas masks as a smoke filter which is comparatively dense, consisting of a large number of fine fibers and filaments and filtering material made of synthetic fibers; almost all particles of radioactive dust, biological aerosols, and TM smoke or fog entering with air through the smoke filter settle on its surface (are filtered) and are retained there by forces of intermolecular attraction.

[*Obviously, a gas filter cartridge should be replaced *before* breakthrough occurs.]

To evaluate the filter materials in a gas filter cartridge (with regard to filter efficiency), breakthrough factors are used; these are expressed in percent:

$$K = \frac{C_1}{C_0} 100 ,$$

where C_1 is the concentration of aerosols after flow through the gas filter cartridge and C_0 is the concentration of aerosols before flow through the gas filter cartridge. It follows from this that the lower the breakthrough factor, the greater the protective properties of the adsorbent.

In gas filter cartridges, the smoke filter and the activated carbon (packing) are situated so that inspired air flows first through the smoke filter and then through the packing. This arrangement results in the following: The toxic smoke particles trapped by the smoke filter may evaporate, and these vapors will be adsorbed on the layers of the packing; when the smoke filter is placed behind the packing, these vapors would not be adsorbed and would invade the human organism and cause injury.

There are presently several filter-type as well as air-supplied gas masks.

4.1.2 Filter-Type Gas Masks

Functional principles of the gas mask. The basic filter-type gas masks intended for general use are designated GP-4Y (Fig. 30*a*), GP-5 (Fig. 30*b*), DP-6, DP-6M (Fig. 30*c*, *d*), and the child's protective chamber, KSD-1 (Fig. 30*e*).

The GP-4Y (Fig. 30*a*) is designed for the adult population. It consists of a gas filter cartridge (1) and face mask (2); the gas mask is carried in the gas mask bag.

The gas filter cartridge GP-4Y (Fig. 31) purifies inspired air by removing toxic and radioactive substances and biological media; it is made of tin and is cylindrical. To increase the mechanical stability of the housing (1), transverse external corrugations (ridges) are embossed. On the upper part of the cartridge there is a cover (2) with threaded neck (3) for attaching the connecting hose; in the lower part, there is a base (11) with aperture (12) for the entry of inspired air.

Inside the cartridge there are two perforated (screen) cylinders, situated one inside the other. The upper part of the small screen cylinder (5) is fastened to the cartridge neck, and the lower part is closed with a metal cap (13). Next to the small cylinder, there is a large

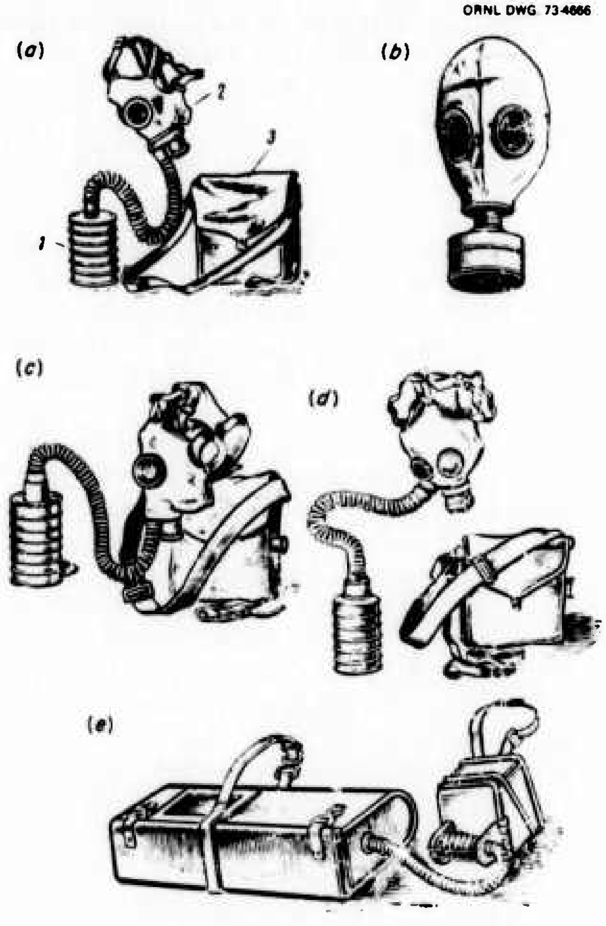

Fig. 30. Gas masks for the civilian population.

screen cylinder (6) which is fastened by its upper part to the roof of the cartridge, while in the lower part there is a fixed bottom (10).

The space between the large and the small cylinders is filled with packing (4) (activated carbon with a chemical additive), which is contained by a movable bottom (8) below. The movable bottom is supported by a spring (9).

A folded, corrugated smoke filter (7) is fastened to the outer surface of the large screen cylinder and traps smoke, fog, radioactive dust, and biological aerosols.

A dust filter (14) of long-fiber paper is fastened to the inner surface of the small screen cylinder. The dust filter is designed to trap dust formed in the gas mask as a result of friction between packing particles.

When outside air is inspired through the aperture in the bottom of the gas filter cartridge, it enters the space between the cartridge housing and the smoke filter where it is cleansed of toxic particles, radioactive dust, and biological aerosols. Further on, the air flows

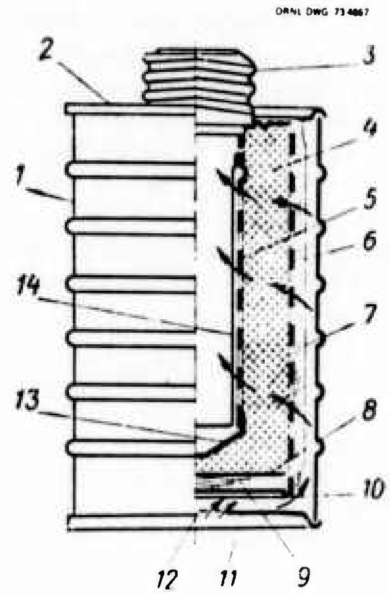

Fig. 31. Cross section of the GP-4Y gas filter cartridge.

through the packing layer, where it is cleansed of TM gas and vapors, passes on through the dust filter, arrives purified at the connecting hose under the face mask, and enters the respiratory system.

The face mask feeds the purified air into the respiratory organs and protects the eyes and face from TM, radioactive materials, and biological media. It consists of a rubber mask with protective goggles, straps, a valve box, and a connecting hose. The eye pieces are made of glass and are snapped into the body of the mask by serrated rings. The rubber head band and the straps hold the mask on the head and keep it tight against the face; the tightness of the straps is adjusted with buckles. The masks are made in three sizes: 1, 2, and 3. The size is indicated on the mask chin with the numbers 1, 2, 3.

The valve box (Fig. 32) is made of tin and distributes and directs the stream of inspired and expired air. It is fastened to the body of the mask (to its lower part) with small wires and rubberized tape. The valve box contains one air inlet and two air outlet valves.

The air inlet valve head (1) is a rubber disk with an aperture in the center through which the stem passes. When air is inhaled, the valve head rises and admits air into connecting hose (4) under the mask; when air is exhaled, the valve head is forced against the valve seat ring, obstructing the path of expired air to the connecting hose.

The upper outlet valve (2) consists of a rubber seat and a "lobe" secured between its four rubber pawls.

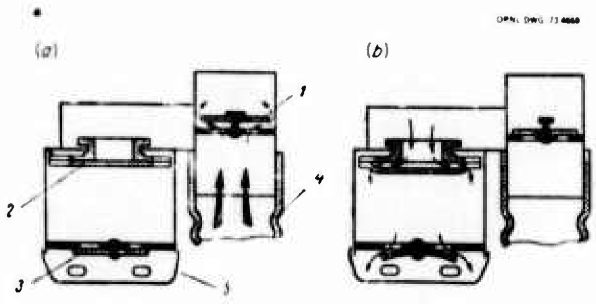

Fig. 32. Valve box: (*a*) Inlet; (*b*) outlet.

The valve lobe is unperforated, but the seat has a central aperture and bosses for mounting in the valve box.

The lower outlet valve (3) consists of a rubber disk with an aperture in the center for attachment to the valve seat. It is protected from possible damage by the separate screen (5).

Between the upper and lower outlet valve there is a chamber called the physiological chamber.

Both outlet valves open with expiration and close with inspiration. The valves operate as follows. With inhalation, air entering from the gas filter cartridge through the connecting hose raises the inlet valve and flows into the face mask. Due to a vacuum produced in the mask by inhalation, the outlet valve is pressed to its seat, and the latter obstructs the inlet of the ambient air under the mask through the valve box.

With expiration, increased air pressure is generated inside the mask. Thus the intake valve head drops down, is pressed against the valve seat, and obstructs the path of expired air in the connecting hose. Due to the air pressure, the disks of the intake valves are moved away from their seats, and the expired air leaves the mask.

The presence of the physiological chamber and the second outlet valve practically eliminates the possibility of inflow of contaminated air into the mask through the outlet valve.

The connecting hose connects the mask to the gas filter cartridge. It is made of rubber, covered with a fabric, and has transverse folds (corrugations) which guarantee air intake even when the tube is bent or accidentally compressed. The upper end of the tube is fastened to the outlet of the valve box, and the lower end is connected to the neck of the gas filter cartridge with nuts.

The gas mask bag is provided for storing and carrying the gas mask. It has two compartments: one (the smaller) for the gas filter cartridge and the other (the larger) for the face mask. Two wooden chucks are fastened to the bottom of the smaller compartment on which the gas filter cartridge is placed; the chucks prevent the aperture at the bottom of the box from being closed by the fabric of the bag during inhalation. There is a special "pencil" in the box to prevent the glass in the goggles from fogging up when the gas mask is operating. At the bottom, the bag is closed with a flap. A shoulder strap is sewn onto the bag for carrying the gas mask; there is a belt strap and a D-ring for fixing the bag to one's body during operation.

The GP-5 gas mask (see Fig. 30*b*) consists of a gas filter cartridge and a face mask. In addition, a gas mask bag and an anticondensation coating or special pencil to prevent the glass in the goggles from clouding are included in the kit.

The gas filter cartridge as well as the valve box of the GP-4Y gas mask are tin cylinders, around the inside of which there is a smoke filter, a special packing layer, and a dust filter. The gas filter cartridge of the GP-5 is half the size of the GP-4Y cartridge; the height of the cartridge is about 70 mm and its diameter is 107 mm.

The face mask of the GP-5 gas mask is made of rubber and has eye pieces, deflectors, and a valve box with inlet and outlet valves. The gas filter cartridge is screwed directly onto the valve box (without the corrugated connecting hose).

The helmet masks (SHM-62) come in five sizes, indicated on the chin part by the numbers 0, 1, 2, 3, or 4.

The design of the DP-6M and DP-6 gas masks is similar to that of the GP-4Y and consists of a gas filter cartridge and a MD-1 mask which comes in five sizes.

The DP-6M gas mask is designed for children from 1.5 to 12 years. These are supplemented by lighter D-11 cartridges and MD-1 masks only in the four smaller sizes. The D-11 mask has a design similar to the GP-4Y cartridge, differing only in its smaller size.

The DP-6 is designed for older children, supplemented by MD-1 masks in five sizes and GP-4Y boxes. The DP-6 and DP-6M gas mask bags differ only in size.

The MD-1 mask has eye pieces mounted in metal rings, a rubber valve box, a connecting hose, and a headpiece with a set of straps. It is made of rubber. The inlet valve is mounted on the valve seat of the nipple to which the connecting hose is attached. Two outlet valves are fastened to the plastic valve seat sockets mounted in the valve box so that a small chamber is formed between them. On the lower part of the valve box exterior there is a metal screen to protect the valves from mechanical damage. The connecting hose is hermetically fastened to the mask — at the side of the valve box for the smallest mask and higher on the valve box for the other sizes.

The child's protective chamber CPC-1 (see Fig. 30*e*) is designed for children up to 1.5 years old. It consists of a demountable wooden housing, a cover made of a rubberized fabric and a GP-4Y gas filter cartridge, a connecting hose, bellows, and straps. The casing of the chamber has a window permitting observation of the child's behavior inside the chamber, a sleeve-glove, a closing device for hermetically sealing the chamber, and inlet and outlet valves. The cover mounted over the housing forms a 50-liter chamber into which the child is placed. One end of the connecting tube is attached to a socket with an inlet valve on the chamber casing, and the other end is attached to the neck of the gas filter cartridge. The bellows are attached to the gas filter cartridge by rubber couplings and straps.

The protective chamber is hermetically sealed by a sealing valve. The purified air is pumped by the bellows. The chamber with the child is carried in the left hand. In addition, the bellows are placed on the right side, and the air is pumped with the right elbow.

To guarantee normal living conditions throughout the child's confinement in the chamber, it is necessary to pump air with the bellows (10 to 15 strokes) every 15 to 20 min, approximately in the rhythm of natural respiration.

Hopcalite cartridge. Civilian filter-type gas masks offer protection from all known TM, except carbon monoxide. When working in an atmosphere poisoned with carbon monoxide, a hopcalite cartridge is attached to the gas mask (Fig. 33); the cartridge is in the shape of a metal housing, the top of which has an externally attached neck piece (3) for attaching the case with the face mask connecting hose (or the mask helmet in the case of the GP-5), and the bottom has an internally attached neck piece (4) for attaching the gas filter cartridge to it.

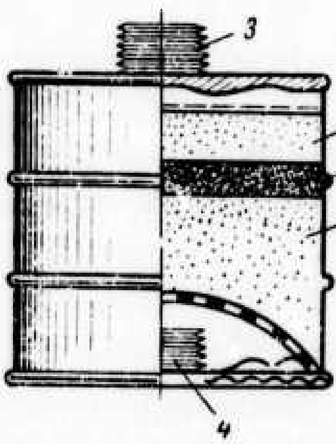

Fig. 33. Hopcalite cartridge.

The hopcalite (gas cartridge) is equipped with hopcalite (1) (a mixture of manganese dioxide and cupric oxide) and desiccant (2). The hopcalite catalyzes carbon monoxide oxidation to carbon dioxide with atmospheric oxygen. Desiccant (2) consists of silica gel impregnated with calcium chloride; it adsorbs water vapor from the air flowing through the hopcalite cartridge, protecting the hopcalite from moisture, because wet hopcalite loses its catalytic activity.

The initial weight is indicated on the hopcalite cartridge. When the weight increases 20 g or more due to moisture uptake, the cartridge cannot be used. The cartridge has a protective service life of about 2 hr.

To put the hopcalite cartridge into use, the following are attached to the gas mask: a connecting hose fastened by a nut (or GP-5 helmet mask) screwed to the external hopcalite cartridge neck piece and a gas filter cartridge screwed to the internal neck piece of the cartridge.

Selecting, fitting, and checking the gas mask. An efficient gas mask gives reliable protection only when the mask is correctly selected and carefully fitted to the face. To determine the required mask size, the length of the adult face must be measured (distance between the point of the largest depression at the bridge of the nose and the lowest point of the chin) as shown in Fig. 34.

The measurement may be made with a standard student ruler with millimeter divisions (Fig. 34*a*) or with calipers (Fig. 34*b*). After the face length is determined, it is necessary to determine the required mask size according to Table 11.

If the measured values are outside the limits of the given table, then the required mask size is determined by carefully testing a mask directly against the face. The mask selected must fit tightly against the face.

The helmet mask is selected according to the size of the head, which is determined by two measurements: the first along the closed curve passing through the crown of the head, the chin, and the cheeks (Fig. 35*a*) and the second one along the line connecting both ear canals and going through the arch of the eyebrows (Fig. 35*b*). The results of both measurements determine the size of the face mask according to Table 12.

The correctly selected helmet mask must fit tightly against the face and prevent ambient air from penetrating into the respiratory organs by passing the gas filter cartridge.

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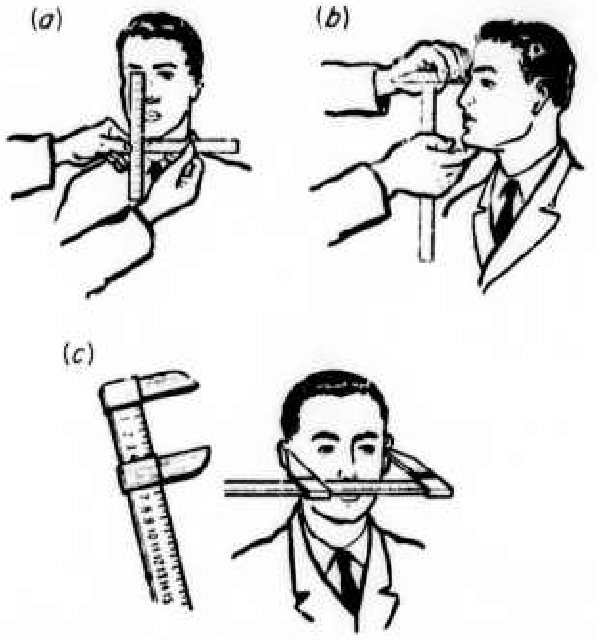

Fig. 34. Measuring the face to select a mask: (*a*) Measuring the length of the face with a ruler; (*b*) measuring the length of the face with calipers; (*c*) measuring the width of the face with calipers.

Table 11

Mask sizes	Face length (mm)
First	99–109
Second	109–119
Third	119 and higher

Table 12

Helmet mask sizes	Total of head measurements (cm)
0	up to 92
1	92–95.5
2	95.5–99
3	99–102.5
4	102.5 and higher

The size of a child's mask is determined in two ways. The first method is the same as the one for adults, that is, according to the length of the face. The second method is to measure the facial width (see Fig. 34*c*), the distance between the most strongly projecting points of the cheek bones. After the length and width

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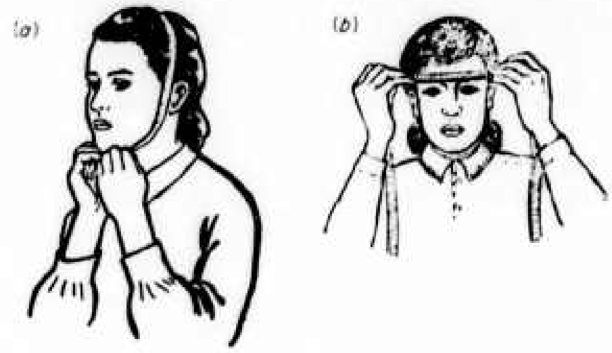

Fig. 35. Measuring the head for selecting the helmet mask of the GP-5 gas mask: (*a*) First measurement; (*b*) second measurement.

Table 13

Mask sizes	Face measurements (mm)	
	Height	Width
1	Up to 77	Up to 108
2	77–85	108–116
3	85–92	111–119
4	92–99	115–123
5	99 and higher	124–135

of the face are measured, the required mask size is determined according to Table 13. If the measurements do not correspond to the data in the table, then the required size is determined by carefully fitting the mask to the child's face.

After the size of the mask is determined, it is necessary to carefully fit it to the face. To do this, it is necessary to completely extend the forehead straps, slip on the mask so that the center back of the mask lies at the center of the back of the head, and then tighten the straps at the forehead and back of the head (but not too much). Before putting on a new mask it is necessary to apply alcohol or a 2% Formalin solution to disinfect it.

When inspecting the gas mask, the following procedure is recommended:

1. check to see if the mask is complete with eye pieces, straps, valve box, valves, and protective screen;
2. check the condition of the connecting hose and the tightness of its connection with the valve box;
3. check the cannister case for dents, rust, punctures, ruptures, and integrity of the attached neck piece;
4. remove the plug closing the aperture;

5. examine the gas mask bag and check for the antifogging pencil for the glass, the baffles, the straps, and the buckles.

After examining it, set up the gas mask as follows: In the left hand take the nut of the connecting hose (letting the mask hang loosely) and with the right hand screw in the cartridge, taking care that there are no misalignments. Put the selected gas mask in the bag.

To put the mask away, take it in the left hand [holding it] behind the valve box so that the eye pieces are facing away [from you], with the right hand put the center of the rear part of the mask and the straps inside the mask, put the connecting tube into the bag, and then the mask with the valve box down.

To check the gas mask for airtightness, proceed as follows: Put the mask on, take the valve box out of the bag, close the aperture on the bottom with the palm of the hand, and take a deep breath. If air does not pass under the mask when [thus] inhaling, then the gas mask has been correctly selected and adjusted. If air does pass under the mask with inhalation, the gas mask is faulty and must be carefully checked.

When the mask has been checked, take a few breaths with the connecting hose and the valve box closed. To check the outlet valve, take a breath with the connecting hose compressed (covered). Also check the connecting tube with a breath, squeezing it at the neck piece of the gas filter cartridge.

To check the gas filter cartridge, it is necessary to remove the connecting tube, take the neck piece into your mouth, close the lower box aperture, and take a deep breath. If no air is admitted, then the box is airtight.

Finally, be sure the gas mask is in good condition; check the accuracy of assembly and adjustment in a room with irritating toxic materials under the supervision of experienced instructors and in the presence of medical workers.

Correct use of the gas mask. Depending on conditions, the gas mask is carried in one of three positions: "approach," "ready," and "combat" (Fig. 36*a*, *b*, *c*). In the absence of an immediate threat of nuclear, chemical, or biological attack by the enemy, the gas mask is carried in the approach position (Fig. 36*a*).

When there is an immediate threat of the use of weapons of mass destruction with an "air raid alert" signal or on command "gas masks ready," the gas mask is carried in the ready position (Fig. 36*b*). To transfer the gas mask to the ready position, it is necessary to unfasten the flap on the bag, take out the strap, bring it around the body, and tie it to the D-ring on the bag.

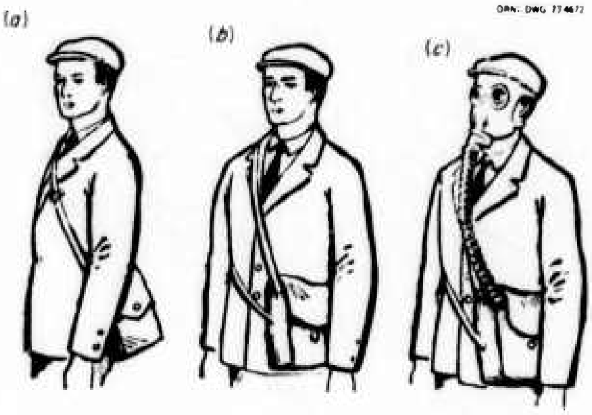

Fig. 36. Carrying the gas mask: (*a*) "Approach" position; (*b*) "ready" position; (*c*) "combat" position.

The gas mask must be fastened so that it does not shift to one side.

The gas mask is shifted to the combat position (Fig. 36*c*) when the nuclear blast occurs, [or] in response to the signals "chemical attack," "radioactive contamination," "biological contamination," or on the command "gases." The gas mask is shifted to the combat position as follows: cease breathing and close the eyes; take the head piece and place it to one side or hold it between the legs; remove the mask from the bag and, taking the forehead and head straps in both hands (with the thumb in), place the lower part of the mask on the chin and tighten the mask on the face, guide the head straps behind the ears; take the free ring of the head straps in the hand and tighten it so that the mask rests snugly against the face (Fig. 37*a*). After this it will be necessary to exhale strongly, open the eyes, recommence breathing, and slip on the head piece.

A closer examination of all ways for putting on the gas mask is obligatory. Holding the breath and closing the eyes protects from the effects of toxic materials until the gas mask has been put on, and a strong expiration after putting on the mask forces out all contaminated air which has penetrated while the gas mask was being put on.

The gas mask is removed at the signal "retreat," at the command "take off gas masks," and when it is certain that the danger has passed.

To remove the gas mask, it is necessary to raise the head piece with the right hand, take hold of the valve box with the left hand, pull the mask down slightly with a forward movement of the arm, and then, with a downward movement, take off the mask (Fig. 37*b*). After this, slip off the head piece, rub off or dry off the mask, and put it back in the bag.

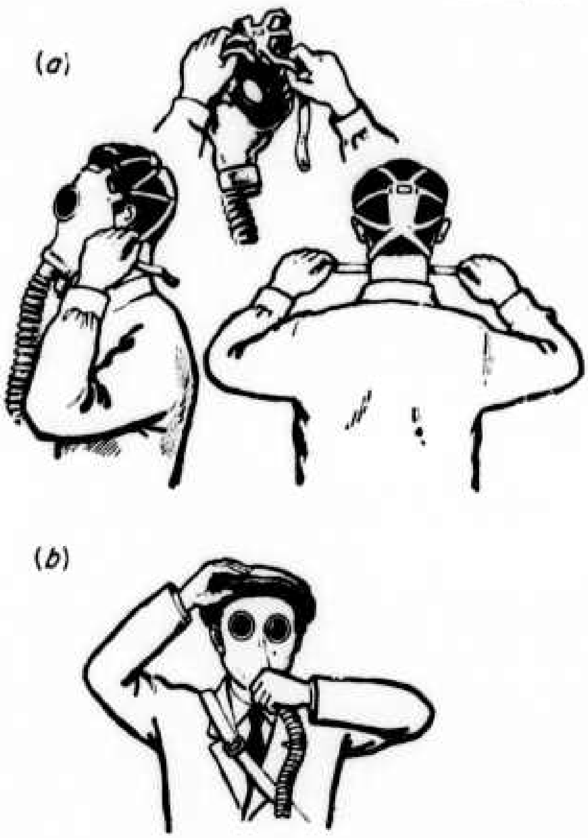

Fig. 37. Examples: (*a*) Putting on the GP-4Y gas mask; (*b*) taking it off.

To put on the GP-5 helmet mask, it is necessary to grasp the lower part of the reinforced edge with both hands so that the thumbs are on the outside and the other fingers are inside; place the lower part of the helmet mask under the chin and with a quick upward and backward movement of the hands draw the helmet mask onto the head so that there are no creases and the eye pieces are directly in front of the eyes.

To remove the gas mask, with the valve box in the left hand, the helmet mask must be drawn down slightly and removed with a forward and upward movement of the arms.

The rules for using, storing, and preserving the GP-5 gas mask are the same as for the GP-4Y gas mask.

When using the gas mask under winter conditions, it is possible that the rubber may become roughened, the lobes of the outlet valve may freeze or they may freeze to the valve box, and moisture may congeal on the glass of the eye pieces and inside the connecting tube. These possibilities make the use of the gas mask more difficult and may result in operating failure. To prevent such things from happening, it is necessary in a noncontaminated atmosphere to periodically warm up the face mask by putting it under one's overcoat and, under combat conditions, periodically warm up the valve box with the hands, simultaneously blowing on the valves.

When a heated room is entered from the cold, the gas mask may be covered with moisture for 10 to 15 min. If so, wipe it dry and blow through the valves. Sometimes ice forms in the connecting hose; if so, it must be unscrewed from the box, carefully washed out, and pieces of ice shaken from it.

Using a defective gas mask. When a gas mask is damaged in a contaminated atmosphere, it must be replaced at once with a properly functioning one, or shelter must be sought. If this cannot be done right away, then the damaged gas mask must be used for a certain period of time.

When TM "breakthroughs" (leaks) are detected, the cause of malfunction must be found. Sometimes the gas mask admits TM through gaps in the hermetic sealing between the connecting hose and the gas box, or the gas mask does not fit tightly against the face; so it is necessary first to check the nut on the connecting hose and tighten the head straps.

When a mask is torn, it is necessary to close the tear tightly with the fingers or with the palm of the hand. In the case of a large rip in the mask or damage to the glass, it is necessary to close one's eyes and hold one's breath, then take off the mask, unscrew the connecting hose, take the neck piece of the gas filter cartridge in the mouth, hold one's nose and breathe only through the mouth, not opening the eyes. The same is done when the connecting hose is damaged. When the gas filter cartridge is damaged, it must be replaced.

When replacing the damaged gas mask in a contaminated atmosphere, it is necessary to:

1. hold the breath, close the eyes, and take off the damaged gas mask;
2. put on a properly operating gas mask, exhale sharply, and then resume breathing;
3. place the box of the correctly functioning gas mask in its own bag and the damaged box in the bag from which the correctly functioning gas mask was taken.

Preservation of the gas mask. The gas mask gives reliable protection from TM only if it is handled carefully and stored properly. It may quickly become dysfunctional due to careless handling and incorrect storage. To ensure the protective properties of the gas mask, it is necessary to protect it from shocks, jolts, and strong vibrations and not allow moisture to penetrate the box; to refrain from drying or storing it near stoves or other heaters; to handle the outlet valves carefully, protect them from plugging up and freezing, and carefully blow them out when they do freeze up; to keep the gas mask assembled in the bag, suspended on a strap or lying on a shelf with the bottom down; during long-term storage, the aperture in the bottom of the valve box must be closed with a rubber plug.

The gas mask must not be lubricated with technical grade oil or stored near volatile liquids (kerosene, gasoline, acetone, etc.), nor should foreign objects be stored in the gas mask bag or the gas mask be used as a pillow.

Checking the gas mask in a fumigation chamber. The final check of the working condition of the gas mask, correct assembly, and fit is made in a chamber (installation) with a training irritant. Personnel who know the properties of the irritant and are familiar with the design and correct use of the gas mask are permitted to test the gas mask in a gas fumigation chamber. Suitable individual vertical chambers for checking the gas mask are those that are free of cracks, with tightly closing doors. There must be artificial or natural illumination in the chamber, and the arrangement of the doors must guarantee fast evacuation of personnel who experience eye irritation. Chloropicrin is used as the training irritant.

The working condition of the gas mask is determined by two checks. The first check is to determine the working condition of the face mask. The test is carried out in the presence of concentrated chloropicrin vapors, 0.85 g/m^3, which form 0.5 cm^3 vapor from liquid chloropicrin per cubic meter of chamber. The second check is to finally determine the working condition of the face mask and the overall service condition of the gas mask as a unit. The test is carried out in the presence of concentrated chloropicrin vapors of 8.5 g/m^3 which form 5 cm^3 of vapor from the liquid chloropicrin per cubic meter of chamber. The personnel remain in the chamber with the irritant for 5 min in each test.

To check the mask selection in first and second concentrations of chloropicrin vapors, it is necessary to shake one's head up and down a few times while wearing the gas mask, turn and incline the head right and left, and then squat several times.

People experiencing eye irritation while testing the gas mask should immediately leave the fumigation chamber and, after checking the gas mask outside of the chamber, continue the check inside the fumigation chamber.

After the exit of each group from the fumigation chamber, it is necessary to evaporate the additional chloropicrin equal to 20% of the original amount. After five of these changes in the chamber, the chloropicrin chamber is ventilated, and the necessary chloropicrin concentration is again produced in it.

The face mask is considered to be a good fit and the gas mask in good operating condition if no eye irritation occurs during the test at a concentration of 8.5 g/m^3.

Fumigation is carried out by supervisors and instructors in the presence of medical workers (doctors or surgeons' assistants). The fumigation supervisor takes a group, explains to them the sequence of operations, regulates the sequence, takes safety measures during the operating period, and gives signals for the order of changes in the fumigation chamber.

Immediate supervision of checking the gas masks and producing the necessary concentration of chloropicrin vapors in the chamber is done by the instructor, who conducts the next group into the chamber, sees to it that the necessary precautionary measures are carried out, and conducts the group out of the chamber to complete the test.

When the group has been led out of the chamber, the instructor dismisses them for a few minutes to remove the chloropicrin vapors from their clothes, after which they are permitted to remove their gas masks.

4.1.3 Air-Supplied Devices and Gas Masks

Unlike filter-type gas masks, air-supplied apparatus and gas masks completely isolate the respiratory system from the ambient atmosphere. Breathing is sustained with self-contained oxygen in compressed form or in the form of chemical compounds.

Air-supplied devices (gas masks) are used when filter-type gas masks cannot guarantee reliable protection, namely: in high TM concentrations, when the gas adsorption packing of the filter-type gas mask becomes rapidly saturated and TM penetrate the mask, that is, the gas mask allows rapid "breakthrough" of toxic material; when working with unknown TM that are not retained very well by the filter-type gas mask; with an oxygen-deficient atmosphere, for example, when extinguishing fires.

Air-supplied devices (gas masks) include: the oxygen-supplied device KIP-5, the oxygen-supplied gas masks KIP-7 and KIP-8, and the air-supplied gas masks IP-46 and IP-46M.

In the KIP-5, KIP-7, and KIP-8 masks, air necessary for breathing is freed of carbon dioxide gas in the regeneration cartridge and enriched in the breathing bag with oxygen from the oxygen bottle; in the IP-46 and IP-46M gas masks, air necessary for breathing is freed of carbon dioxide gas and enriched with oxygen directly in the regeneration cartridge which is equipped with a special material.

The oxygen-supplied KIP-5 device. *Operating principle and designation of KIP parts.* The face mask (1) of the KIP-5 (Fig. 38) isolates the respiratory system and the face from the surrounding atmosphere and is in the form of a mask with straps, or a helmet mask.

The valve box (2), which contains a mica inlet and outlet value, is designed to direct the flow of inspired and expired air.

The regeneration cartridge (9) is designed to purify the expired air of carbon dioxide gas and moisture. It is a tin box filled with a lime adsorber. There are vents in the top and bottom of the cartridge. A connecting tube for exhalation (11) and a lower junction box (8), joined to the regenerative cartridge with a breathing bag (6), are fastened to the upper and lower vents, respectively. The operating time of the cartridge is about 2 hr. An interruption in operation does not affect the protection afforded by the chemical absorber. The cartridge must not be changed while the device is in operation.

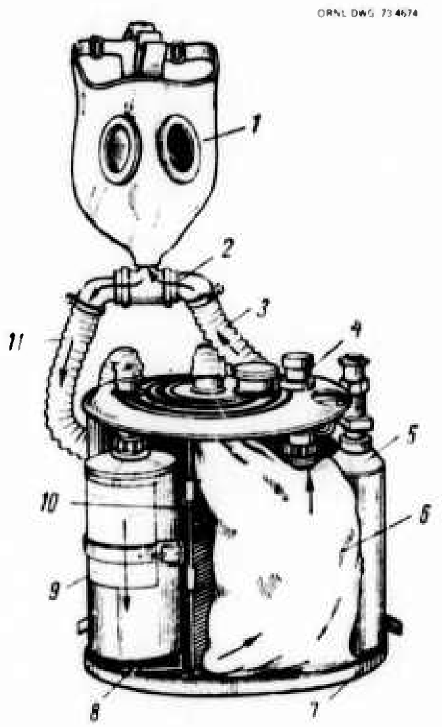

Fig. 38. KIP-5 oxygen-supplied device.

The breathing bag (6), capacity approximately 5 liters, is a reservoir for the required quantity of air, which is enriched with oxygen to guarantee normal breathing for the individual.

The inhalation connecting hose (3) and combined oxygen feed mechanism (4) are connected to the upper part of the breathing bag, and the lower junction box (8) is fastened to the lower part, as described above. The overpressure valve (10) is fastened to the wall of the breathing bag, which is designed to automatically release excess air from the breathing bag when necessary.

The lower junction box connects the regeneration cartridge with the breathing bag, collects moisture flowing out of the regeneration cartridge, and cools the air passing through it.

The oxygen bottle (5) is designed to store the oxygen supply. The capacity of the bottle is 0.7 liters, and its weight is 2.1 kg. The maximum oxygen pressure in the bottle is 150 atm. The oxygen supply in the bottle (150 liters) is sufficient for 45 to 60 min of breathing. The oxygen bottle may be replaced while operating the device without leaving the contaminated area. A valve is installed on the bottle to control the oxygen feed to the breathing bag.

The mechanism for continuously supplying oxygen into the breathing bag consists of the reducing valve, the bypass, the automatic lung, and the miniature pressure gage (pheninneter).

The housing (7) is a metal box with two compartments: the right compartment is for the breathing bag and the oxygen flask; the left is for the regeneration cartridge. Both compartments are closed with hinged lids. Belt and shoulder straps are fastened to the housing for carrying the device. The mask and spare parts are kept in the instrument bag, which is carried on a belt strap.

The oxygen-supplied gas masks KIP-7 and KIP-8 are designed and operate in the same principle as the KIP-5, except that the oxygen bottle capacity of the KIP-7 is 1 liter; in the case of the KIP-8, it is 2 liters, making it possible to work for a longer period of time.

The air-supplied gas masks IP-46 and IP-46M. The working principle of the IP-46 and IP-46M air-supplied gas masks is based on the fact that the air required for breathing is cleansed of carbon dioxide gases and is enriched with oxygen in the regeneration cartridge which is equipped with a special substance.

The IP-46 air-supplied gas mask (Fig. 39) consists of a face mask (1) a regeneration cartridge (5) with a starting device, a breathing bag (7) with an overpressure

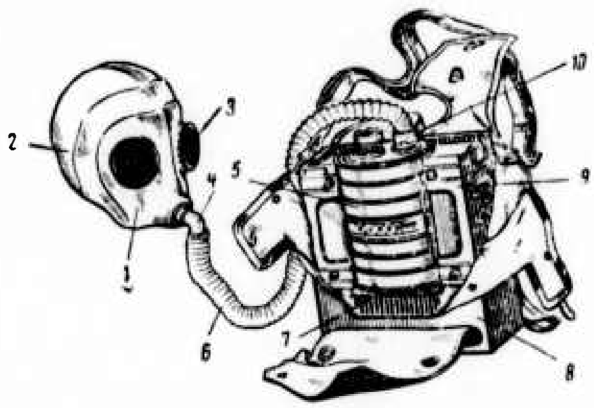

Fig. 39. IP-46 air-supplied gas mask.

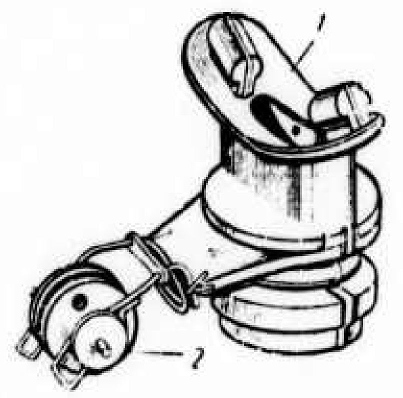

Fig. 40. Components of the air-supplied gas mask: (1) mouthpiece; (2) nose clip.

valve, a housing (9), and a bag (8). In addition, the air-supplied gas mask unit includes a mouthpiece with a nose clamp, a spare starting briquet for the cartridge, a box with ampuls, a box with an antiperspiration film, and a combination wrench.

The face mask of the air-supplied gas mask feeds the purified air to the respiratory system, directs the expired air into the regeneration cartridge, and also protects eyes and face from toxic materials in the air. It consists of a rubber cap (2) with eye pieces (3), a connecting piece (4), and a connecting hose (6) with nipples (10) designed to connect the hose with the regeneration cartridge.

The mouthpiece (Fig. 40) connects the respiratory system of the individual with the connecting piece of the face mask. The presence of a corrugated extension piece on the mouthpiece makes it possible to hold it in the mouth more comfortably and more reliably. A nose clip is attached to the mouthpiece baffle plate which prevents entry of air into the nose. The mouthpiece (1) and nose clip (2) are used only for underwater operation.

The regeneration cartridge (5) (see Fig. 39) provides the oxygen required for breathing and absorbs moisture and carbon dioxide gas in expired air. It consists of a housing containing oxygen-rich compounds, two lids with neck pieces, and a starting device. In the assembled gas mask, the regeneration cartridge is placed in the housing pocket.

The starting device is designed to trigger the regeneration cartridge and consists of a starting pellet set in a glass container with a handle, glass ampuls with acid, a rubber diaphragm, and a nut tightened with a cap. The starting pellet generates the oxygen required for breathing when the gas mask is first put into use and triggers the regenerating cartridge. The briquet operates for a maximum of 2 min and is protected in a special case.

The detachable heating jacket is designed to decrease heat loss from the regeneration cartridge and is used for operation in water and for low air temperatures on dry land.

The breathing bag (Fig. 39) serves as a reservoir for expired air and oxygen produced by the regeneration cartridge. It is made of rubber and has inverted flanges, two in the IP-46 and four in the IP-46M. The following are attached to the inverted flanges: a nipple for attaching the breathing bag to the regeneration cartridge, an overpressure valve, and in two flanges of the IM-46M gas mask [there are] two devices for additional oxygen supply. The breathing bag has lugs for attaching it to the housing.

The overpressure valve consists of forward and check valves which are mounted in one housing. The forward valve automatically releases excess oxygen from the breathing bag; the check valve prevents the entry of ambient air or water into the breathing bag if a negative pressure exists and if the forward valve is accidentally opened.

The housing (see Fig. 39) is made of Duralumin and protects the breathing bag from compression and mechanical damage. The regeneration cartridge, the breathing bag, and the sack are fastened to the housing. The sack (see Fig. 39) is used to protect and to carry the air-supplied gas mask.

The IP-46M gas mask differs from the IP-46 air-supplied gas mask by the presence of two devices for additional oxygen feed, a heating jacket, and a shorter connecting hose. The devices for feeding in additional oxygen in the IP-46M mask inflate the breathing bag with oxygen if it is suddenly immersed in water or if there is an oxygen deficiency in the breathing bag upon inhalation or upon depletion of the regeneration cartridge.

To convert the gas mask to the "combat" position for operation on dry land, one should: hold the breath and close the eyes (when in contaminated air); remove the hat; unfasten the upper right flap of the bag, take out the helmet, and put it on the head so that there are no wrinkles and the eye pieces are aligned with the eyes; ensure that the helmet is on right, correct the misalignments and the wrinkles, if any, exhale sharply, open the eyes, and resume breathing; remove the pin and press down on the diaphragm of the starter; in addition, it is also necessary to listen for the crunch of broken glass of the ampuls, and the tightened nut must heat up; if there is no heat, repeat the process until the ampuls break; replace the hat.

When the starter ampuls are broken, oxygen reaches the starting briquet, causing decomposition of its surface; further decomposition of the briquet takes place spontaneously, proceeding from one layer to another.

Oxygen generation begins due to the effect of water vapor and heat on the substances in the regeneration cartridge. Further generation of oxygen takes place because the carbon dioxide and water vapor exhaled are absorbed by the material in the regeneration cartridge. Generated oxygen and exhaled air enter the breathing bag. Upon inhalation, air from the breathing bag goes through the regeneration cartridge and the connecting tube below the helmet and then reaches the respiratory organs.

When preparing to operate the IP-46M gas mask underwater, the mouthpiece must be taken into the mouth (the lips of the mouthpiece must be between the teeth and the extension piece must be between the lips and the gums), and the nose must be closed with the nose clip so that its spiral rests against the mouthpiece baffle plate before the gas mask is put on.

When using the air-supplied gas mask, it is necessary to take the limited protective capability of the regenerating cartridge into account. The moment the regenerating cartridge ceases to operate, the oxygen generated by it is insufficient for respiration. The period just before the regenerating cartridge is exhausted is characterized by incomplete filling of the breathing bag and collapse of its walls upon inhalation as well as heating of the lower parts of the regeneration cartridge. The exhausted regeneration cartridge is replaced with a new one. As a rule, the replacement is made in noncontaminated air. Caution is indicated when handling an overheated regeneration cartridge since handling may result in burns.

Since they operate in an atmosphere of low oxygen concentration (less than 16 to 18% by volume) or in an atmosphere contaminated with toxic materials (of types that are not absorbed by the skin*), oxygen respirators [RKK-1, RKK-2 (RKK-2m), Ural-1, Lugansk-2, Donbass-2] may be used by the mountain rescue service, as may oxygen safety devices (SK-3, SK-4, and others).

In design and operating principle, the oxygen respirators are similar to the IIP-5. The oxygen respirators (except for the RKK-1) and self-renewing units do not have a helmet mask, and they use a mouthpiece with a rubber extension piece and a nose clip. The basic data concerning the oxygen respirators and the self-renewing units are presented in Table 14. Only well-trained healthy people are permitted to use the oxygen-supplied devices.

Table 14

Oxygen respirator	Technical characteristics		
	Weight of equipped device (kg)	Capacity of oxygen bottle (liters)	Service life protective (hr)
RKK-1	7.4	1	2
RKK-2 (RKK-2M)	11.5 (11.9)	2	4
Ural-1	11.5	2	4
Lugansk-2	12	2	6
Donbass-2	13.4	2	6
SK-3 self-renewing	3.8	0.4	1 2.5

4.1.4 The Most Simple Means for Protecting the Respiratory System

To protect the respiratory system from radioactive dust, it is possible to use dust-protective respirators of different types, cotton gauze, and other bandages in addition to the filter-type gas mask and the air-supplied devices and gas mask. These respirators are designed to protect the respiratory organs from harmful aerosols. They are usually made in the form of a face mask (full or half mask) on which filtering elements are mounted. In some types of respirators, the material of the face mask has filtering properties; thus the entire face mask is a filtering element.

*Toxic materials that are absorbed by the skin penetrate the skin into the bloodstream.

Fig. 41. Respirators: (*a*) R-2 (general view); (*b*) R-2 in "combat" position; (*c*) SHB-1 "Petal"; (*d*) RPP-57; (*e*) PRB-5; (*f*) PRSH2-59; (*g*) cotton-gauze bandage (sling).

Industry is manufacturing several types of respirators: R-2, SHB-1, RPP-57, PRB-5, and PRSHB-59. The R-2 respirator (Fig. 41*a*) consists of a filtering half mask (1) equipped with two inlet valves (2); one inlet valve has a protective screen (3), a headband (4) consisting of elastic and inelastic straps (5), and a nose clip (6). The R-2 respirator is kept in a polyethylene package with a ring.

The outer part of the half mask is made of polyurethane (a porous, synthetic material), and the inner part is made of a thin, air-impermeable layer, in which the inlet valves are mounted. There is a polymer fiber filter between the polyurethane and this layer. Inspired air passes through the entire external surface of the polyurethane and the filter, is cleansed of dust, and passes through the inlet valves into the respiratory organs.

Expired air passes to the atmosphere through the outlet valve. The R-2 respirator comes in three sizes, which are designated on the inner chin part of the half mask and on the label on the polyethylene packet. These sizes correspond to the mask sizes of the GP-4Y, since the respirator is designed like the gas mask, according to the same measurements as listed in Table 11.

After the respirator is selected the face mask is put on and checked for an airtight fit. To put on the respirator, one must: remove the respirator from the package by cutting (tearing) the edge of the upper welded seam of the package and carefully opening the package; put the half mask over the face so that the chin and the nose are inside (Fig. 41*b*); put on the head band so that one inelastic band goes completely around the parietal part of the head and the other around the back of the head; if necessary, adjust the length of the elastic strap with the buckle, so that it is not necessary to remove the half mask and then replace it; press the ring of the nose clip to the nose.

To avoid discomfort when putting on the respirator, the half mask should not be pressed vigorously against the face or the nose clip forcibly compressed.

To check the tightness of fit of the mask when it has been put on, it is necessary to tightly close the opening of the protective screen over the inlet valve with the palm of the hand and exhale slightly. If no air escapes where the respirator is in contact with the face but only inflates the half mask, the respirator is airtight; if an air flow is felt along the outside of the nose, the nose clip ring must be pressed tightly to the nose. If the respirator cannot be made airtight, another size must be tried. After checking the fit of the respirator half mask, return it to the package and close it with the ring, as when storing in the bag.

When putting on the R-2 respirator, it is necessary to remove one's hat. Take the respirator out of the bag and the package and put it on in the order indicated above, but place the package in the bag. Then replace the hat.

When using the respirator, it is necessary to check periodically the tight fit of the half mask against the face. To remove moisture coming through the outlet valve onto the mask surface, it is necessary to bow the head forward. If there is sufficient accumulation, the respirator may be removed for 1 to 2 min, the moisture poured from the inside chamber of the half mask, the inner surface wiped off, and the respirator replaced.

After removing the respirator (when used under conditions of radioactive contamination), it must be decontaminated by removing dust from the outside of the half mask by scraping with a stick (brush) or carefully knocking it against some object. The inside surface of the half mask can be rubbed with a damp cloth (rag), but the mask should not be turned inside out. Then the respirator is replaced in the package, closed with the ring, and put back into the bag.

A good method of protecting the respiratory system from radioactive dust and aerosols is the SHB-1 "Petal" respirator (Fig. 41*c*). It is made of special material, has high filter efficiency, and is intended for one-time use. Total weight is about 10 g.

The SHB-1 respirator consists of housing (1), rubber cord (2), aluminum plate (3), plastic cross bar (4), and two straps (5). To use the respirator, remove it from the package, pull the ends of the rubber cord out to the required length, tie them securely with a simple knot, cut off the rest of the rubber cord, and set the prepared lengths and the knot inside the rim of the respirator, which is uniformly covered with rubber. To don the respirator, begin with the chin; then, while stretching the rubber cord, place the upper edge on the bridge of the nose, squeeze the aluminum plate into the shape of the bridge of the nose, and then tie the straps freely behind the head without stretching them; straighten the edge of the respirator with a slight movement of the fingers, pressing it tightly to the face. The plastic cross bar maintains the hemispherical shape of the respirator and prevents the filter from drawing under the lips when inhaling. A correctly adjusted respirator keeps out up to 99.9% of the dust.

The RPP-57 respirator (Fig 41*d*) consists of a rubber half mask, two metal filter boxes, and an outlet valve box. The half mask has three apertures, two at the sides and one in the lower part. A filter box is mounted in the side aperture and the outlet valve box in the lower one. The filters are made of filter cardboard. The filtering efficiency of the respirator for dust is about 99%. It has a knitted covering to prevent face irritation and to improve the airtight seal of the rubber half mask where it contacts the face. An aluminum strap is fastened on the bridge of the nose part of the mask, which is squeezed to conform to the shape of the nose so that the half mask fits tightly against the face. The head band holding the respirator to the head is adjusted with movable clasps.

The PRB-5 respirator (Fig. 41*e*) offers almost complete protection of the respiratory system from radioactive dust. It consists of the rubber half mask with valves, the housing, the dust filter, and the head piece. The half mask has four flaps. Aluminum or plastic seats are mounted in the two side flaps for the rubber lobes of the outlet valves. The respirator housing and the filter are attached in the first flap. A rubber outlet valve is fastened in the chin flap, which is designed to remove the moisture which collects under the half mask.

Metal rings are fastened to the half mask to connect the head parts. The head gear is a system of elasticized fabric tapes, which have buckles to regulate their length behind the head, at the temple-parietal region, and two at the cheek.

The respirator housing is a circular aluminum or plastic cartridge with the inlet valve seat in the lower part. There is a thread on the housing for screwing on the top which holds the filter in place in the cartridge. The filter is made of corrugated strips of a special activated filter which has high efficiency and low flow resistance to respiration.

The PRSH2-59 (Fig. 41*f*) respirator is designed for work in mines and shafts with a high dust content. The respirator consists of a rubber half mask and two housings with filters. The filter housings are attached to the head piece by rubber straps and connected to the half mask with short corrugated hoses. There is a knitted seal over the edge of the rubber half mask.

The filter housing is a rectangular plastic box with rounded sides and corners, with nozzles for connecting the corrugated hose. Inlet valves are mounted where the corrugated hose is connected to the half mask. The exhalation valve is located in the forward part of the half mask over the discharge valve, for drawing off condensed moisture.

The most simple means of protecting the respiratory system is the cotton gauze bandage. It is made of a piece of cotton gauze 100 × 50 cm. The gauze is spread on a table and a piece of cotton of uniform thickness with dimensions of 30 × 20 cm and thickness 1 to 2 cm is placed in the center. Both edges of the gauze are folded over the cotton. The remaining ends of the gauze are cut longitudinally, 25 to 35 cm from each end, for tying. When the bandage is put on, it must cover the chin, mouth, and cheeks up to the lower eye lid. The split ends of the bandage are tied: the upper ones behind the neck, the lower ones on the parietal region (over the head) (Fig. 41*g*). Cotton must be inserted where the bandage bulges from the bridge of the nose and the cheeks.

To protect the eyes when wearing a respirator or the cotton gauze sling, dust-proof goggles should be worn.

4.2. DEVICES FOR PROTECTING THE SKIN

4.2.1 Special Devices for Protecting the Skin

Skin protective devices protect exposed parts of the body, clothes, footwear, and equipment from contamination by radioactive substances and biological media as well as from vapors and drops of TM. In addition, they completely stop alpha radiation and

Fig. 42. OP-1 protective clothing: (*a*) Arms in sleeves; (*b*) cloak; (*c*) worn as coverall.

attenuate to a large degree the effect of the beta particles. Skin protective devices are classified into isolation and filter types, according to the type of protective effect.

Isolation skin protective devices are made of air-impermeable materials, usually special rubber and fire-proof rubberized fabrics; they may be airtight or nonairtight. The airtight types enclose the body entirely and protect it from TM vapor and drops; nonairtight types protect only from TM drops. The isolation skin protective devices include general troop gear and special protective clothing.

The filter-type skin protective devices are cotton and linen fabrics impregnated with special chemicals. The fabric fibers are impregnated with a thin chemical coating, while the interstices between fibers remain free; because of this, the air permeability of the material is largely maintained, and TM vapors are adsorbed when contaminated air passes through the fabric. Filter-type skin protective devices may be ordinary clothing and linen, impregnated, for example, with a soapy-oily emulsion.

The isolation skin protective devices — general troop protective gear and special protective clothing — are basically designed to protect CD personnel when working in contaminated areas. General troop protective gear consists of a protective coat, stockings, and gloves. Because of the incompleteness of airtight sealing against TM vapors in all protective clothing, as a rule the gear is used in combination with impregnated clothing and underwear.

The protective coat (Fig. 42) is made of special rubberized material; it has two flaps, sleeve fastenings, and a hood, as well as straps and other fastenings,

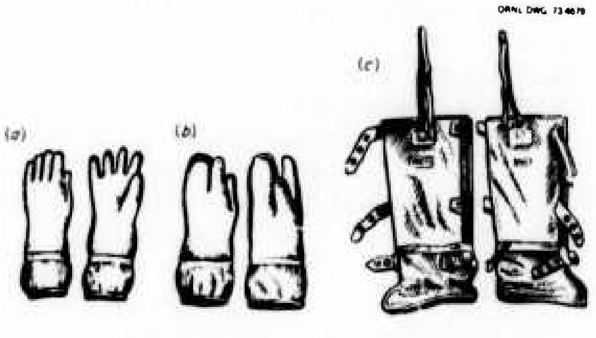

Fig. 43. (*a*) Protective gloves with five fingers, (*b*) with two fingers, and (*c*) leggings.

making it possible to wear the coat in a variety of manners. The coat fabric assures protection from TM, radioactive substances, and bacterial media, as well as from thermal radiation. The weight of the protective coat is about 1.6 kg. The protective coat comes in five sizes: the first for persons with a height up to 165 cm, the second for 165 to 170 cm, the third for 170 to 175 cm, the fourth for 175 to 180 cm, and the fifth for >180 cm.

The protective gloves are made of rubber, with the cuffs made of impregnated fabrics.* There are two kinds: summer and winter (Fig. 43*a* and *b*). The summer gloves have five fingers, and the winter gloves two, with a warm button-in lining. The weight of the protective gloves is about 350 g.

The protective leggings are made of rubberized fabric (Fig. 43*c*). The soles are reinforced with canvas or rubberized material. The leggings with a canvas base material have two or three straps for fastening to the leg and one strap for fastening to the belt; leggings with a rubber material are fastened to the legs with straps and to the belt with bands. The weight of the protective leggings is 0.8 to 1.2 kg.

When work is done in contaminated areas, the protective coat is used in coverall form (see Fig. 42*c*).

Special protective clothing includes: a light protective suit, a one-piece protective coverall, a protective ensemble consisting of a jacket and trousers, and a protective apron.

The light protective suit (Fig. 44) is made of rubberized fabric and consists of a hooded jacket (1), trousers (2) sewn to the leggings, mittens (3), and a cowl (4). In addition, the outfit includes a bag (5) and an extra pair of gloves. The weight of the protective suit

*A fabric impregnated with special chemicals which increase its barrier effects for TM vapors.

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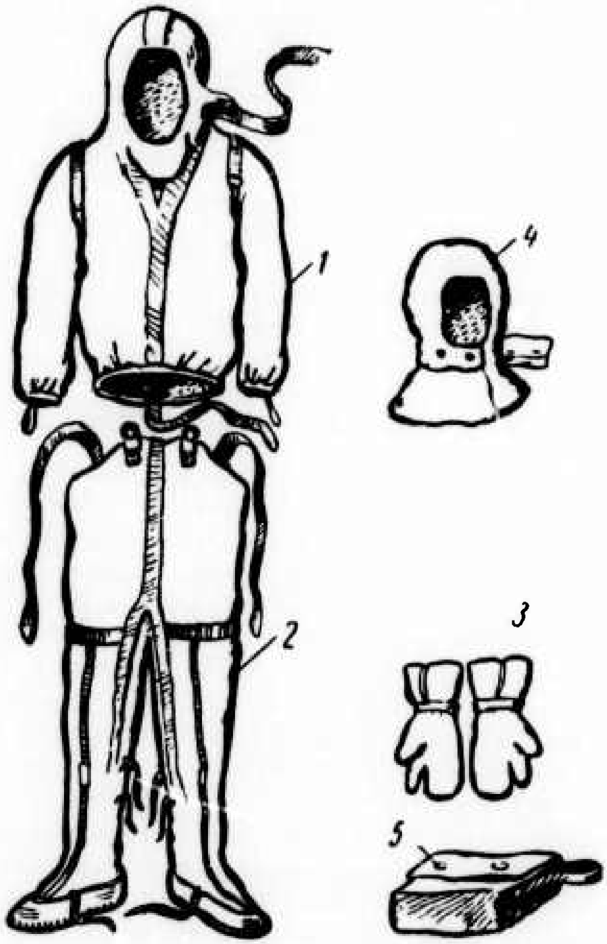

Fig. 44. "L-1" light protective suit.

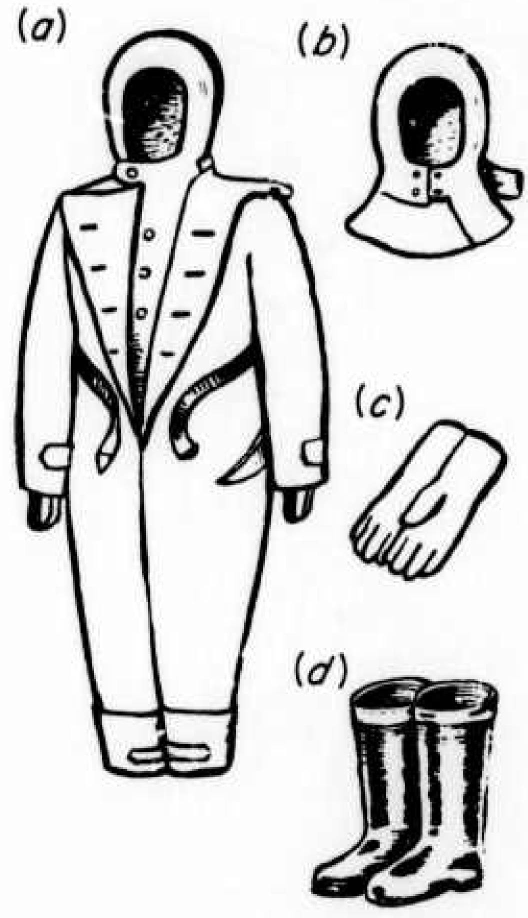

Fig. 45. Protective coverall, boots, and gloves.

is about 3 kg. The suit comes in three sizes: the first for people up to 165 cm, the second for 165 to 172 cm, and the third for >172 cm.

The protective coverall (Fig. 45*a*) is made of rubberized fabric. It comes with the trousers, the jacket, and the hood sewn in one piece. The coverall comes in the same three sizes as the light protective suit. The coverall is used with the cowl (Fig. 45*b*), the gloves (Fig. 45*c*), and the rubber boots (Fig. 45*d*). The rubber boots come in sizes 41 to 46. The five-fingered rubber gloves come in one size. The cowl is a hood with a cape, made of emulsion-impregnated fabric. The weight of the protective coverall, including boots, gloves, and cowl, is about 6 kg.

The protective ensemble (Fig. 46), consisting of a jacket and trousers, differs from the protective combination only in that its component parts are made separately. The set includes rubber gloves, boots, and cowl.

The protective apron is made of a rubberized fabric and is used with the protective stockings and the rubber gloves for degassing, decontamination, and disinfection of transport and other equipment in a contaminated area. All aprons are one size; the weight of the apron is 400 g.

4.2.2 Rules for Using Protective Clothing

A person dressed in the protective jumpsuit (or in the protective ensemble), rubber boots, rubber gloves, and a gas mask is completely isolated from the ambient atmosphere, and so natural heat transfer is inhibited; if the rules for remaining in the protective clothing are not observed, overheating (heat stroke) may occur.

Thus, to protect the working ability of personnel at the specified air temperature, the protective clothing must be worn as indicated:

+10°C and above, over underwear;

from 0 to +10°C, over underwear and summer clothing;

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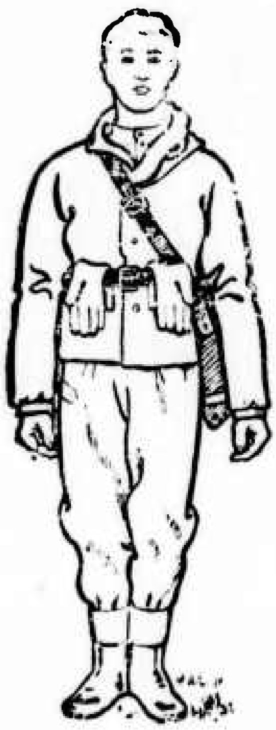

Fig. 46. Protective ensemble.

Table 15

Ambient air temperature (°C)	Work periods in isolating [tight-fitting] clothing	
	Without wetted cotton coverall	With wetted cotton coverall
+30 [86°F] and higher	Up to 20 min	1.0–1.5 hr
+25 – +29 [77–85°F]	Up to 30 min	1.5–2 hr
+20 – +24 [68–76°F]	Up to 50 min	2.0–2.5 hr
+15 – +19 [59–67°F]	Up to 2.0 hr	Longer than 3 hr
Below +15 [59°F]	Up to 4–5 hr	

from 0 to −10°C, over underwear and a winter suit;

below −10°C, over underwear, a winter suit, and quilting.

At temperatures below 0°C, rubber boots must be worn with wool socks or footwear, and rubber gloves must be worn over wool. To dissipate heat in summer and at temperatures above +15°C, it is recommended that a wet cotton coverall be worn over the protective clothing. The coverall is periodically wetted as the water evaporates. If there is only radioactive contamination, only a radiation-protective coverall should be used to protect from fallout, without [additional] wearing special protective clothing.

In addition, time periods dependent on ambient temperatures have been designated for remaining in the protective isolating [leak-tight] clothing (Table 15). The indicated periods of time are given for working in protective clothing in direct sunlight and doing work requiring average physical effort. Trained healthy people working in cloudy weather may increase these periods of time one and a half times.

4.2.3 Improvised Skin Protection Devices

In addition to the special skin protection devices described above, improvised devices may be used to protect the skin from radioactive dust and biological media. These devices include ordinary clothing and footwear. Ordinary coverings and coats made of polyvinyl chloride or rubberized fabric, an overcoat made of heavy material, coarse cloth, or leather give very good protection from radioactive dust and biological media; they can also offer protection from TM in droplet form for a period of 5 to 10 min; quilted cotton clothing protects much longer.

Commercial and domestic rubber boots are used to protect the feet, as well as rubber overshoes, galoshes, felt boots used with galoshes, and footwear made of leather and artificial leather used with galoshes. When leaving the contaminated area, ordinary footwear may be wrapped with several layers of thick paper, burlap, or paper bags.

To protect the hands, rubber or leather gloves and canvas mittens can be used.

When using ordinary clothing for protection, for a high degree of airtight sealing it is necessary to close all buttoned openings and sleeve cuffs, tie the trousers with a strap, and turn up the collar and tie it with a scarf. For better airtight sealing of a zipper-closed trouser fly, it is necessary to prepare an apron inside the jacket which is rectangular in shape, with dimensions of 80 × 25 cm and with ties on the corners of the upper end to fasten it around the neck. At the opening of the upper end of the apron sew on a collar with a width of 4.5 to 5 cm, its length equal to the neck circumference.

Under the fly and trousers hook, sew on a flap. The length of each flap must be 3 to 4 cm longer than the zipper fly, and the width must make it possible to slip on the trousers with sewn-on flap.

To protect the neck and parts of the head not covered by a mask, it is necessary to sew on a hood.

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Fig. 47. Improvised means of skin protection: (*a*) Cotton jumpsuit; (*b*) overcoat.

Small children must be carried out of a contaminated area wrapped in cotton, wool, or flannel blankets. Women should wear trousers.

For more reliable skin protection, a simplified protective filtering set, with special impregnation, may be used to assure protection from TM vapors. The outfit may consist of a ski, worker, or school suit, an ordinary man's suit, or a standard jacket (jacket and trousers), gloves (rubber, leather, or impregnated wool or cotton), commercial or homemade rubber boots and rubber overshoes (galoshes) with impregnated stockings, felt boots with galoshes, leather footwear, and imitation leather galoshes (Fig. 47).

The clothes selected for impregnation must completely (in an airtight manner) enclose the body. The most available means for impregnating clothes in the home is solutions of synthetic detergents OP-7 or OP-10, used for washing, or soap-oil emulsions. To obtain the 2.5 liters of solution required to impregnate one outfit, take 0.5 liter of detergent OP-7 or OP-10 and 2 liters of water heated to 40 to 50°C and then carefully mix together for 3 to 5 min until a homogeneous bright-yellow solution is obtained.

When preparing 2.5 liters of a soap-oil emulsion, put 250 to 300 g of pulverized household soap or soap shavings in 2 liters of hot water (60 to 70°C). When the soap is completely dissolved, add 0.5 liter of mineral oil (castor, transformer, machine, etc.) or vegetable oil (sunflower, cotton-seed) into the hot solution, mix for 5 to 7 min, and reheat to 60 to 70°C while continuing to mix, until a homogeneous soap-oil emulsion is obtained.

The solution must be prepared in an enamel or aluminum vessel in which the protective outfit can also be impregnated: suit, hood, socks, gloves, and apron. First impregnate the suit and then the other parts of the outfit, because it is necessary to achieve a completely uniform impregnation, especially of the suit. After impregnating the entire set, squeeze out excess liquid and dry in air. The clothes must not be ironed with a hot iron.

The clothes impregnated with the indicated solution do not have an odor; the solution does not irritate the skin and is easy to launder out. Impregnation does not harm the clothes and simplifies later degassing and decontamination.

The simplified protective set is put on over underwear or summer clothes. The coat (or jacket) with the apron is tucked into the trousers, and the cuffs of the jacket sleeves are tied with straps or in the protective leggings and gloves. The protective stockings (impregnated) are put on o[illegible] (nonimpregnated) stockings, and footwear i[illegible]

A quilte[illegible] ing over underwear, [illegible] described above. To make the quilted jacket airtight, sew a thick fabric breast covering [gas flap], 22 to 25 cm wide, to the left part of the inside of the jacket at a distance of 10 cm from the edge throughout its whole length from the neck all the way to the bottom. The right side of the flap should be fastened to the right side of the quilted jacket on the inside by means of buttons or fasteners, attached 12 to 15 cm from the edge. Buttons or hooks should be sewn on the lower front part of the quilted jacket, and straps should be sewn on the sleeves to enable them to be drawn tight.

5. Protective Civil Defense Construction

5.1 DESIGNATION AND CLASSIFICATION OF PROTECTIVE CONSTRUCTION

One of the methods for protecting the population from weapons of mass destruction is to shield it in shelters. Civil defense shelters to protect the working shifts, work crews, and population include:

1. blast shelters with industrially manufactured filtering equipment;
2. blast shelters with rugged filtering equipment;
3. fallout shelters prepared in peacetime (special structures or modified farm buildings);
4. fallout shelters constructed in wartime of available materials.

Blast shelters are airtight protective buildings which shield their occupants from the damaging effects of a nuclear blast, as well as from toxic materials and biological media. In shelters located in zones of possible conflagrations or in a possible secondary chemical focal area (created as a result of the destruction of industrial targets), shelter is provided from high temperatures, contamination from burning products, and industrial toxins.

Shelters are classified according to their protective properties, capacity, location, and filtering equipment. They are classified into five groups according to the degree of protection they offer from the blast wave of a nuclear burst.

1. According to capacity (number of people protected) the shelters are [designated as] small, up to 150 people; medium, from 150 to 450 people; and large, more than 450 people.

2. According to location, the shelters may be permanent or temporary. Permanent shelters include shelters in the basements of buildings, and temporary shelters include those outside of buildings.

3. According to the [desired] efficiency of the filtration system, the shelter may be equipped with industrial filtering equipment, with simplified filtering equipment, or with an air-supplied system (without filters).

4. Fallout shelters protect their occupants from contamination by radioactive substances and from radiation in zones where fallout is prevalent.

5. According to the degree of protection from radiation (degree of gamma-radiation attenuation) fallout shelters are classified into three groups.

In a zone of possible slight destruction, these shelters assure protection from collapsed buildings as well.

5.2 SHELTERS: DESIGN AND EQUIPMENT

5.2.1 Shelter Requirements

Shelters intended to protect workers and employees at national economic sites, and also the general population and those responsible for the essential services of a city, must offer protection from all the damaging factors of a nuclear burst, from toxic and radioactive substances, and from biological media. The safety construction of the shelters, that is, the [strength of the] walls and ceiling, must be designed to withstand the effects of the shock wave of a nuclear surface burst. The design features of shelters which protect against the shock wave are determined in each specific case, with regard to the safety characteristics of the basic stress-bearing construction of the building, the appropriate equipment, and the location with respect to the center of the city.

Blast shelters must ensure protection from initial nuclear radiation and radioactive contamination. The protective characteristics of shelters in each case depend on the construction and density of the materials, as well as the compactness of the soil.

The shelter entrance must have the same degree of protection as the main structure. An emergency exit must be built to evacuate people from the shelter if the entrance is destroyed or if rubble falls in front of it.

The shelter [ceiling] height must not be less than 2.2 m. The dimensions of the shelter and its capacity are determined as a function of the climate in which the shelter is built. For temperate zones in the Soviet Union, the minimum standard is 0.5 m^2 [5 ft^2] of floor area over and above equipment space and 1.5 m^3 [53 ft^3] of air space per person.

Blast shelters must be equipped with ventilation devices, sanitary facilities, and appliances, as well as means for purifying the air of toxic and radioactive substances and biological aerosols. Blast shelters located at sites of possible conflagrations must be provided with inlet air-cooling devices and means to protect people in the shelter from dangerous concentrations of carbon monoxide.

Shelters must be constructed in places which are not threatened by flooding, torrential rains, or emergency flooding [e.g., broken water main]. There must be no large water reservoirs or water or sewer mains near the shelter, which if destroyed or damaged might threaten the people in the shelter with drowning. Sewer pipes near the shelter must be enclosed in a metal duct or in a reinforced concrete duct, firmly embedded in the ceiling and in the floor.

Placing the shelter in industrial buildings where technical equipment causes vibrations which may disturb the airtight sealing of the shelter is not recommended. There must be no heavy equipment on the floors above the shelter.

Shelter approaches in buildings must be free of decoration and flammable materials or materials likely to smoulder.

In planning the construction of shelters it is necessary to provide for their dual use: in peacetime, to store spare parts and other equipment for industries and some technological processes; in wartime, to shelter and protect people from the effects of weapons of mass destruction.

When such shelters are constructed, in addition to the protection requirement (reinforced safety design, protected entrances, air-intake ducts, filtering system, etc.), it is also necessary to take into account the special features connected with working in these premises in peacetime.

Shelters may be combined with buildings of the following types:

1. industrial buildings having technological processes which do not endanger human beings;
2. testing stations;
3. buildings for electricians and repair crews;
4. movie theaters, garages, dining rooms, restaurants, cafes, and other premises of various economic and cultural types.

The use of dual-purpose shelters in peacetime must not interfere with their protective characteristics. The conversion of such shelters to wartime operation must be possible within a minimum period of time – no longer than 12 hr.

If the shelters were constructed without a specific peacetime purpose, then they may be used, for example, for patriotic displays, exhibitions, and exhibits of craftsmanship and the like, with consideration given to maintaining the protective construction and special equipment and ensuring the rapid preparation of the facilities to receive occupants.

5.2.2 Shelter Arrangement

As a rule, blast shelters must have areas for occupants, a filter-ventilation chamber, a medical room, lavatories, food storerooms, and vestibules (Fig. 48). In small-capacity shelters, mentioned earlier (Fig. 49), air filtration equipment and food are located in the same area as the occupants, in the absence of special facilities. A medical room may not be set up in such shelters. In large-capacity shelters there may even be facilities to install a diesel generator and a well with a pump.

The walls of the shelter may be made of stone (bricks, concrete blocks), butoconcrete, and monolithic or modular reinforced concrete. The exteriors of underground walls are waterproofed. Blast shelter ceilings are not plastered, but are finished with a cement solution and painted.

The shelter floors are placed on a concrete foundation or, when there is a uniform base, without any foundation. The type of finished floor is selected in keeping with the shelter's peacetime use. Moisture-resistant floors are installed in the lavatory units.

Blast shelters have entrances and emergency exits. The number of entrances is determined by calculating one entrance of 80 X 180 cm per 200 persons or [an entrance of] 120 X 200 cm per 300 persons.

Protection from radioactive and toxic substances, biological media, and the combustion products of fires which might penetrate the shelter through the entrance is ensured by vestibules and antechambers constructed at the entrances. In the vestibule there are airtight blast doors and airtight doors. The doors have rubber strips and wedge seals, assuring a tight fit between the door edge and frame. In shelters with a capacity of 600 or more, an airlock is provided for one of the entrances, which ensures that the protective characteristics of the shelter are maintained when people are admitted after the other entrances have been closed. Protective airtight doors are installed in the airlock openings.

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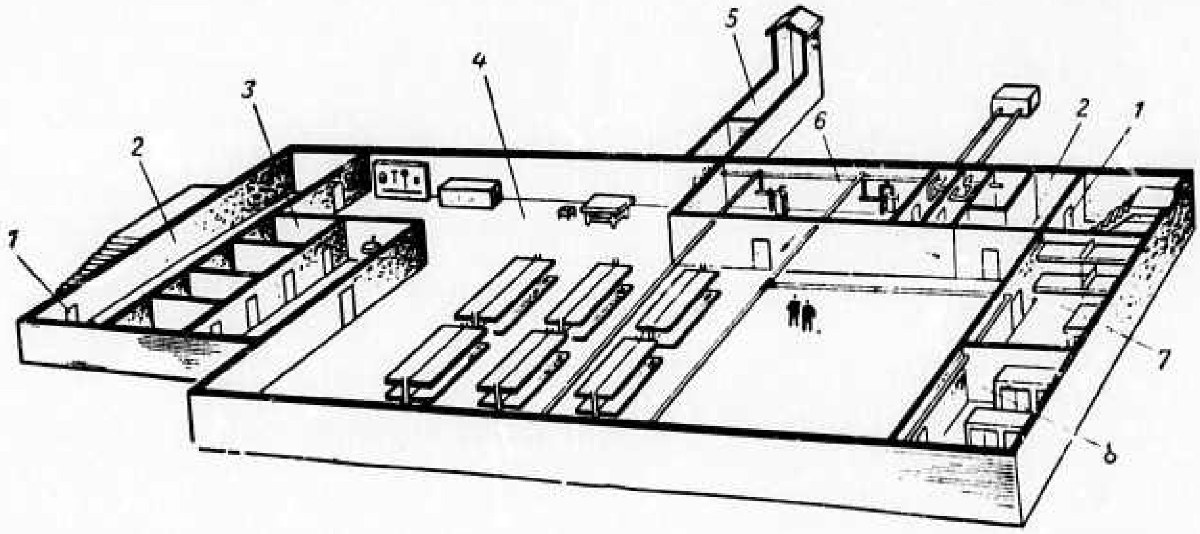

Fig. 48. Diagram of a shelter for long-term protection from the damaging effeets of weapons of mass destruction: (1) protective airtight door; (2) air lock; (3) lavatories; (4) areas for shelter occupants; (5) tunnel and vent cap of the emergency exit; (6) filter-ventilation compartments; (7) medical room; (8) storeroom for food.

An emergency exit is set up in the form of an underground tunnel with dimensions of 90 × 100 cm, with an exit into an open area through a vertical shaft, covered with a vent cap. Side openings are placed in the upper part of the vent cap, with dimensions of not less than 60 × 80 cm; [these openings are] covered with grates and open outside the shaft. The vent cap of the emergency exit must be removed from surrounding buildings at a distance not less than half the height of the building plus 3 m ($L = 0.5\ H_{buil} + 3$ m). A detached shelter need not have an emergency exit if it is located in an open area. The height of the vent cap must be such that the upper opening is located not lower than 1.2 m [from ground level], or not lower than the level to which the vent cap might be obstructed by rubble.

The distance of a blast shelter from working sites or from residences must not be more than 300 to 400 m.

5.2.3 Interior Shelter Equipment

The interior equipment of blast shelters and premises adapted as shelters consists of an air-supply system, sewer lines, electrical power and heating supply, and protection for the air intake and exhaust parts.

Bunks or level benches are set up for convenience of arranging people in compartments of the shelter (railway car type): the lower one for sitting, with dimensions of 0.45 × 0.45 m per person; the upper one for lying down, with dimensions of 0.65 × 1.8 m per person.

The shelter is equipped with communication and warning equipment (telephone and loudspeaker, connected to outside telephones and to a radio broadcasting system). In case the external telephone and radio network is knocked out of operation, it is desirable to have a radio station in the shelter that can operate with an underground antenna for receiving [messages] from the CD staff office (regional).

The interior equipment ensures the collective protection of those in the shelter and helps to maintain healthful conditions. Interior equipment contributes to a healthful shelter environment. The most important factors affecting the sanitary-hygenic conditions in shelters are temperature, humidity, and the composition of the air. It is known that placing a large number of people in an airtight enclosure causes an abrupt change of the atmospheric conditions which is manifest in increased temperatures, increased humidity, increased carbon dioxide content, reduced oxygen availability, and an accumulation of fetid materials. Such changes may adversely affect personal health and lead to more serious consequences for the people in the shelter.

For example, with ambient shelter temperatures of 30 to 32°C [86 to 89°F] and 90% relative humidity, people suddenly begin to have unpleasant sensations – weakness, suffocation, restlessness – which have an adverse effect on their physical and psychological condition. An increase in temperature and relative

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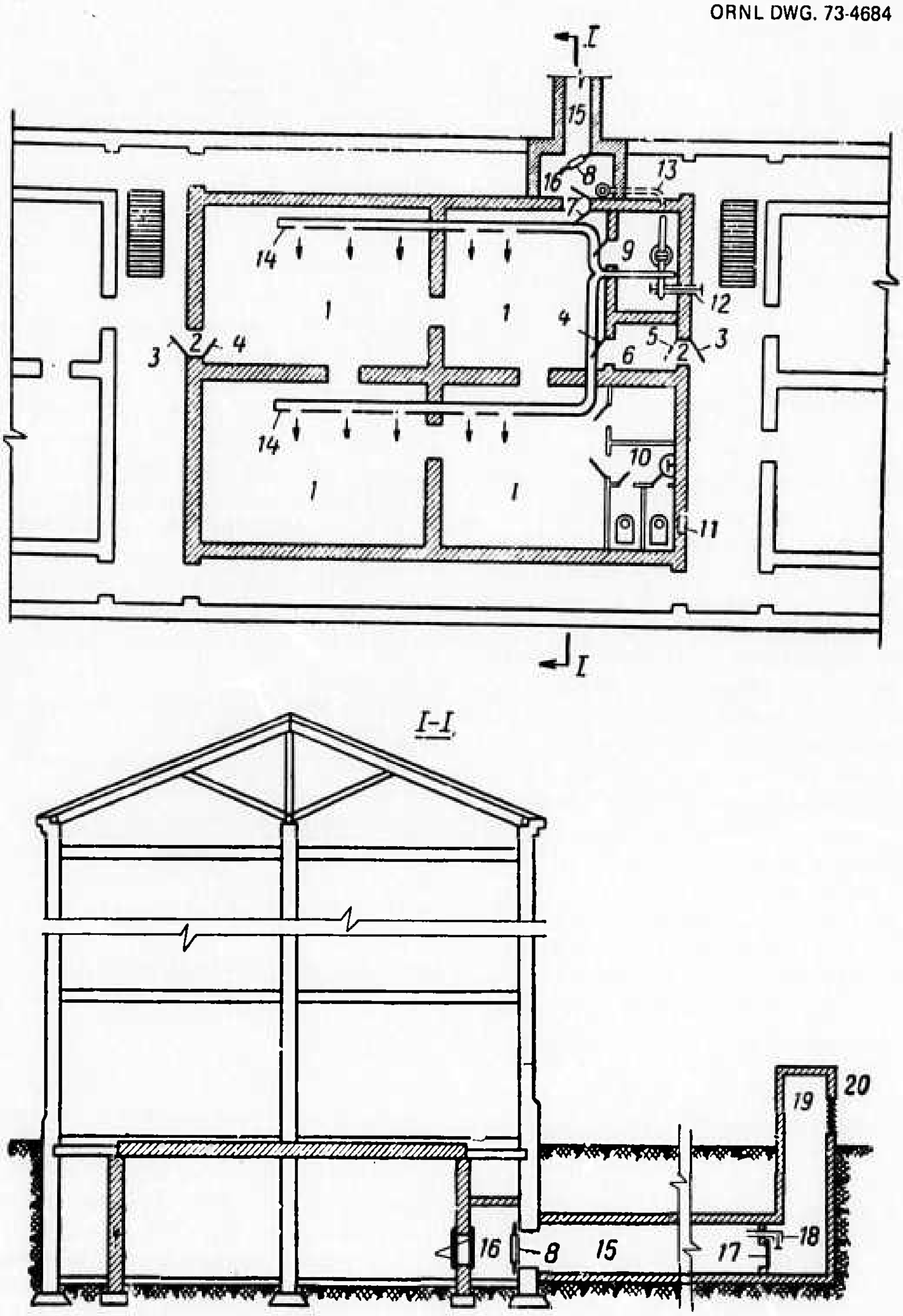

Fig. 49. Shelter in the center of a building basement: (1) compartments; (2) exits; (3) and (4) protective airtight doors; (5) louvered wooden door; (6) vestibule; (7) protective airtight shutters; (8) shutter with dust filter; (9) filter-ventilation chamber; (10) lavatories; (11) exhaust duct; (12) sealing safety valve; (13) basic air intake duct; (14) pressurized pipes. (15) emergency exit; (16) adjoining chamber; (17) airtight safety shutter in emergency exit; (18) floating cutoff valve; (19) vent cap of the emergency exit; (20) wooden louver grating.

humidity in the air occurs in shelters due to the release of heat and moisture from people's bodies.

Under normal atmospheric conditions the basal heat loss of an adult is 75 kcal/hr [300 Btu/hr]. Under conditions in a shelter of the size on which our calculations are based, 100 kcal/hr [400 Btu/hr] of heat is lost to the air.

The total amount of water given off depends largely on the heat-exchange conditions between the human body and the ambient [shelter] air. For practical calculations to determine the amount of water given off we may use the formula [see note*]:

$$d = 7(t_B - 15),$$

where d is the amount of water given off by one human being (g/hr) and t_B is the temperature of the ambient air (°C).

In the process of respiration, a person inhales oxygen and exhales a certain quantity of carbon dioxide (about 4% of the volume of inhaled air). In a state of rest and under normal meteorological conditions, a person requires 14.2 liters of oxygen per hour and exhales 11.8 liters of carbon dioxide. When inside the shelter, an increase in pulmonary ventilation is observed in humans, and the oxygen requirement increases up to 24 liters/hr, while the amount of carbon dioxide expired increases to 20 liters/hr. Because of this, the change in gaseous composition and heat-humidity conditions of the air in shelters is rather marked, and dealing with these changes presents great difficulty.

In unventilated shelters, the decisive parameter determining the condition of the occupants during their confinement in the shelter is the composition of the shelter air, since this becomes limiting before the heat-humidity conditions. If we assume that the shelter's volume per person is 1.3 to 1.5 m³ [46 to 53 ft³], the carbon dioxide concentration after 2 to 2.5 hr increases by 3.4%. Further confinement of the occupants to the unventilated shelter may result in serious consequences.

The time of increase in the carbon dioxide concentration up to critical values is determined according to the formula

$$t = \frac{C_{\text{dop}} V}{100B},$$

where C_{dop} is the limit concentration of carbon dioxide (%), V is the volume of the premises for one human being (m³), and B is the amount of carbon dioxide expired by one adult (liters/hr).

In ventilated shelters the greatest difficulty is dealing with excess heat and humidity. When 2 m³/hr [1.1 cfm] of ambient air is supplied per person, the concentration of carbon dioxide in the shelter does not exceed 1.5%. However, when air is admitted for 10 to 12 hr, the temperature in the shelter increases to 29 to 30°C [84 to 86°F], and conditions for those in the shelter deteriorate. Thus, the normal air supply must be increased 2 to 3 times [see note*] for extended confinement to the shelter.

Air supply in the shelters. As a rule, supply of ambient air to shelters must be ensured by two systems: by a clean ventilation system (primary system) and by a filter-ventilation system (secondary system). In shelters located in possible fire zones, it is also necessary to provide for a partial-insulation system, along with cleaning of the ambient air from combustion products during fires, and cooling of the air and regeneration of the internal air (tertiary system). The clean ventilation system purifies the ambient air of radioactive dusts, and the filter-ventilation system removes radioactive dust [and also] toxic materials and bacteriological agents. Ventilation system changeover is achieved by airtight valves and by activating existing fans.

The air-supply system consists of air-intake installations, dust filters, absorption filters, a heat-capacity filter, fans, air-expansion chambers, and air-regulation facilities. In the air-supply system of shelters located in possible fire zones, there is also a carbon monoxide filter and means for regenerating the air (Fig. 50).

A dust filter, in particular a screen filter, of different design is used to free ambient air of radioactive dust. The screen dust filter (Fig. 51) consists of a metal screen pack assembled in a unit with dimensions 510 × 510 × 80 mm. The screens are impregnated with machine oil. When the air passes through the filter, airborne dust adheres to the oily layer on the screen. The capacity of one filter pack is 1000 to 1100 m³/hr with an aerodynamic resistance of 3 to 8 mm. Dust filters are located in special places (chambers), separated from the shelter proper by a main wall to protect the occupants from exposure to radioactive substances which accumulate on the filter.

[*This formula is realistic; for 24 hr at 90°F, it indicates 3.1 quarts of water per person as the loss by sweating and respiratory processes.]

[*This guidance is not consistent with the more realistic requirements stated in Table 16, which specify 20 m³/hr (10.6 cfm) per person of outdoor air at 30°C (86°F).]

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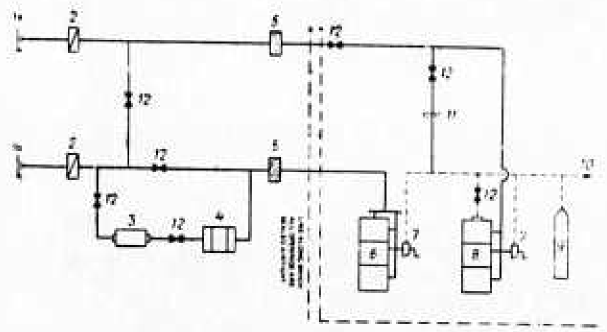

Fig. 50. Schematic diagram of a shelter supply system with industrial equipment (variant): (1*a*) air intake on the filter-ventilation system; (1*b*) air intake on the clean ventilation system; (2) antiexplosion mechanism (gravel blast attenuator); (3) carbon monoxide filter; (4) heat-protective filter; (5) dust filter; (6) filter-ventilation unit; (7) electro-manual ventilator fan; (8) regenerating unit; (9) oxygen bottle; (10) air-separation network; (11) ROV electric blower; (12) airtight valves.

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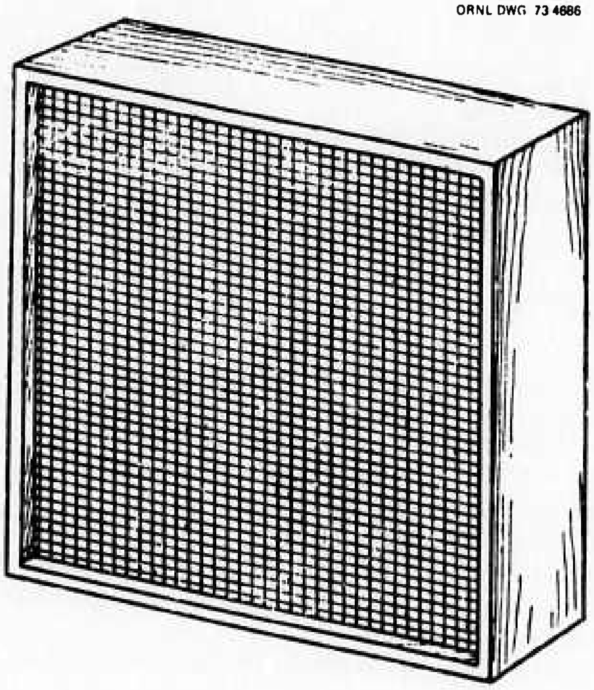

Fig. 51. Screen dust filter.

Freeing the ambient air of toxic materials and biological media is accomplished by filter absorbers of types FP-100, FP-100Y, and FP-200-59.

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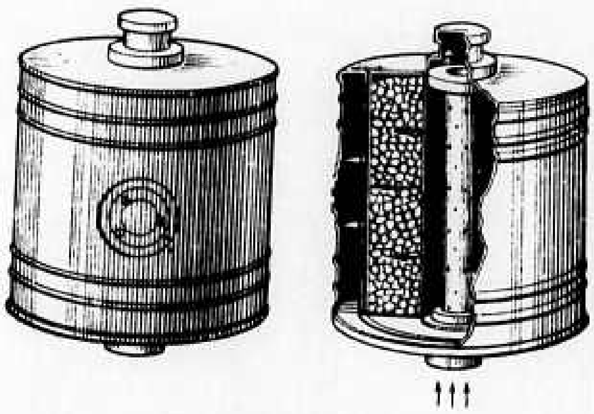

Fig. 52. Absorption filter.

The absorption filter (Fig. 52) consists of a cylinder with two central (top and bottom) openings and one side opening. It operates on the same principle as the filter-type gas mask. Ambient air enters the filter through one of the central openings, passes through a cardboard filter and a layer of carbon adsorbent, where it is freed of toxic materials and biological media, and then passes through the side opening. The absorption filters are stacked in columns, 2 to 3 in each [column]. Stacking more than three filters is not permitted since this greatly increases the resistance of the filter collectors. If necessary, feeding more air into the absorption filter stacks will require the use of a battery.

Electric blowers are used to force ambient air into the shelters, and, in large-capacity shelters (more than 450 people) with a protected independent power source, centrifugal fans with an electric drive are used. As a rule, filter-ventilation unit FVA-49 (Fig. 53) is used in small- and medium-capacity shelters. The FVA unit includes an electrically powered blower ERV-49, an absorption filter, a double-acting sealing valve, a flowmeter, and connecting and mounting components.

To cool the inlet air in the event of fires, it is possible to use filters of gravel or other heat-absorbent materials. The gravel is distributed in a special chamber with brick or reinforced concrete walls, on a metal grating. When the shelter is located in a possible isolated fire zone, the volume of the gravel must be 2 m^3 [70 ft^3] per 300 m^3/hr [165 cfm] of inlet air and 100 m^3/hr [55 cfm] in possible fire storm or conflagration zones. The thickness of the filter bed should be 0.8 to 1 m.

To calculate the heat capacity of the filter, we use the formula

$$H = 0.25 + 0.005\ V/S\ ,$$

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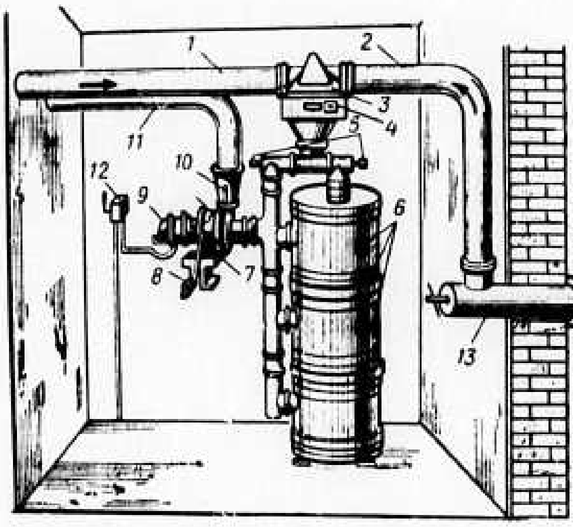

Fig. 53. Filter-ventilation unit (FVA-49): (1) basic air intake; (2) emergency air intake; (3) handle of butterfly valve; (4) dust-proof oil filter; (5) changeover rod of the double-sealing valve; (6) filter absorber; (7) electro-manual blower; (8) blower shaft; (9) electric motor; (10) air-separation system; (11) ROV electric blower duct; (12) sealing valve.

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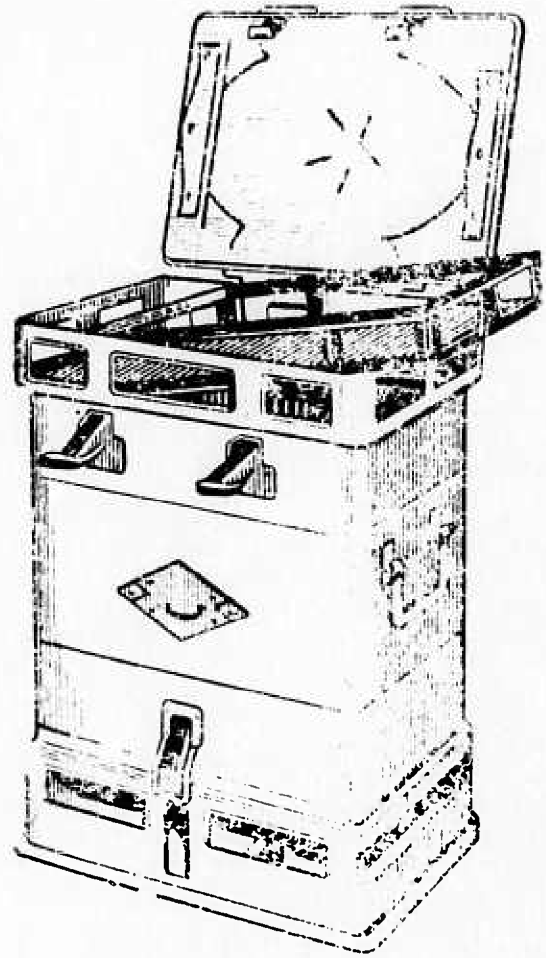

Fig. 54. CTRU regenerating unit.

where H is the height of the filter bed (m), V is the amount of air supplied to the shelter (according to a standard of 2 m^3/hr [1.1 cfm] per person), S is the surface of the filter bed (m^2), and V/S is the ratio determining the air flow rate, which must not be greater than 400 m/hr.

When group fires spread in cities, the air is contaminated with carbon monoxide, which is very toxic. When the carbon monoxide concentration is 0.45 mg/liter [0.04%, or 400 ppm], people suffer headaches and nausea in 1 to 2 hr, and concentrations of 3.6 mg/liter [0.3%] are fatal in 30 min. In group fire zones the carbon monoxide content in the air may be from 0.4 to 5.4%; at the same time, the oxygen content of the air may decrease to 6% and the carbon dioxide content may increase to 3 to 16%. For this reason the air supply system includes carbon monoxide filters. It is possible to use industrial emission filters FMSH and hopcalite cartridges of the FK-G type as carbon monoxide filters. In these, carbon monoxide is oxidized with atmospheric oxygen to carbon dioxide. In this case, hopcalite is a catalyst.

The low oxygen content and high carbon dioxide content in the atmosphere of fire zones disqualify ambient [outdoor] air for air-supply use, even in shelters equipped to cool and clean the inlet air of carbon monoxide. In this case, it is necessary to convert the shelter to completely self-contained operation with regeneration of its atmosphere. Air may be regenerated in shelters with the aid of a convection-type regeneration unit (CTRU), which uses sodium or potassium peroxide compounds. These assure simultaneous absorption of the carbon dioxide and release of oxygen. One kilogram of a potassium peroxide compound can release as much as 250 liters of oxygen and absorb 150 liters of carbon dioxide.

The CTRU unit (Fig. 54) consists of a metal housing in which cartridges are inserted with the peroxide compounds. In the lower part of the housing, there is an opening for the intake of air, and in the upper part there is an outlet for the regenerated air. The top of the housing is closed with a cover. This unit does not require the use of a forced draft, since air is drawn through the unit by thermal pressure (convection currents).

The convection type regenerating unit is installed in the same area as the shelter occupants. The number of units is calculated as a function of regeneration time, number of occupants, and power of the unit.

To prevent penetration of ambient air through leaks in the shelter, it is necessary to maintain an air overpressure equa' to 1.5 to 2 mm H_2O. This is achieved by supplying air through the filter-ventilation system at a rate of one-third the volume of the premises [entire shelter] per hour. Thus, in shelters located in possible mass fire zones, it is necessary to use a special air-supply system. This system is intended to supply the minimum amount of ambient air required to maintain the overpressure; the air is purified from carbon monoxide, and regeneration equipment is also used in order to maintain the gas composition of the atmosphere within tolerable limits. As a rule, air fed into the shelter through the filter system enters through two air-intake ducts, of which one is primary and the other on standby.

To protect the air-supply system and the filter-ventilation equipment from damage and to prevent the blast wave from penetrating the ventilating ducts, antiexplosion devices have been designed, consisting of metal deflectors (Fig. 55*a*), reinforced protective units (Fig. 55*b*), floating cutoff valve KOP, etc.

Depleted air is removed from the shelter through exhaust ducts in which sealing and regulating valves as well as antiblast mechanisms have been installed. Exhaust fans are set up in large-capacity shelters. The exhaust ducts in the shelter are closed with overpressure

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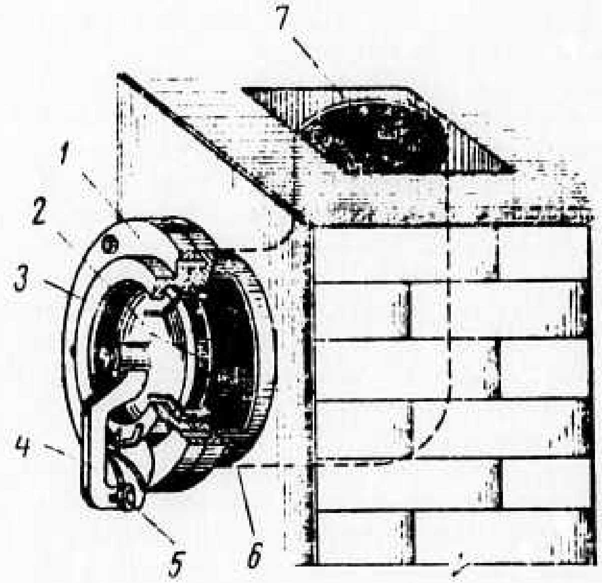

Fig. 56. Overpressure valve (diagram of the unit at inlet of bathroom exhaust duct; the arrows show the direction in which the air is moving from the shelter): (1) valve housing; (2) disk; (3) rubber lining; (4) lever connecting the disk to the valve housing; (5) counterweight system for regulating the disk position; (6) metal pipe; (7) exhaust duct.

valves (OPV) (Fig. 56). This valve in the exhaust duct consists of a metal disk with a rubber packing connected to the metal housing by a pin and a hinge. The disk is pressed to the valve seat by the action of the blast wave, closing the orifice through which the depleted air is removed.

The following modes of operation are conditionally provided for the filter-ventilation unit: in the absence of contamination, the clean ventilation mode with an air supply of 7 to 20 m^3/hr [4.1 to 10.6 cfm] per person (Table 16); in the presence of atmospheric contamination, the filter-ventilation mode with an air supply of 2 m^3/hr [1.1 cfm] per person; at the moment of a nuclear burst, the self-contained mode,

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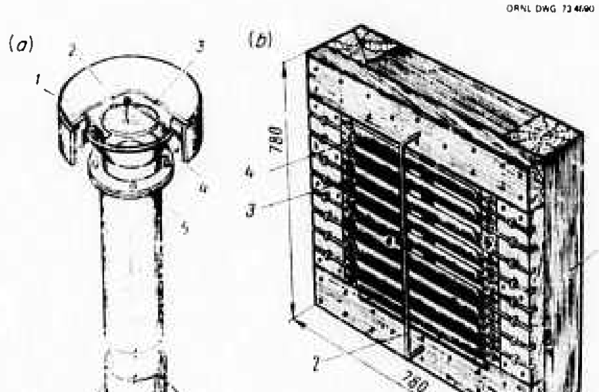

Fig. 55. Antiexplosion mechanism: (*a*) metal deflector – (1) cover; (2) spring; (3) support for flap; (4) flap; (5) housing; (*b*) reinforced protective units – (1) frame; (2) bracket; (3) blade; (4) crosspiece.

Table 16

Ambient air temperature (°C)[°F]	Air-supply standards for the clean ventilation system per person (m^3/hr) [cfm]
20 [68]	7 [4.1]
20–25 [68–77]	10 [5.8]
25–30 [77–86]	14 [8.2]
30 [86]	20 [10.6]

whereby the filter-ventilation system is turned off for 1 hr and the sealing valves are closed, and [as a result] the system is completely self-contained.

The shelter is supplied with electricity from the municipal (plant) power plant. The basic consumers of electrical energy in the shelters are the lighting system and the electric-powered ventilating system. In addition some shelters require electrical energy for an artesian well pump. A diesel-generator may be placed in large-capacity shelters for emergency power. In shelters without an independent protected electrical power source, emergency lighting is provided by batteries or pocket flashlights, bicycle-powered generators, and the like. However, the blower assembly is worked with a manual drive mechanism.

Candles and kerosene lamps are used for illumination to a limited extent and only under good ventilation conditions. When calculating the air supply, it is necessary to take into account the character of the illumination, since the air will be highly contaminated with combustion products when candles and kerosene lamps are used.

Air is used to ventilate the generator system and [also] to cool motors; the air is drawn from the shelter proper. In the case of an air deficit, a supply of ambient [outdoor] air into the generator system is provided, after it has been cleansed of radioactive dust.

Water supply and sewer system. As a rule, a shelter's water supply and sewage disposal systems are based on the existing municipal or installation water supply and sewer systems. However, in view of the probability of these systems being destroyed by a nuclear burst, an emergency water supply must be provided in the shelter, as well as sewage water tanks that operate independently of the outside sewer system. To maintain the emergency water supply, use is made of flow-through pressure reservoirs or pressureless containers equipped with removable covers, float valves, and water-level gauges.

The minimum water supply for drinking and for washing hands in the shelter is 3.5 to 4 liters per person per 24-hr period; 16 to 20 liters are required for normal operation of the sewer system. Consequently, in a shelter with a capacity of 300 people, the daily water supply must be about 7 m^3, for which 1 m^3 [270 gallons] is for drinking and 6 m^3 [1620 gallons] is for operating the sewer system.

Emergency water supply facilities are established in the shelter. The running-water tank is usually located under the ceiling in sanitary units and in pressureless reservoirs – in special compartments. To purify the water in the shelter, there must be a supply of chlorinated lime or DTS-GK. A mixture of 8 to 10 g of chlorinated lime or 4 to 5 g of DTS-GK is required to chlorinate 1 m^3 of water.

Gate valves are installed in the water supply pipes and other systems in the shelter to prevent damage from [damage to] outside systems. The shelters are equipped with flush drains which admit water to the existing sewer system to remove stagnant and fecal water. In the detached shelters, pumping stations have been provided to pump sewage water into the sewer system. In case the outside water supply system and the sewer system have [both] been damaged, an emergency sewage unit is installed inside the shelter, consisting of vessels for collecting sewage (temporary waste holdup containers).

Heating. Central heating is provided to blast shelters from the heating system of the building (district heating plant). Dampers are installed on horizontal pipelines to regulate and turn off the heat inside the shelter. The pipes of the engineering network inside the shelter are color-keyed:

White, air-intake pipes of the cleaning and ventilating system;

Yellow, air-intake pipes of the filter-ventilating system;

Red, ventilation pipes in case of fire (leading to the heat capacity filter);

Black, electrical conduits;

Green, water pipes;

Brown, heating ducts.

On air-intake and water pipes and heating ducts, arrows on the inlet indicate the flow direction of the air or water. In addition to the interior equipment which we have considered, a blast shelter is provided with various fireproof, sanitary, and other equipment, as indicated in the appendix.

5.2.4 Adapting a Basement as a Blast Shelter

A basement may be remodeled as a shelter. For this [purpose] it is necessary to do the following: to reinforce the ceiling and interior walls, coming out on the stairwell and in the adjacent nonmodifiable premises (reinforcement is not provided for exterior basement walls); to construct an entrance of 60 × 160 cm using the existing entrance from the stairwell; to construct two simple emergency exits (manholes) and adapt them for air flow-through; to seal unnecessary openings and communication apertures; to construct a sanitary unit with a cesspool, a floor, plank bunks, and sand filters.

As joint reinforcement of the ceiling and the interior basement walls, longitudinal log frames are erected, fastened transversely by horizontal clamps made of strips 4 to 5 cm thick and floor boards, and nailed to a horizontal frame, while the walls are reinforced with supplementary timber supports set up along the front of the longitudinal frame. Boards are laid behind the support and are nailed to the vertical clamps.

Metal construction is reinforced by increasing its lateral cross section and welding on metal supports, that is, I beams, channel irons, sheet metal, etc. Reinforced concrete construction is strengthened on one side by cast monolithic concrete with supplementary reinforcement.

The bearing capacity of the safety construction is increased by installing additional interstitial supports in an arch. Decreasing the [span of an] arch reinforces the construction and increases its bearing capacity. For example, when the span of an arch is halved, its bearing capacity is quadrupled (Figs. 57 and 58).

Protection from the effects of initial nuclear radiation and high temperature may be obtained by covering the surface of the ceiling with boards 3 to 5 cm thick,

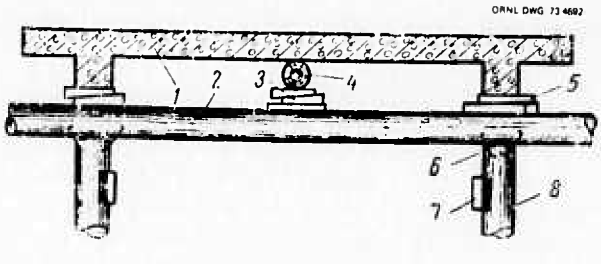

Fig. 57. Reinforcing ribbed coilings: (1) plate; (2) lining; (3) beam; (4) girder; (5) shims; (6) brackets; (7) interlock; (8) support [column].

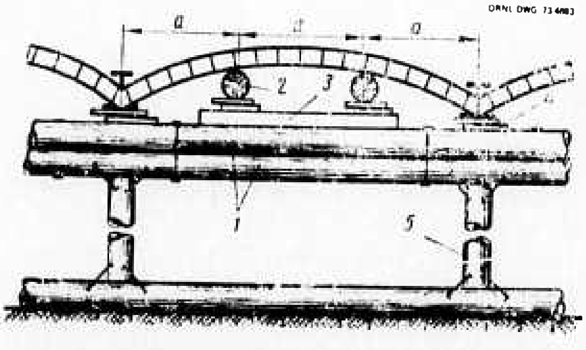

Fig. 58. Reinforcing a brick arched ceiling: (1) double girder; (2) beam; (3) lining; (4) shims; (5) support [column].

reinforcing the horizontal clamps, piling earth (slag) over the existing cellar roof, or stacking sand bags.

The entrance is equipped with a protective door of the BD type 60 X 160-0.6 and an airtight door GD-60 X 160-0.1 [both of] which are installed in the vestibule unit. The simplified emergency exits (manholes) are of wood-earth construction, using existing windows. Auxiliary manholes with vent caps are installed in multistory buildings.

The bathroom is equipped, according to plan, with one toilet per 50 to 75 people, with a cesspool and a discharge rate (reserve) of 4 liters per person. The bathroom flue is a wooden box [duct] with a vent cap having a protective baffle plate, covered with scrap materials. To collect the solid waste products, a refuse storage tank is installed with a capacity of 2 liters per person.

Chinks and fissures in the shelter construction are sealed with rags and a cement solution. Tiered plank bunks made of a board frame and panels are built in basement shelters.

The air-supply system in basements remodeled for blast shelters consists of sand (slag) filters and fans with bicycle-powered mechanisms, or bellows-bags, and also an ROV ventilation unit. The amount of forced air [required] for the filter-ventilation system is calculated from the air supply as not less than 2 m^3/hr [1.1 cfm] per person.

Air for the clean ventilation system is admitted into the shelter from the reserve manhole through the air intake in which a protective UZC unit is installed for protection against the blast wave (see Fig. 55*b*). To clean the air of radioactive dust, there is a screen dust filter. Openings of 30 X 30 cm are installed in the partitions of the shelter to enable the air to flow from one room to another.

Air is removed from the shelter through an exhaust duct, exhaust valves in the airtight doors, and the exhaust ducts in the lavatory. The lavatory ducts are protected by a vent cap with a protective device and an exhaust opening in the walls with UZS or OPV protective units.

In these shelters there must be a reserve supply of drinking water in tanks, 600 liters per 100 persons. Food for the occupants is stored in cans on shelves.

The amount of materials required to remodel a basement into a blast shelter with a capacity of 100 persons is listed in Appendix V.

5.2.5 Rugged Filter-Ventilation Equipment

Rugged FVO devices. To clean the inlet air of radioactive dust and toxic and biological materials,

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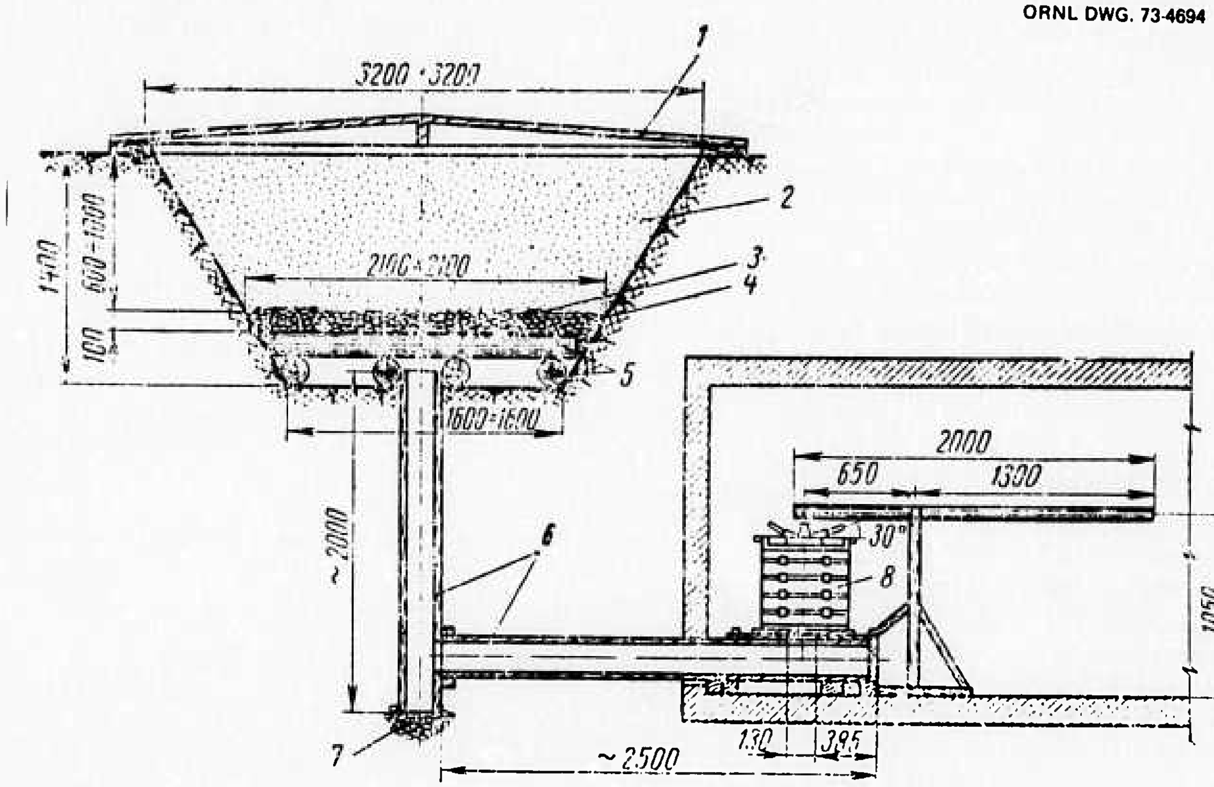

Fig. 59. Rugged filter-ventilation equipment: (1) cover for protecting the filter from atmospheric fallout; (2) coarse sand and coal slag; (3) fine gravel; (4) coarse gravel; (5) beam of 15 to 16 cm diameter; (6) duct; (7) drainage; (8) bellows.

rugged filter-ventilation equipment is used, including sand or slag filters and a bicycle-powered fan or bellows.

The filter is set in the excavation, the sloping sides of which are covered with a layer of waterproofing materials or with a 10-cm-thick layer of compacted clay. The filter walls must be constructed of brick or wood and carefully sealed airtight. The inner surfaces of the walls must have ribs projecting into the sand in order to prevent air leaks between the walls and the sand (Fig. 59).

A metal or a wooden grating, with a diameter of 15 to 16 cm, is laid on the bottom of the excavation. The grating is covered with a 10-cm-deep layer of gravel of 25 to 30 mm particle size and then a 5 to 6 cm layer of 5 to 10 mm particle size. A load of local filtering materials is placed on the gravel, for example, sand of 0.5 to 3 mm particle size, shell rocks of 0.5 to 1 mm particle size, and furnace slag of 0.05 to 5 mm particle size. The top of the filter bed is covered with a sloping roof to protect it from rain and snow. The depth of the sandy layer, which purifies the air of toxic materials and bacteriological media, must be not less than 1 m and of furnace slag or shell rocks not less than 0.75 m.

The cross-sectional area of the absorption filter is determined by the capacity of the shelter and the standard per capita air supply (depending on the ventilation system). The required cross-sectional area S of a bed is calculated according to the formula

$$S = \frac{nV}{W}\ \text{m}^2 ,$$

where n is the number of people in the shelter, V is the standard air flow rate for one person (m^3/hr), and W is the air flow through 1 m^2 cross section of the bed per hour (m^3/hr).

For a sand absorption filter $W = 30\ \text{m}^3/\text{hr}\cdot\text{m}^2$, and for an absorption filter of slag, shell rocks, or opoka, $W = 60\ \text{m}^3/\text{hr}\cdot\text{m}^2$. Table 17 gives the minimum area of a bed for a simplified absorption filter for a standard air flow rate of 2 m^3/hr [1.1 cfm].

The proper operation of the rugged absorption filter devices is checked on the basis of the air flow resistance

Table 17

Shelter capacity (number of persons sheltered)	Absorption filter capacity (m^3/hr)	Absorbent surface of the absorption filter, depending on the filter material (m^3)		
		Opoka and shells	Coal slag	Sand
50	100	1.65	1.65	3.3
100	200	3.3	3.3	6.6
150	300	5.0	5.0	10.0
300	600	10.0	10.0	20.0

for a given capacity. The flow resistance is measured with a ve.tical manometer connected to the air duct fitting in front of the ventilating fan and should not exceed 50 mm H_2O.

To assure an air supply in the filter-ventilation system, it is possible to use metal fans with a bicycle-driven mechanism (Fig. 60*a*) (bicycle fans), bellows mechanisms, sewing machine treadles, etc; if electrical power is available, it is possible to use vacuum cleaner motors on ROV axial fans (Fig. 60*b*).

One or two bellows bags are used in the bellows-bag ventilation system. The bellows bag consists of two casings, a bottom, a top, and valves. The inside casing is made of thin canvas, burlap, linen, or cotton fabric, and the outside casing is made of leatherette, rubberized fabric, or film. The bottom and top consist of panels in one or two layers. The ventilation system of one bicycle fan or one bellows provides an air flow rate of 150 m^3/hr [88 cfm] and may be used only in shelters with a capacity of 75 people or less. When outfitting large-capacity shelters, it is possible to use bicycle fans or single and twin bellows mechanisms.

The pit under the filter grating is connected to the ventilation mechanism by metal or wooden ducts. To ensure airtight sealing of the ducts, they are wrapped with any available waterproofing material (tar paper, Pergamyn [wax paper], Rubberoid, etc.). The axial fan ventilator ROV with an electric motor and manual drive mechanism is used to supply ambient air in the clean ventilation system.

A dust-proof oil filter or other filters with a retention efficiency of not less than 90% are installed in front of the ROV fan on the air intake to free the air of radioactive dust. The fan is connected to the air intake duct by a flexible hose. In the case of the filter-ventilation system, the depleted air is removed through exhaust ducts installed in the lavatories and by means of exhaust valves provided in the airtight doors. Wooden deflectors (Fig. 61) and other protective devices are used to protect the air intake and exhaust openings from being penetrated by the blast wave.

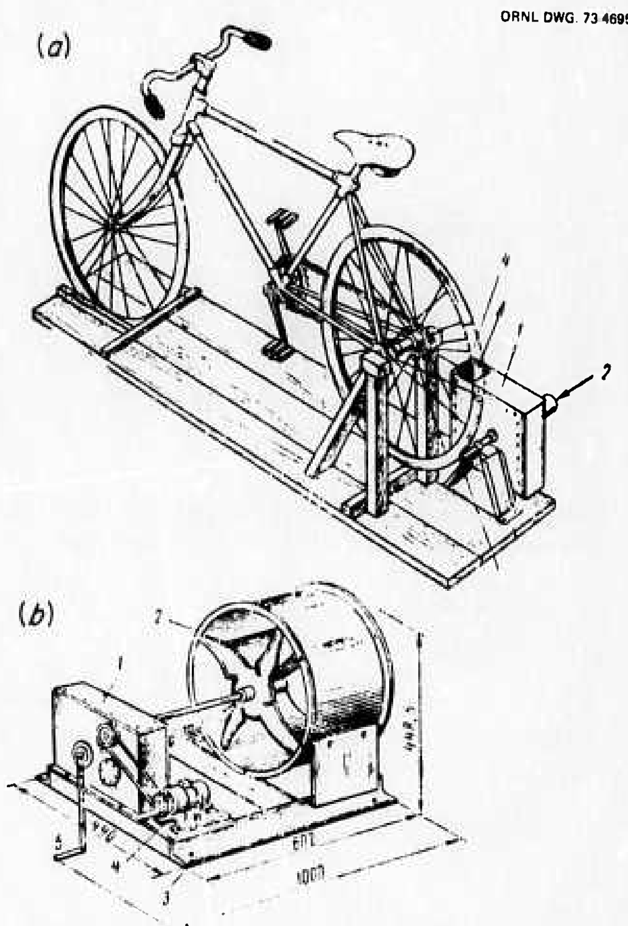

Fig. 60. Fans: (*a*) metal fan with bicycle-driven mechanism – (1) metal fan; (2) intake nozzle; (3) power drive shaft; (4) air outlet: (*b*) ROV axial ventilator – (1) reducer; (2) blade wheel; (3) support; (4) electric motor; (5) crank.

The degree of airtight sealing with a simplified system and with a single-stage air exchange must ensure an air

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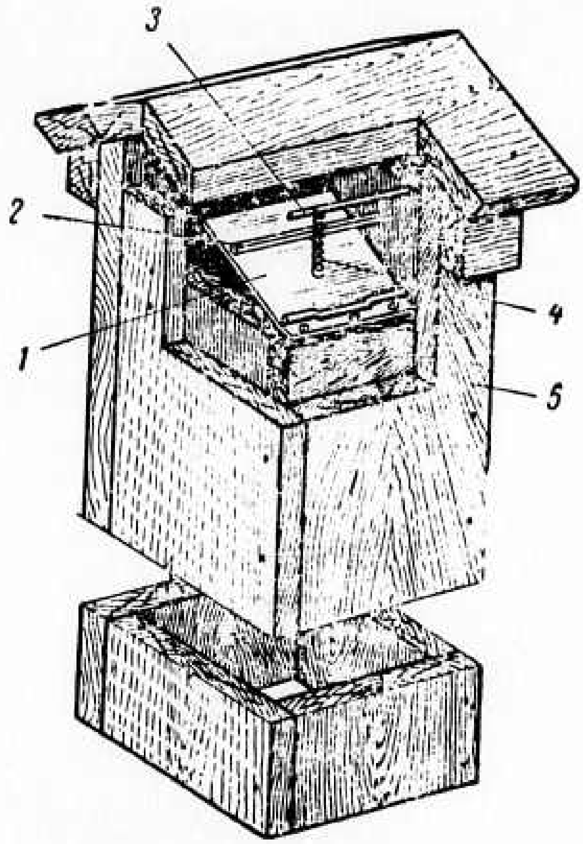

Fig. 61. Wooden deflectors with protective ZU mechanism: (1) valve; (2) valve support; (3) clamp; (4) spring; (5) duct.

pressure of at least 2 mm H_2O. To ensure an air supply equal to a single-volume exchange, the bellows' pumping rate during the filter-ventilation mode is determined according to the formula [see note*]

$$n = 30V/L_{gen},$$

where n is the number of bellows cycles, V is the volume of the shelter (m^3), and L is the total calculated capacity of the bellows.

Rules for using a rugged absorption filter. After a nuclear blast, the filter-ventilation system is turned off for 1 hr and then is turned on again. The rugged absorption filter must be inspected and checked for flow resistance once every two months. The check is to determine the condition of the upper bed layer, the integrity and serviceability of the air ducts, the need for repair, etc. If the bed is very wet and shows greatly increased flow resistance, it must be dried out. The bed is dried by blowing through air of 50 to 60% moisture content for a period of 8 to 12 hr (in the summer in dry weather, in the winter in freezing weather). The amount of materials required to make a rugged filter-ventilation system with a capacity of 300 m^3/hr [175 cfm] is indicated in Appendix VI.

[*Since no time requirements are specified, the editors do not understand the purpose of this formula.]

5.3 HOW TO ARRANGE AND EQUIP FALLOUT SHELTERS

In rural areas, protection of the population is ensured (1) by building fallout shelters and by adapting basements, cellars, and other underground structures as shelters in peacetime and (2) by building and adapting such structures when the threat of enemy attack is announced.

5.3.1 Fallout Shelter in Homes

The fastest and easiest adaptation is fallout shelter in basements (Fig. 62) and cellars (Fig. 63). The basic goal in adapting basements for shelter use is to prevent the entrance of radioactive dust and toxic materials in droplet form into the shelter, as well as to provide protection from external radiation. The shielding of ceilings of basements and cellars is improved by using a poured earth fill or by stacking bricks, etc. Additional

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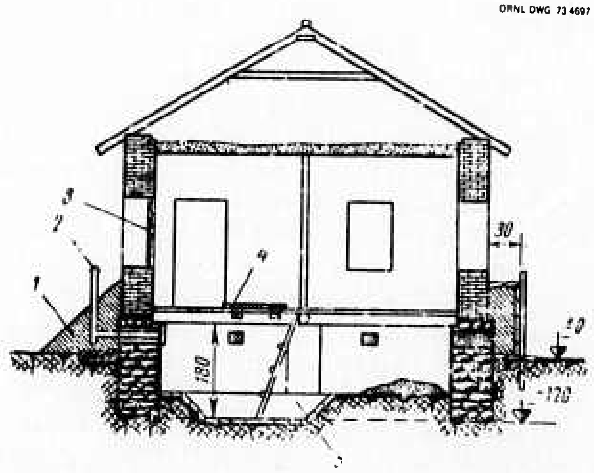

Fig. 62. Basement of a stone house adapted for shelter: (1) earth embankment; (2) exhaust duct; (3) curtains on windows; (4) airtight hatch; (5) recessed pit. Material requirements: lumber, 0.5 m^3; nails, 1 kg; earth, 3–5 m^3; labor, 15–29 hr [man-hours].

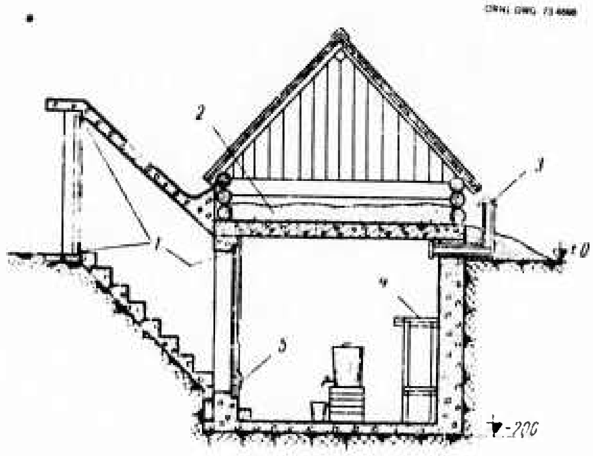

Fig. 63. Detached cellar, adapted for a shelter: (1) placement of airtight doors; (2) earth layer (or slag), 20 cm; (3) exhaust duct; (4) plank bunks; (5) air inlet opening.

supports and girders are placed under the ceiling to avoid damage.

To provide adequately for the extended confinement of people in such shelters, it is necessary to assure a supply of fresh air; provide benches for sitting and plank bunks for resting and a reserve of water and food; set up lavatory facilities; furnish batteries for illumination and a radio transmitter and electrical illumination from the electric power system.

For small-capacity fallout shelter accommodations in basements and cellars (up to 40 persons), ventilation may be achieved by means of natural ventilation through a specially constructed ventilating duct with a cross section of not less than 10 X 10 cm [see note*]. The duct opening is screened with a piece of cloth and closed with a cover. Two such ducts are installed in shelters: one for inlet, the other for exhaust. The inlet duct opening is installed at a maximum height of 50 cm above the floor and the exhaust duct at a distance of 20 to 25 cm below the ceiling. On the outside, the duct must be located at a height of 50 cm above the surface of the earth covering [embankment].

When the shelter capacity is above 40 people, it is advisable to install the simplest filter-ventilation equipment from the materials available.

[*In warm or hot weather, if this shelter were to be occupied for days with even twice the Russian-specified 0.5 m^2 minimum floor space per person, lethal temperature-humidity conditions would probably result.]

5.3.2 Construction of Detached Fallout Shelters

In addition to using basements, cellars, and other sunken structures, in the civil defense system it is also possible to build detached structures ensuring protection from the blast wave in a zone with pressures not greater than 1 kg/cm^2, protection from initial nuclear radiation and thermal radiation, and, when airtight sealing and filter-ventilation equipment are present, to ensure protection from contamination by radioactive and toxic materials and biological agents.

Such shelter is made of local materials, sunken into the ground, covered with a layer of loose dirt at least 70 to 80 cm thick, and designed to hold up to 100 people.

Shelter designs may be of various types, but, if made in a rectangular form, the construction of the framework is simplified, facilitating installation and erection work around the foundation. As a rule, shelters have facilities for accommodating people, a vestibule, a heating system, and a ventilation or filter-ventilation system.

Constructing a shelter includes the preparatory work, marking off and surveying the site, excavating the site and constructing drainage, erecting and assembling the framework of the structure and internal equipment, waterproofing the structure, installing ducts and a roof and covering the shelter with earth and with sod. When the shelter proper is being outfitted, it is also provided with filter-ventilation equipment.

After the foundation is excavated and the prefabricated components are installed, the shelter framework should be erected. Shelter frameworks may be constructed of wood, reinforced concrete, or metallic elements. When a shelter framework is built of wood, the following constructions can be used: continuous-frame, frame-block, frame-panel, mitered, and unnotched.

A continuous-frame construction is composed of frames; the frames are fastened at the corners by staples and are joined by nailing. The framework made of frames is assembled manually directly on the foundation.

The special feature of the frame-block construction is that the frames are prefabricated into units which are then set on the foundation. The frame-blocks are assembled with the aid of a motorized crane. Board planks are cut and fastened to the corners of the blocks to ensure lateral stability (Fig. 64).

Essentially, the frame-panel construction is a variation of the large frame-block construction.

The structures just listed may be used only to construct ordinary-foundation, trench-type shelters. In

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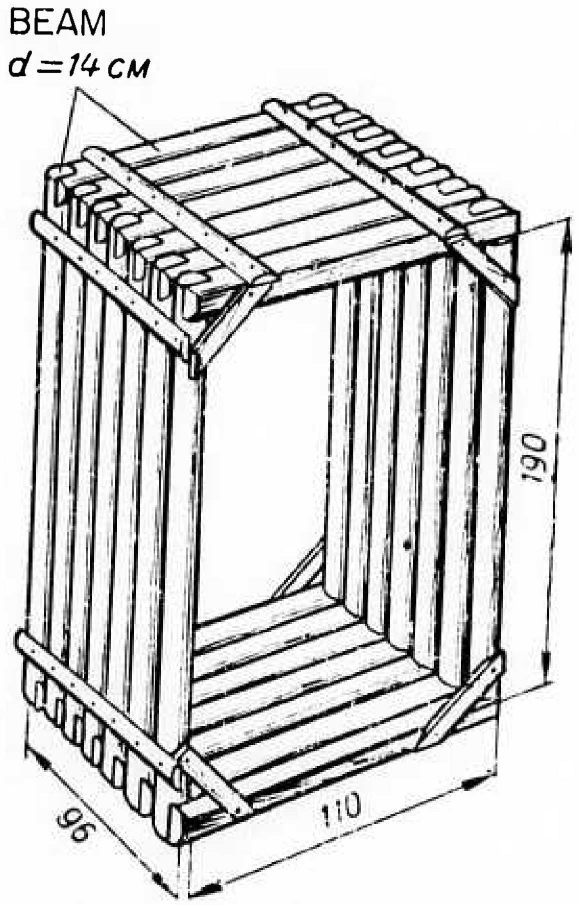

Fig. 64. Block framework for a shelter in frame-block construction.

semi-buried shelters these structures may not be used advantageously because of poor cross-sectional stability. The entrances to these shelters can be constructed only at the face of the framework.

Mitered construction framework can be used to construct either the [trench type] foundation or the semi-buried types. In shelters of the trench type without a rubble base (Fig. 65*a*) and in shelters of the semi-buried type with a rubble base (Fig. 65*b*), the elements of the framework construction are joined at the corners by quarter rounds. To ensure the stability of such a shelter, reinforcing braces are set up in the form of interstitial transverse pieces. Entrances into a shelter with a mitered framework may be built in the front walls as well as in the side walls. Wherever the entrance openings are located, it is necessary to provide not less than two complete miters at the top and the bottom and to insert auxiliary double brackets.

A structure [shelter] of unnotched construction (Fig. 66) is made of poles with diameters of 10 to 14 cm. Supports, framing, and cross braces are connected without notches (only small cuts [are made] in the framing where the braces are installed). The supports [the wall posts] are positioned against the sides of the bracing; the roofing [poles] rest on the upper ends of the supports [wall poles]. To withstand [horizontal] pressure on the corners of the structure, longitudinal poles are installed with cross braces at spacings of 50 to 60 cm, along the length of the structure. At the top, these [horizontal] poles and cross braces are fastened to the framing with twisted wire splices and nails. The expenditure of materials and time required to erect a shelter of unnotched construction is shown in Table 18.

The structure [shelter] made of prefabricated reinforced concrete slabs (Fig. 67) is erected with the aid of a motorized crane. The length of the structure depends on the required capacity (volume) of the structure.

When building shelters, it is possible to use prefabricated reinforced concrete elements designed for constructing heat ducts, communications conduits, large pipes, etc. The joints between the reinforced concrete blocks are sealed from rain water by Rubberoid or other similar material. The norms for the basic types of work in constructing a shelter of reinforced concrete elements are shown in Table 19.

The framework of the shelter may also be made from corrugated Duraluminum components. This kind of framework is preferred because of its resistance and light weight; [also] assembling the prefabricated framework is simple and does not require much time.

The protective cover must be thick enough to protect people in the shelter from contamination by radioactive and aerosol toxic materials, as well as prevent leakage of rain water into the shelter. The average thickness of the cover must be about 1 m. A waterproof layer is usually laid on the ceiling first (roofing) and then a layer of soil with a thickness of 70 to 90 cm.

The weakest part of the shelter is the entrance; thus, it is necessary to provide for its protection. This is achieved by constructing labyrinth entrances with protective doors, vestibules, and airtight entries. The airtight protective doors are made of boards reinforced with planks. The frame of this airtight door is covered with canvas or another fabric impregnated with machine oil; a sealing strip of rubber tubing is mounted on the frame around the door. The doors are hung in gas-impermeable partitions and are closed tightly with clamped bolts.

To prevent toxic materials and radioactive dust from penetrating the shelter, the floor and ceiling at the

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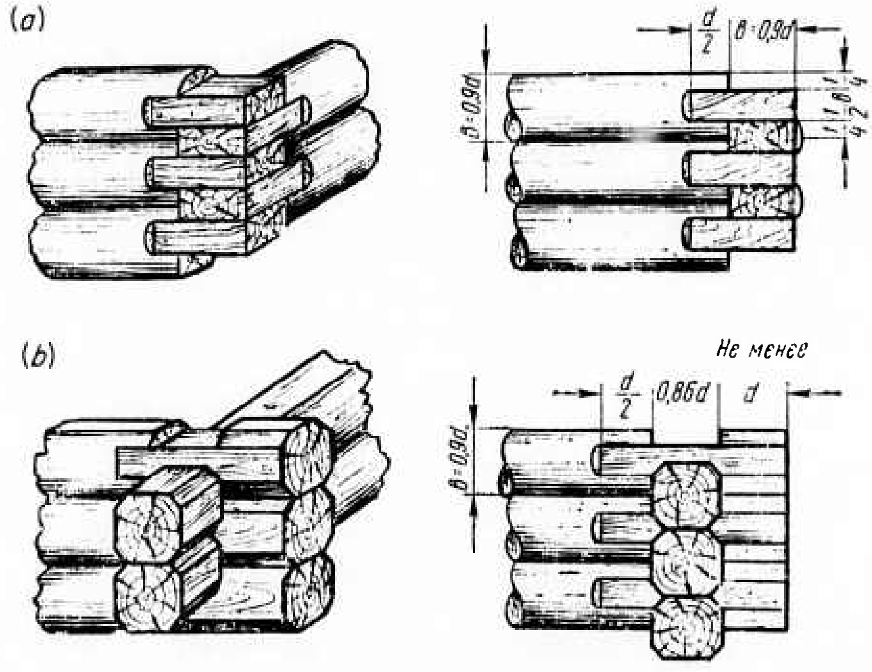

Fig. 65. Connecting framework elements of mitered construction.

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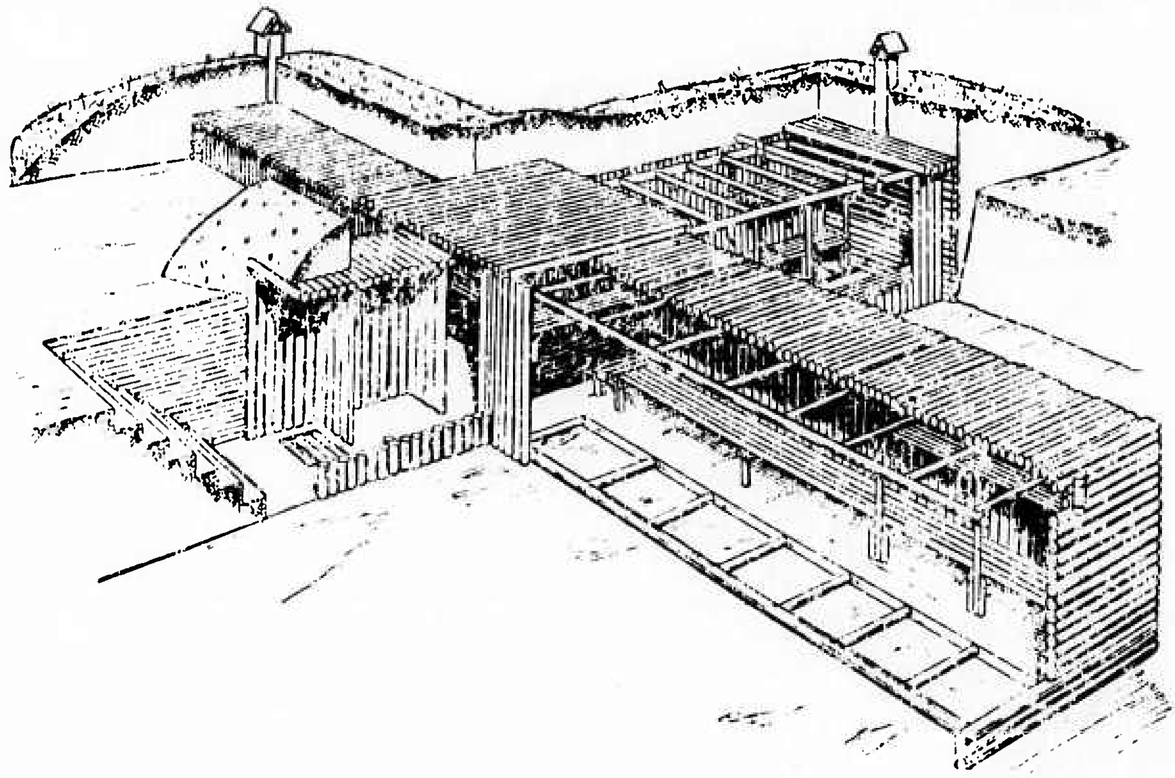

Fig. 66. Shelter of unnotched construction for 40 persons.

Table 18. Materials and time required to erect a structure of unnotched construction

	Single-row [of benches with overhead bunks] disposition		Double-row [of benches with overhead bunks] disposition		
	10 per	20 per	10 per	20 per	40 per
Material requirement					
Round logs, m^3					
subflooring, diam = 8–11 cm	0.1	0.1			
subflooring, diam = 14 cm			3.31	5.28	10.17
poles, diam = 5–7 cm	0.7				0.14
poles, diam = 7–8 cm	4.1	6.16	0.26	0.29	0.89
Total round logs, m^3	4.9	6.26	3.57	5.57	11.20
board 2.5 cm thick, m^3	0.02	0.04	0.02	0.044	0.07
brushwood, m^3	0.4	0.7	0.07	0.1	0.15
nails, kg	0.33	0.33	0.06	0.06	2.7
wires 3–4 mm, kg	3.1	3.72	22.50	30.00	3.20
canvas, m^2	4.64	4.64	2.6	2.6	2.6
General weight of materials, kg	3542.0	4605.0	2560.0	3980.0	8260.0
Labor requirement, hours [man-hours]					
Excavating and digging the shelter foundation	20	34	11	18	47
Preparing the rough construction of the shelter	24	40	18	21	50
Erecting the shelter	86	131	66	86	173
Total labor requirement	130	205	95	125	270

Note: The [material and man-hour] costs for building the plank bunks [benches with overhead bunks] are not included in the table. "Per" denotes persons.

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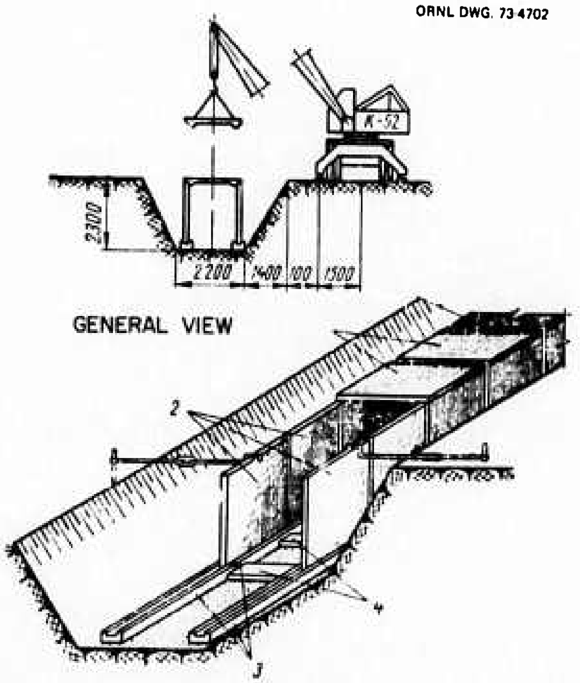

Fig. 67. Installing the shelter with reinforced concrete components: (1) platform of the shelter; (2) platform of the walls; (3) foundations; (4) reinforced concrete cross braces.

Table 19

Type of work	Productivity per hour of work (m^3) [ft^3]
Excavating a trench manually (medium density soil) [1 man working]	0.4 [14]
Excavating a trench with a power shovel	
E-505	45 [1530]
E-252	22 [750]
E-153 (on Belarus tractor)	10 [340]
Excavating a trench with a bulldozer	18 [620]
Mounting miscellaneous reinforced concrete slabs (team of 4 men), No. of pieces	4 [136]
Mounting miscellaneous reinforced concrete slabs, beams with the aid of hoists (team of 8 men), No. of pieces	2 [68]
Constructing a wooden bracing frame (team of 6 men)	3 [68]

joints of partitions and walls must be offset all around the door frame and 25 to 30 cm outside it.

The interior equipment of a shelter includes plank bunks, lighting, heating, and ventilation. The plank bunks are set along the walls at two levels; the [vertical] distance between the levels [the bunks] must be not less than 85 cm, and from the second level to the ceiling not less than 50 cm. Lighting is provided by batteries, flashlights, candles, or from a dc power supply. The shelter is usually heated with a stove; cast iron stoves, makeshift stoves made of galvanized-roofing sheet metal, or special heaters are provided.

If the shelter is airtight and is planned for protracted occupancy, then it is equipped with simple filter-ventilators and fans made of available material, the construction of which was discussed earlier.

5.3.3 Simple Protective Structures Constructed for the People

In addition to the protective structures which we have considered, the population can, under the threat of enemy attack, construct such cover as [covered] trenches and dugouts by using available materials and their own labor. The trench (Fig. 68) is a narrow ditch with a depth of up to 2 m and a width of 1 to 1.2 m at the top and 0.8 m along the bottom; it is covered on top. To prevent the simultaneous destruction of a large number of trenches, they are excavated in several rectilinear modules, laid out at right angles to one another. Each rectilinear module has a length of about 10 m and is designed to accommodate up to 60 people. Entrances are made at one or both sides of the trench. They are closed with doors which reduce the direct effect of the blast wave to a considerable degree. The entrance into the trench must be offset, oriented at a right angle to the trench.

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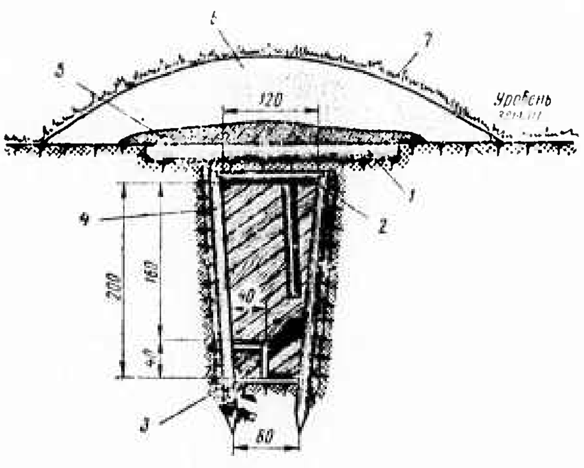

Fig. 68. Trench: (1) roofing (diam 14 cm); (2) cross brace (diam 10 cm); (3) lining of slabs, 18 × 2; (4) stud; (5) compacted clay (20 cm layer); (6) earth covering (60–80 cm); (7) sod.

Where groundwater is near the surface, the trench is semi-excavated so that the floor of the trench is at least 20 cm higher than the possible level of the groundwater. In this case, the part of the shelter that is above the ground is covered with earth. The earth covering must have a slope no steeper than 2:1.

To protect against fire, all the exposed wooden parts of the trench are covered with fire-proofing substances (lime coating, 62% slaked lime, 32% water, and 6% common salt).

Digging a trench begins with selecting a site which satisfies the requirements, the most important of which is that it will neither collapse nor flood Once selected, the site must be surveyed, that is, a site plan must be made. In order to do this, small wooden pegs are driven into the ground at the corner junctions, a string is stretched between the corner junctions, and then the trench is opened up along the string. After surveying [the site], the sod is removed between the survey lines and piled to one side, and the trench is excavated. Digging is begun, not over the entire width, but just slightly within the survey lines. With increasing excavation depth, the walls of the trench are gradually trimmed off evenly and excavated to the required dimension.

After the trench is excavated, the sides are reinforced with boards, poles, brushwood, reeds, and other available material. Then the trench is covered. First, a roofing of logs is placed; then a layer of packed moist clay, with a thickness of 15 to 20 cm, [is placed over it] to protect the roofing from rainwater; next, dirt is piled on the clay to a thickness of 60 to 80 cm; and finally the sod, which was removed before the trench was excavated, is replaced. A drainage ditch is dug on the trench floor, with a water-collecting sump situated at the trench entrance.

Benches and stands for water containers are built along one of the walls. A drainage ditch is dug around the trench so that surface water will not enter the trench.

Dugouts [underground peasant's houses or "mud huts"] (Fig. 69) are shelters intended for a prolonged occupancy and may be used as temporary dwellings for people left without housing. Therefore, dugouts are more completely equipped than trenches. They are

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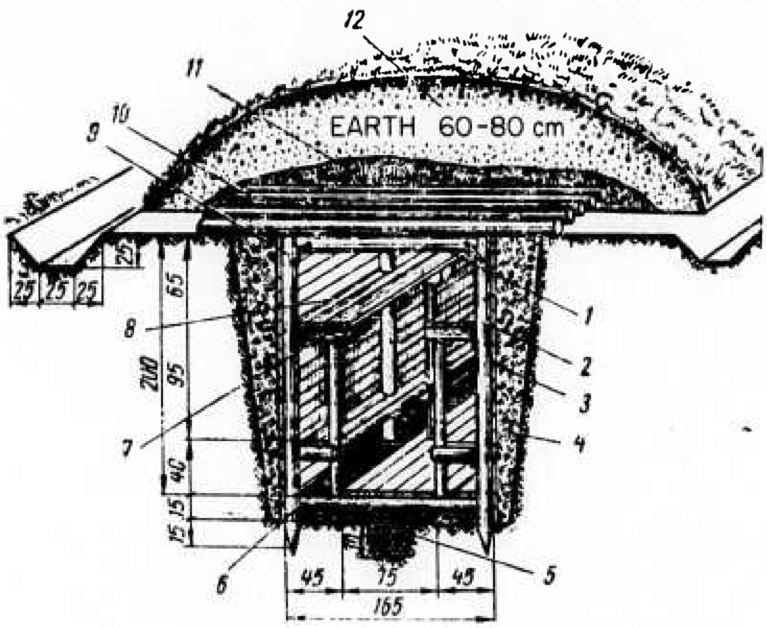

Fig. 69. Dugout: (1) cross braces (diam 16 cm); (2) support (diam 16 × 90 cm); (3) lining of boards, logs, or split poles; (4) compacted clay; (5) drainage; (6) cross braces (diam 12 cm); (7) planks (5 × 10 cm); (8) boards (25 cm); (9) brackets; (10) roofing (diam 16 cm); (11) compacted clay (20 cm); (12) earth covering (60–80 cm); (13) sod.

provided with heating, a vestibule, double doors, a portable toilet, small water tanks, and along the walls there are tiered plank bunks, the upper for sleeping, the lower for sitting. Dugouts can be sealed airtight and have a simplified filter-ventilation or merely a ventilation system.

Ideal dimensions for the dugout are about 2 m wide X 2 m high, with the length depending on the number of people it shelters, but not less than 3 m. The walls of the dugout may be of logs, boards, or other available material. The roofing is made of a continuous log ceiling (diam 18 cm). The roof is covered with a packed bed of moist clay, with a thickness of 20 to 25 cm, for waterproofing. The moist clay is also packed between the lining of the walls and the walls of the foundation. It is possible to use tar paper, rubberoid, etc., for waterproofing. A layer of at least 70 cm of earth is piled on the clay and is then covered with sod. A drainage ditch is constructed under the floor of the dugout, with a sump situated at the entrance to the dugout. The entrance to the dugout is stepped; with respect to its protective characteristics, the best entrance is a covered trench.

When the groundwater level is [quite] high, the mud hut can be built partially sunk into the ground. In these cases, the part of the mud hut projecting above the ground is covered with earth, while the embankment must have a grade of not less than 1:2.

5.3.4 Shelter Made from Fascines

In the absence of the structures and materials considered above, it is possible to construct a fascine shelter of dry branches or reeds, canes or stems, or agricultural plants and other similar available materials. The fascines are bound brushwood [bundles made of canes or sticks], each stick up to 3 cm in diameter, held together by soft wires 1 to 3 mm in diameter. Wires are tied [around a fascine] at a distance of a diameter [of the fascine] from its ends, and subsequent ties are made at two diameter intervals. Arched fascines 25 cm in diameter made of cane reeds, or 20 cm in diameter if made of sticks, are used for the roofing.

A shelter for ten persons with a covering made of arched fascines is shown in Fig. 70. The arched fascines are laid closely touching each other and are lashed longitudinally with a single wire, with a total of eight wires being used at the ends and center parts of the fascine. It is possible to join the fascines with wooden poles, 3 to 4 cm in diameter and 60 to 65 cm long, wedging them in checkerboard sequence at every other pair of fascines. As a result, the separate fascines are converted into a continuous arch which supports a significant load.

Special attention needs to be paid to the ends of the fascines, which are cut off to form an even surface perpendicular to the axis of the fascine. The ends of the fascine must be tied not more than 20 to 25 cm from their end planes. The entire surface of the end planes on the fascines must rest on the ground. If this is not possible, an earth bank is placed under the end plane of the fascine so that it rests tightly against the ground.

On loose or weak soil, the sloping part of the roof is covered with poles while supports are placed between the arched fascines and tied together with wires. If poles are unavailable, hooped fascines are used which simultaneously form the roof and the walls of the shelter (Fig. 71). This type of shelter requires a great deal of materials and time to prepare and construct compared with the shelter of arched fascines (Table 20).

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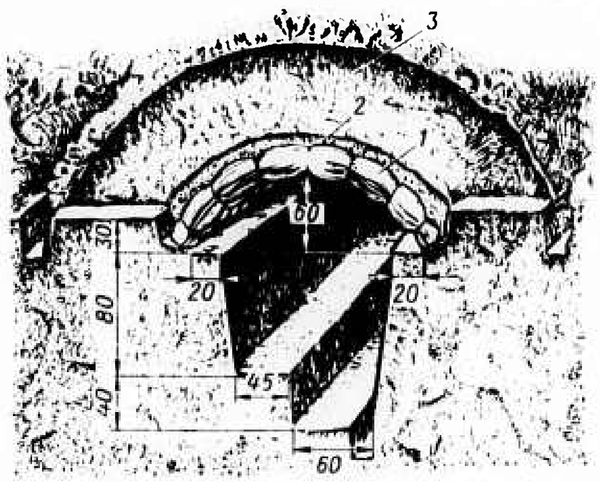

Fig. 70. Shelter in clay ground with a covering of cane-reed arched fascines: (1) fascines; (2) layer of compacted clay 3–5 cm thick; (3) soil layer 70–80 cm thick.

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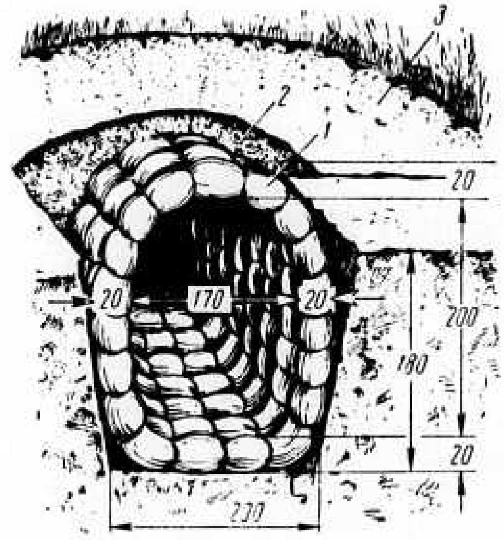

Fig. 71. Shelter in sandy soil made of annular brushwood fascines: (1) fascines; (2) layer of compacted clay 3–5 cm thick; (3) soil layer 70–80 cm.

Table 20. Basic materials and time costs for constructing a shelter of fascines

Name of materials and designation	Shelter for 10 persons				Shelter for 20 persons		Shelter of hooped framework	
	Single row		Double row		Double row			
	Without covering of the sloping part	With covering of the sloping part	Without covering of the sloping part	With covering of the sloping part	Without covering of the sloping part	With covering of the sloping part	10 Persons	20 Persons
Cane reeds (brushwood), m^3	12	13	11	10	17	15	15	23
Poles, m^3	0.04	0.6	0.04	0.5	0.04	0.6		
1 mm wire, kg	4	4	3.5	3	5.5	4	7.5	13
Canvas, m^2	17	10	17	10	17	10	16	16
No. of persons in brigade	12	12	12	12	14	14	12	16
Preparation of basic components for cover, hours of labor	40	35	30	25	50	40	75	105
Building the shelter, hours of labor	80	85	75	80	110	105	95	150
General construction time, hr	11	11	9	9	12	11	15	16

5.4 USE OF MINES AND MINE SHAFTS FOR SHELTERS

To shelter the population in mining regions, it is possible to use coal mines, ferrous and nonferrous mines, mines for extracting building materials, catacombs, caves, etc. The protective characteristics of mines and other shafts are much greater than those of the detached blast shelters and fallout shelters which are usually built.

Adaptation of a mine for shelter must be made in advance, in peacetime. Primarily, the preparations for radiation shielding and simple measures for shockwave protection are completed first, followed by the rest of the work required to achieve the maximum degree of protection and the maximum capacity. The basic preparations for adapting a mine as shelter include:

1. constructing protective and airtight partitions; adapting the entrances for rapidly moving people into the mine and constructing emergency exits from the mine; preparing vertical staircases or ladders and emergency elevators for people;
2. supplying air to the occupants by means of one of the following modes:
   a. a constant volume of air [forced and unfiltered];
   b. a system of natural ventilation, with [a capability for] switching over to a constant-volume mode (in 2 hr);
   c. filter-ventilation system with the air freed of radioactive dust with the ERV-49 unit;
3. ensuring a water supply for the occupants by using mine water, water in fire hose pipes, and water reserves stored in mine cars or in mine reservoirs;
4. preparing sanitary facilities in isolated mines by using mine cars or water-collecting channels, along which the waste water can be drained off into lower unused levels;
5. developing a system of control points, medical units, and storerooms to keep food supplies;
6. constructing plank bunks for sitting and sleeping;
7. creating a system of electric lighting and radio communications.

In mines, shelter can be set up in the form of tunnels consisting of several rectilinear units arranged in a square shape with two entrances and exits or in an L-shape with one exit and one entrance. The width of the tunnel is 1.2 to 1.5 m; the height is 2 m. The capacity of one rectilinear unit is a maximum of 20 people (Fig. 72).

The walls and the ceiling of the tunnel are reinforced with stable wooden or reinforced concrete frames, props, or cross beams. A protective wall is placed in front of the tunnel, forming a through-passage; a vestibule with two doors is constructed at the entrance. Benches and overhead bunks are arranged inside the tunnel, which is furnished with light and heat and, when there is airtight sealing, with a simplified filter-ventilation system.

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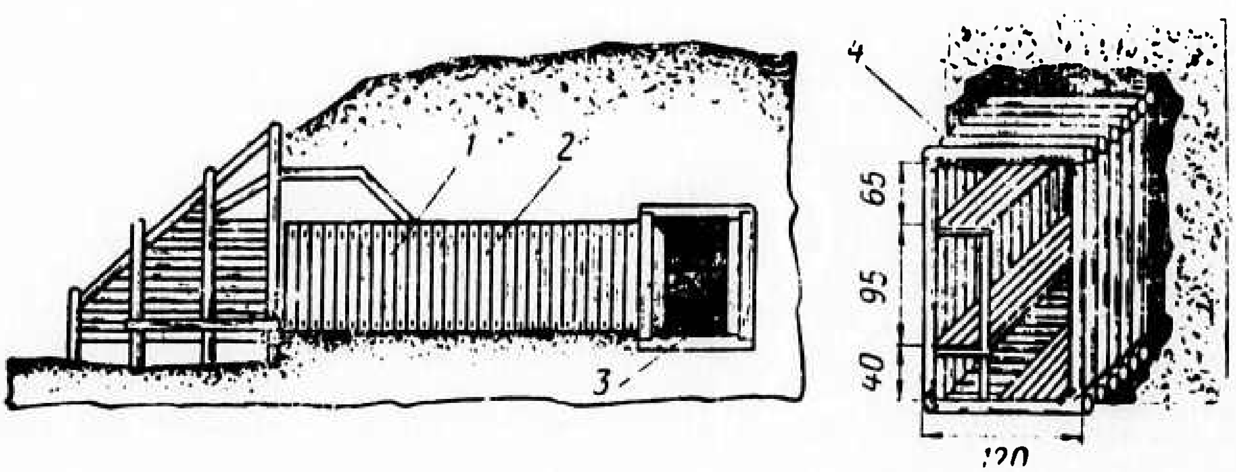

Fig. 72. Tunnel (cross section): (1) entrance; (2) wooden frames; (3) tunnel; (4) frames made of logs or beams.

5.5 RULES FOR USING THE SHELTER

5.5.1 Reception and Contents of Shelters

The shelter is made operational after it is approved by the appropriate inspection commission. The order under which the inspection commission operates, as well as the total documentation which must be presented to the commission, is indicated in the section on building standards and rules of the SN&P III-A. 10-62, "Approval for Use of Completed Architectural Undertakings, Buildings, and Structures (Basic Assumptions)." Only those shelters in which construction is complete and the equipment is installed and assembled are approved for use.

On each shelter there is a diagram, a small map relating the shelter to obvious landmarks, and a map for evacuating people from the shelter. The diagram shows the ventilation ducts in the wall; the air intake system; the water supply, sewer, heating, and electrical lighting networks; the location of the cutoff mechanisms; the emergency exit; the thickness and the material of the walls and shelter roof; the interior area and cubic volume of the premises. A table is given indicating the permissible confinement time with a constant air volume (depending on the number of occupants).

The shelter map shows the shelter location and its disposition with reference to characteristic, permanent local landmarks, by which it is possible to rapidly find an obstructed [buried] shelter.

The plan for evacuating people beyond the city limits indicates some possible routes from the area of departure to where the shelter is located. Foot routes are selected along the least obstructed streets and through regions where no group fires are expected to break out. Reliable and easily recognizable landmarks are plotted on the foot routes. This document is developed in peacetime, and two copies are made: one [to be left] in the shelter itself, the other with the CD staffs.

After all construction, installation, and cleaning work are finished, the structure is checked for airtight sealing. The degree of airtight sealing of the shelter is determined by the magnitude of the air pressure. A check for airtight sealing should proceed as follows:

1. close all the entrance doors, shutters, and hatches;
2. plug the overpressure ducts; close the airtight valves and plugs on the air-water outlet system;
3. start the inlet air supply system for the purified ventilation system;
4. determine the amount of air entering the shelter;
5. measure the air pressure head in the shelter.

When the filter-ventilation unit is switched on, air will enter the compartments, creating an overpressure inside the premises. It is possible to evaluate the amount of air which has entered by the flowmeter on the filter-ventilation unit. Knowing the capacity of the filter-ventilation unit and the interior volume of the shelter being tested for airtight sealing, it is possible to determine the "multiplicity" factor of the air exchange according to the formula

$$K = Q/V ,$$

where Q is the amount of air which has entered (m^3/hr) and V is the volume of the airtight sealed shelter area (m^3).

The air pressure head is measured with an inclined manometer of the THZh type (liquid level), one leg of which (having the lower pressure) is connected to the duct connected to the ambient air. The pressure head must be at least 5 mm H_2O on all ventilation systems in the shelter. Depending on the air-exchange multiplicity factor, the air pressure head must correspond to the following magnitudes:

With an air-exchange multiplicity factor	0.5	0.6	0.8	1.0	1.2	1.4
Required pressure head in mm H_2O	5	6	8	12	15	18

If the air pressure head is insufficient, then the location of the leak is determined by flame deflection with a match, in addition to which the following are checked:

1. the condition of the seal on airtight doors and shutters, as well as the operation of the lock mechanisms (wedge-shims);
2. the fit of the door panel (shutters) with the sealing structures and door seals (sealing strips) to the door (shutter) frame;
3. airtight sealing of the penetrations of various inlets through the protective structure;
4. airtight sealing of the joints of the ceiling and the floor with the surrounding walls, joints between blocks, and seams between structural components, especially in entrances (vestibules).

The airtight seal of the shelter is checked by periodic inspections (at least once every three months) and also immediately after it has been occupied, after an "air raid" alert.

During the period of shelter occupancy, it is necessary to maintain a pressure head of 5 to 7 mm H_2O. It is assumed that with [such] a pressure differential, toxic vapors cannot enter the shelter.

To ensure the safety of the structure – the interior equipment and the contents – the entrance doors as well as the shutters of the emergency exits are locked and opened only for maintenance and ventilation. A list is hung on the entrance doors which indicates where the keys are kept, the responsible members of the group (shelter managers), their work and home addresses, telephone numbers, and the shelter number. The locks to the doors and shutters must have at least two keys. One set of keys is kept by the shelter manager and the other by the plant (business, institution) maintenance man in the plant supply office, or in the technical inspection building.

It is recommended that the filter-ventiliation chamber be kept closed. The protective-sealing valve on the emergency air intake must be kept closed, and the sealed double valve closed and sealed in position, thus preventing flow of air through the absorption filter under ordinary conditions. (In addition, the right stem of the double valve must be kept in its extreme left position.) Otherwise [i.e., if these instructions are not followed], the filters may become damp and ineffective when using the unit to ventilate the shelter, especially in wet weather. The oiled dust filters installed in the expansion chamber or in the emergency exit may be removed for better preservation in peacetime and stored in the filter-ventilation chamber.

To prevent condensation, the inlet air blower of the ambient air is insulated with felt or other materials. To prevent warping and to increase the life of the rubber gaskets on the airtight doors and shutters, they are, as a rule, left open, and the airtight blast doors and manhole shutters are closed so that the rubber packing does not become pinched. The cutoff valve (KOP) must be systematically inspected; to prevent corrosion, the stem and the inner surface of the valve are lubricated with commercial grease, and the exterior metal parts are painted with oil paints.

The gravel shock attenuator must be washed with water not less than one to two times per year; the washing is done with a fire hose or by hand with pails. After washing the gravel, the water is collected in a special pit, or it flows through an opening into a drip pan of the shock attenuator. This water is removed from the tunnel of the emergency exit. The overpressure valves or the protective-hermetic dampers on the exhaust duct in the lavatory must be adjusted and have the proper rubber packing. It is necessary to systematically check the water pipes, sewer pipes, electrical system, and telephone and radiocommunication lines to make sure that they operate properly.

The filter chamber must have spare parts in a kit along with the filtration unit, an instruction guide of the filter-ventilation unit (Appendix VII), a list of the shelter personnel, and a floor plan of the shelter. A poster is hung on the wall of the chamber showing how to operate the filter-ventilation unit and the ventilation system (Appendix VIII) and [also giving the] rules of conduct for the shelter occupants. The list of documents and diagrams which are recommended for the shelters and the equipment table are given in Appendices IX and X.

Maintaining the proper temperature and humidity in shelters is very important for maintaining the shelter and its equipment in good condition and for maintaining normal conditions of shelter occupancy. In winter the temperature in the shelter must not be lower than +10°C [50°F] and, as a rule, not higher than +15°C [59°F]. To keep the temperature within these limits, it is necessary to ventilate the shelter regularly by opening the doors and briefly using the filter-ventilation unit of the purified ventilation system.

When the shelter is to be ventilated, it is necessary to take into account the temperature and humidity of the ambient air. In the warm season of the year, ventilating should be done only at night, and during the fall-winter period, at the warmest time of day. Ventilating is not recommended when it is raining and is forbidden in foggy weather. The recommended schedule for ventilating a shelter is shown in Table 21.

Table 21

Season of year	Hours most favorable for ventilation	Ventilation methods	Duration of ventilation
May 15 to Aug. 31	24–6 hr [Midnight–6 AM]	Natural	Not less than 3 hr without interruption
Sept. 1 to Oct. 31	In clear weather, from 12–18 hr	Natural	From 2–3 hr without interruption
Nov. 1 to Mar. 1	Any time of day	Natural	In short intervals of 20–30 min; two–three times with interruptions of 30 min; with freezing temperatures not lower than 20°C [–4°F]
Mar. 1 to May 15	7–11 or 18–22 hr	Natural	From 2–3 hr without interruption

Information on relative humidity can be obtained from the local weather station. The relative humidity in a shelter usually is determined by an instrument called the psychrometer. The simplest method for determining the optimum period for ventilating, that is, when the ambient air which has entered the shelter will not precipitate (condense) moisture from the shelter air, is as follows: place a bottle of water on the floor; then, after a short period of time (30–40 min), carry it into the street; if the bottle is covered with dew, the shelter must not be ventilated, since ventilation would cause moisture to condense on the walls and on the metal parts. When the humidity in the shelter is higher than permitted, it is necessary to quickly find the cause for the excess humidity and take measures to eliminate it.

5.5.2 Shelter Maintenance

Responsibility for shelter maintenance in wartime falls to the Blast and Fallout Shelter Service in plants, institutions, and organizations which have personnel using these shelters. For each shelter a maintenance team of seven persons is designated, headed by the team commander who is the shelter commandant [manager]. The maintenance team of the shelter is equipped with the following year:

Gas masks for each member of the team
A light protective suit "L-1," 2 sets
Rubber gloves, 2 pairs
Chemical survey equipment, type PXR or VPXR-1
Dosimetric equipment (DP-63, DP-5, etc.), 1

The commandant [shelter manager], with the other members of the shelter team, inspects the shelter, helps check the filtering unit, checks the airtight sealing and the equipment, and helps to set up the telephone equipment and the radio transmission stations. The team services three posts (two persons at each post).

Post No. 1 (double shift, around the clock, at the entrance). When the shelter is being filled, one attendant keeps watch outside the shelter at the entrance, admits people, and keeps order; the second [attendant], at the entrance inside the shelter, assigns the occupants their places in the shelter, and assists those with children, the sick, and the old. When the signal is received to close the doors, the person on duty closes the doors and remains on duty at the entrance, and the second one helps maintain order within the shelter and then rests before returning to his duties.

Post No. 2 (double shift, around the clock). The people at this post check and prepare the filter-ventilation mechanism for operation under the orders of the team commander (shelter commandant), turn it on, and oversee its operation. The sequence for turning on the filter-ventilation equipment is shown in Appendix VIII.

Post No. 3 (double shift, around the clock). Before filling the shelter, this post turns on the lights and closes the manholes and the regulating dampers of the exhaust system; if necessary, closes the passageways and then assigns people to their places and orders their confinement in the shelter.

If the shelter has diesel equipment or artesian wells, the team should include specialists to maintain them.

The shelter manager must give instructions to the members of his team and guide them in fulfilling their duties; pay special attention to CD signals; be well acquainted with the proper use of the shelter and its equipment; know the layout of the shelter, the location of the emergency exits, the possible exits through basements adjoining the shelter, and the location of nearby sheltering structures. He must also know the location and designation of the basic communications systems near the shelter, the inlet location of electrical networks, water pipes, the sewer system, etc., and know how to use the disconnecting mechanisms; know the locations of the local CD staff telephones, the nearest fire brigades, and the medical facilities. He must check the inventory in the shelter, check the firefighting and emergency equipment, according to the shelter inventory list, and supply what is lacking; make sure that the shelter can be quickly readied for use, ventilated regularly, and kept clean and orderly; personally check the operating conditions of interior shelter equipment (especially the filter-ventilation equipment) and take measures to quickly correct defects; check the operating condition of the telephone and the radio.

At the "air alert" signal, the shelter manager, along with the shelter team personnel, must report immediately to the shelter. The team personnel go to their posts; the command is given to switch off the heating system and switch on the ventilation equipment, using the purified ventilation mode; the occupants are admitted and assigned spaces in the shelter, and the rules of shelter conduct are observed.

On the signal "close the protective structure," or when the shelter is filled, the doors and shutters are shut, and the shelter is supplied with air by the purified ventilation mode. In addition:

1. the ventilation equipment of the purified ventilation mode must be turned on;
2. the airtight valves and other airtight equipment must be open if they are installed on the air-water clean ventilation system, and there must be absorption filters on the bypass lines;

3. the airtight valves in front of and behind the absorption filter must be closed, and also the valves both before and after the filters that purify the air from carbon monoxide.

On the signals "chemical attack" and "bacterial contamination," the air supply system is immediately connected to the filter-ventilation system. When making the transition to the filter-ventilation mode:

1. the following are shut off! [1] the airtight valves in the airlines of the clean ventilation mode and the valves in the bypass channel of the filter absorbers and [2] the protective and airtight units placed in the emergency exit used as an air intake duct in the purified ventilation mode;
2. the exhaust fans and the inlet air fans of the clean ventilation system are stopped;
3. the sealing and damper equipment on the exhaust ducts is closed (adjusted);
4. the airtight valves in front of the absorption filter and the heat capacity filter are opened;
5. the inlet fans of the filter-ventilation system and the exhaust fans (if their operation has been provided by a given ventilation system) are started;
6. after a nuclear blast, the ventilation system is turned off, all the air-water ducts and openings are shut, and the conditions outside are determined. No longer than 30–40 min after the blast, the ventilation system required in the complex situation is switched on.

If fires occur and if more than 0.02 mg/liter of carbon monoxide is detected in the inlet air, the filter for purifying the air from carbon monoxide and the equipment for renewing the inside air are turned on; then, the ambient air should be supplied only in order to maintain the air pressure head (not less than 1.5 mm H_2O), using a total volume equal to 0.3 of the volume of the shelter [? per hour ?]; the exhaust ducts and openings are completely closed off. After the fire, the heat capacity filter and the filter for freeing the air of carbon monoxide are disconnected.

5.5.3 Order for Occupying and Leaving the Shelter

Admission to the shelter must be orderly. Children and old people are admitted first. People arriving at the shelter with children are arranged in a separate compartment or in a special place set aside for them. Assignments are made according to the instructions of the shelter manager and the team members. The shelter team personnel must carry distinguishing identification, for example, arm bands.

Exit of anyone from the shelter is forbidden without the express permission of the shelter manager. Occupants must obey all orders of the commandant [manager] concerning conduct in the shelter, and the manager must help maintain proper order.

The occupants are obliged to bring a two-day food supply in polyethylene or oilcloth bags, toilet articles, as well as essential personal items, documents, and individual means of protection (gas masks, respirators, etc). It is forbidden to bring easily flammable or strong-smelling materials, unwieldy objects, and domestic animals into the shelter. It is also forbidden to go needlessly to the shelter, to make noise, to smoke, to burn kerosene lamps, candles, and homemade lamps without permission.

In the shelter, conversations, reading aloud, and use of the radio receivers are recommended. These measures are carried out on the instructions of the manager with a group of the shelter team members or occupants. People can leave a shelter on the instructions of the manager (after receiving the signal "all clear" or in the case of an emergency in the shelter which threatens the lives of the people) and do so under the direction of the shelter team personnel.

With damage or collapse of the shelter, the shelter manager (team commander) evaluates the risk of continuing shelter occupancy and, without waiting for assistance from rescue units from outside, arranges for the doors to be opened and the rubble cleared from the entrances and emergency exits, choosing some of the occupants for these tasks.

First the entrance is opened. This is done by releasing all the locks and partially prying the door open with a crowbar and wedges. If these measures are not successful in opening the entrance door, then (in the case of a flat door panel) the door can be removed from the hinges by means of a crowbar or wedge. In a curved door panel (thickness 3–5 mm), with the aid of drills, chisels, and hand saws, an opening is made through which rubble is moved to the inside of the shelter, and it is possible for a few persons to crawl out and remove additional rubble from the entrance Along with the work of opening the door and freeing the entrances of rubble, some of the people are directed to clear away possible rubble from emergency exit tunnels.

After the work of opening entrances or emergency exits has been completed, the shelter manager arranges for determining the degree of radioactive or chemical contamination in the area where the shelter is located and also for establishing marching routes for moving evacuees from the shelter. Depending on the results of the reconnaissance, the manager decides on the advisability of the occupants vacating the shelter.

Evacuation of occupants from the shelter proceeds in the following manner: first a few persons go outside to help those occupants who cannot leave the shelter independently, then old people and children are evacuated, and finally, everybody else.

6. Technological Civil Defense Measures to Increase the Continuous Operation of National Economic Installations [Facilities]

To wreck the enemy's economy has always been the purpose of war. Even in the First World War, adversaries tried to use air power to disrupt the rear of the enemy. But at that time, aviation was not in a position to do this. In the Second World War, the German fascists attempted to disrupt England's economy by bombing large cities with airplanes and rocket strikes. "Thus the German fascist command launched 4320 FAU-2 rockets on England and Belgium. Each rocket carried a few hundred kilograms of conventional explosives. The explosions of the FAU-2 warheads inflicted great damage on London and other cities. In London 2724 people were killed and about 6500 wounded. In Belgium more than 4000 people were killed by the FAU-2. In England more than a million homes were damaged. But Fascist Germany was unable to succeed in its goal of destroying industry and putting England out of the war."* In turn, the allies attempted to undermine Fascist Germany's economy through systematic raids on targets in the rear and achieved considerable success. However, they were not able to disable completely the industry of Fascist Germany.

Through modern nuclear missiles, targets in the rear are damaged much more effectively than in the past. Missiles can destroy targets at any point on the earth's surface, and nuclear weapons make it possible to destroy an entire city with one blast. Under conditions of nuclear missile war, destroying large administrative-political and industrial centers may be one of the high priority goals of the enemy. The combat commanders of imperialistic countries have more than once discussed massive nuclear attack on cities and other targets in the rear of our country.

Our enemies plan to inflict nuclear strikes not only on military targets (rocket bases, troop concentrations, airports, and communication centers), but also on densely populated areas and national economic facilities. Other populated areas not under direct attack may find themselves in a zone of radioactive, chemical, or biological contamination.

Revolution in the Affairs of War, Voenizdat, 1967, pp. 18–20.

The larger the city, the greater its probability of being selected by the enemy as a target of nuclear attack. In conformity with building standards and rules,* all cities can be classified into the following groups:

1. very large cities, with a population of 250,000 to 500,000 people;
2. big cities, with a population of 100,000 to 250,000;
3. average cities, with a population of 50,000 to 100,000;
4. small cities, with a population of less than 50,000 people.

The threat of destruction to large industrial centers and other important targets makes it necessary to execute civil defense measures and to increase the operational stability of national economic facilities in time of war. Technological measures are carried out first in very large and large cities and in important potential targets.

6.1 THE CONCEPT OF ZONES OF POSSIBLE DESTRUCTION IN A NUCLEAR BLAST

To plan technological measures, the CD staff of a city or of a national economic facility must estimate the power of the munitions which the enemy may use on the city or other target. To do this, they must try to

**Building Standards and Rules*, Part II, Sect. R, p. 3. Publishing House on Literature Concerning Building Construction, 1967.

put themselves in the enemy's place. The enemy, in preparing an attack, determines the nuclear power required to destroy a city or any [other] given target by taking into account the importance of the city target as an administrative-political and industrial unit, and its geographical area, as well as the probability of destruction, by calculating the deviation of the nuclear weapons from the target due to scattering.

According to foreign data, to calculate the strikes on cities it is customary to use the magnitude of the blast wave overpressure equal to 0.3 kg/cm^2 [4.3 psi]. Such overpressure causes great damage to dwellings, as well as to industrial buildings.

The area of destruction caused by the nuclear explosion is approximately the shape of a circle. Thus, if the city is built compactly, then its geometrical center is the target point (Fig. 73*a*). The distance to the outskirts is the radius of destruction. For cities that are not built compactly, the force of the nuclear blast is usually selected so that the radius of destruction equals half the distance from the center of the city to its most distant outskirts (Fig. 73*b*).

So the first step in estimating the power of nuclear weapons to be used on a city is to measure the radius from the center of the city to its outskirts. Then, according to the overpressure and the measured radius, one finds the appropriate power of the nuclear weapon in Table 4 (see p. 26).

The CD staff of a city determines the size of the zone of possible complete, high, moderate, and slight destruction. From the center of the city, the perimeters are drawn of the zones of destruction, assuming maximum deviation of the missile and a given power of the nuclear explosion; these [factors] will delimit the zones of possible destruction which must be taken into account when planning civil defense measures (Fig. 74).

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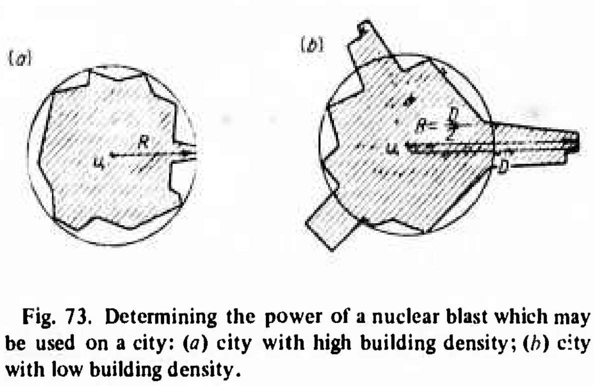

Fig. 73. Determining the power of a nuclear blast which may be used on a city: (*a*) city with high building density; (*b*) city with low building density.

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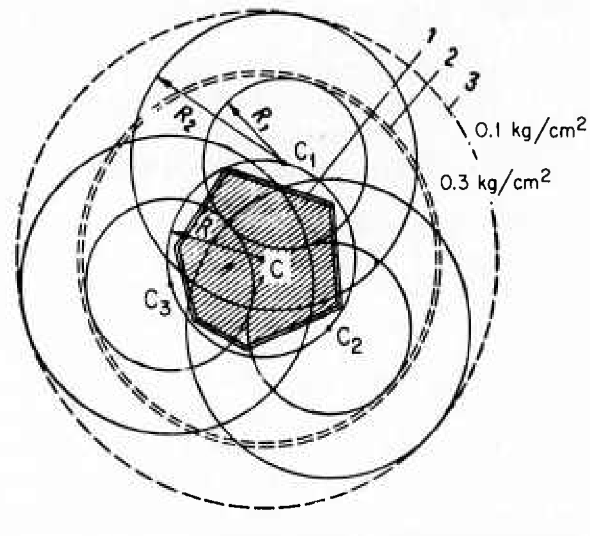

Fig. 74. Sketch for determining the boundaries of the zone of possible destruction of a city from a nuclear blast: C = geometric center of the city and target point; R = radius of the rocket scattering circle [a rocket can land anywhere within this area]; R_1 = radius of destruction of a single nuclear explosion with 0.3 kg/cm^2 [4.3 psi] overpressure with maximum deviation of the rocket; R_2 = radius of destruction from a single nuclear blast with 0.1 kg/cm^2 [1.4 psi] overpressure with maximum deviation of the rocket; C_1, C_2, C_3 = possible centers of nuclear explosions; 1 = boundary of urban buildings; 2 = boundary of possible heavy destruction from 0.3 kg/cm^2 overpressure; 3 = boundary of possible slight destruction from 0.1 kg/cm^2 overpressure.

Since we do not know which cities and industrial sites will be the target of nuclear attack, it is necessary to take CD measures in all cities, all population centers, and every national economic center. To ensure the stable operation of industry under conditions of nuclear war, a large complex of organizational and technological measures are taken. These measures are taken on a republic-wide scale, as well as in cities and national economic establishments.

Measures may be taken nationally to limit the concentration of industry in certain regions. A rational and dispersed location of industries in the territories of our country is of great national economic importance, primarily from the standpoint of an accelerated economic development, but also from the standpoint of organizing protection from weapons of mass destruction. A uniformly dispersed distribution of plants may be accomplished gradually by developing industry in underdeveloped regions and limiting the construction of new plants in highly industrialized regions. The enormous territory of our country and its very rich natural resources may facilitate the solution of industrial defense problems by means of maximum dispersion.

6.2 URBAN PLANNING AND BUILDING OF CITIES AND INDUSTRIAL REGIONS WITH CONSIDERATION OF NATIONAL DEFENSE REQUIREMENTS

Urban planning and preparation with civil defense in mind greatly enhances the prospects of decreasing the damage to populated areas and providing the opportunity for rescue and urgent emergency-restoration work.

The general plans for urban construction, reconstruction of residential and industrial districts, and projects for building plants and other buildings are determined in conjunction with the appropriate CD staffs. Urban planning with an eye to civil defense needs, that is, limiting possible damage to property and human life which could result from enemy attack, is entirely compatible with peacetime needs. Civil defense requirements are taken into account in building new areas of the city and reconstructing old ones.

The civil defense measures carried out in planning new regions of cities include the following:

1. reducing the building density of urban regions and creating satellite cities;
2. constructing wide major thoroughfares;
3. creating greenbelts and strips;
4. constructing artificial reservoirs;
5. developing suburban zones;
6. building a network of highways around the city.

6.2.1 Reducing the Building Density of Urban Areas and Creating Satellite Cities

The building density is the ratio of the base area [covered with] buildings and structures to the [total] area of a given region or a small section of a region. Usually, the building density is expressed in percentages. For example, if the building density is 50%, then the buildings and structures occupy one-half of the area, and the remainder is occupied by streets, plazas, thoroughfares, etc. Damage from a nuclear weapon is much greater with a high than with a low building density in a city. Further, a high building density increases the likelihood of fires and continuous rubble which hampers rescue work in the centers of destruction.

To a considerable degree, the aftereffects of a nuclear blast depend on how population centers are planned. Population centers which have many buildings close together may suffer destruction over a large area (Fig. 75*a*). Population centers with an elongated shape (Fig. 75*b*), including satellite cities (Fig. 75*c*) located at a

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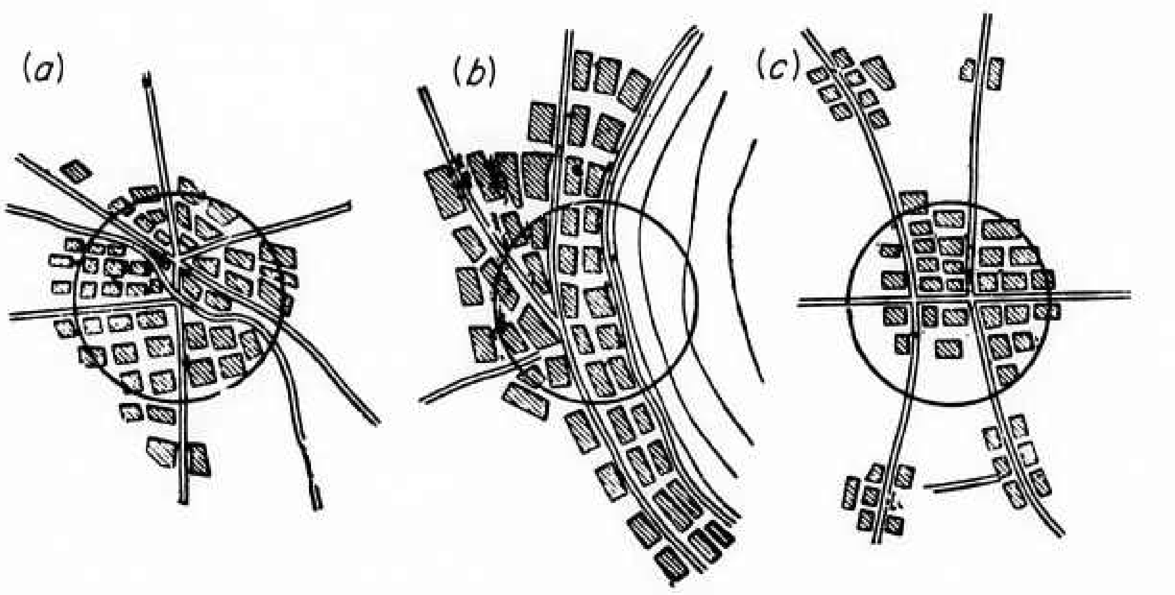

Fig. 75. Zone of destruction from a nuclear blast as a function of the type of urban development: (*a*) compact development; (*b*) city extending along the banks of a river; (*c*) plan of a city with satellites.

certain distance from the center, are destroyed only in territory in the blast area.

A change in the shape of very large cities and a reduction in population density are brought about by urban and regional planning and are also taken into account in reconstructing large cities. Reducing the population density of large cities is also possible through construction of satellite cities. In large cities, where resettlement in satellite cities is impossible or inexpedient, measures may be taken to limit growth and prohibit the building of [new] industrial plants.

Planning population centers is very important with regard to fire safety. Thus, when drawing up plans for new population centers and when reconstructing existing ones, provision is made for the construction of water reservoirs, wide streets, and sufficient space between buildings so that fires will not spread from one building to the other. Wide streets, space between buildings, the amount of open country, and a sufficient number of exits from the small sections of a region should assure escape from the threatened place and freedom of action for firefighters, rescue workers, and other CD service personnel. It is especially important to divide (break down) the total developed area of the city into self-contained regions, microregions, and sectors. Such a breakdown reduces fire propagation and facilitates more effective rescue work, as do wide major thoroughfares, green strips, and water reservoirs.

6.2.2 Constructing Wide Major Thoroughfares

If nuclear weapons are used on a city, then buildings and other structures are destroyed, and where there are narrow streets continuous rubble is formed which hampers CD operations and evacuation of victims. Therefore, it is very important to construct major thoroughfares in a city. Such wide streets would not be clogged if buildings were destroyed and would lead from the center of the city into the outlying zone. The width of major thoroughfares is determined according to the formula:

$$W = \frac{H_1 + H_2}{2} + 15 \text{ m},$$

where

W = width of the major thoroughfare,

H_1 = height of buildings on one side,

H_2 = height of the buildings on the other side.

Sufficiently wide major thoroughfares ensure free movement of transportation, increase ease of movement, and provide a necessary condition for the functioning of a large city. In addition, they constitute one of the requirements of civil defense. The existence of these thoroughfares creates a natural fire lane and at the same time a convenient path for moving rescue formations. With partial reconstruction of the city, such thoroughfares are possible. To answer these needs, the major thoroughfares are made wide, up to 100 m, since only a wide major thoroughfare can help to limit fire spread. As a rule, a wide major thoroughfare is not completely obstructed with rubble; thus, for example, a street with a width of 100 m [*sic*] is not likely to be obstructed with rubble even when the highest buildings (up to 30 stories) are destroyed.

Major branch roads are constructed in such a way that they provide exit from the central city into the outer zones and enable all areas of the city to be connected by means of transportation leading out of the city: trains, ships, and planes.

6.2.3 Creating Green Areas [Greenbelts] and Strips

Greenbelts enhance the sanitary and hygienic conditions in the city; at the same time they serve to limit firespread if nuclear and incendiary weapons should be used by the enemy. Thus, when the construction of a city is in the planning stage, landscaping is designed in such a way as to create fire breaks and divide the city into microregions and independent sectors. To achieve these goals, parks, plazas, gardens, and groves are connected with greenbelts in a comprehensive planting scheme which creates a unique barrier against fire propagation. The development of parks and greenbelts is done gradually in conjunction with the overall urban construction and development plan, which in turn is in keeping with municipal CD fire fighting services.

6.2.4 Construction of Artificial Water Reservoirs

The construction of water reservoirs in combination with plantings is an important fire fighting measure. In each population center it is necessary to provide a sufficient water supply by means of natural and artificial water reservoirs. Such water is needed primarily for putting out fires, but also for decontaminating the area and the people.

In large cities there is a municipal water-distribution system. However, in the event of a nuclear strike, its survival and use for extinguishing fires cannot be assumed. Thus, artificial water reservoirs must be built in cities where there are no natural ones; these have recreational value and can also be used for extinguishing fires. First, the necessary amount of water for putting out mass fires must be determined. Then, sufficiently large water reservoirs can be gradually constructed.

6.2.5 Development of the Outer Zone

The outer zone is used for large-scale recreation of the population and for locating medical and sports institutions. In addition, the outer zone is the location for settling the dispersed workers and employees of plants and the evacuated population. Thus, the outer zone must be prepared in advance. The main objectives in preparing the outer zone are to guarantee placement of the evacuated population, plant workers, and employees and to set up the necessary living conditions for these people. In the outer zone, it is also necessary to ensure protection of the population from radioactive contamination.

In connection with planning the mass evacuation of the population and dispersal of workers and employees under threat of attack, it is necessary to provide for the construction of traveler's rest stations in the outlying areas, as well as boarding houses and primitive camps; it is also necessary to develop a road network and to secure a water supply, electrical supply, and communications. These goals coincide conveniently with developing rest areas for the population and with providing satisfactory living conditions in regions adjacent to the city. To ensure evacuation of the population to shelters in event of enemy attack, it is necessary to take into account all the available underground and semiunderground structures (basements, cellars, and other structures) in order to utilize them for protection against fallout.

To assure the supply of the material needs of the evacuated population and dispersed workers and employees in the outer zones, buildings are constructed for use by the local population in peacetime as warehouses, eating places, and gathering places. These establishments must have water, electrical energy, and access routes.

6.2.6 Building a Road Network Around the City

A branched network of roads around the city is of great importance for the national economy. It ensures

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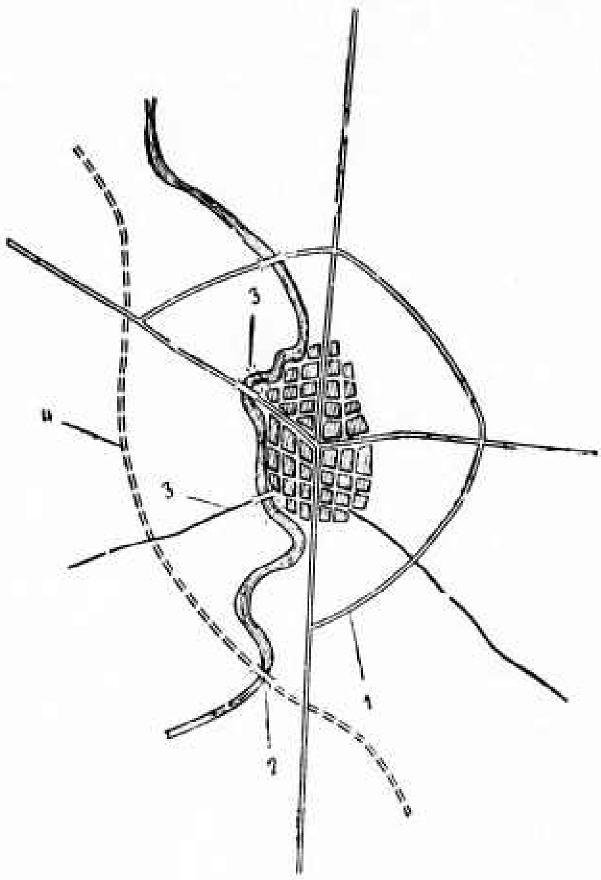

Fig. 76. Construction of a road network around a city with consideration of civil defense requirements: (1) connection of roads passing through the city; (2) construction of bridges for safe evacuation of survivors; (3) preparation of crossings other than bridges in the city; (4) projected intercity highways to bypass large cities.

rapid movement of convoys through the city and good communications between individual regions of the city, the outer zone, and neighboring cities. Such a network creates advantageous conditions for evacuating the wounded from the city in a short period of time and also for rapidly conveying CD teams to perform rescue work, should the city be destroyed by nuclear weapons.

When planning new roads, an intercity highway should be constructed for bypassing large cities (Fig. 76). The highways passing through the city connect the roads within the city limits. New bridges are built far enough apart that they cannot be destroyed by one explosion.

6.3 EVALUATING THE OPERATIONAL STABILITY OF NATIONAL ECONOMIC FACILITIES IN RESPONSE TO A NUCLEAR BLAST

6.3.1 Methods for Evaluating the Stability of Industrial Facilities

The [operational] stability of facilities under nuclear attack is determined mainly by the ability of the basic components of the facilities to resist the damaging effects of a nuclear blast. For industrial plants, such components are various buildings and structures. Moreover, as a rule the vital activity of a facility will be completely disrupted by the destruction or demolition of the majority of the ordinary buildings by fire, even though individual stable buildings may survive.

The survivability of a facility is determined by the capacity of its buildings and structures to withstand the destructive forces of a nuclear blast. To evaluate the survivability of a facility means to determine the characteristics and strength of the damaging forces which the facility, that is, its buildings and structures, would survive. The purpose of evaluating the survivability of a facility is to assess the vulnerability of its components in order to strengthen them through technological means and, in so doing, increase the stability of the installation as a whole.

In addition to the concept "survivability of a facility," there is also the concept of "operational stability," that is, the facility's capability to withstand the damaging forces of a nuclear blast and to maintain production, as planned. Operational stability is a broader concept; assessing it includes calculating the possibility of continuing work by workers and employees, as well as the possibility of operating the facility in the event of [a partial] breakdown through cooperation with other plants and suppliers of raw materials. To evaluate the operational stability of a facility means to conduct a general study of the plant from the standpoint of its ability to withstand the damaging effects of a nuclear blast and to maintain production at the planned level.

National economic facilities differ markedly from one another with regard to their structural specifications and also their technical principles. Thus, since each facility has its own special characteristics, its evaluation requires in each case a specific approach to solving the problem. Various aspects are included: buildings and structures, equipment, technological processes, central electrical networks, and the area in which the facility is located. In any given case it is possible to evaluate only roughly the survivability of facilities against the destructive forces of a nuclear blast or the secondary destructive impacts.

An evaluation of survivability begins with determining the location of the facility relative to that of the anticipated nuclear blast. The facility may be located in a city, beyond the boundary of its planned construction, or at some distance from a large city which may serve as a target for an enemy nuclear attack. When a facility is located in a city or on its outskirts, the distance of the site from the geometrical center of the city is determined, as is the anticipated magnitude of the shock wave overpressure; the prevailing direction of the wind in a given locality is also studied (the dew point is determined [see note *]). If the facility is located at a considerable distance from a large city, then it is considered as a potential target of a nuclear attack. The requisites for becoming such a target are the size and importance of the facility. In addition, the possibility of the facility's becoming radioactively contaminated if a nuclear attack strikes the city is examined.

After the general condition of the facility is determined, it is necessary to make a detailed evaluation of the survivability of all components. The design of all buildings and structures is examined and then statistically evaluated. The equipment in each building is studied, and its survivability is determined. The number of protective buildings, their capacity, their protective characteristics, and the percentage of workers and employees on shifts who can be sheltered is [also] determined. All underground structures which may be used as shelters are taken into account. The central power system of the facility is studied, and the survivability of power lines and structures is evaluated. The survivability of stores of raw material, finished production, and other materials, as well as of liquid fuel tanks, is determined. Survivability from the standpoint of potential damage from a nuclear blast is evaluated by a commission composed of the chief specialists of the national economic facility.

6.3.2 Evaluating the Survivability of a Facility Under the Influence of a Shock Wave

To evaluate the survivability of a facility means to determine the shock wave overpressures which the site can withstand and also those after which it can still operate. The criterion for determining the survivability of national economic facilities subject to the effects of a nuclear blast wave is the magnitude of the overpressure at which the buildings or structures of the site

[*Possibly for its importance to ignition of fires by the thermal pulse.]

survive or sustain only slight damage. When evaluating the survivability of a facility, it is necessary to identify the most vulnerable parts and units – those on which all productive activity depends.

The practical work in evaluating the survivability of a national economic facility should be carried out in the following order:

1. determine the composition of the basic structures of the facility;
2. study each facility and its individual components with regard to construction, as well as to material specifications used in erecting the protective structure;
3. study the network of the municipal electrical and utility systems and protective installations;
4. determine the overpressures (according to manuals or by means of calculations) at which the buildings, structures, and individual components may sustain complete, heavy, moderate, or slight damage;
5. determine the character of possible damage to the equipment inside the protective structure if the structure should collapse.

The characteristics of the buildings and structures and the magnitude of the overpressure causing slight damage are listed in Table 22. It is evident from Table 22 that three plant buildings might sustain slight damage at an overpressure of 0.2 kg/cm^2 [2.8 psi] and two at 0.1 kg/cm^2 [1.4 psi]. In our example, the machine finishing and assembly shop buildings can be damaged most easily. The same method is used to evaluate other structures of the facility as well as the plant equipment.

After the individual structures are evaluated, the facility is evaluated as a whole. Moreover, overall survivability is determined by the building or structure which is destroyed at the lowest overpressures. In our example, the survivability of the facility is retained at a blast overpressure of less than 0.1 kg/cm^2 [1.4 psi], since at a pressure higher than 0.1 kg/cm^2, it is not possible for the facility to operate with two of its plants incapacitated. After evaluating the survivability of the facility, the measures necessary to increase its operational stability under the influence of a nuclear blast wave are considered, and to this end the range of desirable measures for increasing the survivability of the site are expeditiously determined.

6.3.3 Evaluating the Survivability of a Facility with Regard to Thermal Radiation

The survivability of a facility with regard to thermal radiation is evaluated in accordance with the possible occurrence of fires and disruption of the facility's operation. The criterion for the survivability of a facility under thermal radiation is the thermal pulse at which a building or structure is ignited and fire breaks out. To estimate the survivability of a facility with respect to the effects of thermal radiation means to determine at what level of thermal radiation fires will occur directly due to the thermal pulse or indirectly from secondary causes.

An evaluation of survivability includes a consideration of the quality of the structural materials and also of the characteristics of the buildings and structures and special features which may lead to the occurrence of fires when destruction is caused by the blast wave. Whether fires develop depends primarily on the structural materials used in the construction of the buildings and structures of the facility. All structural materials are divided into three groups according to flammability: nonflammable, fire-retardant, and flammable.

Nonflammable materials are those which do not burn in the presence of a flame or high temperature. These include all natural and synthetic inorganic materials, as well as metals used in construction.

Table 22

Name of building and structure	Characteristic of building and structure	Magnitude of overpressure at which slight damage may occur (kg/cm^2) [psi]
Foundry	Modular, reinforced concrete, single-story, height 12 m	0.2 [2.8]
Blacksmith	Modular, reinforced concrete, single-story, height 15 m	0.2 [2.8]
Machine shop	Modular, reinforced concrete, height 10 m	0.2 [2.8]
Machine finishing shop	Solid brick, one-story, height 10 m	0.1 [1.4]
Assembly plant	Solid brick, single-story, height 10 m	0.1 [1.4]

Fire-retardant materials are those which are difficult to set afire even in the presence of a flame or high temperatures: they smoulder or smoke when a flame is actually present, but when the flame is gone, the burning or smouldering stops. Fire-retardant materials include those consisting of nonflammable and flammable components; for example, asphalt-concrete mixtures, gypsum, and concrete components with organic fillers; clay-straw materials with volumetric weight of not less than 900 kg/cm^2 [obviously a Russian typo]; cement fibrolite; wood, subjected to deep impregnation with antipyrene; felt soaked in clay solution, etc.

Flammable materials are those which burst into flame or smoulder in the presence of flames or high temperatures and continue to burn or smoulder after the fire source is removed. These materials include all organic materials not subjected to deep impregnation with antipyrene.

Buildings filled with combustible materials are the most dangerous, but even buildings filled with nonflammable materials can endure the effect of fire or high temperatures only for a limited time. The fire-resistance limit of a structure is determined by the time (in hours) during which penetrating cracks do not form; the construction does not lose its load-bearing capacity, or collapse; nor is it heated on the opposite [inner] side to a temperature on the order of 200°C [392°F].

Buildings and structures are divided into five groups (I, II, III, IV, and V) according to the degree of flammability and depending on the fire resistance of parts of the buildings and structures. The classification of buildings and structures according to fire resistance is listed in Table 23. It is clear from Table 23 that the fire-resistant buildings or structures are brick (concrete) buildings of first- and second-degree fire resistance in which all parts consist completely of nonflammable materials. Buildings of the fourth and fifth degree are the most dangerous in terms of fire resistance.

The occurrence of fires also depends on the technological process and the character of production. Therefore, facilities are evaluated for fire hazard in accordance with the character of production. Moreover, fires may result from thermal radiation and the destruction of production buildings by the blast wave. Depending on their vulnerability to fire, all installations are divided into five categories: A, B, C, D, and E.

Plant category A includes oil refineries, chemical plants, viscose and xanthane plants manufacturing artificial fibers, benzene extraction plants, hydrogenation plants, distillation and cracking plants of artificial liquid fuels, gasoline storage tanks, plants for reprocessing and using metallic sodium, potassium, etc.

Plant category B includes plants for processing and transporting coal dust and sawdust, washing stations where tanks and other vessels are decontaminated from oil and other liquids with a vapor flash point of 28 to 120°C, stamping and grinding departments of pulverizing mills, synthetic rubber reprocessing plants, sugar refineries, and photographic film warehouses.

Plant category C includes sawmills; wood processing, carpentry, pattern, and forest products plants; open oil warehouses and oil industry power plants; and the overwhelming majority of textile manufacturing plants.

Plant category D includes the metallurgical industry, molten metal reprocessing plants, thermal, and other plants, as well as boiler plants.

Plant category E includes metal and other plants connected with storing and reprocessing nonflammable materials.

Plants A and B seem to be the most vulnerable to fire. The reality of the fire threat in industrial buildings of categories C, D, and E depends on the degree of the buildings' fire resistance. An evaluation of the probability of fires in the sites and adjacent areas is possible from the data of Table 24, in which fires are classified

Table 23. Degree of flammability and minimum limits of fire resistance of buildings and structures in hours

Parts of buildings and structures	Limits (hr) and degree of fire resistance: I (fireproof)	II (fireproof)	III	IV	V
Supporting and self-supporting walls, walls of a stairwell	3	2.5	2 (fireproof)	0.5 (fire-retardant)	(flammable)
Filling between walls	1	0.25	0.25 (fireproof)	0.25 (fire-retardant)	(flammable)
Intrastory floor (ceiling)	1.5	1	0.75 (fire-retardant)	0.25 (fire-retardant)	(flammable)
Combined floors (ceilings)	1	0.25	(flammable)	(flammable)	(flammable)
Partitions (nonsupporting)	1	0.25	0.25 (fire-retardant)	0.25 (fire-retardant)	(flammable)
Fire walls (fireproof walls)	4	4	4 (fireproof)	4 (fireproof)	4 (fireproof)

Table 24

Degree of fire resistance of building and structure	Magnitude of overpressure (kg/cm^2)	Character of buildup	Fire conditions after nuclear blast (after 30 min)	Fire conditions 1–2 hr after nuclear blast (region hazardous due to rapid fire propagation)	Potential fire storm zone
IV–V	0.1–0.2	Urban building density. Industrial buildings of C, D, and E categories according to fire hazard.	Individual fire zones	Conflagrations with building density 10% and higher	Building density 20%
	0.2 and more		Burning and smouldering in rubble		
III	0.1–0.2 0.2–0.5	Same	Individual fire zones Zone of continuous fires	Conflagrations with building density 20% and more (rapid fire propagation). Most dangerous regions [are] with building density 30% or more.	Single and multistory structures with building density of 30% or more, three to five-story buildings with density 20% or more.
I–II	0.1–0.2	Same	Individual fire zones	Dangerous regions with regard to rapid fire propagation with a building density of 30% or more.	With ordinary building density, potential fire storm zone.
	0.2–0.5	Same	Conflagration zones	Same	
	0.1–0.5	Industrial buildings of categories A and B according to fire hazard.	Conflagration zones (conflagration). Rapid propagation of fires, explosions of industrial apparatus and vessels are possible.		

and their special propagation properties listed as a function of the building.

It is evident from Table 24 that for plants of categories C, D, and E the possibility of individual fires and conflagrations depends basically on the fire resistance of the building, but for plants of categories A and B it must be remembered that conflagrations can occur at distances from the epicenter [ground zero] of the blast where the overpressure in the wave front is 0.1 kg/cm^2 [1.4 psi] or more.

Mass fires can occur in buildings and structures which are not completely destroyed, that is, with overpressures in the blast wave front up to 0.5 kg/cm^2 [7.1 psi] for buildings of fire resistance I–III (with stone walls) and 0.2 kg/cm^2 [2.8 psi] for buildings of resistance IV–V (with wooden walls) [see Table 23]. Thus, mass fires can occur at distances from the epicenter of the burst if overpressures of the blast wave are 0.1 to 0.5 kg/cm^2 [1.4 to 7.1 psi].

Data concerning vulnerability to thermal radiation are given in Table 25. Thus, in evaluating the vulnerability of a facility to the effects of thermal radiation, all buildings, structures, and industrial installations on the plant grounds are carefully studied, and the location of potential fire hazards, as well as the residual effects due to the fire, are determined with consideration of the character of the industry. After evaluating the fire resistance of the buildings and structures and studying the character of the technological process, conclusions are reached concerning the overall vulnerability of the facility with regard to thermal radiation. On the basis of the evaluation, measures are undertaken to increase the fire resistance of the facility.

6.3.4 Evaluating the Operational Stability of a Facility in the Presence of Initial Nuclear Radiation and Radioactive Contamination

Initial nuclear radiation and radioactive contamination [fallout radiation] are harmful to people, but do not affect buildings and structures. The only exceptions are chemicals and materials which change properties under the influence of radiation. Thus, for example, the optical glass of instruments turns dark under the influence of radiation, and photographic material in lightproof packages is exposed. In addition, initial nuclear radiation causes a change in the electrical characteristics of electrical instruments and can lead to

Table 25

Name of building or structure	Characteristics or building or structure [with respect to combustibility]	Degree of fire resistance	Production category according to fire-explosion hazard	Thermal pulse causing combustion of materials (cal/cm)
Foundry	No combustible materials			
Blacksmith	Same	I	D	
Machine shop	Same	I	D	
Grinding shop	Wooden doors and window frames painted in dark colors	I	D	
Assembly shop	Same	II	E	30
		II	E	30

deterioration or failure of electronic instruments. Semiconductor, gas-discharge, and vacuum equipment is especially subject to the effect of initial nuclear radiation, as are capacitors and resistors. When evaluating [operational] stability under conditions of initial nuclear radiation, the presence of materials, instruments, and apparatus sensitive to this radiation must be determined.

The operation of a facility depends primarily on the condition of the people working there. When the workers and employees are injured by radiation, plants cannot operate. Thus, the radiation dose which workers and plants can receive in the active radiation zone can be used as a criterion of the operational stability of a facility. In addition, the degree of radiation shielding from buildings and other structures is taken into account.

Evaluating the operational stability of a facility in the presence of initial nuclear radiation includes determining the shielding coefficients (the dose attenuation factors) for blast shelters and fallout shelters and for buildings and other structures in which people work. The shielding coefficient can be determined according to the formula on p. 32.*

Determining the operational stability of a facility in the presence of fallout also includes determining the shielding coefficient of the buildings and shelters of the plant. When evaluating the operational stability of a facility in the presence of fallout, the possibility for making the production premises airtight against radioactive dust should also be examined. The shielding coefficients for various buildings and structures are listed in Table 26. Data on the stability of a facility in the presence of radioactive contamination [fallout] are listed in Table 27. To evaluate stability in the presence of fallout, operating procedures of the facility are examined under various conditions of radioactive contamination.

Table 26

Types of buildings and structures	Shielding coefficient (attenuation factor)
Wooden home	3
One-story stone home	10
Three-story stone home	20
Five-story stone home	27
Covered trench	40
Basements of one-story homes	40
Basements of two-story homes	100
Basements of multistory homes	400
Fallout shelters	500
Blast shelters	1000

Table 27

Name of building or structure	Characteristics of building and structure	Shielding coefficient (attenuation factor)
Foundry	Walls of reinforced concrete with a thickness of 65 cm, ceiling 20 cm	10
Blacksmith	Same	10
Machine shop	Same	10
Grinding shop	Brick walls with a thickness of 60 cm, ceiling 10 cm	7
Assembly plant	Same	7

*$d_{semi} = 23/\rho$.

6.3.5 Evaluating the Operational Stability of a Facility to the Effects of Secondary Damaging Factors

Secondary damaging factors include accidents, fires, explosions, and contaminated atmosphere and terrain, as well as the collapse of damaged structures. In a number of cases, the scale of the damage from secondary factors can exceed that from the direct effects of the nuclear explosion. Secondary damage can result from the destruction caused by a nuclear explosion in a given facility itself or in neighboring facilities subjected to the direct effect of the nuclear blast in an area.

When assessing vulnerability to secondary damage resulting from a nuclear blast, all possible sources of such damage should be determined. First, all such sources in the same plant are identified. These may be tanks and vessels with slightly flammable liquids and gases; storehouses with explosive substances; potentially explosive technological and communications installations (the destruction of which causes fires, explosions, or gas release); easily flammable buildings and structures. External sources of secondary damage may be chemical and petroleum plants, petroleum and gas distributors, refrigeration stations, water pumping stations, petroleum-product and other liquid-fuel tanks, gas stations, and other sites located too close to one another. While all possible sources of secondary damage are being identified, consideration should also be given to the specific nature of such damage at any given facility, as well as to its extent and likely duration. The relevant parameters of secondary damaging factors may be seen in Table 28.

6.3.6 Evaluating the Operational Stability of a Facility in the Presence of Chemical and Biological Weapons

Chemical and biological contamination affects personnel. The continuing operation of the facility depends on the availability of individual means of defense and the character of the contamination. In evaluating the operational stability of a facility, the possibility of sealing airtight the plant buildings and structures in which people work and the possibility of working while wearing individual means of defense are determined. In addition, the shielding characteristics of the available shelters, where workers and employees are protected against chemical and biological weapons in the event of enemy attack, are determined. The possibility of decontaminating the grounds, buildings, and structures of the facility and of giving health care to the people, if necessary, is determined.

6.4 TECHNICAL ENGINEERING MEASURES FOR NATIONAL ECONOMIC FACILITIES

One of the basic problems of civil defense is increasing the operational stability of national economic facilities in wartime. To accomplish this, a large number of measures are taken in advance at these facilities to increase their operational stability under conditions of nuclear war. These include technical engineering, technological, and organizational measures.

Technical engineering measures are intended to increase the survivability of industrial buildings, structures, equipment, and communication systems if nuclear weapons are used. Technological measures are

Table 28

Type of damage source	Characteristics of damage source	Character of damage and radius of action	Distance to damage source (km)	Duration effect (hr)
		Inside		
Tanks for fuels and lubricants	Half-underground reinforced-concrete tanks for 50 tons of gasoline	Fire and explosion to a radius of 0.8 km	Up to the grinding shop, 0.7	2–3
		Outside		
Hydro plant	Water storage reservoir	Flooding caused by destroyed dam for up to 50 km	10	Up to 24

intended to increase the operational stability of a facility by changing the technological process, thereby excluding the possible occurrence of secondary damage resulting from the direct damage of a nuclear explosion. Organizational measures are intended to delineate and plan in advance the activities of staff personnel, employees, and CD trainees if the enemy uses weapons of mass destruction. Of the complex of measures to increase the operational stability of national economic facilities in wartime, the most important are technical engineering measures.

The importance of implementing these measures is seen in the following example. In the event of a nuclear explosion with a power of 1 megaton, the overpressure of the shock wave reaches 0.1 kg/cm^2 [1.4 psi] at a radius of 11.2 km;* 0.2 kg/cm^2 [2.8 psi] at a radius of 7 km. Consequently, if the survivability of a national economic facility is increased by only 0.1 kg/cm^2 (from 0.1 to 0.2 kg/cm^2), then the radius of destruction of the blast wave decreases from 11.2 to 7 km, that is, by 4.2 km (see Table 4).

Technical engineering measures are most effective and economical when planning and building new national economic facilities, municipal power plants, buildings, and structures. Thus, new national economic facilities must be planned and built with consideration of the civil defense needs. Planning must mainly provide for dispersion of the structures on the grounds of the installation, since this is important in preventing fires, secondary damage, and rubble. It is especially important to isolate potentially explosive plants, laboratories, and structures. In planning and construction, provision should be made for the safety of workers and employees: also, the distribution systems and structures of the facility's central electric power plant should be installed underground. For currently productive national economic installations, the technical engineering measures are executed during reconstruction and in the process of modernizing production.

The quantity and the character of the technical engineering measures depend on the importance of the installation, its location, the building density, and the size of the facility, as well as the number of workers. To determine the extent of technical engineering measures needed to increase the operational stability of any given industrial installation or power plant, it is necessary to correctly evaluate its stability if weapons of mass destruction are used. National economic facilities vary widely according to designation, type of industrial process, and layout. Thus, it is impossible to prescribe one set of technical engineering measures suitable for all facilities.

For each national economic installation, the technical engineering measures are based on specific conditions. However, some of the technical engineering measures are general and can be applied to each installation. Such measures include:

1. safeguarding workers and employees from weapons of mass destruction;
2. increasing the administrative survivability of the civil defense [capabilities] of the facility;
3. increasing the survivability of buildings and structures;
4. protecting costly and unique equipment;
5. increasing the survivability of the electrical power supply and also the gas, steam, and water supply;
6. increasing the survivability of utility networks [systems];
7. preventing fires;
8. placing the individual components of production in underground structures;
9. ensuring protection from radioactive, chemical, and biological contamination;
10. increasing the survivability of the supply of technical materials.

6.4.1 Safeguarding Workers and Employees from Weapons of Mass Destruction

Reliable protection of workers and employees from weapons of mass destruction is an important factor in increasing the operational stability of any facility of the national economy, since production is unthinkable without people. Protection of workers and employees of the plant is achieved by dispersing them in outlying zones during their off-duty time and by providing blast shelters for them if the enemy should attack during work hours. To protect workers and employees of industrial installations which will continue their productive activities in time of war, the blast shelters and fallout shelters (which may be located on the site of the installations themselves as well as on adjacent sites) must be prepared in advance.

*These Russian range-overpressure statements very likely involve near-surface bursts; corresponding U.S. figures (see *The Effects of Nuclear Weapons, 1962*) show that a 1-megaton surface burst results in a 1.4 psi overpressure at a range of 9.5 km from ground zero, whereas a 1-megaton weapon detonated at optimum burst height results in a 1.4 psi overpressure 16 miles from ground zero. The Russian figures indicate a burst height of about 2500 feet, low enough to produce some fallout.

The following may be used as blast shelters and fallout shelters: specially constructed protective blast shelters, equipped basements, modified belowground and semi-belowground industrial structures which are not too isolated, and also, wherever possible, mines which contain very little gas and only small amounts of mine water. When equipping a mine or a mine shaft as a shelter, provision is made for the construction of airtight safety partitions and emergency exits; a supply of air, water, and food for occupants; equipment in the control center; a communications and warning system; a medical center; and sanitary facilities, as well as an emergency power supply.

Protective structures are located in residential neighborhoods so that they may be occupied quickly when an "air raid" signal is given. Thus, the entrance into the blast shelter or fallout shelter must be located not more than 200 to 400 meters from the homes of potential occupants. A shelter is equipped with an independent electric power source. Such a power source may be a diesel unit located in one of the shelters and designated to supply electrical power to other nearby shelters. Storage batteries may be used to assure emergency lighting.

Individual protective structures are erected to protect personnel servicing the operational equipment which must continue to function even during the "air raid" signal, due to the special features of a production process. In addition, it is also necessary to construct fallout shelters approximating the protective properties of the blast shelters. Fallout shelters are constructed to protect the shift which is in the outer zone when the threat of an attack arises. The construction of fallout shelters is planned in peacetime. The designs are drawn in advance, utilizing local building materials that are taken into account. The blueprint indicates the amount of labor required, the materials needed and sources for obtaining them, the necessary transportation facilities, machines, and tools.

Some of the fallout shelters in places where the off-duty shift of workers and employees is located can be constructed in peacetime. These fallout shelters can be used in peacetime as storehouses for the [required] interior equipment of all the other shelters that are planned for construction during a threat of enemy attack.

6.4.2 Increasing the Administrative Survivability of the Civil Defense [Capabilities] of a Facility

Administration is the basic activity of the CD chief and CD staff of the facility and includes supervisory personnel and employees of the CD brigades [formations] in all stages of civil defense performance. To increase the administrative wartime survivability of civil defense at an installation, it is necessary to devise a CD administrative system, organize a communications and warning system, and formulate the system as a component part of the general CD plan. Administrative organization must be provided during threat of attack, during evacuation and dispersal, and under actual enemy attack.

In important national economic facilities which would continue productive activity in wartime when there is a threat of attack, two administrative groups are created: one in the plant itself and the other in the outer zone in the area where workers and employees are to be dispersed. The plant is administrated by the director and by the director's assistant (when the director is in the outer zone). After the threat of attack has been announced, one administrative group remains on the grounds with workers and employees of the working shift, the other goes to the dispersion area. Thus, there is a director or assistant with each shift.

Two command posts must be prepared for these two administrative groups: one on the grounds of the installation, the other in the outer zone in which the off-duty shift is located. A protected command post is constructed to ensure continuous CD administration. The on-site command post is a specially equipped protective structure provided with the necessary communication and administrative facilities. In it is located the combat organization of the command post, which includes:

1. command group (CD chief, his deputies, and the chief of staff);
2. operational-reconnaissance section (chief of the operational-reconnaissance section, assistant chief, and telephone operator);
3. chief of service;
4. communications group (chief of communications unit, telephone operator, and radio operator);
5. maintenance group (commandant of the command post, electricians on duty, sanitary engineers, and other workers).

The command post must ensure:

1. reliable protection from weapons of mass destruction;
2. scheduling of the combat organization of the command post for around-the-clock work over an extended period of time;

3. disposition of food supplies, water, medical supplies, and protective means for the combat organization of the command post.

To fulfill these requirements the facility's command post has:

1. a command room;
2. an operations room for location of the reconnaissance operations section and the telephone operator;
3. a room for the service chief;
4. a lounge;
5. a communications terminal where the communications group is located;
6. sanitary facilities;
7. warehouses and chambers for the units.

The command post may be located in a basement of a detached belowground structure specially constructed for this purpose. It ensures continuous radio communications and is equipped with an antenna for radio operation. The command post operates by transmitting verbal orders (instructions) over wire and radio or using signal and portable communication facilities.

The administrative survivability of a command post depends on uninterrupted communications. Thus, as a rule, the communications unit is located in the command post itself or, in exceptional cases, in a detached protective structure nearby. To increase the survivability of communications, the cables are laid in protective trenches designed for great resistance to dynamic loads in the ground. To disconnect the communications lines at the onset of overvoltage, created by electromagnetic fields from a nuclear explosion, automatic cutoff equipment is provided.

Radio communications are used for the installation when [other] communication lines are put out of commission.

Protected remote control stations are set up to administer production. The construction of these stations, if they are located in detached structures, must ensure the protection of the maintenance personnel and keep the equipment and instruments from being damaged by fragmented pieces of the main building (in which the station is located) if it should be destroyed. To accomplish this, these structures must be properly reinforced.

To administer the off-duty shift in the outlying dispersal area, command posts are established in blast shelters, and if there are no blast shelters, in fallout shelters. Organization of this command post is analogous to that of command post on the site of the installation. The command post in the outer zone is provided with means of communication. The communications unit is located with the command post in a protective structure. Communications with the command structure are achieved by communication lines and radio. The outer-zone command post of an installation may be constructed and equipped with communications facilities under the threat of attack, but to accomplish this, the necessary components must be available in peacetime.

6.4.3 Increasing the Survivability of Buildings and Structures

Destruction of industrial buildings in the majority of cases results in a failure of machinery and communications. A variety of equipment and electronic devices are particularly susceptible to the effects of a nuclear blast. Industrial buildings and structures are built with consideration of the weight and wind loads and are not calculated to resist the damaging effects of a nuclear blast.

Increasing the survivability of buildings and structures may be achieved when planning new construction as well as when rebuilding installations already built or in use. However, these measures are taken only if they are economically feasible.

Increasing the survivability of buildings through basic structural changes involves a great deal of expense and does not yield positive results, since increasing the survivability of individual structures and components cannot guarantee survival from a nuclear detonation. Depending on the [actual] power of the weapon [used] and the [actual] center of the nuclear explosion, the destructive effect of the blast wave may be higher than the limit which was set in the technical engineering design. So taking measures to increase the survivability of individual buildings and their components is practical only (1) when the important individual components of the installation (those on which production depends) are much weaker than the other components or (2) when there is an increase in survivability of those components which could continue production by themselves and turn out products for immediate use. Increasing the survivability of weak individual elements results in the equal survivability of all parts of the facility, as well as in efficiency under a given effect of a nuclear blast.

A study of the nature of the effects of the damaging factors of a nuclear detonation shows that the effects on buildings and structures are not equal. The blast wave, causing damage in varying degrees, and thermal radiation, causing fires, have direct effects on buildings and structures. Initial nuclear radiation and fallout do not have a direct damaging effect on buildings (and structures), but injure persons inside them. Thus, increasing the shielding coefficient and attenuating the harmful effect of radiation on people is very important.

The survivability of buildings and structures in the presence of nuclear detonations increases when their mechanical stability and fire resistance are increased.

1. An increase in the mechanical strength of existing buildings and structures is achieved through appropriate planning as well as through the use of stronger materials and designs giving greater strength. Moreover, various structural solutions are possible. The most important measures for increasing survivability may be putting the building partially underground, or [building it] with a smaller cross-sectional area (a decrease in the area of the walls), and decreasing the height, which greatly increases resistance to the blast wave of a nuclear explosion (Fig. 77).

2. Existing buildings and structures can be reinforced with metal supports and beams to increase their stability. This method is used to increase the survivability of modified basement shelters, as well as the lower stories of buildings on which heavy and cumbersome equipment is located. The use of beams and supports greatly increases the survivability of basements and makes them as strong as a shelter (Fig. 78). Erecting supplementary support columns in single-story plants may be expedient in increasing the survivability of roofs with large spans.

3. Buildings and structures in which expensive equipment is located can be strengthened by the construction of additional walls or structures to withstand the pressure of the blast wave. The walls of buildings can be strengthened with monolithic reinforced concrete slabs.

4. Low structures can be partially covered with earth to increase their survivability. This method of increasing survivability can be used for semi-sunken buildings and various structures (Fig. 79).

5. Tall structures (chimneys, derricks, towers, and columns) can be reinforced with guy wires designed for the load generated by the high-velocity wind of the nuclear blast wave. A ring (for stacks) is mounted as the upper band for the guy wires (Fig. 80).

6. Structures in which easily flammable liquids are stored can be effectively enclosed with an earth embankment. The height of the embankment is determined in accordance with the amount of liquid which would discharge if the vessel were destroyed (Fig. 81).

ORNL DWG 73-4712

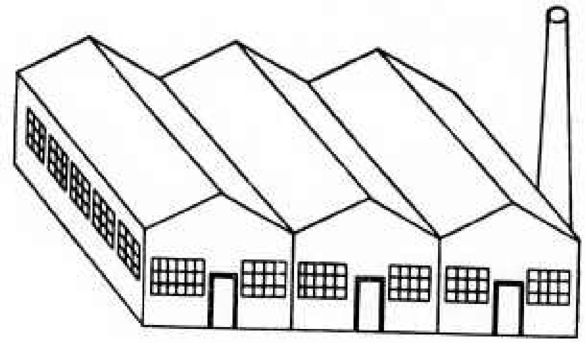

Fig. 77. Overall view of a single-story plant.

ORNL DWG 73-4713

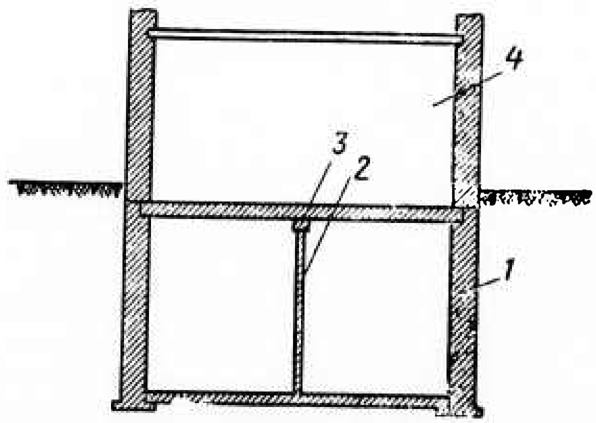

Fig. 78. Reinforcing basement with beams: (1) basement; (2) support; (3) beam; (4) first story.

7. Pipelines of various kinds [that are ordinarily] laid on the surface are advantageously installed underground; this practice increases their survivability five to seven times. It is also possible to lay industrial pipelines and power lines in semi-belowground trenches, thus maintaining all the advantages of aboveground lines and avoiding the disadvantages of underground lines. The survivability of such pipelines is enhanced by covering them with earth when under threat of attack.

8. To protect facilities located in zones of potential catastrophic flooding if hydroelectrical structures are destroyed, it is possible to build dams. These are usually planned during the overall design of the city.

9. Under the threat of enemy attack on plants, equipment and various structures can be covered with sand bags to protect them from damage in a nuclear

ORNL DWG 73 4714

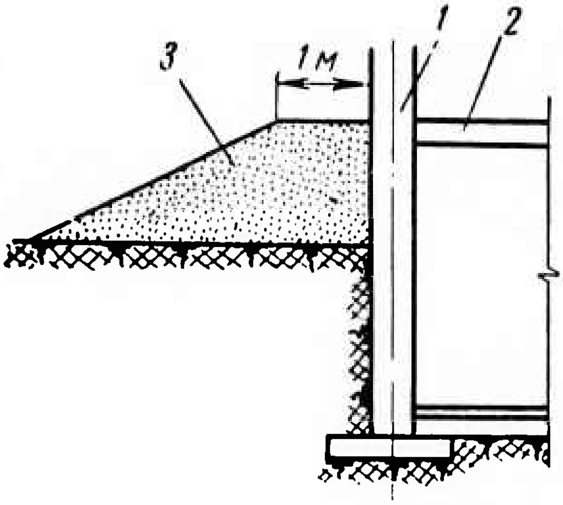

Fig. 79. Shielding a half basement with earth: (1) wall; (2) ceiling; (3) shielding.

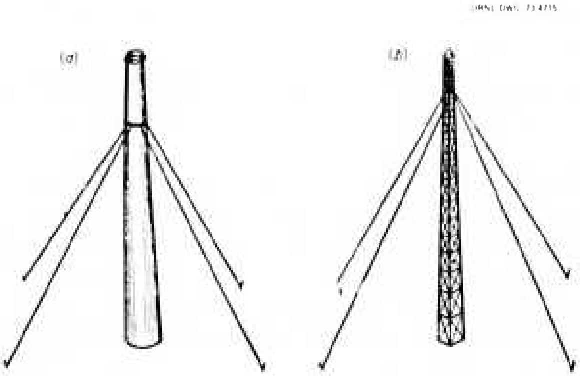

Fig. 80. Reinforcing tall structures with guy wires: (*a*) stack; (*b*) metal tower.

explosion and from falling fragments of destroyed structures.

10. To protect people and equipment, part of the window openings can be blocked with bricks; this procedure increases the survivability of walls and facilitates airtight sealing of the premises. It is also used to increase the survivability of food storehouses, finished-product warehouses, and the like.

Such measures are carried out to decrease the vulnerability only of industrial buildings and special protective shelters. In addition, national economic installations can be built in underground structures.

ORNL DWG 73 4716

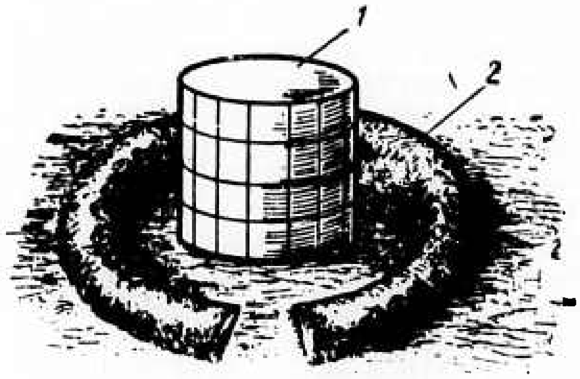

Fig. 81. Structure with earth embankment around liquid fuel tank: (1) liquid fuel tank; (2) earth embankment.

Using natural and artificial underground chambers to house such installations is one of the most effective means of solving the problems of protection against nuclear weapons.

Underground structures were used by Fascist Germany to house industrial plants as early as the Second World War. Near the city of Nordhausen in the Kochstein Hills, old [underground] structures were found which consisted of three parallel, horizontal tunnels about 3 km long. These tunnels were cleared, widened, reinforced, and connected to each other by passageways. Railroad tracks were laid along each tunnel. These tunnels, safe from aircraft, contained a factory producing the FAU-2 rocket.

However, such protection is possible only for individual, particularly important factories and plants; only a fraction of the vast number of plants and industries allocate some units to underground facilities.

To protect buildings and structures from the effects of thermal radiation, it is necessary to increase their resistance to fires. Buildings and structures are made fire resistant by using noncombustible materials in their construction and by satisfying the fireproofing specifications. To increase the fire resistance of existing buildings and structures which are flammable, use fire-retardant paints or use clay as a plaster; wooden structures should be impregnated with fire-resistant compounds (antipyrene). To reduce the probability of buildings and structures catching on fire and to reduce the propagation of fires caused by thermal radiation, a complete system of preventive fireproofing measures is carried out.

To protect people from the damaging effects of initial nuclear radiation and fallout, it is possible to construct protective buildings and worker accommodations which can be sealed airtight in case of radioactive contamination. Only special protective structures, blast shelters and fallout shelters, are built with protection against initial nuclear radiation and fallout being taken into account.

Shelters are sealed airtight to keep out contaminated air, and they have coverings which can almost completely exclude or greatly attenuate radioactive fallout. Because of economic considerations, residential and industrial buildings are not built with fallout protection in mind. However, these buildings can be adapted to protect against initial nuclear radiation and fallout during threat of enemy attack. To achieve such protection, some of the windows in the buildings are sealed off, protective walls are built at the entrances, and the outside walls are partially covered with dirt.

To keep out radioactive dust, all openings are sealed airtight, the windows and doors are sealed, and filters are installed in the intake of the ventilation system. The entrances are provided with vestibules with double, tightly closing doors.

In the case of plants far from large cities and other potential targets of nuclear attack, it is possible to increase their operational stability under fallout conditions by sealing production units airtight, by constructing vestibules, by sealing doors and window openings airtight, and also by sealing off openings around large lines. The ventilation system must be equipped with dust-removing equipment. Storehouses and vessels for storing food products and drinking water must also be sealed airtight.

6.4.4 Protecting Expensive and Unique Equipment

Expensive and unique equipment is protected primarily by technological measures to increase the overall operational stability of the plant. In addition, it is possible to carry out special measures to protect costly equipment. It is practically impossible to reliably protect all equipment from the shock wave, because it is not economically feasible to make plants as safe as shelters. Thus, the problem, essentially, is to minimize the vulnerability of especially valuable, sophisticated equipment, such as calculators and computers; complicated polishing, turning, boring, and gear-milling machinery; forging machines and presses; and pumping and other equipment.

Equipment and finished products can be protected by placing some of the most costly items in semi-buried

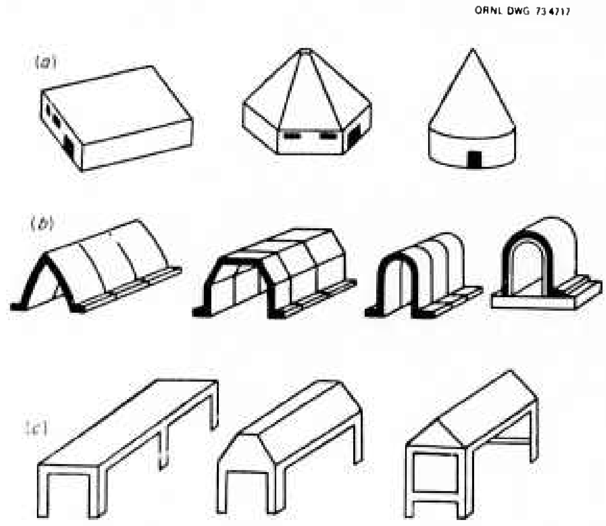

Fig. 82. Protective structures for valuable equipment: (*a*) enclosures, (*b*) hoods and housings, (*c*) canopies.

structures and other protective facilities. Underground structures for housing sophisticated equipment can be planned for installations under construction and for existing installations undergoing remodeling, and existing basements can also be used for this purpose.

Special protective structures to shield equipment from the falling rubble of destroyed buildings and the harmful factors of a nuclear explosion may be prepared during threat of enemy attack. These structures are classified according to type as [*a*] enclosures, [*b*] hoods and housings, and [*c*] canopies. Enclosures (Fig. 82*a*) are [completely enclosed] structures for single units or groups of units. They provide full protection from all harmful factors of a nuclear explosion. Hoods (Fig. 82*b*) are protective structures which are not closed on all sides, but are open on one or both ends, thereby ensuring protection of equipment on top and on both sides. A housing (Fig. 82*b*) is a protective structure resting directly over the part of the equipment it protects. It is used to safeguard units of important equipment: control panels, panel boards, hydraulic systems, and computers. A canopy (Fig. 82*c*) is a roof-shaped protective structure on supports which protects equipment from building fragments falling from above. Covers can be flat, arched, or latticed.

In addition to the use of protective structures, it is also desirable to mount lathes securely on their bases and install abutments, thereby increasing their stability against the tilting action of a high-velocity blast wave front.

6.4.5 Increasing the Survivability of the Electrical Power, Gas, Steam, and Water Supply

Failure of the electrical power supply leads to a work stoppage of the plant and interruption of planned production. Thus, increasing the operational stability of electrical energy of the installation is of utmost importance.

Electrical power. An increase in the survivability of the electrical power system is achieved by implementing general technological measures to stabilize the urban power supply. In addition, provision is made in the plant itself for executing technological measures according to plan.

1. The stability of the electrical power system of the facility is enhanced by connecting the plant to two or more substations, far enough away to rule out the possibility of both being destroyed in one nuclear explosion.

2. If the plant receives power from a regional transmission system, it is desirable for it to be supplied from two directions, because if the receiving substations are built far enough away from one another, they cannot both be destroyed by a single nuclear attack [warhead].

3. If there is no chance of receiving power from two sources, an independent local reserve source should be made available in case the one major electrical power system is damaged beyond use. For important national economic facilities, such sources may be specially constructed small power plants, or they may be mobile power plants. It is also expedient to protect existing reserve substations, as well as those under construction, by housing the control apparatus and equipment in protective structures.

4. Electrical power must be transmitted through underground cables laid in protective trenches designed for a high degree of resistance to the shock wave in the ground.

5. To preclude failure of the electrical network, it is necessary to install automatic cutoff mechanisms for use when overvoltages occur from electromagnetic fields due to a nuclear blast.

Gas supply. Gas is used as a fuel in many national economic installations and for industrial processes in many chemical plants. If the gas network is destroyed, gas may be the cause of secondary damage. The stability of the gas supply is increased by existing technological measures in the city in general, as well as in the facilities.

1. An underground tank containing a reserve supply of gas is recommended in case the gas supply source or the gas lines are damaged in large plants. The gas is pumped under high pressure into the underground tank which serves as a reserve. In addition, it is necessary to prepare the plant to operate with various types of fuel and to create reserves.

2. The gas [pipelines] network is laid underground at a depth of 2 to 2.5 m and is supplied to installations from two directions. The redundant gas lines are connected to each other, and the entire gas supply system is thus interlinked. The gas lines encircle the facility [installation] and make it possible to bypass the damaged sections and use the undamaged ones.

3. To avoid the occurrence of secondary damage when the gas network is damaged, it is desirable to equip gas networks with mechanisms which automatically isolate parts of the gas supply lines.

4. On the gas supply lines it is necessary to install cutoff assemblies with remote controls and other valves which automatically stop the gas flow when the pipes are damaged.

5. To be able to repair gas lines and feeders in an emergency, it is necessary to set up a reserve of materials, spare parts, and tools.

Steam supply. Since many plants use steam, it is necessary to inaugurate technological measures to increase the stability of the steam supply. These measures include protecting the underground steam lines and the inlet connections through which steam is admitted and installing shutoff mechanisms. The steam source may be a thermal power plant (TPP) or a boiler. In either case, technical measures are executed to increase its operational stability. Usually the boiler is located underground or in a special detached installation which can be adequately reinforced by proper engineering. Steam pipes must be laid underground in special trenches to ensure protection of the pipe from the effects of the shock wave.

Water supply. A disruption of the water supply causes a stoppage at the plant and an interruption of production, even when the plant itself has not been destroyed by a nuclear blast. Thus, measures increasing the stability of the water supply of the installation are of vital importance. The following measures can be taken to increase the operational stability of the water supply of a national economic facility:

1. The availability of a primary and reserve water supply is one of the civil defense requirements which is assured by building a reserve water supply on the site of the installation. An underground source is more reliable and may be used when the primary source has failed. To provide such a source, a deep well is drilled at the

plant and connected to the water supply system. It stands in reserve until the primary water supply source is unavailable. The reserve source can be close to the water tank from which the water supply line runs and near the water intake. To utilize the reserve water supply, it is necessary to have a reliable fuel supply which can power an internal combustion engine. In addition, a small water tank is built on the plant and is kept filled with reserve water.

2. The stability of the water supply system can be increased by placing all the water supply lines in the ground, locating fire hydrants and the shutoff mechanisms in areas which cannot be strewn with rubble when buildings and structures are destroyed by a nuclear blast, and also by constructing connecting lines making it possible to shut off damaged lines and structures.

3. The stability of the water supply system can also be increased by interconnecting it to the municipal systems and also the water supply systems of a number of large plants. A recycled water supply, with repeated use of water for industrial purposes, reduces the overall requirements of the plant and consequently also increases its stability to some extent.

4. A weak spot in the water supply system of an installation having its own water distribution system is the [elevated] water pressure tank, which is damaged at shock wave overpressures of 0.4 to 0.5 kg/cm^2 [5.6 to 7.1 psi]. Therefore, the water supply system of such installations should be designed to supply water directly into distribution systems, with the elevated water tank being bypassed. The same result is achieved with bypass lines, through which water is shunted to avoid the damaged structures, for example, with bypasses around the filtering-settling tanks and around the clean water reservoir filters.

6.4.6 Increasing the Stability of a Municipal Power Plant

The municipal utilities system ensures normal operation of each national economic facility. Thus, technological measures are also inaugurated for these.

Heating. Technological measures are taken to increase the stability of the heating system of facilities either when new sites are built or when existing ones are rebuilt. When measures are taken to protect the heating system from the blast wave, it is expedient to construct it as a ring-shaped system, laying the heating system pipes in special conduits, and then connecting the redundant components. The shutoff and regulating devices must be placed in inspection trenches, in areas which will not be affected if a building is destroyed. A shutoff system (gate valves, valves, etc.) must be installed on the heating systems which make it possible to shut off damaged parts.

Sewer system. To increase the stability of the sewer system, it is necessary to build two separate sewer systems, one for rain water and the other for industrial and domestic waste water. In the industrial and domestic sewer system, it is expedient to provide at least two outlets with connections to the municipal discharge collector. It is desirable to construct emergency discharge outlets (into a river near the site) in case of damage to the municipal distribution system and pumping station. For the discharge it is necessary to construct sumps with emergency gate valves and install them along facility collectors [sewer pipes] at intervals of 50 m, if possible in an area not likely to be covered by falling debris.

Fire prevention. Fire-preventive measures at a national economic facility increase protection from fires and prevent fire spread. For these purposes, new industrial buildings and structures are built of fire-resistant materials. Fire breaks are provided between the buildings, and there are a sufficient number of exits from the industrial plant site. These measures permit free movement for the fire department.

Measures to prevent fires in buildings and structures include fire-resistant construction, fire-retardant treatment of combustible building elements, and special firewalls. In stone buildings, the ceilings are made of reinforced concrete and concrete slabs. Large buildings are made in sections with nonflammable walls (fire walls). These walls, which run through the attic and divide it into sections, project above the room. Openings in the fire walls and nonflammable walls must not constitute more than 25% of their area. They are closed with metal doors or wooden doors made of boards covered with roofing tin, asbestos, or felt impregnated with a nonflammable material.

In addition to the regulations and standards followed for new buildings, fire-prevention measures are taken in already functioning installations:

1. To reduce the probability of ignition and fires from thermal radiation, it is necessary to clean the yards and spaces between buildings, to remove flammable rubbish in advance, and to make it possible for fire trucks to move freely on the grounds of the installation, with ready access to the fire hydrants and water tanks around the buildings.

2. To increase the fire resistance of wooden structures, fire-protective paint and grease are recommended. The paint comes in bright colors. Fire-resistant paints,

as well as whitewash, are used as protective coatings to reflect radiation. To protect exposed wooden structures the following are used: lime coatings consisting of 62% slaked lime, 32% water, and 6% common salt; a superphosphate coating, consisting of 65% superphosphate and 35% water. A 2-kg coating is required for 1 m^2 of wood surface. The fire-resistant coating is applied in two layers. The general thickness of the protective layer must not be less than 1.0 to 2.5 mm. In the absence of these materials, the wooden parts can be coated with lime.

3. Water tanks are built on the site to extinguish fires caused by thermal radiation. Good approaches must be built to the existing water tanks, while platforms and piers should be built on the shores of rivers, lakes, and ponds in order to set up fire pumps. If necessary, the water tanks are partially buried to obtain a sufficient amount of water in winter when ice is at its maximum thickness.

4. If water tanks cannot be installed, deep wells are drilled to obtain water for the industrial needs of the site and to extinguish fires.

5. To prevent explosions and fires in storage tanks for petroleum, gasoline, oil, and other materials which present a fire or explosion hazard, it is necessary to build such tanks at the outskirts of the facility and partially bury them in the ground. Solutions of toxic chemicals must be prepared and stored in a central place outside the limits of the main plant. In the case of storage tanks containing compressed gases, volatile liquids, acetylene, and other explosive substances, installations are built to contain the explosion. Moreover, to accomplish this, relief rupture valves, blowout panels, and self-opening windows and transoms are installed. Gasoline pumps, fuel, and lubricant tanks, oxygen and hydrogen bottles, and potentially explosive materials are located at a distance from other structures in isolated areas or in underground structures.

6.4.7 Installation of Individual Production Components in Underground Structures

To increase the survivability of the most important components and production units (those on which the work of the installation depends), they should be placed in underground structures. This procedure increases their survivability several times. For this purpose it is possible to use existing basements or special structures built on the plant site. Control panels, electronic apparatus, power sources, fuel tanks, and spare components from other plants, as well as raw materials, may be located in the underground structures. It is especially important to store fuels and easily flammable liquids, as well as toxic chemicals, in underground structures.

6.4.8 Ensuring Protection from Radioactive, Chemical, or Biological Contamination

Fallout hampers the operations of an installation, and at high radiation levels it is necessary to discontinue work and put the workers and employees in blast shelters or fallout shelters. Chemical and biological contamination creates especially dangerous conditions in the installation, interrupting work and making it necessary to protect the people and eliminate the residual effects of contamination. Ensuring the protection of workers and employees increases the operational survivability of the plant under conditions of radioactive, chemical, and biological contamination.

To assure protection of workers and employees on the site of the facility, it is necessary to inaugurate a whole series of measures in advance and establish rules of conduct for workers and employees under conditions of radioactive, chemical, and biological contamination.

1. First, workers and employees must be provided with individual means of protection and instructed in how to use them.

2. The premises of the plants and laboratories in which people work are prepared for airtight sealing in the event of contamination. Such preparation consists of tightly sealing doors, windows, and other apertures.

3. Shelter is available for all shifts of workers and employees to protect them from radioactive, chemical, and biological contamination. The shelters must be equipped with filter-ventilation units.

4. The warning system is very important to get the people to shelter in time; thus, there must be means for conveying CD signals to the site.

To rapidly cleanse the facility of contamination, it is necessary to prepare supplies of decontaminants and disinfectants as well as equipment for decontamination.

6.4.9 Increasing the Survivability of the Equipment and Supplies at a Facility

The equipment and supplies are very important to the stable operations of a facility since it is not possible to work when plant supplies are destroyed. Modern plants consume many different types of materials. Continuous production depends on systematic supplies of raw materials, other materials, fuel, electrical power, and instruments. In addition, modern plants operate in cooperation with many other plants and factories, which are interdependent; that is, if one plant is disabled, operations shut down at the others because of interruption in the delivery of units and spare parts.

For instance, the automobile plant in Tol'yatti delivers various units, components, and equipment to more than a hundred plant affiliates. From this example, one can conclude that almost every plant has to have a reserve of materials, raw materials, instruments, and implements. Reserve supplies of manufactured goods, materials, raw materials, and equipment are determined in advance by the appropriate ministry for each plant, based on the required plant working days if the supply is cut off. For this purpose, it is necessary to set up assured reserve supplies of manufactured goods, materials, raw materials, equipment, instruments, and fuels. The assured reserve supply of all [essential] materials must be stored, if possible, in dispersed places, where it is unlikely that all will be destroyed by a nuclear attack. This assured reserve supply of all [essential] materials is calculated on the basis of the days of plant operation after which it will be possible to restore a normal supply.

In industrial plants, fuel is consumed in technological processes, generation of power, transportation, heating, and [other] everyday needs. The fuel requirement in case the supply is destroyed is determined according to standards based on the number of plant operational days. In addition, the plant may be designed for operation with different types of fuel (gas, petroleum, coal).

At the site, the possibility is also considered of providing local materials and raw materials and of manufacturing spare parts and instruments independently in the event that other plant affiliates which supply these products are disabled.

6.5 PLANNING ENGINEERING MEASURES

Technological measures are taken in advance, in peacetime, because large investments and extended periods of time are necessary to complete them. Technological CD measures to increase the stability of a national economic facility in the event that weapons of mass destruction are used are planned on the basis of an evaluation of the stability of the facility made by a special commission.

Documents (tables) on the following subjects are prepared as a result of the conducted evaluation:

1. assessments of the survivability under static loading of buildings, structures, and communications;
2. evaluations of machinery and industrial equipment;
3. calculations and evaluations of protective structures;
4. evaluations of the stability of the facility to secondary damage;
5. evaluations of conditions guaranteeing basic types of supplies;
6. recommendations concerning measures to be taken to increase the operational stability of the facility.

Thus, the conclusions drawn in the course of stability evaluations lead to recommendations for implementing technical engineering measures. On the basis of these conclusions, the CD chief of the facility (the plant manager) decides on the technological measures to be carried out. Consequently, the basis for planning measures to increase the stability of the facility is the decision of the CD chief of the establishment (plant manager) and the approving ministry (office) to which the facility is responsible.

The degree of increased stability of important installations which would continue their productive activity in wartime is established by the ministry, which also determines the order in which the measures will be executed. At the national economic facility the CD staff, together with chief specialists, evolves a plan to increase the stability of the facility. This plan provides a time schedule for the work to be done, and necessary facilities and materials are made available. All work to increase the stability of the installation may not be finished in a year; thus, a long-term plan may be created for three to five years. In addition, a subplan is devised for each year and indicates which part of the whole task should be finished by the end of the year.

Construction work is done by special construction organizations which are assigned to the facility.

7. Civil Defense Planning

7.1 BASIS OF CIVIL DEFENSE PLANNING FOR A NATIONAL ECONOMIC FACILITY

The Communist Party and the Soviet government are constantly striving to prepare the country, its national economy, and the entire population for defense against weapons of mass destruction. Advance preparation for protecting the population and the national economy is one of the basic principles of defense. The more preparatory measures carried out in peacetime, the easier it is to solve defense problems in wartime, especially in the initial period [of a war].

The Communist Party and the Soviet government have decreed certain measures to protect the population of the country against weapons of mass destruction, but it is not possible for such measures to be fulfilled instantaneously, nor can civil defense problems be readily resolved in time of peace. V. I. Lenin taught that preparing a country to defend itself requires not mere talk, not a call to arms, but a long-term, intense, persistent, and disciplined effort carried out on a massive scale. Many times he emphasized that without a plan of operation, it was impossible to prepare the country for defense.

Practical realization of the basic principles of protecting workers, employees, and the population not engaged in production starts with devising a CD [civil defense] plan for a national economic facility. The decisions of the chief and a timely CD plan devised for the national economic facility is the basis of administration. Thus, working out a CD plan for a national economic facility constitutes one of the fundamental tasks for the civil defense staff of the facility.

7.1.1 Developing a Civil Defense Plan for a National Economic Facility

A CD [civil defense] plan is a list of basic measures, drawn up ahead of time, to protect workers and employees and to increase the operational stability of a national economic facility, should weapons of mass destruction be used. The CD plan also designates the order in which these measures should be inaugurated, some in sequence, some simultaneously. The plan must include the basic conditions under which the civil defense forces and civil defense facilities are administered in all stages of their operations.

The CD plan is determined by the character and sequence of activities of forces, the nature and volume of the work, the periods of time for initiating and completing it, the order in which measures should be undertaken when attack threatens, and the order in which the residual effects of the attack should be liquidated, with consideration of the special physical-geographical, economic, and other features of each facility. The plan consists of the facility CD chief's decisions concerning the organization and conduct of civil defense; these decisions are promulgated in the form of orders and supplements to them. The decisions of the CD chief of a facility include:

1. a plan for dispersing workers and employees, together with their families, from national economic facilities;
2. provisions of cover [from weapon effects] for workers and employees of the national economic facility;
3. a plan for converting the facility to a basic [wartime] regimen, according to national defense needs;
4. a plan for training workers and employees of the facility to use individual means of protection;
5. a plan for organizing administration, warning, and communications at the facility;
6. a schedule of basic civil defense measures for the facility;
7. a plan for carrying out rescue and urgent emergency-restoration work at the national defense facility;
8. a plan for protecting food supplies, forage, and water supply sources from radioactive and toxic materials and biological agents.

Other documents may be included in the CD plan of a national economic facility, in accordance with local conditions and the decision of the chief.

Thus, the CD plan is designated to organize and systematically implement methods and measures to maximally reduce the loss of workers and employees, to restore the national economic facility [if necessary], and also to create conditions for its stable operation in wartime. A timely, well-thought-out plan, scientifically designed and creatively structured for civil defense of a national economic facility, in conjunction with technical information, technical equipment, and defense facilities, makes it possible to solve problems and complete civil defense measures for a facility in wartime even under the most complex conditions.

7.1.2 Basic Requirements of the Civil Defense Plan for a National Economic Facility

The basic requirements of the CD plan for a national economic facility include: a complete yet concise presentation, accurate calculations of the time required to complete CD measures, the economic expediency of these measures, as well as their realism, and compatibility with the overall CD plan of the [city] staff superiors.

Whether the plan is sufficiently comprehensive is determined by how successfully it provides for protecting workers and employees, increasing the stability of the facility under the effect of weapons of mass destruction, and creating favorable conditions for performing rescue and urgent emergency-restoration work in centers of mass destruction. The plan must achieve maximum defense quickly with minimum expenditures by executing a complete system of civil defense measures, either sequentially or simultaneously, in wartime as well as in peacetime. Hence, it is necessary for the CD plan to include all measures, without exception, for protecting people and the facility from the effects of weapons of mass destruction. Failure to adequately develop one or several civil defense measures may lead to irreparable consequences in wartime.

Brevity in presenting the parts of the plan is necessary for convenient use in wartime. The number of defense measures covered by the plan is so large that even a short textual [written descriptive] presentation would result in a document with so many pages that it would be impossible to use under the tense and fast-moving conditions in a period of threat of attack, or in wartime, or when organizing and executing rescue and urgent emergency-restoration work. Thus, brevity in presenting the plan, with all defensive measures completely delineated, is accomplished by using figures and graphs. On the plan (diagram) of the facility, arbitrary graphic symbols set forth the nature and scale of the prospective rescue and urgent emergency-restoration work for the facility. Explanations of the graphical presentation of the CD plan are given in the form of tables, graphs, and legends. The graphical plan is convenient to use under wartime conditions. The conditions at the facility can be plotted on the graph after the explosion; reconnaissance data can be entered; it is possible to make and plot decisions quickly or to correct earlier decisions regarding rescue and urgent emergency-restoration work at the facility [if it is] in an area of destruction. Accurate calculations [of time requirements] are needed to set deadlines for giving aid to victims, to contain and extinguish fires, to isolate people exposed to excessive radiation doses, and to promptly remove wreckage from networks [systems] of the national economy.

Economic expediency. When devising and accomplishing defense measures at a national economic installation, there must not be a "freezing of facilities," that is, setting aside of shelters for use only in wartime. Each protective structure or measure must unquestionably have an economic use in peacetime. Shelter-garages and shelter-movie theaters are economically expedient in peacetime as well as in wartime: in peacetime as cultural-domestic facilities, in wartime as protective structures.

The feasibility of the plan is the most important thing — an assurance that the plan will be used if the need should arise. For this reason, only carefully studied, actual concrete data regarding local conditions are reflected in the plan. The development of defense measures is soundly based on careful evaluation of the conditions which may arise at the installation in wartime. First, an assessment is made of the probable character of destruction and damage, the possible losses in human life and technical equipment, and the number and kind of civil defense forces and facilities needed to deal with the secondary effects of enemy attack, as well as the presence of forces and facilities on the site and their readiness.

Conditions are evaluated by means of repeated calculations with respect to concrete situations. The plan must be flexible, that is, capable of being refined and corrected with regard to practical matters, training, and instruction at the site, should there be any changes in the composition of civil defense facilities. In other words, it must be realistic.

To coordinate the civil defense plan of a national economic facility with the plan of the overall civil defense administration involves providing centralized administration, reflecting the requirements of the overall plan's primary goals, and firmly agreeing on both the methods and the time schedule for executing the measures.

When developing a civil defense plan for a national economic facility, it is necessary to observe strictly the basic requirements and adhere to scientific rules. The plan should not include *a priori* conclusions or formulations which do not proceed from the actual facts, nor should a superficial presentation of problems, models, or plans be permitted. To develop a plan, it is necessary to have original data and various kinds of information. These must be studied and used rationally.

7.1.3 Data Base for Developing a Civil Defense Plan for a National Economic Facility

The data base for working out a plan for a national economic facility should include: problems presented to superiors on the CD staff; instructions of the ministry or office supervising the facility; characteristics of the facility (economic and defense significance, territory, density and type of buildings, number of workers, employees, and members of their families; number and constitution of civil defense forces and facilities at the site); the anticipated situation at the facility in wartime; the availability of individual means of protection; the number of blast shelters and fallout shelters and their capacity; possibilities for erecting protective structures and preparing individual means of protection; guiding documents and civil defense manuals.

7.1.4 Sequence for Developing, Checking, and Correcting the Civil Defense Plan for a National Economic Facility

The sequence for developing the plan is determined by the CD chief of the national economic facility. It is he who decides on the basic defense principles and the data base for developing the plan, as well as deadlines and responsible executives. In accordance with the decision of the CD chief of the facility, the staff produces a graph illustrating the design sequence of the civil defense plan for the national economic facility. The chief of staff, his assistants, the service chief, and the commander of the CD formation, as well as the technological personnel and organizations with which they are involved in creating the plan, participate in developing the plan.

Planning is conveniently broken down into stages: the first stage is to draw up and confirm lists of executives, assemble general data, and evaluate the data base needed for the plan; the second stage is to develop a practical documented plan; the third stage is to coordinate all parts of the plan and to delineate and confirm the plan with the [city] civil defense staff superiors and present it to the executives.

The civil defense plan for a facility is drafted in one copy. It is signed by the chief of staff and confirmed by the civil defense chief of the site. The chief submits it to the [city] staff superiors for their signatures and confirmation that the plan is in accord with the [overall] plan of the [city] staff superiors. The plan is not bound. This makes it possible for it to be used simultaneously, in sections, by the CD chief, the staff, and service workers. The documents of the plan should be carefully kept track of according to the established document-accountability system at the facility. After confirmation, the plan is brought to the service chiefs and building supervisors and to the plant and department heads and sections under their supervision. The plan is never altogether finalized. It is always subject to corrections to make it more effective. Thus, the drafted confirmed plan must be reviewed and brought into conformity with changing conditions and with the data base for the facility and the region. Changes and corrections in the civil defense plan of a facility are made when the data on which the plan was originally developed have changed, or at least once a year.

Checking and revising the plan is accomplished empirically, chiefly through practical exercises and civil defense instruction at the facility. Consequently, even in peacetime there is still full opportunity to analyze alternative decisions, study in detail existing possibilities for protecting workers and employees, select the most appropriate alternatives for a given facility, and carefully plan its operations. Under threat of attack, the civil defense plan is activated upon order of the staff superiors, and in the case of a sudden enemy attack, it is activated immediately.

7.1.5 The Documents of the Civil Defense Plan and Its Contents for a National Economic Facility

The decision of the CD chief of a national economic facility to organize and execute civil defense. The decision to organize and execute civil defense measures at a national economic facility is promulgated in the form of orders (Appendix XI), which reflect the following:

Organization of civil defense at a national economic facility.

Composition of the administrative staff. This includes combat estimates of the military personnel of the command post (CP), the civil defense services, the base (basis) on which the service is to be set up, and which CD services are to be organized under what circumstances.

Methods provided by the facility for protecting workers and employees. The following categories are included: the working shift at the factory (plant) in the event of sudden enemy attack; the resting [off-duty] shift in transit — both on the way to the plant and on the way to the dispersal area; the facility's civil defense formations [brigades] en route to a center of destruction and while performing rescue and urgent emergency-restoration work there.

Organization of administration, warning, and communications. These determine: the location of the command post at the national economic facility; assignment of personnel and equipment for radio, wire communications, and warning systems; CD warning methods and signals, the organization of a lookout system at the facility, in the dispersal area, and on the marching routes; the CD organizations which will warn the workers and employees at the facility, in the dispersal area via the established communications channels; the communications facilities at the command post, at the observation posts, at the assembly posts where the CD brigade commanders and staff officials are stationed.

Steps for converting the facility to a basic CD mode of operation. These steps determine: changes in the production processes in plants on the site in the event of sudden enemy attack, as well as in accordance with civil defense signals; which plants and aggregates [of plants] should stop working and the prescribed shutdown order; protection in blast shelters for the workers and employees on the working shifts.

Problems with services and brigades [formations] when engaged in civil defense missions. These problems include determining the order and location [of means] for protecting formations, workers, and employees of the plants and departments of the facility from the damaging effects of a nuclear blast and toxic materials, and ensuring the safety of CD forces at the facility.

Organization of rescue and urgent emergency work. This includes calculating the forces and facilities needed to perform the rescue and urgent emergency-restoration work, the purpose of their operations, the order of their operations, safety measures, and permissible radiation doses for personnel in the organization.

Sequence of interactions with neighbors. This sequence establishes the operations of the CD forces of the facility in cooperation with neighboring forces, with military subdivisions of the CD reconnaissance units, with security forces, and with the forces performing rescue and urgent emergency-restoration work.

Problems concerning combat, material, technical, and other types of security. These affect: reconnaissance forces and facilities at the site during the threat of enemy attack, on CD marching routes of workers and employees in the dispersal area and in the area where rescue and urgent emergency-restoration work is being performed; the times and purposes of conducting reconnaissance; the times and methods for presenting scouting reports; transport facilities for moving CD units to the center of mass destruction and for moving workers and employees to the dispersal area and back to the work site; methods for conducting radiation and chemical reconnaissance and dosimetric checks and the sequence for using them; instruments and technical equipment for CD organizations; provision of the personnel with individual means of protection; place, time, and sequence for special processing of the personnel of organizations and technical equipment.

In addition to the decision of the CD chief of the facility with regard to organizing and carrying out civil defense, the following documents should be included in the CD plan:

A plan for dispersing workers and employees and for evacuating members of their families from a national economic facility. The following is indicated: the number of workers and employees and members of their families subject to dispersal and evacuation; the place and sequence of their departure; evacuation assembly points designated for use; measures to assure [adequate] transportation; the reception area and marching routes; sequence of shifts and transfer of workers and employees to the dispersal region, to the working site, and back. A variant of the plan for dispersing workers and employees and evacuating members of their families from a national economic facility is given in Appendix XII.

The designation of shelter for workers and employees of a national economic facility. This section of the plan describes procedures for using [blast] shelters and fallout shelters to protect working shifts at the site. It also is concerned with fallout protection for the resting shift in the dispersal area and for CD personnel in the area where rescue and urgent emergency-restoration work is being carried out, and with measures to hasten the construction of blast shelters with simplified equipment and fallout protection at the national economic facility and in the dispersal area under threat of enemy attack. An illustrative plan for sheltering workers and employees of a national economic facility is given in Appendix XIII.

Plan for converting a facility (installation) to the basic civil defense regimen. The plan takes account of the following: the sequence for changing the industrial process over to the basic operating regimen under the threat of attack and in accordance with civil defense signals; the plants and aggregates which will continue or discontinue their work, as well as the order in which these shutdowns can be made without difficulty; the location of shelter for specialists on duty at the installation. A variation of the plan for converting a facility to a basic operational civil defense regimen is given in Appendix XIV.

Plan for providing the formations [brigades], workers, and employees of a facility with individual means of protection. This plan shows the sequence for distributing individual means of protection to the personnel and measures for adequately preparing simple means of protection. An illustrative plan for providing CD formations, workers, and employees with individual means of protection is given in Appendix XV.

Plan for organizing administration, warning, and communications at a facility. This plan includes: the organization of radio and wire communications between supervisory personnel of the national economic installation, CD staff supervisors, the organization commander, and plant and department heads; the sequence for warning and assembling administrative and command personnel; facilities and means for sending (repeating) civil defense signals; times and sequence for setting up the command post; observation posts. An illustrative plan for organizing administration, warning, and communications at a facility is given in Appendix XVI.

A schedule for basic CD measures at an installation. This schedule indicates specific measures for preparing and setting in motion a civil defense system under the threat of attack and in accordance with civil defense signals, a timetable for these activities and the responsible personnel. An illustrative schedule for basic CD measures at an installation is given in Appendix XVII.

Plan for performing rescue and urgent emergency-restoration work at a national economic facility. This plan specifies: the sequence for organizing and carrying out reconnaissance; the assembly points for the [CD] formation; the decision to organize and conduct rescue and urgent emergency-restoration work in centers of nuclear, chemical, and biological destruction (contamination). There are two versions of the plan: one for surprise attack and one [for a period of escalating crisis] when there would be time to take preparatory measures for protecting workers and employees and for increasing the stability of the facility for operation in wartime. An illustrative plan for carrying out rescue and urgent emergency-restoration work at a national economic installation is given in Appendix XVIII.

Plan for protecting food supplies, forage, and water supply sources from radioactive and toxic materials and biological agents. The plan is created for installations connected with the production, storage, reprocessing, and transporting of food products, as well as for water supply stations (independent utilities). The plan indicates ways to protect food products, forage, and water supply sources (airtight sealing of packages, storage areas, and transport means; available supplies of covering and packaging materials; preparation of storehouses in places where foodstuffs are dispersed). [The plan also includes] methods to decontaminate and use contaminated food.

Depending on local conditions and decisions of the chief, other documents may be included in the civil defense plan of a national economic facility. These documents must include staggered shift schedules. The shift schedule determines the order of work and shifts for workers and employees in each plant [of a facility]. In addition, it sets up the number of transport vehicles necessary to transfer workers and employees to the outer zone, to the dispersal settlements, and back to the place of work. The staggered shift schedule lists all shops by type. It indicates the approximate number of workers and employees for each shop, subject to dispersal. It establishes the shifts and the number of workers and employees for each shift. The actual work hours of each shift are indicated, as well as the times for changing shifts. One of the possible variations of a shift schedule is shown in Table 29. Whether a staggered shift schedule is necessary depends mainly on the conditions for protecting workers and employees of an installation from injury by a nuclear blast.

The dispersal of workers and employees from the facility into an outer zone assumes the presence of a single shift of workers and employees at the installation — a probable target of destruction. The off-duty workers and employees of the facility are in the outer zone at a safe distance. However, if the working day ends in all shops [of a facility] at the same time, then during the shift change all workers and employees of the facility are in the probable target of destruction at the same time and are endangered. To prevent workers and employees of all shifts from being at a facility at the same time, it is desirable to stagger the shifts in wartime. A shift change in all plants according to a staggered schedule not only increases the safety of personnel and makes [effective] dispersal possible, but also makes it easier to transport workers and employees of a facility into the outer zone and back to the working site.

Table 29. Shift schedule for a tannery

	Number of workers			Shift working hours				Time of shift change		Provision for transportation, No. of automotive vehicles	
				1st shift		2nd shift					
	Total	1st shift	2nd shift	Start	Finish	Start	Finish	Start	Finish	1st shift	2nd shift
Mechanical repair shop	75	50	25	14.00	02.00	02.30	14.00	02.00	02.30	3	2
Transportation shops	175	100	75	14.00	02.00	02.30	14.00	02.00	02.30	7	4
Cutting mills	700	400	300	12.00	24.00	00.30	12.00	24.00	00.30	16	12
Carton factory	913	488	425	8.00	20.00	20.30	8.00	20.00	20.30	16	16
Leather-cardboard factory No. 13, 14	1345	800	545	6.00	18.00	18.30	6.00	18.00	18.30	26	18
Technical library and warehouses	392	162	230	10.00	22.00	22.30	10.00	22.00	22.30	10	7

8. Conduct of the Population under the Threat of Enemy Attack and in Response to Civil Defense Signals

Successful defense from weapons of mass destruction depends largely on the conduct of citizens, on their sensible and proper behavior under the threat of enemy attack, in accordance with civil defense signals [both] in centers of destruction and in contaminated areas. To avoid and curtail losses if the enemy should use weapons of mass destruction, all citizens, including college students, are obligated to participate in taking civil defense measures, as well as know how to conduct themselves under conditions of enemy attack and help the injured. For this reason, in peacetime all citizens should take an established civil defense course, in which they learn the effects of weapons of mass destruction and methods of protecting themselves against them, preparation and use of defensive measures, civil defense signals and proper conduct on hearing them, and means of providing assistance to the injured. When the enemy attacks with weapons of mass destruction, discipline and a high degree of alertness on the part of all citizens is of the utmost importance. Only when the population is well prepared and organized is it possible to carry out defensive measures quickly under threat of attack and to undertake rescue work if weapons of mass destruction are used. Let us examine the conduct of the population under the threat of attack and in accordance with civil defense signals.

8.1 CONDUCT OF THE POPULATION UNDER THREAT OF ENEMY ATTACK

The existence of nuclear missiles makes it possible for the enemy to inflict nuclear strikes on cities. Thus, warning the population of the threat of an attack and taking defensive measures in time are especially important. To warn the entire poulation of impending enemy attack, the threat of an attack is announced on the decision of the government. Warning the population is accomplished by authoritative Soviet and civil defense organs through messages communicated directly over radio networks, television, and other facilities. In addition, special decrees and decisions of the Executive Committee of Council of Workers' Deputies are transmitted, stating the obligations of all citizens to take the necessary steps to defend against weapons of mass destruction.

Under modern conditions it is difficult to foresee and determine the duration of the threat of enemy attack, the time available to implement defensive measures, and the duration of the nuclear strike. It is possible that the period of threat of an enemy attack will last from several hours to several days. However, it is necessary to proceed as if there were a minimum of time, since the threat of attack may rapidly grow into a real attack. On this basis, people must act fast, spending the precious time that remains economically and diligently.

The announcement of threat of an attack depends on extreme exacerbation of international relations and signifies that at any moment the territory of [our] country may be attacked with weapons of mass destruction. Because of the character of modern warfare, all citizens, wherever they may be living, must immediately take defensive measures and complete them in the shortest possible time. Upon the announcement of the threat of an attack, all civil defense systems are put on combat readiness, and the following basic measures are carried out:

1. the administrative posts, warning systems, communications, reconnaissance [units], observation [posts], and laboratory control [facilities] are put on full combat alert;
2. the population is warned of the threat of the use of weapons of mass destruction by the enemy;
3. individual means of protection are issued, and preparations for the simplest means of defense are organized for the entire population;
4. blast and fallout shelters are prepared for workers on plant shifts which continue production;

5. the command service is organized, and provision is made for maintaining public order on evacuation routes, on marching routes for advancing civil defense forces, and in populated regions;
6. dispersal is accomplished, and shelter is provided in outer zones for workers and employees of installations which will continue, or temporarily interrupt, their production activities in wartime;
7. the following categories of people and institutions are evacuated from large cities into rural regions: persons not involved with production, entire childrens' homes and medical institutions, training schools, and scientific-research institutes;
8. reconnaissance is organized along with the relocation of formations into the outer zone, and civil defense forces and facilities are set up to carry out rescue and urgent emergency-restoration work;
9. mass cover [fallout shelters] is built for the entire population of small cities and rural areas;
10. evacuation is organized from large cities, as well as removal and distribution of material goods into the outer zones;
11. food products, forage, and water are protected everywhere from radioactive, chemical, and biological contamination;
12. farm animals and plants are protected.

All civil defense measures planned for the period of threat of an enemy attack are reviewed and carried out by organs of Soviet authority and civil defense staffs at all levels, with the active participation of the entire population. During this period, all the activities of Soviet government and Party organs and staffs and civil defense services are directed toward solving the main problem of providing reliable defense for the population and national economic facilities from weapons of mass destruction. All citizens, to the full extent of their abilities, are obliged to take an active part in carrying out all measures as directed by organs of Soviet authority and civil defense. The conditions during the threat of attack may be very complicated and diverse. Thus, in such situations a high degree of discipline, organization, intelligent action, and [ability to make] frequent independent decisions is required from each citizen.

As soon as the threat of an enemy attack becomes known, it is necessary at once to undertake defensive measures and to complete them purposefully. These measures include:

1. Ensuring prompt reception of signals, commands, and edicts from organs of Soviet authority and civil defense. To receive warning signals in time, a radio must be turned on at all times in every home, institution, plant, educational institution, collective farm, and state farm; the radio receivers are tuned to one of the national broadcasting stations, and the television sets are tuned to the main program of its television station. Even small transistor receivers can be used, but if so, it is necessary to provide power and to always keep the receiver sets turned on. The municipal CD staff warns the population of the threat of attack, using all facilities for this – radio broadcasting, television, the press, etc. Local radio broadcasting systems in plants, institutions, collective farms, and state farms must operate around the clock. All these measures permit the population to receive civil defense signals and decrees from Soviet authorities at any time of day or night and in every corner of the country, and consequently to take the necessary defensive measures in time.

2. Preparing individual means of defense. Under the threat of attack, all citizens must prepare means for protecting their respiratory systems and skin. If gas masks are not available, respirators can be used, as well as more simplified means for protecting the respiratory organs (dustproof cloth masks or cotton-gauze strips) prepared by the people themselves to afford protection against contact with radioactive dust and biological media. To protect against radioactive dust, it is also possible to use gas masks of the types used in peacetime in various branches of industry (special gas masks intended to protect against harmful gases in industry). To protect the skin, the population may use a variety of coveralls, rubberized coats, and rubber footwear (rubber boots, overshoes, and galoshes). To protect the arms and hands, it is possible to use rubberized or conventional leather gloves and mittens.

Prepared, individual means of defense and personal documents must be readily available when the threat of attack arises. For self-help, it is necessary to prepare means for rendering first aid: individual antichemical and dressing packages and a first aid kit with drugs (iodine, ammonium hydroxide, potassium permanganate, bandages, baking soda, various antibiotics, and other medicines recommended by a doctor).

3. Preparing for evacuation. When an enemy undertakes combat operations, the primary effort will be directed toward striking large cities, industries, and administration centers in which the basic industrial plants are concentrated; transport centers and communications; as well as other important sites which are population centers. Thus, when the threat of attack arises, workers and employees in plants of large cities may be dispersed into the outer zones, and the [general] population may be evacuated. To evacuate

quickly, it is necessary to make careful preparations, observe discipline, and follow orders.

Warning the population of an imminent evacuation (dispersal) will be accomplished by various means: radio, television, newspapers, and special announcements or communications, issued by plant managers and institution directors. When the situation warrants it, the population will be given the order to evacuate, the times to assemble at the evacuation points and stations (posts) for loading on transport, the marching routes to be followed, the list of necessary documents to take along, the permissible baggage weight, and other information. When the evacuation is announced, citizens are obliged to gather quickly and come to the various evacuation points at the times and places indicated in the evacuation certificate.

Citizens should take only what is absolutely necessary: clothes, underwear, bedding, toilet articles, and the necessary personal documents. It is recommended that a tag be sewn to the clothing of preschool-age children, indicating first and last name, patronymic, year of birth, permanent address, and final evacuation point (Fig. 83). A small reserve of food (for 2 to 3 days), medical supplies, and individual means of protection must be prepared for the road. It is best to bring those foods which take up least room, are nonperishable, and may be quickly prepared under traveling conditions. An address tag should be sewn on the baggage (suitcase, knapsack, bag).

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Fig. 83. Preparing clothing for a child.

When arriving at the various evacuation points, the evacuees will observe order during reception and registration; they will present the appropriate documents (evacuation certificate, passport). After receiving the seat assignment coupon for the transport, the evacuees will gather in a designated place and await orders. Leaving the designated evacuation point during this period is not permitted. When the attendants announce the beginning of embarkation, the evacuees are seated in railroad cars or in motor vehicles, without any commotion or panic.

After embarkation, while being transported, the citizen must observe the rules of conduct on the transport. When traveling by railroad, the evacuee is not permitted to leave the railroad car during stops. If the citizen is being evacuated by motor transport, then he is permitted to leave the vehicle on the right side during stops, according to command, but must remain near the vehicle so that he may get back in quickly on signal. While in the vehicle, a chief is designated to keep order.

When the last stop is reached, debarkation takes place only on command of the echelon chief (column chief). All the arrivals are organized at the evacuation reception point, where they are registered, receive orders (tickets) where they are to be settled, and then are guided to the relocation points. The evacuees do not have the right to independently select a living place (point) or to move from one region to another without the permission of the local evacuation organizations.

When an evacuee from a city has arrived and has been assigned to a rural locality, he must prepare cover [a fallout shelter] and continuously improve its protective properties.

4. Participating in the preparation of collective means of shelter. Each person in a city not scheduled to be evacuated must know in advance the location of the shelter nearest to his home, as well as the most convenient and rapid access route. If shelters are lacking when the threat of attack occurs, each city dweller must actively participate in preparing or equipping existing shelters or adapted basement facilities or in erecting fallout shelters. If everyone is highly organized and active, it is possible to do a great deal even in a short time: equip existing shelters, construct cover [fallout shelters], and improve cover [fallout protection] in basements, cellars, and other structures.

5. Preparing to protect one's own home or apartment. First, the apartment must be fireproofed. There must be no easily flammable items in the apartment.

Curtains and ordinary blinds must be removed from the windows and replaced with blinds covered with white paper or fabric impregnated with a solution of boric acid and borax, which makes the paper or the fabric fire-resistant. If desired, the window glass may be whitened with chalk or lime. If possible, wooden shutters (screens) should be placed on the window, coloring the outside white or covering it with a fireproofing substance. Clothes, footwear, and books which will not be used must be placed in suitcases, drawers, or cupboards. Kerosene, gasoline, and other flammable materials must be removed from the house and stored in safe places.

Articles blocking the entrance hall, corridors, and stairwells should be moved, but for extinguishing fires in the apartment and stairwells it is necessary to prepare a supply of water, sand boxes, and a simple fire-fighting kit. The house or the apartment must also be protected from penetration by radioactive dust and biological aerosols. For this reason, it is necessary to check for cracks and openings in walls, ceilings, floors, doors, and windows. All detected cracks must be carefully sealed. Window frames should be reconditioned and covered on the inside with paper and the glass smeared with plaster. The doors should be expeditiously covered [on the inside] with thick material (leatherette, burlap, blankets).

It is very important to protect buildings or individual premises from penetration by radioactive dust. In stone houses and plastered ceilings with cracks, it is necessary to apply a filling or plaster compound. In wooden buildings the grooves must be additionally caulked and then glued or cemented. Buildings made of prefabricated wooden panels must be glued with two layers of paper. To prevent penetration of radioactive dust into the premises through flue pipes and chimneys, it is necessary to install protective devices on the chimneys, and flues should be smeared with clay. Under the threat of enemy attack, it is possible to greatly increase the protective characteristics of buildings and especially small houses. This is achieved by piling bricks in the window openings, or even sandbags or earth. It is possible to increase the protective thickness of the wall of a one-story building by covering it with earth to a height of 1.8 m from the floor. To support the earth covering against the walls, it is possible to use fencing, boards, and other means. The protective characteristic of a ceiling can be increased if an additional layer of earth is placed on it, and basement facilities can be strengthened by additional pillars and beams.

6. Taking measures to protect foodstuffs and water. To protect foodstuffs from contamination by radioactive and toxic materials and biological media, they must be kept out of contact with the air. In the home, waterproof and ordinary wrapping is used for this, or the products are wrapped in soft, protective materials. In rural areas foodstuffs are kept in cellars under the floor, in basements, and storerooms, which should be sealed airtight if possible. Using impermeable containers, available in the city as well as the country, assures complete protection of the food and water from contamination by radioactive and toxic materials and biological agents. The impermeable containers include canning jars, glass jars with screw-on lids, bottles with ground-glass stoppers, milk containers with airtight lids, metal and wooden kegs, and thermos bottles.

Use of penetrable packaging materials makes it possible to reduce contamination to a considerable degree. Penetrable packaging materials include cardboard boxes, containers, and other vessels (Fig. 84). To increase the protective properties of containers and boxes, they can be lined on the inside with paper, and the tops of vessels can be sealed with paper or cloth packing (Fig. 85). Wrapping the foodstuffs in various types of packaging materials reduces the degree of contamination, and multilayered wrapping may completely protect them. Paper, oilcloth, canvas, and cellophane and other films are used as packing materials.

Wrapping is used primarily to protect the useful life of the products. Soft, protective materials may also be widely used to protect various types of products. Well wrapped products can be placed in containers, boxes, and other non-airtight containers. Such a combination of wrapping and packing may well protect the food-

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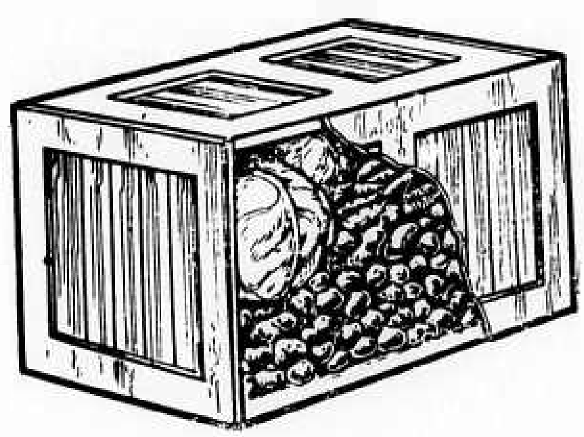

Fig. 84. Box for protecting vegetables.

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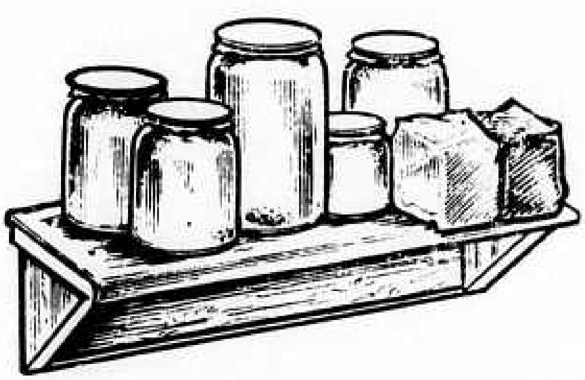

Fig. 85. Protecting products under home conditions.

stuffs from contamination by radioactive and chemical substances, as well as biological media.

To protect water, use glass bottles, canisters, cans, barrels, and other containers. Water reserves must be replenished daily. Well shafts in rural areas are closed tightly with an adjustable cover. A shed is built over the frame or, better still, a closed booth. The area around the wall in a radius of 1.5 to 2 m is covered with a 20-cm layer of clay, and the surface of the clay is covered with a 15-cm layer of sand. To drain rain water from around the edge of this area, a trench is dug. Under the threat of contamination, the well may also be covered with canvas or water-impermeable material.

7. Participation in execution of antiepidemic measures. The enemy may use biological weapons, which may cause epidemic infectious diseases; in addition, during war operations infectious diseases may occur as a result of destruction of sewage and water supply systems, low-quality food preparation, and other causes. To forestall the occurrence and spread of epidemics, it is necessary to carry out all antiepidemic measures strictly, follow inoculation programs, and take drugs which prevent sickness. It must be remembered that preventive mass inoculation programs and the use of vaccines, serums, antibiotics, and other preparations not only reduce the number of victims but also help to quickly stem the spread of the disease. Inoculations are provided which will immunize a person simultaneously against several infections. Immunization of the population can be achieved by different methods: cutaneous, subcutaneous, perorally (by mouth), and aerosols. The simplest method is oral, providing mass inoculations in a short period of time and creating a long-term immunity to infection. In addition to vaccines to prevent illness, we also use sera which create immunity very rapidly, but do not maintain it for more than one month.

It is necessary to strictly observe sanitary-hygienic rules. It is the duty of each citizen not only [personally] to observe rules of personal hygiene, but to see that they are kept by all family members, neighbors, and working colleagues. He must wash his hands with soap after work and before taking food and observe the sanitary-hygienic conditions both at home and at [other] places he frequents; all lavatories must be thoroughly cleaned. It is also necessary to observe rules for storing food and water. Milk and water must be boiled before use; vegetables and fruits must be carefully washed with boiling water, while meat and fish must be boiled thoroughly.

8.2 WHAT THE PEOPLE SHOULD DO IN RESPONSE TO CIVIL DEFENSE SIGNALS

To warn the population of imminent danger, signals have been planned by civil defense organs:

Air alert (AA)
Close protective shelters (CPS)
All clear (AC)
Threat of radioactive contamination (TRC)
Radioactive contamination (RC)
Chemical attack (CA)
Biological contamination (BC)
Threat of flooding (TF)

Let us examine some rules of conduct for the population upon [hearing] civil defense signals under various conditions. The "air alert" signal is given to warn of the imminent danger of attack. The signal is announced over radio networks with the words "Attention! Attention! This is the civil defense staff speaking! Citizens! Air alert! Air alert! Air alert!" The signal is also given by extended intermittent industrial and transport whistles and sirens for periods of 2 to 3 min. At national economic facilities, the signal is repeated by telephone, in noisy factories by electric sirens, and at observations posts by hand sirens.

On the signal "air alert," all citizens take refuge in blast shelters or fallout shelters or use the protective features of the terrain, since it is dangerous to stay at home, especially in a multistory house. What a person does depends on where he is. If the signal is heard at home, then it is necessary to organize oneself quickly, leave the apartment, and go to a blast shelter or fallout shelter. Before leaving the apartment, it is necessary to turn out the lights and heaters and shut off the gas. If a kerosene lamp, a stove, or an oven is lit, they must be extinguished. Then the prepared food supply, drinking water, and individual means of protection should be taken out, and safety should be sought in the nearest blast shelter or fallout shelter.

It is not permissible to take unwieldy articles, inflammable liquids, or domestic animals into the shelters. On the way to the blast or fallout shelter, it is necessary to keep calm; one should not panic, run, or pass others. When entering the shelter, it is necessary to keep order and not crowd one another. All citizens arriving in the shelter are obliged to observe the rules of shelter use and to obey all orders of the commander and civil defense officials, occupying their assigned places and not blocking passages. In the shelter the citizen is not allowed to smoke, make noise, talk loudly or shout, walk around unnecessarily, run, or burn lanterns or matches. When feeling ill ([with such symptoms as] headache, nausea, high temperature, or other indications of sickness), it is necessary to report immediately to the commander or to the medical room (if there is one in the shelter).

Everyone in the shelter must have individual protective equipment in readiness. If one is in a shelter lacking airtight sealing and filtering equipment, it is necessary to don the individual devices for protecting the respiratory system at once.

If the "air alert" signal is given at work, then the workers and employees act in accordance with the instructions and directions of the management. Usually, the majority of workers and employees in the plant stop working on the signal and go to the blast or fallout shelter. Attendants assigned to production equipment which is to continue to operate safely stay on the job. For these workers, individual cover is provided near the equipment. In mechanized plants, laboratories, warehouses, and loading areas, all work is suspended, all production and technical equipment is stopped, and the workers go into the [blast] shelters or to fallout shelters prepared for the plant, department, section, or formation.

If the signal is sounded [while one is] on the city transportation system (street car, trolley, bus), each person should leave the vehicle as soon as it stops and run for cover. Blast shelters or fallout shelters can be located by listening to the instructions of civil defense officials or police. When riding near the outskirts of a city, the driver, in accordance with the instructions of civil defense officials, must stop near natural cover (ravines, open pits, shafts, ditches), which may be used for protection from the damaging effects of a nuclear blast.

If the "air alert" signal sounds in a store, in the movies, or in another public place, it is necessary to listen carefully and quietly to the instructions of the management regarding the location of blast shelters and fallout shelters and the most convenient access [to them]. If the management does not give instructions, then one should leave the shop and go to the shelter as indicated by signs. Citizens who are not successful in reaching a shelter at the time of the blast can use ditches, ravines, hills, and mounds for this purpose, or lie prone on the ground since in this position injury will be greatly decreased.

The signal "close protective structures" is given after the "air alert" signal when some time [still] remains until the nuclear blast. This signal is transmitted by radio with the often repeated announcement: "Close protective structures! Close protective structures!" On this signal, admission to the shelter is stopped, and the shelter commander orders the civil defense official to close the entrance doors and the emergency exits (manholes).

The "all clear" signal is given to inform the population that the threat of attack has passed. The signal is transmitted over the radio with the words: "Attention! Attention! This is the civil defense staff speaking. Citizens! The danger of attack has passed. The air raid alert is lifted." In addition, information is given concerning the activities of the population and civil defense formations based on the actual overall situation. On this signal, all citizens leave the blast shelters and fallout shelters and go about their business. At national economic facilities, "all clear" signals are repeated by local radio networks and by telephone. On this signal the workers and employees of the plant, having sought safety in shelters, leave and resume work or follow the instructions of the staff.

After announcement of the signal "all clear," the population must be prepared for a second attack and follow the rules and decrees of the civil defense staff established during the period of the threat of enemy attack. If the enemy has already succeeded in destroying some cities, then the "all clear" signal does not apply to them; the radio will provide information as to what the population should do on the basis of the actual overall situation and take measures to liquidate the secondary effects of the attack.

Activities of the population at a center of nuclear destruction depend on where people happen to be at the moment of the nuclear blast: in blast shelters, in fallout shelters, or outside [such] shelters. If a shelter has remained undamaged, the people can take cover in it for an extended period of time until special instructions are given by the civil defense staff or until a signal has been received. In a shelter damaged by a blast, the air intake ducts may [also] be damaged and the air supply to the shelter may be cut off; when the municipal water supply or the shelter sewer system are damaged, there is the threat of flooding. In addition, fires may start near or in the building under which the shelter is located. Under such conditions, it is dangerous for people to remain in the shelter. Thus, they must take measures to leave the shelter without waiting for the arrival of rescue teams.

As soon as contaminated air is discovered to have penetrated the shelter, it is necessary to put on gas masks or other means of protecting the respiratory system. Following instructions of the commander, the shutters of the emergency exit are opened (if possible) so that the people can leave the damaged shelter (Fig. 86). If it is impossible to use the exits, it may be necessary to clear away the obstructions blocking the exits using available help or to make a new exit where the shelter commander indicates. In all cases, before leaving the shelter and entering contaminated territory, it is necessary to put on individual means of protection, check them carefully, and listen to the instructions of the commander concerning exit routes, the direction in which to move, and the location of medical posts.

A center of nuclear destruction presents serious dangers for people in view of the possible collapse of partially destroyed buildings, fires, and radioactive contamination. Thus, movement through urban areas after a nuclear blast requires great care and adherence to the rules of safety. If civil defense reconnaissance designates quarantined areas and has erected signposts to indicate routes of passage, it is necessary to exit along the designated marching routes and thoroughfares and to follow the erected signposts (Fig. 87). If the safety signs and instructions have not been posted yet, the marching route must be selected independently and

Fig. 86. Leaving a damaged shelter.

Fig. 87. Leaving the focal area of destruction.

exit made from the center of destruction without waiting for the completion of reconnaissance work. It is necessary to exit in the direction of least destruction.

The signal "threat of radioactive contamination" is issued on the basis of the anticipated movement of the radioactive cloud from the nuclear blast in order to warn the population of the danger of radioactive contamination. This signal is given by the surviving communications facilities and by radio with the words: "Attention! Attention! This is the civil defense staff speaking. Citizens! A threat of radioactive contamination exists!" The direction in which the nuclear cloud is moving and the time at which radioactive fallout is expected are announced. In addition, a report is made concerning the necessary defensive measures which should be taken by all directors of national economic facilities and by each family, according to the instructions of the civil defense staff.

Upon the warning signal "threat of radioactive contamination," all citizens should prepare immediately to shelter themselves from fallout. In addition, the time of arrival of the radioactive cloud is calculated. The period of threat of fallout may be very brief. Thus, with the threat of fallout, it is necessary to complete elementary preparations for defense in consideration of the overall circumstances.

First, individual means of protection are prepared and kept ready. Fallout shelters are prepared and [during these preparations] work sealing them airtight is carried out (if this work was not [already] completed), and food and water are protected.

At a national economic installation which is continuing its productive activities, measures are taken to ensure plans operations under conditions of radioactive contamination. First, the civil defense staff warns the observation posts, a working regime is established for the plant, and the working time of each shift is set in consideration of the anticipated radiation level. The availability of individual means of protection is checked with the working shifts. Measures are taken for partial airtight sealing of the production facilities: the windows are closed, along with ventilation [ducts] and other apertures.

When the observation posts detect radioactive contamination, the signal "radioactive contamination" is given to warn the population of the danger of radioactive contamination. The signal is transmitted by radio with the words "Attention! Attention! Civil defense staff speaking. Citizens! Radioactive contamination." In addition, the population is given explicit advice concerning defense measures. At a national economic facility, the signal is transmitted over the local radio systems and repeated by frequent strikes on a bell or gong.

On the signal "radioactive contamination" it is necessary to put on individual protective means and go into a blast or fallout shelter. If there is a high degree of contamination, it is necessary to stay in the shelters for an extended period of time. Under such circumstances, the shelters must be supplied with food and also with light and heat facilities, which can be prepared beforehand.

The order of operations and the standards of conduct for the population in the contaminated region is determined by the civil defense staff, which describes the radiation conditions and advises people what they should do. What people should do depends on the zone of radioactive contamination in which they find themselves.

In the zone of moderate radiation (A), on the boundary of which the radiation dose D_∞ [total dose from time of deposition to infinity] amounts to 40 R, it is advisable to be under cover for several hours, after which one should return home. In the first day it is permissible to leave the house for not longer than 4 hr. Moreover, in dry windy weather it is necessary to use individual means of protection.

In the zone of strong radiation (B), on the boundary of which the radiation dose D_∞ amounts to 400 R, it is necessary to stay under cover for up to three days, after which one may return home. Moveover, one should stay in the house for up to four days. One should leave the house not more than 3 to 4 hr per day. When leaving the house, it is necessary to use individual means of protection, since there is radioactive dust in the air.

In the zone of dangerous contamination (C), on the boundary of which the radiation dose D_∞ amounts to 1200 R, it is necessary to stay under cover longer than three days. After this it will be possible to return home, but not to leave except in utmost necessity and not for more than 4 hr.

Such standards of conduct for the population are required when a very high level of radiation is observed. This level drops fairly rapidly: to one-tenth after 7 hr and to one-hundredth after two days. Thus, in the presence of fallout it is necessary to be under cover to reduce the exposure dose. Then, when the radiation level drops, one can go home again. Length of confinement to the shelter depends on the zone in which it is located and the type of shelter being used.

The degree of radiation attenuation afforded by the shelter is characterized by the shielding coefficient K. Basements of brick buildings and sod-earth covering attenuate radiation 100 times. Thus, in the first period of contamination one must be under such cover. Residential homes have a lower shielding coefficient than do fallout shelters; thus it is practical to be in them [only] after the radiation level drops.

When in contaminated territory, it is necessary to remember that one must never eat food from open containers or drink water from exposed sources since they may be contaminated with radioactive substances. One must eat only protected products, stored in basements, cellars under the floor, refrigerators, cupboards, and in various packages, and also food wrapped in various materials (oilcloth, film, paper). Water for drinking or for preparing food may be taken from water supply lines and from protected wells. Water in open reservoirs covered with a thick layer of ice is also suitable for drinking.

If there are no fluids to drink or water protected from contamination, water must be decontaminated before consumption. Decontamination methods depend on the type of product and may be carried out in the following order. Dry, loose products stored in bags may be poured into a fresh package since the radioactive substances settle on the surface of the package. If the products are stored in the open, then it is necessary to remove the top 2 to 3 cm. Meat, fish, vegetables, and fruit are decontaminated by washing them with a spray of water and cutting away the upper layers. Potatoes are washed and cleaned. Solid fats (lard, butter, cheese) are decontaminated by paring the upper layer 2 to 3 mm thick. Food products stored in airtight packages remain aseptic, but it is necessary to carefully decontaminate the outer surface by wiping it off and washing it with water.

In the absence of protected water sources, water can be decontaminated by various methods: distillation, filtration, sedimentation, and, under domestic conditions, by filtration and settling. Use [several] different filters to filter the water. Put a layer of gravel and sand in a small tank or in a barrel with a spigot, and then use a carbon filter made with a cloth bag so that the water passes through it. Settling is the simplest method for decontamination, but it does not guarantee reliable removal of dissolved radioactive substances. To hasten the process of settling undissolved radioactive substances in the water, it is necessary to add special substances — coagulants. To settle water, it is poured into a tank for 10 to 15 hr, after which the upper layer is carefully decanted. It is possible to obtain uncontaminated water by digging a hole 2 to 3 m in from a shore. Water flows into the hole from the water reservoir, filtered through a layer of soil, and becomes fit to drink.

Dosimetric instruments (radiometers) are used to verify the complete decontamination of food products and water. The permissible radioactivity level of food products and water is listed in Table 30.

At national economic facilities when the signal "radioactive contamination" is given, the workers and employees put on their individual means of protection and act in accordance with the directions of management. The CD staff establishes the working regime of the facility beforehand, depending on the contamination zone in which it is located. The workers and employees may continue working in their protective facilities or take cover in shelters for the period during which the radiation level [rapidly] decreases.

If necessary, decontamination is organized at a national economic facility. First, means of transport and thoroughfares are decontaminated. Motor vehicles are decontaminated, they are washed with water or decontaminated with solutions at decontamination stations of the transport service. Sweeping, harvesting, and irrigation equipment is used to decontaminate areas. Primarily, thoroughfares, passages from plants to shelters, and embarkation-debarkation transport areas are decontaminated. When their work is finished, the workers and employees undergo personal decontamination. Each person partially decontaminates himself after he leaves the contaminated zone. In addition, complete decontamination takes place at special washing stations, set up on the base of bathhouses, sanitation posts, and public showers. Complete decontamination of clothing and footwear is carried out at special places set up beside the washing station (Fig. 88).

The signal "chemical contamination" is given to warn the people that toxic materials have been used and detected. The signal is given over the radio: "Attention! Civil defense staff speaking. Citizens! Chemical contamination!" In addition, at national economic installations, the signal is repeated by announcements over local radio stations, by the frequent blowing of factory whistles, and by beating the [railroad] tracks and sounding bells, gongs, etc. On this signal it is necessary immediately to put on a gas mask and protective clothing and enter a shelter. It might be necessary to remain in the shelter, which is equipped with antichemical devices, until orders come from the CD staff to leave.

In the shelter it is necessary to put on individual means of protection: gas masks and rubberized mantles. If a person is outside the blast or fallout shelter he must slip on his gas mask and protective clothing and leave the area of contamination. The direction in which he proceeds in departing from the center of chemical contamination is designated by signs. If no signs have been put up, then he will leave to the windward side

Table 30

Name of product	Volume of the product	MPC (mR/hr)
Macaroni		
Vermicelli	Small kettle	0.2
Groats, fresh fruits	(1.5 liters)	0.4
Boiled drinking products		
		0.4
Bread, loaf	1 kg	0.3
Fish	$25 \times 25\ cm^2$	0.4
Drinking water	Pail (10 liters)	0.9
Industrial water		9
Meat	Carcass, halfcarcass	4

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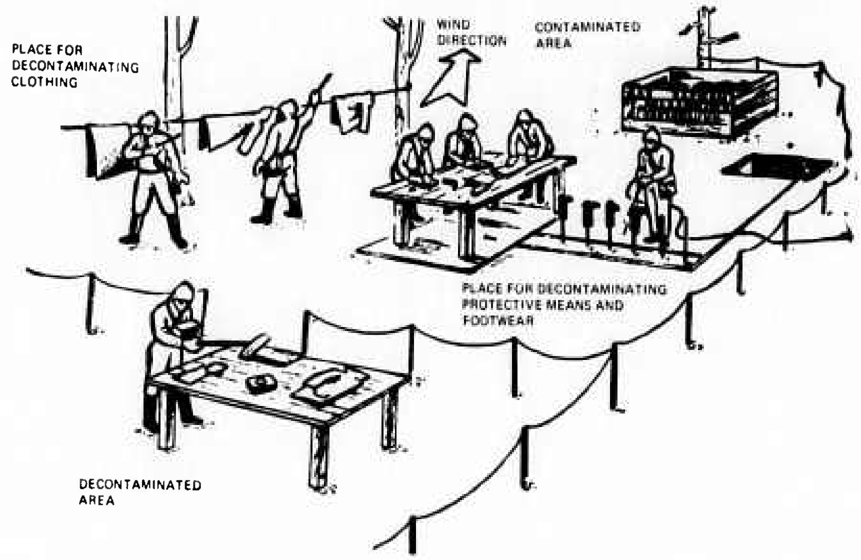

Fig. 88. Decontaminating clothing and footwear.

(gainst the wind) or toward the side perpendicular to the wind direction.

It is necessary to pass quickly through the contaminated territory, but he should not run or raise dust. When moving through contaminated territory, one must remember not to lean against buildings, sit down, or remove one's gas mask and other means of protection. One must not take off one's gloves and adjust one's gas mask and clothing with bare hands. It is necessary to continuously check to be sure the entire surface of one's body is covered.

If the enemy has used TM, special attention must be paid to the path over which one is moving: avoid drippings, grease, and puddles, as well as contact with plants and other objects. If TM drips on one's skin or clothing, it must be carefully removed. For this purpose the individual antichemical kits IPP-51 (Fig. 89) or IPP-8 (Fig. 90) can be used. If there is no individual antichemical package, then the TM drops can be wiped off with cotton, rags, or fiber packing. In extreme cases it is possible to use paper, hay, and other materials. When removing the TM drops, care must be taken not to smear or to transfer these drops to other parts of the skin. The contaminated area on the skin must then be decontaminated with a liquid from the antichemical kit, using a solution from the small container or preparing the solution from the large container in advance. If there are no kits for decontaminating burn-causing TM, any solvent can be used: alcohol, gasoline, kerosene. In extreme cases it may be necessary to remove the TM with only a pad.

It must be remembered that even after leaving the contaminated region, the surfaces of clothing, footwear, and protective means are still contaminated to some degree by TM vapors. Thus, it is not permissible to remove the protection, especially the gas mask, without an order. Having left the center of contamination, people are required to proceed with complete decontamination and disinfection of clothing at special washing stations set up in accordance with CD staff instructions.

Protection of workers and employees from chemical contamination while working in plants and in institu-

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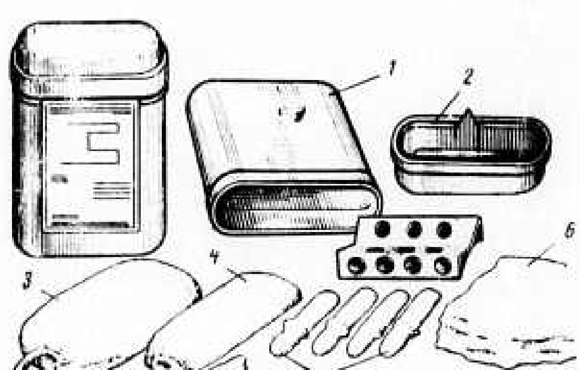

Fig. 89. Individual antichemical kit (IPP-51): (2) plastic box; (2) cover with tab; (3) large container for decontaminating vesicant TM; (4) small container for decontaminating nerve-paralytic TM; (5) ampuls with antismoke mixtures; (6) gauze pads.

Fig. 90. Individual antichemical kit (IPP-8): (1) overall view of kit; (2) flask with disinfecting liquid; (3) cotton-gauze pads.

tions is ensured by carrying out a system of medical measures using individual and collective means of protection, as well as by performing decontamination. At national economic facilities, when the "chemical contamination" signal is given, the workers and employees don their individual means of protection and act according to plans developed by the management and according to the predetermined schedule of activities for workers and employees in special situations, especially during chemical contamination. The instructions may be to stop work and take cover in shelters or to continue work while wearing individual means of protection. In addition, measures are taken to seal the plant premises almost airtight: Windows and doors are closed and ventilators are stopped.

Decontamination work is undertaken to clean up the area of chemical contamination, especially where there is persistent droplet-liquid contamination of the terrain or of various objects. Working in centers of contamination requires great physical effort from people, as well as experience in dealing with special means of protection, technical equipment, and special substances. Thus, decontamination work involves special training.

The signal "biological contamination" is issued to warn the people of the use of biological weapons by the enemy. The signal is given over the radio with the words: "Attention! This is the civil defense staff speaking. Citizens! Biological contamination!" When the signal is given, instructions are issued concerning the area of biological contamination, the measures which must be taken, and the conduct of the population in the area of biological contamination. At a national economic facility the signal is repeated by the local means. On this signal the population takes cover in shelters and stays there unless otherwise instructed by the CD staff. Citizens who are outside of the shelter when the "biological contamination" signal is given don their individual means of protection and act according to CD staff instructions issued by radio. If there are no shelters, people should remain in their apartments.

If the terrain has been contaminated with biological weapons, a quarantine or observation period may be imposed. The CD staff will announce implementation of these measures on the radio. When a quarantine is imposed, the entire region of suspected contamination is completely isolated; boundaries are established, and crossing them from either side is absolutely forbidden. Observation posts are set up at the limits of the quarantined zone. The medical CD service carries out the necessary preventive medical measures over the entire territory of the quarantined zone. In the case of an observation period, the departure of individuals from the contaminated zone is not forbidden, but is limited and is permitted only after the necessary preventive measures have been taken.

In contaminated areas complete personal decontamination of the people is performed, as well as decontamination to clothing, footwear, household articles, and living quarters. The entire population in the contaminated zone and in adjoining areas is given preventive inoculations as well as vaccines, antibiotics, and other medicines.

When the first signs of illness appear, a doctor must be called, and the patient isolated. After being examined by a doctor, the patient may be hospitalized or left at home for treatment, depending on the character of the infectious disease and the actual situation. When being treated at home, sick persons are kept in a separate room or their beds are partitioned off with screens. It is recommended that patients be nursed by [only] one person who, when on duty, uses individual means of protection. Separate dishes which are systematically disinfected are set aside for the patient. The population which is within the zone of biological contamination must strictly adhere to all the requirements of the civil defense medical service.

Social intercourse is limited. Courses in educational institutions and the work of certain [other] institutions and plants is discontinued on the instructions of the CD staff. Public transportation is limited, and trade in markets is discontinued.

Rules pertaining to personal hygiene and to the sanitary conditions of dwellings and the territory adjacent to them must be strictly observed. One must not drink powdered milk and [ordinary] water. Water must be obtained from uncontaminated sources checked by the medical service. All foodstuffs must be kept in tightly wrapped packages and processed before being eaten. Water and milk must be boiled thoroughly, green vegetables and fruits must be washed in boiling water, and bread must be toasted over a fire. Dishes must be carefully washed and boiled, and when taking food each person must have his own dishes. Food wastes must not remain in the house; they must be kept in tightly closed barrels or boxes and then removed. The packages of the used products must be burned. To observe sanitary standards in dwellings, it is necessary to treat the handrail of the stairs and the door handles with disinfectants, and the toilet bowls should be sprinkled with calcium hypochlorite. Flies and other insects must be kept out of the living quarters. Rodents must be especially combatted.

All citizens leaving the premises must use individual means of protection: gas masks, dustproof masks, and face masks, as well as rubber footwear and cloaks. Before entering from the street, it is necessary to remove footwear and cloaks and leave them outside the door to be treated with disinfectants.

Protection of workers and employees while they are working in plants and institutions is ensured by instituting an entire system of sanitary-hygiene measures, providing immunization, using individual and collective means of protection, and also by timely liquidation of the secondary effects of biological contamination.

It is particularly important to carry on the entire complex of all antibiological protection measures when obviously infectious diseases have entered a facility and may cause many people to get sick simultaneously. When the "biological contamination" signal is given at a national economic facility, the workers and employees put on individual means of protection and take cover in shelters. To liquidate the secondary effects of biological weapons, it is necessary first of all to prevent spreading of infection beyond the limits of the site. After the use of biological weapons and the type of biological agent have been established, social contacts between people working in the plant are limited; entering and leaving the contaminated area are discontinued. The arrival and departure of transport vehicles are permitted only after the area, the building, and the structures have been disinfected.

All persons leaving the territory of the contaminated site must be subjected to special preventive measures and complete sanitary processing, including decontamination of underwear, footwear, and individual means of protection. When people are found to be sick, they are sent to a hospital for infectious diseases or are placed in a field hospital set up in the plant area. It is not permissible to evacuate people with especially dangerous infectious diseases (plague, cholera, smallpox).

Decontamination of a contaminated area is carried out in the following sequence: transportation equipment is decontaminated first, then the outer surfaces of buildings and structures, and, finally, the inner premises of plants and other facilities (Fig. 91.)

The signal "threat of flooding" is issued to warn the population of possible flooding due to the destruction of water-control structures. The signal is issued over the radio with the words: "Attention! Civil defense staff

Fig. 91. Decontamination of premises.

speaking! Citizens! There is danger of flooding." At the same time instructions are issued over the radio concerning measures which must be taken to protect the people and property. People living in flooded areas must leave and go to unflooded areas. Preparations for actions to be taken on the signal "danger of flooding" are made in advance. With the threat of enemy attack, persons living in regions in danger of flooding must be evacuated. Evacuation of these regions is organized by civil defense organizations and is accomplished by the entire population. It is carried out in two stages: first, exit from the flooded zone into nonflooded territory; second, evacuation into the outer zone.

Thus, upon threat of attack it is necessary in a short period of time to carry out a large complex of civil defense measures. To successfully carry out the protective measures it is necessary to study the methods and sequence for their implementation in peacetime. Knowledge of civil defense signals is also very important. Thus, it is the duty of all citizens of our nation to prepare to protect themselves from weapons of mass destruction and to know what to do on hearing the civil defense signals.

9. Radiation Detectors, Chemical Survey Meters, and Dosimetric Control Instruments

9.1 DESIGNATION, CLASSIFICATION, AND OPERATING PRINCIPLES OF DOSIMETRIC INSTRUMENTS

Dosimetric instruments are designed to determine the radiation levels on terrain and to measure the dose rate of radioactive contamination of various structures and objects, the dose rate on the surface of clothing and on human skin, the contamination of food products, water, forage, etc. They are also used to determine the exposure dose of individuals working at radioactively contaminated sites and areas.

Dosimetric instruments can be classified into two basic groups according to their purpose: radiation survey meters and dosimeters for exposure dose monitoring. The group of instruments for radiation surveys includes activity detectors and roentgenometers, while the group of instruments for exposure dose monitoring includes radiometers and dosimeters.

Detection of radioactive materials is based on the power of their radiation to ionize the material in the media in which the radiation is propagated. The following methods are used to detect and measure radioactivity: photographic, chemical, scintillation, and ionization.

The photographic method is based on measuring the degree of blackening of photoemulsions under the effect of radiation. Gamma rays, acting on silver bromide molecules in the emulsion, knock out electrons from the compound. As a consequence, minute silver grains are produced [on development] which cause an increase in density of the developed photographic film. The degree of film blackening (density) is proportional to the gamma dose. By comparing the density with a standard, it is possible to determine the exposure dose received by the film.

The chemical method is based on determining the color change of some chemical compounds under the effect of radiation. Thus, chloroform, for example, when irradiated decomposes and forms hydrochloric acid which, by accumulating in a determined amount, discolors a dye added to the chloroform solution. By comparing the color of the medium with specified standards, it is possible to determine the dose.

The scintillation method is based on the fact that under the influence of radiation, some substances emit photons of visible light. The light flashes produced (scintillations) can be recorded.

The ionization method is based on the fact that gases in an isolated volume ionize under the influence of nuclear radiation; electrically neutral atoms (molecules) of the gas split into positive and negative ions. If there are two electrodes in this volume, to which a constant voltage is applied, then an electrical current flow is produced between the electrodes. A directional stream of the ionized gas particles occurs in the presence of an electrical field, that is, an electrical current called the ionization current flows through the gas. By measuring the ionization current it is possible to determine the radiation intensity.

In modern field dosimeters, the ionization method is the one more widely used to detect and measure radiation. Instruments operating on the principle of the ionization method have basically the same design, including a sensing device (ionization chamber or gas-discharge counter), the electrical circuitry (ionization current amplifier), current indicator (microammeter), and power pack (as a rule, dry-cell batteries).

The ionization chamber [integrating device] looks like a capacitor, to the plates of which a constant voltage is applied from a battery. The gap between the plates, called the working volume of the chamber, is usually filled with air. In the absence of radioactivity, the air in the chamber is not ionized and no current is conducted. Under the influence of radioactivity, the chamber air is ionized and an ionization current flows through the chamber, creating a voltage drop (Fig. 92) on the resistor connected to the circuit. Since the

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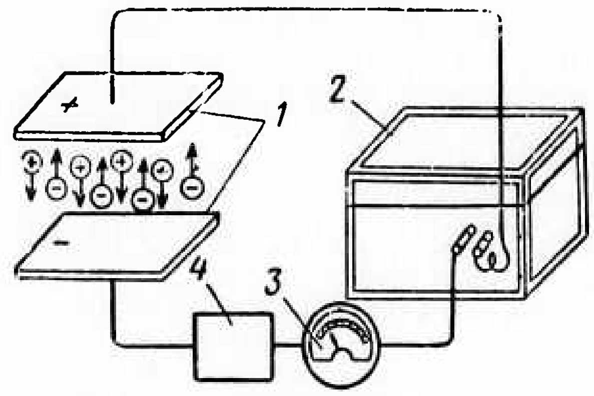

Fig. 92. Schematic diagram of ionization chamber: (1) electrodes; (2) power pack; (3) meter; (4) amplifier.

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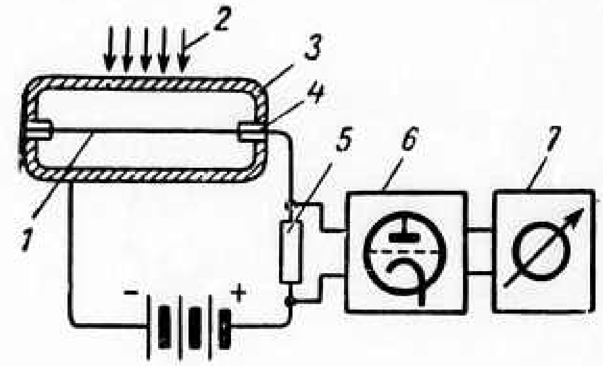

Fig. 93. Schematic diagram of the gas discharge counter: (1) wire (anode); (2) radiation incident on counter; (3) thin-walled metal tube (cathode); (4) insulator; (5) load resistance; (6) electronic amplifier; (7) recorder.

quantity of the voltage drop is directly proportional to the intensity of the ionization current and, consequently, to the dose rate incident on the chamber, the radiation level can be determined by measuring the voltage drop. The design of the ionization chamber (geometry, volume) can vary greatly. It depends on the type of radiation to be measured, the magnitude of the measured dose, and the type of instrument in which the chamber is used.

The gas discharge counter [*sic*, pulse ionization chamber] (Fig. 93) consists of two electrodes on which a constant voltage is applied from the power pack. One of the electrodes is a metal cylinder connected to the negative terminal of the battery; a thin metal wire, functioning as the second electrode, is stretched along the cylinder axis and connected to the positive battery terminal across a resistor. The metal cylinder is simultaneously the counter housing. There are also gas discharge counters [*sic*, geiger counters] with a glass housing, the inside surface of which is covered with a layer of copper, which serves as the negative electrode. This gas discharge counter is hermetically sealed. The electrode gap is filled with a rare gas mixture of inert argon and neon with some additions, improving counter efficiency.

The gas discharge counter is used to measure the ionizing activity of low-level radiation and the level of alpha, beta, and gamma contamination on technical equipment, clothing, food, etc. A high counter sensitivity makes it possible to measure low-level activity. The degree of contamination is measured by the number of radioactive decays of the material per unit time, which in turn are determined by the number of pulses produced in the gas discharge counter. Thus, measuring the degree of contamination reduces to counting the pulses produced on the counter per unit time. The gas discharge counter may be used to measure the gamma dose rate since the number of pulses produced in the counter per unit time is proportional to the gamma dose rate incident on the counter. Usually, such counters are used as sensors in radiometers.

9.2 RADIATION SURVEY METERS

The instruments designed for radiation surveys include: radioactivity indicators DP-63 and DP-63-A, roentgenometers DP-2 and DP-3, and roentgenometric radiometers DP-5 and DP-5-A. Radioactivity indicators DP-63 (Fig. 94) and DP-63-A are designed to determine the beta-gamma contamination of terrain, as well as to measure low activity levels. The basic components of the instrument are: the semiconductor transformer PEV; two gas discharge counters, one designed to measure dose rates up to 1.5 R/hr and the other to measure dose rates up to 50 R/hr; a microammeter M-130; and a power pack (two dry cells of type 1.6 PMTS-X-1.05).

Switches for turning the power on and off are located on the outside panel. The remaining components and parts of the electrical system are installed in the housing, mounted on the inside of the front panel by means of brackets. The measuring range of the device for gamma radiation is 0.1 to 50 R/hr. To increase precision, this range is divided into two stages: the first 0.1 to 1.5 R/hr and the second 1.5 to 50 R/hr. One power pack assures uninterrupted operation of the instrument for 50 hr. A standard specimen (beta active) under the meter serves to check the efficiency of the instrument at 1.5 R/hr.

Gamma rays with high penetrating power freely penetrate the instrument walls. The housing walls are

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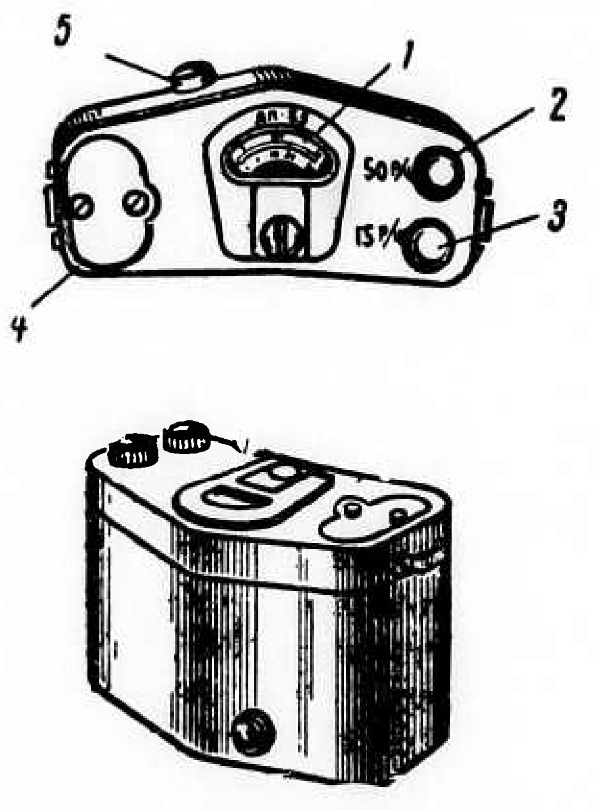

Fig. 94. DP-63 radioactivity indicator: (1) recorder scale; (2) button for the range 1.5–50 R/hr; (3) button for range 0.1–1.5 R/hr; (4) battery compartment; (5) button for reading beta radiation.

opaque to beta particles due to their weak penetrating power. Thus, there is a rectangular window in the bottom of the housing as an inlet for beta radiation to the instrument; the window is sealed with aluminum foil 0.1 mm thick. This window is closed from within by a shutter, which is opened by pressing a button on the front wall of the instrument housing when beta radiation is to be measured. This makes it possible to detect beta contamination in the first range stage. The weight of the instrument in the housing is about 1.2 kg.

Sequence for using the instrument. The following steps are necessary to prepare the instrument for operation:

1. examine the outside of the instrument, insert the two batteries 1.6 PMTS-1.05 in the power compartment, and tightly fasten the lid with [its] screws;
2. test the power source by simultaneously pressing the buttons "1.5 R/hr" and "50 R/hr" on the top panel; the instrument needle must be to the right of the figure 5 R/hr on the scale; if the needle is to the left of the 5, then the batteries must be changed; with new batteries in the instrument, the needle must deflect to the end of the scale, 50 R/hr;
3. test the operating readiness by pressing the button "1.5 R/hr"; the pointer must be at "0" on the scale; the operational capability of the instrument should be tested in the absence of a gamma background.

Making the measurements. When measuring the radiation level, the instrument is held at a height 0.7 to 1.0 m from ground level, the "1.5 R/hr" stage button is pressed, and, without releasing it, the reading is taken on the instrument scale. If the needle moves up to the end of the scale, the "1.5 R/hr" button is released, the "50 R/hr" button is pressed, and a reading is taken on the instrument scale. Two readings determine the beta radiation. In the first step the gamma-ray reading is taken in the sequence indicated above. In the second step, the "1.5 R/hr" button and the button on the front wall of the instrument housing are pressed simultaneously, and the instrument is taken 20 to 30 cm away from the contaminated surface. In addition, the window for beta particles is opened on the counter, and if the reading is higher the second time, this attests to the presence of beta radiation.

The DP-2 roentgenometer (Fig. 95) is designed to measure the gamma-radiation level in the field. The instrument has a measuring range of 0 to 200 R/hr; the range is divided into three stages: 0 to 2, 0 to 20, and 0 to 200 R/hr. The roentgenometer has changeable scales for the various stages which are read by turning a switch. The radiation level is read directly on the instrument scale in roentgens per hour. The instrument may be immersed in water for a short time (up to 10 min) to a depth of not more than 0.5 m and may be left in the rain. The operational capability of the meter is

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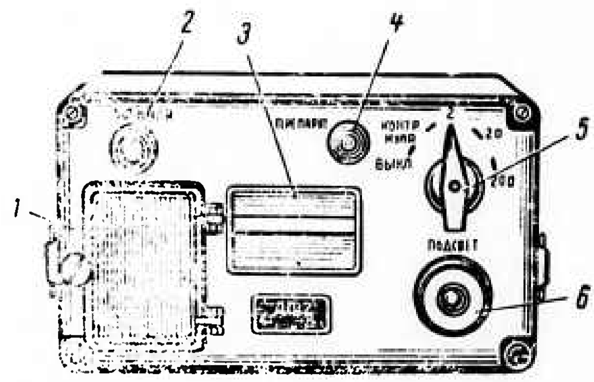

Fig. 95. Roentgenometer DP-2 (front panel).

tested with the aid of a radioactive standard in the instrument.

The instrument is powered by a dry-cell battery of type 1.6 MPTS-V-8, allowing continuous operation of the instrument for 60 hr at +20°C. There is a small lamp in the meter to illuminate the scale for nighttime operation. The weight of the instrument is about 3.5 kg. The basic components of the DP-2 roentgenometer are the ionization chamber, the input resistance, the dc amplifier, the microammeter, and the power pack.

The air in the chamber is ionized by gamma radiation, and an ionization current is produced in the circuit which is proportional to the dose incident on the chamber. The ionization current flowing through the input resistance produces potential difference, which is measured with the aid of a dc amplifier. A microammeter is connected to the amplifier output, directly indicating the radiation level in roentgens per hour. The instrument is mounted on a panel and enclosed in an aluminum case. On the control panel there is a lid for battery compartment (1), meter (3), stage switch (5), "zero drift" control (2), "calibration" switch (4), and "light switch" (6). The instrument is kept in a carrying bag with pockets for the technical instructions and log book. The instrument is operated while in its bag.

When preparing the DP-2 roentgenometer for operation, it is necessary to:

1. set the range stage switch in "off" position;
2. open the lid of the battery compartment, install the 1.6 MPTS-V-8 battery in the compartment, clamp it in place, close the lid, and fasten it with its screws;
3. put the stage switch to "zero control" position and adjust the "instrument zero" pointer to zero on the scale division;
4. place the stage switch to the 2 R/hr position, allowing one scale increment drift of the instrument pointer;
5. press the "calibration" button; the instrument needle must deflect to the control mark on the instrument name plate.

Taking the measurements. When the instrument is turned on to detect radioactive contamination, it is set at the first range, 2 R/hr. If radiation is present, the pointer moves and indicates the measured dose rate, that is, the radiation level. If the needle goes off the scale, then it is necessary to switch the instrument to the next range (20 R/hr and 200 R/hr) according to the instrument readings.

When monitoring the radiation level by reconnaissance on foot, the instrument is fastened to the belt with straps at a height of 0.7 to 1 m from ground level. When monitoring the radiation level with an automobile-mounted meter, it is necessary to multiply [the reading] by the attenuation factor of the vehicle body, which on the average is: 2 for automobiles, 4 for armored transports, and 10 for tanks. While working with the roentgenometer, it is necessary to check the instrument for "zero drift" every 10 min for the first half hour, and every 30 min subsequently. When operating at night, it is necessary to press the "light" switch to illuminate the instrument scale.

The DP-3 roentgenometer (Fig. 96) is designed to measure the radioactivity level from motor vehicles, armored transports, or helicopters. The measuring range of the instrument is 0.1 to 500 R/hr. To increase the reading precision, the range is divided into four stages: (1) 0.1 to 1.0, (2) 1.0 to 10, (3) 10 to 100, and (4) 50 to 500 R/hr. The roentgenometer is powered from the vehicle electrical system by a low-voltage network with a constant voltage of 12 of 26 V. The voltage of 150 V necessary to power the ionization chamber is guaranteed with the aid of a semiconductor transformer. The time required for taking the readings (up to 90% of the measured values) is 5 sec for the first stage, 3 sec for the second, and 2 sec for the third and fourth.

The basic components of the instrument are the indicator console measuring block, wiring, mounting brackets, and accessory and spare parts. The indicator console consists of a metal housing, the front panel, and

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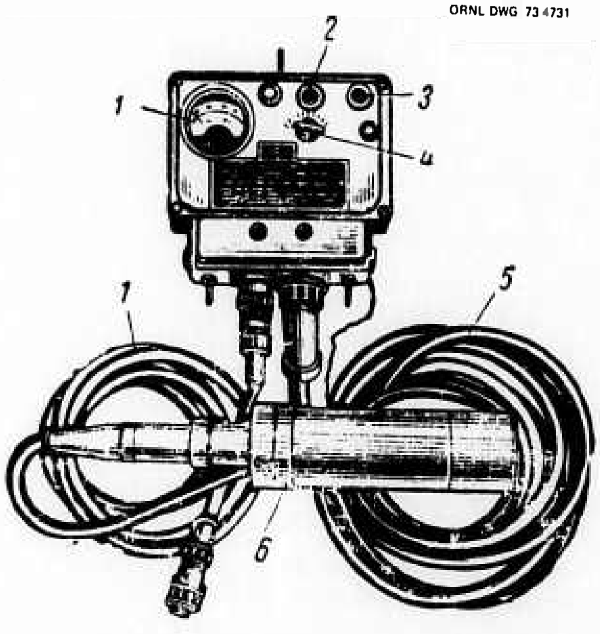

Fig. 96. Roentgenometer DP-3 (control panel).

the back cover. On the front panel there are: (1) microammeter; (2) illuminating indicator of the stages; (3) light for indicating radiation; (4) stage switch. The connecting cable (5), the measuring block (6), and the power cable (7), as well as the roentgenometer panel, are mounted in the compartment or under the hood of the vehicle.

Preparing a roentgenometer for operation consists of switching on the power and testing operational capability. Before turning on the power it is necessary to remove the back cover of the lower console compartment and set the slide switch to conform with the voltage value of the vehicle electrical system. Two light bulbs, an operating one and a spare one with nominal voltage conforming to the vehicle electrical system, must be screwed into the console sockets.

To test the operational capability of the instrument, the switch must be in the "test" position. If the instrument is in good condition, it is necessary to ensure that the signal lamp operates at a flash frequency of 3 to 4 per second and to check the deflection of the microammeter pointer, for example, at the center of the instrument scale. The measurement is made in the usual order by taking the reading on the instrument scale graduated in roentgens per hour. Movement of the microammeter needle is accompanied by flashes from the signal lamp, the frequency of which, when operating in the first stage, is proportional to the dose incident on the ionization chamber. In the third and fourth stages the signal lamp emits a steady light even in the absence of radiation.

When measuring the radiation level with a DP-3 roentgenometer, the instrument readings must be multiplied by the attenuation factor of the vehicle body as mentioned in the discussion of the DP-2 roentgenometer. The radiation level is measured in one of the stages by the readings on the instrument scale. In the first stage the position of the stage switch pointer and the light switch pointer is set as "X1," in the second at "X10," in the third at "X100," and in the fourth at "500." The readings on the first, second, and third stages are taken on the top scale of the instrument with divisions of 0 to 1. To obtain the value of the radiation level acting on the ionization chamber, the microammeter reading must be multiplied by 1 [*sic*] when operating on the first stage and by 10 or 100 when operating on the second and third stages, respectively. Readings in the fourth stage are taken directly from the lower scale in roentgens per hour.

Roentgenometer-radiometers DP-5 and DP-5A (Fig. 97) are designed to detect and measure the radiation level in the field and the radioactive contamination of

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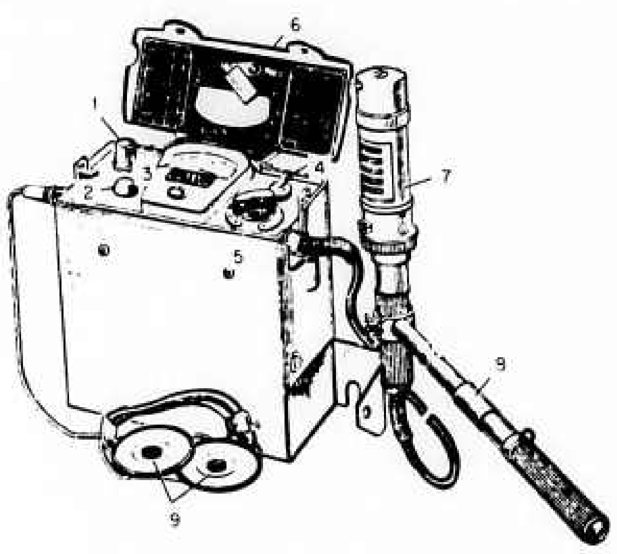

Fig. 97. Survey roentgenoradiometer.

human skin, clothes, technical equipment, food products, water, and various articles. The radiation level in the field is expressed in roentgens per hour, and the radioactive contamination is expressed in beta decays per minute per square centimeter of scanned surface (DP-5) or, for gamma radiation, in milliroentgens per hour (DP-5A). The DP-5 and DP-5A meters are similar in design as are the rules for operating them; they differ only in range stages and measuring scales, and thus can be discussed together. The basic components of the DP-5 and DP-5A instruments are the measuring console and the probe, connected to the console by a flexible cable 1.2 m long. In addition, the instrument set includes a headset, a carrying case with straps and a standard specimen, an extension rod, ten probe sleeves (of polyethylene film), a battery as the power source for the radiometer, a spare parts kit, documents (technical description, technical rating plate), and a storage box.

The following are located on the measuring console: electrometer (3), the stage switch (5), the regulating potentiometer (1), indicator switch (2), the toggle switch for lighting the scale (4), and standard specimen (6). The console also has the mounted cable, connecting the console with the probe, and headset (9).

Probe (7) is cylindrical in shape; in the probe there is a mounting plate, the radiation detectors, chamber-normalizing amplifier, and other circuit components. A steel sheath with a window is put on the plate to scan beta radiation. The window is covered with a waterproof ethylcellulose film. The probe has a movable

Table 31

Stage	Switch position	Instrument scale	Measuring stages	
			For beta rad. (decomp./min·cm^2)	For gamma rad. (R/hr)
I	200	0–200		5–200
II	5	0–5		0.5–5
III	0.5	0–5		0.05–5
IV	×1000	0–1000	100,000–1,000,000	
V	×100	0–1000	10,000–100,000	
VI	×10	0–1000	1,000–10,000	
VII	×1	0–1000	100–1,000	

shutter which may be set in two positions: "B" and "G." When setting the shutter in position G, the window of the housing is closed and the instrument measures only gamma radiation, while in position B the window of the housing is open and the instrument measures gamma and beta radiation. The housing is bolted to the plate. There are two lugs on the housing with which the probe is positioned to survey the beta contamination on the surface to be examined. For convenience of operation, the scanning probes have a handle, to which the extension rod (8) is attached.

The instrument is powered by two batteries of type 1.6-PMTs-Kh-1.05 providing continuous operation for at least 40 hr. The scale light is powered by one battery of the same type. The instrument has a changeover control for powering from external power sources at constant voltage of 3, 6, or 12 V. The changeover contact of the power control is in the compartment with the 1.6-PMTs-Kh-1.5 batteries.

The readings are taken on the scale of the electrometer with subsequent multiplication of these readings with the appropriate coefficient of the stage. The scale divisions from zero to the first significant value are inactive. The instrument has a buzzer for all stages except the first. The weight of the instrument is about 2 kg.

The DP-5 has a measuring range of 0.05 to 200 R/hr for gamma radiation and 100 to 1,000,000 decays/min·cm^2 for beta radiation. The measuring range is broken down into seven stages (Table 31). These meters can measure low levels of gamma radiation, for example, from 0.05 to 0.1 and up to 50 to 100 mR/hr on beta stages V, VI, and VII according to the scale increments. The DP-5A has a measuring range for gamma radiation from 0.05 mR/hr to 200 R/hr. The measuring range is divided into six stages (Table 32).

Table 32

Stages	Switch position	Instrument scale	Stages
I	200	0–200	5–200 R/hr
II	×1000	0–5	500–5000 mR/hr
III	×100	0–5	50–500 mR/hr
IV	×10	0–5	5–50 mR/hr
V	×1	0–5	0.5–5 mR/hr
VI	×0.1	0–5	0.05–0.5 mR/hr

To prepare the instrument for operation, one must:

1. set the "0" of the instrument with the mechanical corrector;
2. turn on the instrument, set the switch to "oper" position;
3. smoothly turning the "oper" lever clockwise, set the instrument needle at the "▼" mark on the upper scale; in "oper" position, the needle must be within the limits of the indicated arc;
4. test the operational condition of the instrument on all stages except for "200" with the aid of the standard mounted on the lid of the case. To do this one must release the specimen by turning the shield plate around its axis; place the probe window in position "B"; place the probe on the support lugs on the case cover so that the source is opposite the window; switch on the headset.

When bringing the probe into contact with the open standard on stages X0.1 and X1, the needle must be off scale, on stage X10 it must move, and on stages X100 and X1000 it may not deviate because the activity of the standard is too low. On subranges 0.5 and 5, the operational condition of the instrument is checked only by the clicks in the telephone.

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Fig. 98. Determining the degree of contamination with the DP-5 meter.

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Fig. 99. Determining the radiation level with the DP-5 meter (probe head set in "D" position, at a height of 1 m).

To measure the beta radiation one must:

1. test with the probe shutter in position B;
2. bring the probe to a distance of 2 to 3 cm (Fig. 98) from the surface to be scanned;
3. set the switch successively to positions X1000, X100, X10, and X1 until the needle of the microammeter moves within the limits of the scale;
4. read the instrument according to scale B corresponding to the position of the switch, considering the correction factor;
5. turn the probe shutter to position G, and measure the value of the gamma background.

The gamma background is subtracted from the total beta radiation to obtain the net beta contamination. To measure a gamma dose rate higher than 50 mR/hr, that is, the radiation level, it is necessary to turn the probe shutter to position G and to set the stage switch successively in positions 200, 5, and 0.5 until a reading is obtained within the limits of the scale. On stage 200 the radiation level is detected at the console location (Fig. 99) (on the operator's chest). Under these circumstances the readings are taken on scale 0 to 200 R/hr. In stages 0.5 and 5 the instrument records the radiation level at the probe location, the reading being taken from scale G (0.5–5). In stage 0.5 of the scale readings, it is necessary to divide by 10. It must be kept in mind that in position B of the probe shutter the total beta-gamma radiation dose is measured in stages 0.5 and 5.

9.3 DOSIMETRIC MONITORS

The dosimetric monitors include: the DP-12 radiometer, a set of individual DP-22-B dosimeters, and a set of individual DP-23-A dosimeters. In addition to these instruments, it is also possible to use the DP-5 and the DP-5A, mentioned earlier, for dosimetric monitoring. The DP-12 radiometer (Fig. 100) is designed to detect

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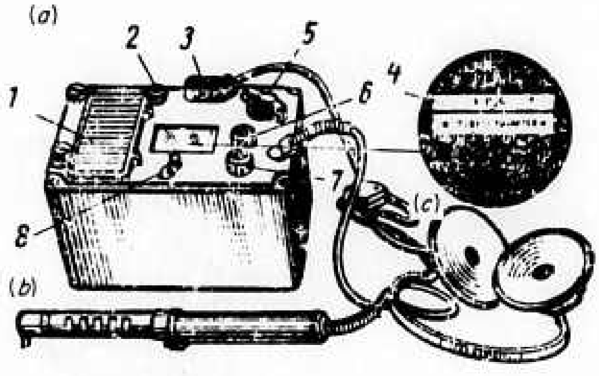

Fig. 100. DP-12 radiometer: (*a*) meter housing; (*b*) probe; (*c*) headset.

and measure the degree of radioactive contamination of skin and clothing, food and water, and technical equipment and other objects. It consists of a housing (*a*) with power pack, a probe (*b*) with a flexible cable connecting it to the panel, and a telephone (*c*) with a headset for listening. In addition, the set includes a rod for the probe, a carrying strap, a storage box, spare parts, and instruments. The instrument is powered by two 1.6-PMV-8 batteries assuring continuous operation for 75 hr.

The top of the radiometer housing contains an electrometer, with range scales (4), substage switch (5), filament voltage regulator ("filament") (6), anode voltage regulator ("anode") (7), socket (3) for plugging in the headset ("TLF"), light switch ("Light")(2) for turning on the scale illumination of the meter when working at night, set pointer (8) for fixing the reading, and battery compartment lid (1). The panel is closed with a hinged lid having a viewing window; on the inside of the lid there are brief operating instructions.

The radiometer probe has a small head and a mounting plate. There is a counter in the probe head, closed from within by a metal envelope. An outer sheath is slipped over the inner cover and can be fixed in three positions: G, B_1, and B_2 (Fig. 101). The radiometer probe is hermetically sealed and waterproof. If necessary, the probe may be provided with a special extension rod. The length of the rod can be adjusted from 415 to 709 mm.

The beta activity is measured in decays per minute per cm^2 of scanned surface or from one gram of loose material, and the gamma dose rate is measured in milliroentgens per hour (mR/hr). The CP-12 range covers 1,000–5,000,000 decays/min·cm^2 for beta radiation and 1–125 mR/hr for gamma radiation. The beta radiation range is divided into five stages, while the

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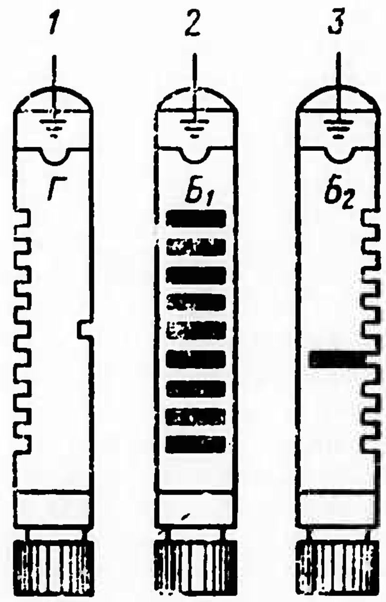

Fig. 101. Probe heads: (1) for gamma radiation; (2) for low-level beta contamination; (3) for high-level beta contamination.

Table 33

Switch position (color of the scale)	Stage			
	For beta radiation		For gamma radiation	
	Position of probe head	Decays/min·cm^2	Position of probe head	mR/hr
Black	B_2	500,000–5,000,000		
Red	B_2	100,000–500,000		
Blue	B_1	25,000–125,000	G	20–125
Green	B_1	5,000–25,000	G	5–20
White	B_1	1,000–5,000	G	1–5

gamma radiation range is divided into three overlapping stages. The transition from one stage to the next is made by the stage switch on the housing and the jacket of the probe head. Turning the switch on the housing automatically changes the reading scale (Table 33).

The total weight of the radiometer in its case is about 8.5 kg; the weight of the operating unit is not more than 4.5 kg.

To prepare the instrument for operation, the power is switched on, and the controls are adjusted. To begin operation one must set the stage switch on the console in "on" position, turn the "filament" and "anode" button counterclockwise as far as they will go, open the lid of the battery compartment, place the toggle switch in the battery compartment in "parallel" position, insert the cells in the battery compartment, clamp them in position, and close the compartment lid.

To set for operation, proceed as follows: move the stage switch on the panel from "off" to the right in any other position; press the "filament" button and turn it smoothly in clockwise direction; set the meter pointer at the increment line "R"; press the "anode" button and turn it smoothly clockwise; set the pointer of the meter at increment line "R." The presence of clicks in the headset and a weak, high-pitched sound means that the radiometer is operating normally.

Measuring the contamination of objects with the aid of the radiometer is carried out on uncontaminated background. Since the instrument indicates the total beta-gamma contamination, it is necessary before taking the reading to determine the gamma background as well as the corresponding pulse count which must be subtracted from the reading. To determine the gamma background, it is necessary to set the probe head to position G and set the stage on the blue scale, after which the probe head is lowered to the surface to be surveyed. The gamma radiation is read on the lower scale (in disintegrations per minute from one cm^2). If the gamma background level is lower than the stage of the blue scale, then it is necessary to shift to a lower stage with the green or white scale.

When high-level beta contamination (more than 100,000 decays/min·cm^2) is measured, the probe head is in position B_2, and the reading is taken on the stage corresponding to the black and red scales. When low-level beta contamination (up to 100,000 decays/min·cm^2) is measured, the probe head is in position B_1 and is used in the stage corresponding to the blue, green, and white scales. Without hurry, each stage is passed through (10–30 sec), and the pointer deflection and the indication are read on the lower scale. The value of the gamma background is subtracted from the total beta-gamma contamination.

If the contamination of an object shows a total beta-gamma contamination equal to the gamma background, only gamma radiation is measured for the surveyed object, and beta contamination is neglected. To measure a low-level gamma radiation in the presence of beta-gamma radiation, the probe head is set in position and the gamma radiation level is read on the upper scale (in milliroentgens per hour).

The individual dosimeter DP-22-B and DP-23-A sets are designed to monitor and determine the exposure dose of persons in radioactively contaminated areas.

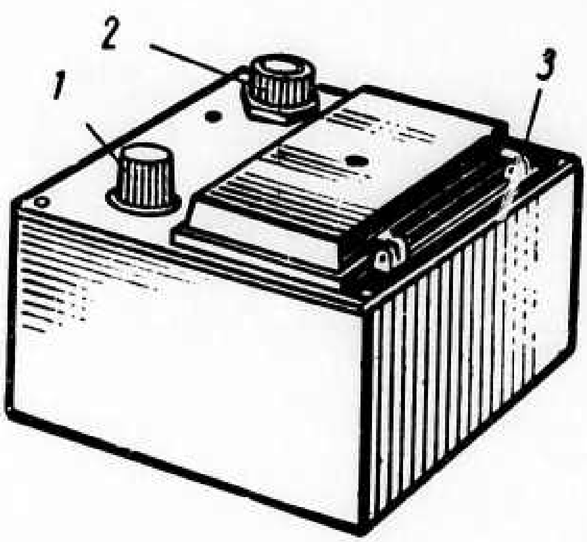

Fig. 102. Charging device ZD-5.

The DP-22-B set. A set of individual DP-22-B dosimeters consists of a charger ZD-5 for charging 50 individual DKP-5-A dosimeters. The charger ZD-5 (Fig. 102) consists of a charging plug, a voltage transformer, a high voltage rectifier, a potentiometric voltage regulator, a lamp for illuminating the charging socket, a microswitch, and batteries. On the top ZD-5 panel there is a potentiometer button (1), charge socket (2), and battery compartment (3). The charger is powered by two dry cells of the 1.6-PMTs-V-8 type. One set assures operation of the instrument for at least 30 hr with a current of 200 mA. The output voltage of the ZD-5 must be smoothly regulated between 180 and 250 V at a supply voltage of 3V.

Dosimeter DKP-50A (Fig. 103) is a simple ionization chamber (9) with a built-in capacitor (6). The Duralloy cylindrical housing (3) of the dosimeter is the outer electrode. The inner electrode (5) is an aluminum wire with a movable hairpin filament (4) of platinum. The reading device is shaped like a microscope with 90X magnification, consisting of eyepiece (1), lens (10), and scale (2). The scale has 25 divisions; the value of one division corresponds to 2 R. A plug (12) with openings for the eyepieces is screwed to the upper end of the dosimeter, while on the lower end there is a plug (7) with a window (8). For carrying in the pocket, the dosimeter has a clip (11).

The operating principle of the direct-reading dosimeter is similar to the operation of a simple electrode. When the dosimeter is charged, a voltage is generated between the electrodes of the platinum filament and

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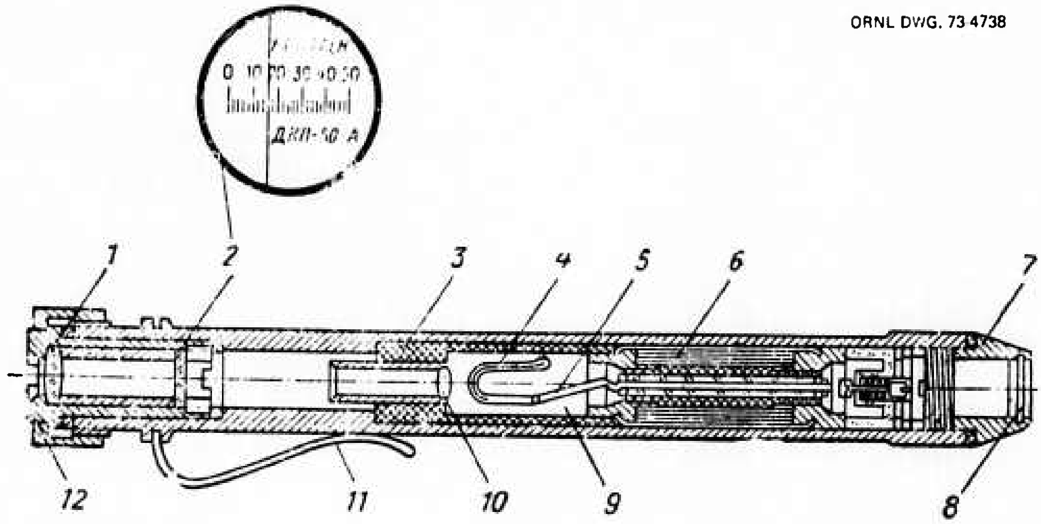

Fig. 103. DKP-50-A dosimeter.

chamber housing. Since the filament and the central electrode are connected, they receive the same charge, and, under the influence of the charge repulsion, the filament is deflected from the central electrode. The filament can be adjusted to zero by regulating the charging voltage. Under the influence of radiation, an ionization current is generated in the chamber, as a result of which the dosimeter voltage drops in porportion to the incident dose and the filament moves as shown on the scale, since its repulsion by the central electrode is reduced in comparison to [its repulsion resulting from] the initial voltage. When the dosimeter is held against the light and the filament is viewed through the eyepiece, it is possible to read the [accumulated] dose at any moment.

The DKP-50-A dosimeter provides for measuring the individual doses of gamma radiation in the 2- to 50-R range with a dose rate of 0.05 to 200 R/hr in the 200-keV to 2-MeV energy range. The direct-reading DKP-50-A dosimeter does not require auxiliary equipment to determine the exposure dose, but it must be charged before use on a charging device, and a platinum filament must be set on scale zero. Self-discharge of the dosimeters under normal conditions does not exceed two scale divisions per day. The weight of the set in the packing box is about 5 kg. The weight of the DKP-50-A dosimeter is not more than 32 g.

To charge the dosimeter on the charger one must:

1. unscrew the protective dosimeter case (glass plug) and the protective cap of the charge socket;
2. turn the potentiometer button as far to the left as possible;
3. plug the dosimeter into the charging socket of the charging unit and then turn on the light for the charging socket and raise the voltage;
4. looking into the eyepiece, press lightly on the dosimeter and turn the potentiometer button to the right until the filament image on the dosimeter scale reaches "0," after which the dosimeter is unplugged from the charger socket;
5. check the position of the filament in daylight; with a vertical filament position, it must be at "0";
6. close the protective dosimeter case and the charging socket.

When operating in a region of gamma-ray activity, the dosimeter is carried in the pocket. When the dosimeter is read periodically through the eyepiece, the position of the filament on the scale shows the exposure dose received during the period of operation. The reading must be taken with the filament image in the vertical position.

The DP-23-A set. This set of individual dosimeters DP-23-A is also designed to check the exposure of personnel working in a radioactively contaminated area. The set consists of 50 individual DKP-50-A dosimeters and 150 DS-50 dosimeters with a charging mechanism. The DKP-50-A dosimeter is the same as the one in the DP-22-B set.

The DS-50 dosimeter (Fig. 104) is a duraluminum tube (1), containing a rod (2), which does not touch the walls, as well as an insulated capacitor (3). One of the capacitor plates is connected to the rod, serving as an inner electrode, and the other to the inside chamber

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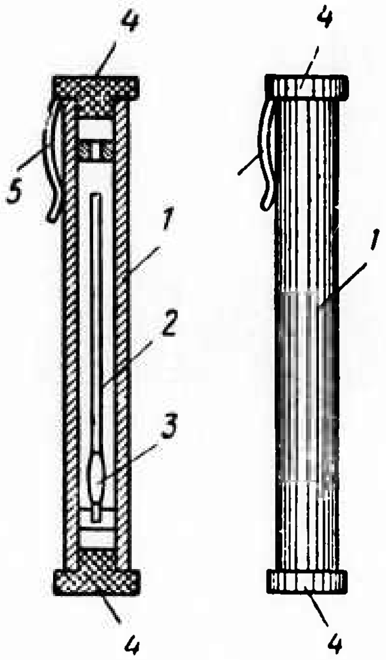

Fig. 104. DS-50 dosimeter.

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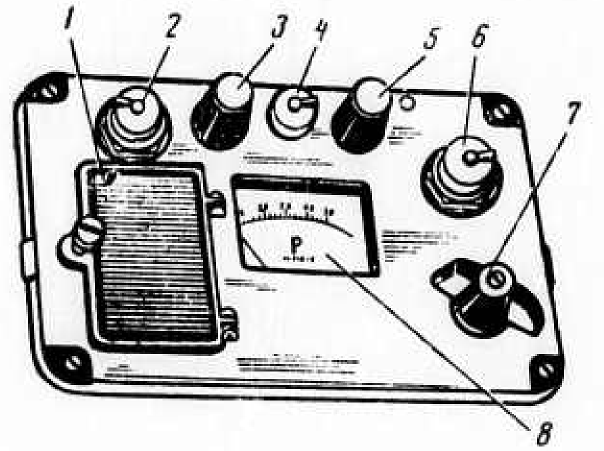

Fig. 105. Top panel of charge meter DP-23-A.

wall, which is the outer electrode. The chamber is filled with air and closed with two plugs (4). The serial number of the chamber as well as the number of the set to which it belongs are stamped on the upper plug. The lower plug is screwed to the charging and measuring chamber. The spring clip (5) on the upper plug serves to hold the chamber in a pocket. The weight of the chamber is 15 g.

The operating principle of the DS-50 is basically the same as that of the DKP-50. The dosimeter is charged by a charging device; in the presence of gamma radiation an ionization current is generated in the working volume of the chamber, and the electrode charge drops proportionally with the gamma dose wherever the chamber is located. The exposure dose can be judged according to the potential drop in the chamber.

The set provides for the measurement of individual gamma doses in the 0- to 50-R range. The dose incident on the DS-50 dosimeter is read from the scale of the charge meter device, graduated in roentgens. As described above, the doses recorded by the DKP-50 dosimeter are read directly on the dosimeter scale. The charge meter is powered by one cell of type 1.6-PMTS-V-8, which assures continuous operation of the instrument for at least 50 hr. The following are located on the panel of the charge meter (Fig. 105): the battery compartment lid (1), the socket (2) for charging the dosimeters, control button (3) for the charging voltage, the supply voltage regulator (4), the scale setting button (5), the socket for reading the doses (6), the stage switch (7), and electrometer (8).

To prepare the charge meter for operation, one must:

1. place the stage switch in "off" position;
2. insert the cell in the battery compartment, connect it, and close the compartment lid;
3. place the switch in "charge" position with the "charge" button and set the meter pointer on the extreme right increment line;
4. open the caps covering the "charge" and "reading" sockets;
5. unscrew the lower plug on the DS-50 dosimeter, insert it into the "charge" socket, and press the cap over it; this is how the dosimeter is charged;
6. set the switch in the "read" position and with the "scale set" button set the meter pointer on the extreme right increment line of the scale;
7. insert the DS-50 dosimeter in the "reading" socket and press the cap over it; the meter pointer must be set at zero.

The DS-50 dosimeter must be charged in the following sequence:

1. place the switch in "charge" position;
2. set the meter pointer on the far right increment line of the scale, using the "charge" button;
3. unscrew the lower plug of the DS-50 dosimeter;

4. open the cap of the "charge" socket and charge by alternately inserting the dosimeter in the socket and lightly pressing down on it;
5. screw in the lower dosimeter plug tightly, turn off the charge meter, and close the charging socket with an end cap.

Charged dosimeters are issued to persons whose exposure should be monitored. One charged dosimeter, DS-50 No. 150, is left in the set as a control. To charge the DKP-50 dosimeter, proceed as follows:

1. place the charge meter so that light falls into the side socket of the housing under the "charge" socket, or use an electric lamp for illumination;
2. unscrew the lower plug of the DKP-50 dosimeter;
3. set the switch into "DKP-50" position;
4. in sequence, plug the dosimeter in the "charge" socket and, turning the "charge" control knob, set the electroscope filament image of each dosimeter at zero on the scale;
5. tightly screw on the lower dosimeter plug, turn off the charge meter, and close the "charge" socket with a cap.

To measure the exposure dose on the DS-50 dosimeter, one must:

1. place the instrument switch in "read" position and, with the "scale control" knob, set the meter pointer on the far right scale increment line;
2. unscrew the lower plug of the DS-50 dosimeter;
3. in sequence, plug the dosimeter in the "reading" socket and, while pressing the dosimeter down, read the dose in roentgens on the meter scale;
4. screw on the lower plug of the dosimeters and place the dosimeters in the appropriate compartments of the packing box, turn off the charge meter, and cap the "reading" socket;
5. control dosimeter No. 150 is checked first. Its reading is subtracted from the reading of the other dosimeters. The results are recorded on the dose log.

Other types of instruments can be used for individual dosimetric control, for example, the chemical gamma dosimeter DP-70. This dosimeter (Fig. 106) is shaped like a glass ampul (4); it contains a colorless solution and is placed in a metal case (2). The serial number of the dosimeter is stamped on the bottom of the case. The case is closed with lid (3), on the outside of which is a color standard corresponding to the color of the solution exposed to 100 R. The dosimeter measures a gamma dose of 50 to 800 R. The weight of the dosimeter is about 40 g, and it is carried in a pocket. The operating principle of the chemical dosimeter is based on the fact that the solution colors under the influence of gamma radiation, a high dose corresponding to a high color intensity.

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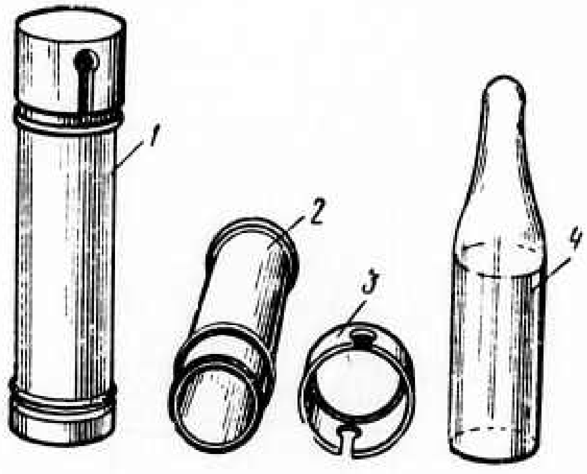

Fig. 106. DP-70 chemical dosimeter.

The field colorimeter PK-56 is used to determine the dose received by the dosimeter (Fig. 107). The dose is read in roentgens directly from the colorimeter scale. The colorimeter results are based on a comparison of the color of the liquid in the dosimeter ampuls with the color of one of 11 filters, corresponding to doses of 0, 50, 75, 100, 150, 200, 250, 300, 450, 600, and 800 R. The gamma radiation dose is measured no sooner than 1 hr after the dosimeter exposure, because the time to develop maximum color in the ampul solution is 40 to 60 min.

To measure the gamma doses, it is necessary to remove the ampul from the dosimeter case, expose it, plug the colorimeter into the right ampul holder socket, remove the colorimeter with the left hand, and hold it horizontally at eye level at a convenient distance for observing the field in the eyepiece; then hold it so that light falls on the frosted glass window in the lid of the ampul holder; with the right hand rotate the disk with the light filters until the colors of the fields visible in the eyepiece are the same. The gamma dose is read in the window of the colorimeter when the colors match. If the color of the solution in the dosimeter ampul is intermediate between two filter standards, the average is taken as the dose. The dosimeter allows the determination of exposure doses after a single or multiple exposure (in a 10- to 15-day period). The ampul must

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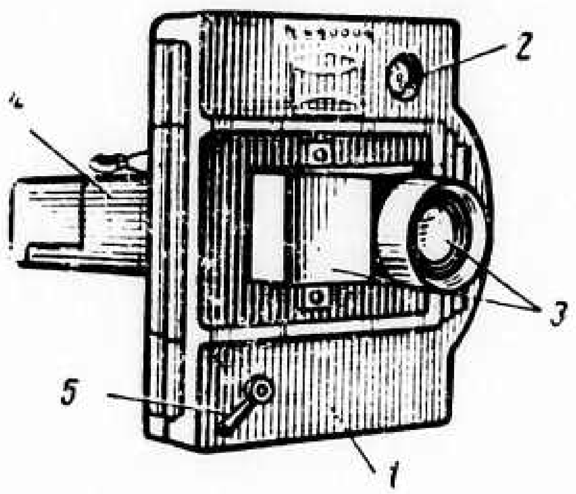

Fig. 107. Field colorimeter PK-56: (1) colorimeter housing; (2) reading window; (3) prism with eyepiece; (4) ampul holder; (5) lock.

not be exposed to direct sunlight nor read more than five or six times over a period of 1 min in daylight.

9.4 CHEMICAL SURVEY INSTRUMENTS

Toxic materials in the air, on the terrain, on technical equipment, and on other objects are detected by using chemical surveying instruments and gas detectors or by taking and subsequently analyzing samples in a chemical laboratory. The principle of detecting and identifying toxic materials with chemical survey instruments is based on the color changes of indicators reacting with the toxic materials. Depending on the sample that reacts with the indicator and depending on its color changes, the type of toxic material is identified; comparing the color intensity obtained with a color standard makes it possible to judge the approximate concentration of toxic materials in the air or the density of contamination on the object. The chemical surveying instruments are identical in principle. We will examine three models of these instruments: the army chemical surveying instrument (AICS); the chemical surveying instrument (CSI); the semiautomatic chemical surveying instrument (SICS).

The AICS (Fig. 108) consists of a covered housing containing a hand pump (1), a pump fitting (3), paper

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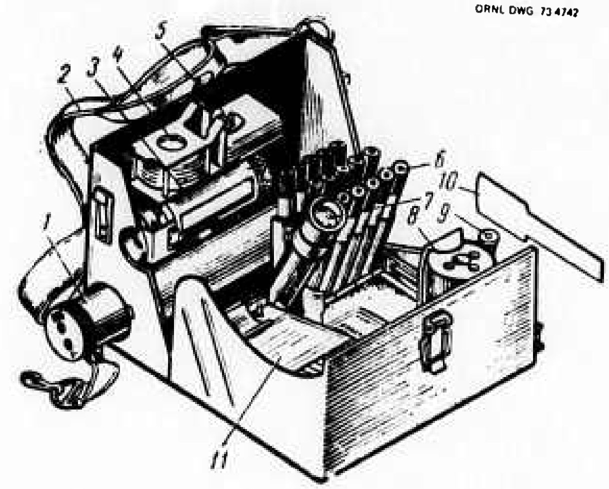

Fig. 108. Army instrument for chemical surveying (AICS).

adapters with indicator tubes (11), smoke filters (5), protective caps (4), lamp (7), and a heater (8) with 15 cartridges (6). The instrument kit also includes a pin (9), a trowel (10), an instruction book for operating the instrument, and an instruction book for determining the airborne soman-type toxic materials. There is an adjustable shoulder strap (2) for carrying the instrument. The weight of the instrument is about 2.2 kg.

The hand pump (Fig. 109) serves to pump the contaminated air through the indicator tube. The pump head contains a socket for inserting the indicator tube. The pump fitting (Fig. 110) makes it possible to increase the amount of TM vapors passing through the indicator tube. It is used to determine the presence of stable toxic materials on terrain and on various objects. The indicator tube (Fig. 111) is designed to identify the toxic materials. It is a sealed glass tube with a packing and glass ampuls of reagents. The tube has ring markings showing which toxic materials are determined by a particular tube. The AICS kit contains three types of indicator tubes: one with a color ring and color dot for determining soman, sarin, and V gases [lit.]; another with a yellow ring for determining yperite [mustard]; the third with a green ring for determining phosgene, hydrocyanic acid, and chlorocyanide. They are packed in paper cartridges of ten indicator tubes with the same marking.

The smoke filter is plateshaped and made of special cardboard. It is used to determine toxic materials in the soil and in bulk material, as well as to take smoke samples. The protective cap is also used to determine toxic materials in samples of soil and bulk material. The

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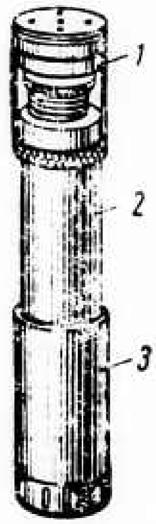

Fig. 109. Hand pump: (1) collector; (2) pump housing; (3) pump handle with ampul opener.

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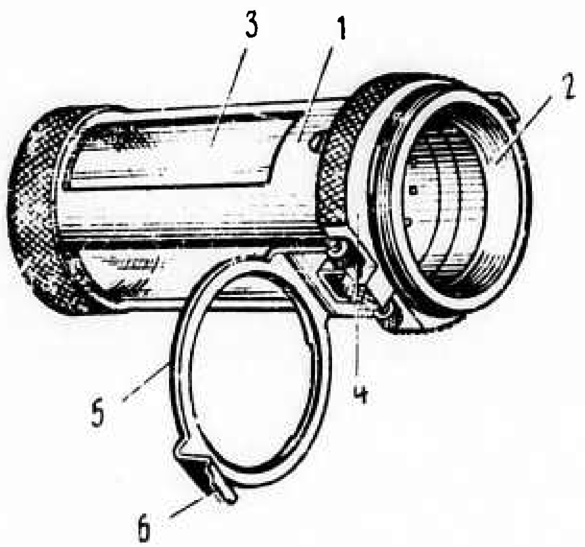

Fig. 110. Fitting to pump: (1) housing; (2) funnel; (3) glass cylinder; (4) nut; (5) clamping ring; (6) catch.

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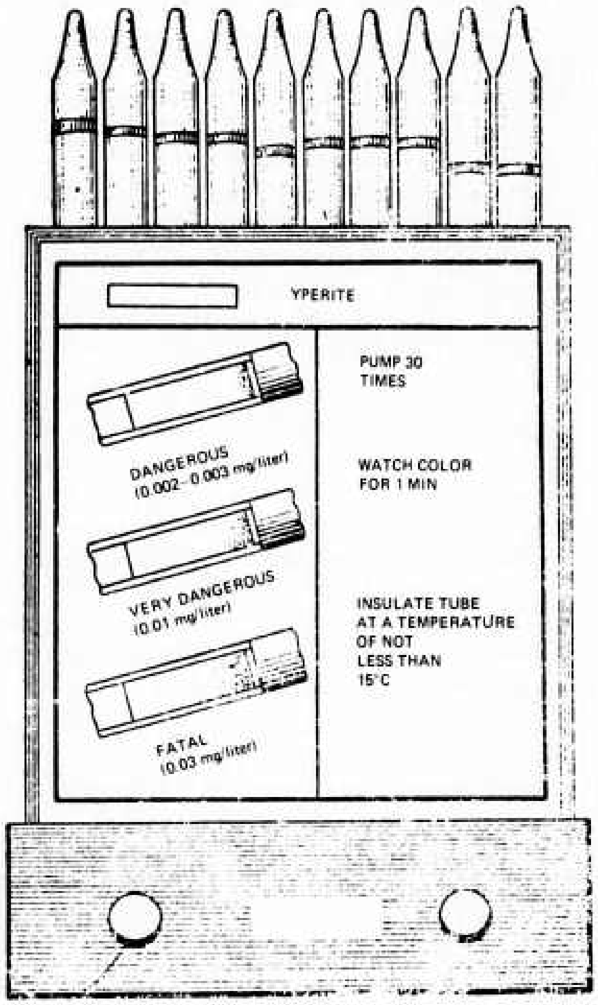

Fig. 111. Cartridge with indicator tubes.

cap is used to protect the inner surface of the funnel fitting from contamination by toxic materials. The heater is designed to heat the indicator tubes to determine the presence of TM at low ambient temperatures; it also serves to heat the indicator tubes for yperite when the temperature is below +15°C and to heat the tubes for soman when the temperature is below 0°C, as well as to thaw the ampul in the indicator tubes.

Determination of the presence of airborne toxic materials begins with checking for sarin, soman, and V gases. To do this, open the instrument lid, lift the latch, and remove the pump. Remove two tubes with one red ring and a red dot, cut off their ends, and open them. Using the pump ampul opener with the marking corresponding to the marking on the indicator tubes, break open the upper ampul of both tubes, take each tube by the end with the marking, and shake each of them two or three times with an energetic backhand stroke. Insert one of the tubes (experimental) in the pump with the unmarked end down and pump air through, pumping five to six times. Air is not pumped through the second tube (control). After this, using the ampul opener break open the lower tube ampuls, shake the tubes, and watch for color changes in the packings. A red color of the upper layer in the packing of the experimental tube (at the moment when the control tube turns yellow) indicates the presence of soman, sarin, or V gases in the air. A yellow color of the packings in both tubes is evidence of the absence of dangerous concentrations of these toxic materials. If the packings turn yellow the moment the lower ampuls of the indicator tubes are broken (this is possible if a substance with an acid character is present in the surveyed atmosphere), then the TM determination is repeated using a smoke filter.

With the use of this instrument it is also possible to determine safe concentrations of soman, sarin, and V gases, which is very important in instances when it is necessary to make a decision concerning removal of gas masks. Such a determination is made in the sequence described above, except that 30 to 40 pumpings are made when pumping the air through the experimental indicator tube, and the lower tube ampuls are broken only after 2 to 3 min rather than immediately after pumping air through.

The presence of airborne phosgene and hydrocyanic acid is determined independently [regardless] of the results obtained in determining nerve-paralytic TM. To test for their presence, open the indicator tube with the three green rings, break its ampul, insert the tube in the pump, and pump 10 to 15 times. Remove the tube from the pump and compare the color of the packing with the standard printed on the cartridge in which the indicator tube with three green rings was kept. Then test for the presence of yperite vapors in the air. To do this, open the indicator tube with one yellow ring, insert it in the pump, and pump 60 times. Then remove the tube from the pump and after 1 min compare the color of the packing with the standard printed on the cartridge for the indicator tubes with one yellow ring.

To test the air at low temperatures with the tube with one red ring and a red dot or with the tube with one yellow ring, heat the tube with the heater in the following sequence:

1. insert the heater cartridge in the central opening of the heater housing as far as it will go;
2. break open the ampul with the heater pin through the opening in the cartridge cap (the pin must be completely inserted in the cartridge);
3. several turns of the pin are sufficient to break the ampul, after which the pin is removed from the cartridge.

Before opening the indicator tubes with the red ring and the red dot at an ambient temperature of 0°C and below, insert the heater in the housing and heat the tube until the ampul is thawed (this takes 0.5 to 3 min, depending on the temperature). After the ampul is thawed, slowly remove the indicator tubes from the heater and use them to identify the toxic materials. After pumping the contaminated air through the indicator tube with one red ring and a red dot, open the lower ampuls of both indicator tubes, insert the tubes with the unmarked ends into the heater socket, and heat them simultaneously for not more than 1 min.

At an ambient temperature of +15°C and below, the tubes with one yellow ring are heated for 1 to 2 min after pumping through the contaminated air. In case of doubtful readings in the tube with three green rings at low temperature, the determination must be repeated using the heater.

Determining the presence of toxic materials on terrain, technical equipment, clothes, and various objects also begins by determining the presence of sarin, soman, and V gases. To accomplish this, remove the indicator tube with one red ring and a red dot, open it using the ampul opener, break open the upper ampul of the tube, and shake the tube vigorously two to three times. Then insert the unmarked end of the tube in the pump socket, turn the protective cap which is slipped over the fitting funnel, set the fitting on the soil or on an object to be studied so that the funnel covers the zone giving the best indication of contamination, and pump air through the tube about 60 times. After this, remove the fitting, take off the protective cap, remove the indicator tube from the pump socket, and break open the lower tube ampul. One minute after air has been pumped through the indicator tube compare the color of the tube packing with the color standard on the cartridge.

The presence of yperite on terrain, technical equipment, clothes, and various objects is determined in a similar manner; in this case use the indicator tube with one yellow ring.

The chemical surveying instrument (CSI) consists of a housing with a cover. Inside there is a manual pump, paper cartridges with indicator tubes, smoke filters, pump fittings, protective caps, and paper cartridges with protective coverings. In addition, the instrument set includes a flashlight, a small shovel, an instruction handbook, and an ampul opener for breaking open the ampul of the indicator tubes with one red ring and with a red ring and a red dot. The weight of the instrument is 2.8 kg. In contrast to the AICS pump, the CSI pump has a collector, making it possible to work simultaneously with one, two, three, four, or five indicator tubes.

There are four types of indicator tubes in the CSI instrument: [1] with one red ring for determining sarin and soman at concentrations of at least 0.001 mg/liter; [2] with one red ring and a red dot for determining soman up to concentrations of at least 0.00005 mg/liter; [3] with one yellow ring for detecting yperite; [4] with three green rings for determining phosgene, hydrocyanic acid, and chlorocyanide.

To determine airborne toxic materials one must: set up the pump collector in a position permitting operation with three indicator tubes; insert the indicator tubes for sarin in the pump collector (with one red ring), for yperite (with one yellow ring), and for phosgene, hydrocyanic acid, and chlorocyanide (with three green rings), opening them beforehand and breaking open the ampul of the tube with three green rings; pump 120 times; remove the indicator tube for sarin from the collector and break its ampul with a special pin; 1 min after pumping air through compare the color of the packing in each tube with the color standard on the appropriate cartridge. A color change of the packing in any tube corresponding to the color standard is evidence of the presence of airborne toxic materials as determined in this tube.

If, despite external indications of the use of TM, none of the tubes gives a positive reading, make a further air analysis with a tube for the soman-type TM (with a ring and a red dot), using two tubes simultaneously for this purpose: one for determining the TM (the air sample is pumped through this tube) and the other as a control (no air is pumped through). The sequence for working further with the CSI to determine TM in the air, on the ground, on buildings, technical equipment, and various objects is similar to that for working with the AICS, discussed above.

At very low temperatures (in winter), the ground may be contaminated with unstable toxic materials. Under these conditions it is necessary to insert a tube with three green rings in addition to the indicator tube with one red and one yellow ring.

The semiautomatic instrument for chemical surveying (SICS) (Fig. 112) is intended for special reconnoitering vehicles. It includes the following components: a pump with a heater, a fitting, indicator tubes in eight cartridges, a smoke filter, eight protective cartridges, report forms, spare parts, an oil can, and an instruction book for the indicator tubes with one red ring and a red dot. All these instrument parts are packed in a special box.

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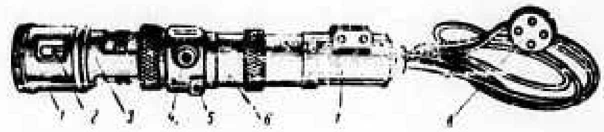

Fig. 112. Semiautomatic instrument for chemical surveying (general view).

The principle for detecting and identifying toxic materials with the SICS is also based on the color change of indicators when contaminated air is pumped through. The basic component of the instrument is a pump with a heater, with the aid of which the indicator tubes are opened, the ampuls are broken open, and air is drawn through the tubes and heated at low temperatures. The instrument [also] consists of a collector with a heater (3), a rotary pump unit with an electric motor (6), and a circuit breaker (7) with a flexible cable and a forked plug (8). The instrument housing has a window for a test tube with thermoindicators (1), a rotameter (2) (a float-type flow meter), a device (4) for opening the indicator tubes, and an ampul opener (5). The instrument is powered with 12 to 14 V by the vehicle's electrical system.

The collector is used to set up one, two, or three indicator tubes, as well as to connect the pump to the rotameter. It consists of a drum with a rubber gasket with openings to insert the indicator tubes. On the side surface of the drum there are indicator markings "1," "2," and "3," which can be seen through the window with an iron ring, while increment lines are made on the side surface of the iron ring. When the drum is set at marker 1, 2, or 3 according to the increment line, the pump is started corresponding to one, two, or three indicator tubes, in addition to which the rotameter is disconnected from the pump. When setting the drum at letter "P," according to the increment line, the opening for the indicator tubes is closed, the aperture is opened on the rotameter, and the ambient air flows only through the rotameter.

At ambient air temperatures of +10°C and below the heater can heat the indicator tubes by direct current of 12 to 13 V from an automobile's electrical system. For an orienting check of the temperature generated by the heater, the last two test tubes with thermoindicators are used. There is a slip of paper in one test tube with an indicator impregnated with a yellow dye; in the other there is dyed paraffin. A color change of the thermoindicator from yellow to orange reveals that the temperature in the operating range of the heater has reached about +30 to 35°C. When the paraffin begins to melt, this shows approximately 50 to 55°C. The thermoindicators and the tube indicators set up in the heater are observed through a window in the iron ring.

To prepare the instrument for operation, one must check the integrity of the instrument, the presence and amount of oil in the pump oil chamber, and the operating efficiency of the heater (at temperatures below +10°C) and of the pump. The operating efficiency of the pump is checked with a rotameter located in the heater housing. For this purpose the collector drum is set so that the letter "P" coincides with the increment line on the case, the pump is set vertically (heater down), and when the pump is operating, one observes the position of the rotameter float. With normal operation of the pump float, the end plane of the rotameter must be on a level with the control increment line (or higher).

To check the operating efficiency of the heater, the heater switch is set at the "VK" position. After connecting the nut in the center of the flat end surface of the heater, one must heat for 1 to 2 min (check by touch). In order to test the air of the pump collector, set it at position "Z"; open the tubes with one red, one yellow, and three green rings, insert them in the collector, and turn on the pump for 1 min to pump air through. Then, turn off the pump, remove the indicator tube with one red ring, and break its ampul; 1 min after pumping air through compare the color of the packing in each tube with the standard color on the appropriate cartridge label.

If, despite the presence of outward signs that toxic materials are being used, none of the tubes gives a positive reading, test the air further in the tube with the red ring and the red dot. To accomplish this, place the collector in position "1"; withdraw the two indicator tubes and open them at both ends; break the upper ampuls of both tubes, taking care to break completely the upper but not the lower ampuls; pick up the tubes by the marked ends and shake them vigorously 2 to 3 times; insert one of the tubes (experimental) in the collector, turn on the pump for 10 to 15 sec, and pump air through; do not pump air through the second tube (control); first break the second ampul in the experimental tube and then in the control tube; shake both tubes one to two times so that the upper layer of the packing is completely wetted; watch for the color change in the packing of the control tube, and when the packing in this tube changes color from pink to yellow, compare its color with the color of the packing in the experimental tube. A pink color of the upper layer of the packing in the experimental tube is evidence of the presence of airborne soman-type TM in a concentration of 0.00005 mg/liter or higher, and a yellow color is evidence of the absence of soman-type TM in these concentrations.

To be convinced that toxic materials are absent and that it is possible to remove one's gas mask, take a reading using the tube with one red ring and a red dot as indicated above, but instead of 10 to 15 sec, pump air through the tube for 2 min, and do not break the lower ampul of the tube at once, but about 2 to 3 min after completing pumping. In the presence of inert smoke, the TM determination must be made with the use of fittings with smoke filters.

The determination of toxic materials at an ambient air temperature of +10°C and below is made with the use of the heater. The heater should be heated in the process of preparing the instrument for operation; during heating, carefully watch the color of the thermoindicators and turn off the heater in time. A color change of the thermoindicator from yellow to orange shows that the heater has reached the optimum operating range for working with tubes at a temperature of +30 to 35°C. When the paraffin begins to melt in the red indicator, this is evidence that the maximum permissible temperature has been attained in the operating range for heating the indicator tubes (about +50°C). In this case the heater must be turned off immediately (avoiding damage to the tubes with the red ring and red dot).

When using the heater, work with the tubes is almost the same as without the heater, with the following differences:

1. after pumping the air through, the tube for yperite is heated in the heater for 1 to 2 min, and then the color of the packing is compared with the color of the cartridge label;
2. if the liquid in the ampuls of the indicator tubes has frozen, then the tubes must first be heated in the heater until the ampul contents melt;
3. in the process of determination, the control and experimental tubes must both be set up in the heater. In this case, one end of the control tube is not opened, and the tube is inserted with this end in the collector, in position "2."

In the process of working with the instrument, the pump and the heater must be periodically kept in a vertical position for 0.5 to 1 min in order to lubricate the pump.

The automatic gas detector GCP-1 (Fig. 113) is designed to continuously determine the presence of airborne toxic materials, as well as to detect radiation.

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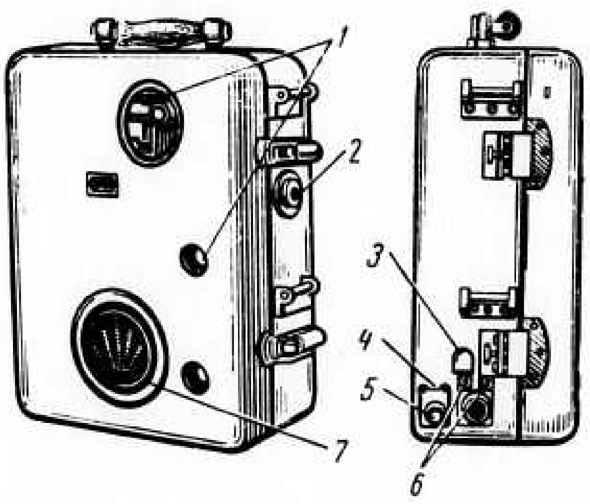

Fig. 113. Outside view of automatic gas detector GCP-1.

When operating the device, air is pumped through the periodically adjusted and wetted reactive indicator strip, which changes color when toxic materials are present in the air. The color intensity (darkening) of the strip is proportional to the TM concentration in the air. The color spot on the strip is sensed by the photoelectric cell, which responds to a light and sound signal.

The gas detector operates continuously since air is drawn through the wetted part of the strip in a set time interval (about 5 min), after which (with the aid of a strip feed mechanism) replacement of the used sections of strip takes place automatically. The strip is also wetted periodically, synchronized with its change of position. Thus, one operating cycle of the detector takes 5 min. In the presence of airborne TM, the concentration of which is equal to or higher than that determined by the instrument, the instrument produces a signal. The signal response time depends on the TM concentration, amounting to 2 to 4 min for the minimum concentration determined by the detector. In the case of high concentrations, the TM signal is given in the first minute of the operating cycle.

A gas-discharge counter with an electronic amplifying mechanism is used to detect radiation. A light and sound signal is given in the presence of radiation, since the operation of the gas detector is not connected with the cyclic operation of the instrument relative to TM. When low-level radiation is present (about 0.1 R/hr), the PV signal can be intermittent, while at a high level of activity it operates continuously. The gas detector is mounted in a metal housing. There is a viewing window (1) in the housing cover to observe the flow, and the sound signal is of type C-37 with the signal lamp on the indicator; the following are located on the side of the housing: a button for turning on the lamp of the flowmeter (2), an outlet opening covered with a cap (3), a cycle switching butt on (4), a toggle switch (5), and electrical terminals (6).

An adjustment unit for the indicator strip, an eye dropper, a bobbin for the used strip, a timer, a signal and light switch, a flowmeter, a protective cartridge, a lamp, a signal and lamp control, a thyratron button for controlling the relay, a rheostat, a scale for the membrane unit elements, a gas discharge counter, and a contact for switching on the voltmeter and relay are attached to the housing on a hinged panel with the photoelectric cells on the front.

The following are on the rear wall of the panel: the strip feed mechanism with its electric motor, a rotary pump, a filter, the voltage transformer, and the power pack. The following are included in the instrument set: a box with a battery for powering the gas detector, wiring, TM indicators calculated for three charges of the gas detector, and a voltameter for checking the voltage on the various parts of the instrument.

The gas detectors are turned on by moving the toggle switch (see Fig. 113) to the "on" position and simultaneously pressing the cycle switch. To activate the gas detector more rapidly, one must press the cycle switch twice in an interval of 1 min. Beyond this the instrument works automatically. With normal operation of the instrument, the green light turns on periodically with each cycle change, automatically tripping the strip feed, moving the indicating strip, wetting the reagent, and producing the characteristic sound.

In the presence of TM or radiation in the air, the gas detector automatically produces a signal. The gas detector is designed for continuous operation without overloading the indicating system for a period of not less than 8 hr and at a temperature of +30°C [86°F] and higher for not more than 8 hr.

10. Organizing and Conducting Reconnaissance at a National Economic Facility in a Center of Mass Destruction

10.1 KINDS OF RECONNAISSANCE AND PROBLEMS INVOLVED

Reconnaissance is the most important means by which civil defense forces assure the accomplishment of their missions. It is organized by the civil defense chiefs, their staffs, and service personnel, and is conducted to obtain the data necessary (1) to determine the extent and priorities of rescue and urgent emergency-restoration work and the means for doing it; (2) to determine the level of radioactive, chemical, and biological contamination in a given area, and location and condition of obstructed blast shelters and fallout shelters, the degree and character of destruction of buildings and formations [organized units], engineering systems, and communication lines; and (3) to clear the approaches to working areas and routes for evacuating the injured.

The basic requirements for reconnaissance operations are activity, continuity, expedience, and validity. *Activity* includes the employment of all methods and means to acquire data on the conditions necessary for organizing the activities of the civil defense forces. *Continuity* is achieved by full-scale reconnoitering both by day and by night and under all weather conditions. *Expedience* is assured by acquiring and transmitting information on conditions accurately and within established time limits. *Validity* is achieved by obtaining reconnaissance data from various sources and carefully studying, correlating, and, if necessary, verifying and confirming these data.

Reconnaissance is conducted by all formations and civil defense services by means of visual observation, instruments, and direct inspection of the terrain (facility). The problems of reconnaissance must be examined as a function of the conditions.

1. Reconnaissance is faced with the following tasks under the threat of enemy attack:

continuous radioactive, chemical, and biological observation and laboratory checks of the contamination of various surfaces and objects;

the determination of road conditions and the state of repair of highways, especially on routes for the dispersal of workers and employees and the evacuation of the population and on marching routes for the advance of civil defense forces;

the determination of sanitary-epidemiological conditions in regions where formations and units have been deployed.

2. In the evacuated area and in the area of dispersal and evacuation, reconnaissance must:

constantly watch for changes in the ground and air conditions;

pinpoint the place, time, and height of nuclear blasts and determine their power in a timely manner;

detect radioactive, chemical, and biological contamination of terrain, air, and exposed water reservoirs;

determine the level of radiation, the level of concentration of toxic materials, and the type of pathogens causing infectious diseases.

3. On marching routes where civil defense forces advance to a center of destruction, reconnaissance must:

establish the presence and level of radioactive, chemical, and biological contamination of a given area as well as the character of destruction of roads, bridges, and crossings, and the degree to which their destruction affects the progress of formations and units;

locate and designate routes for bypassing destroyed sections of roads and highways;

establish conflagration (mass fire) zones and the direction of their propagation.

4. In centers of destruction, the tasks of reconnaissance are:

to determine the center (ground zero) of a nuclear blast and the radiation level, especially in facilities where rescue work is needed;

determine the condition of protective structures, the location of fires, and the character and quantity of destroyed buildings and public power networks;

determine conflagration (mass fire) zones:

establish paths for approaching facilities to do rescue work;

continuously monitor changes in the radiation, chemical, and biological situation.

Completing the tasks with which reconnaissance is confronted depends on:

a high degree of readiness of reconnaissance personnel and of reliability of their reconnaissance instruments and their means of individual protection, communications, and transportation;

proper organization of reconnaissance, advance planning, and constant supervision;

constant readiness of reconnaissance forces and facilities to execute tasks imposed on them, especially in the case of sudden attack;

deployment of basic reconnaissance forces in the most important directions;

organization of reliable communications between observation posts and reconnaissance formations, and also cooperation between them;

maneuverability of [committed] forces and facilities, as well as the availability of reserve forces and facilities, when reconnaissance is being conducted.

Depending on the means for obtaining relevant data and deploying reconnaissance facilities for this purpose, reconnaissance is classified as air (1), river (sea) (2), and ground (3) (Fig. 114).

Air reconnaissance is conducted through visual observation and systematic and continuous photography, as well as with dosimetric and television equipment. It specifies the center (ground zero) of the nuclear blasts, establishes the boundaries of the zones of destruction, and locations of obstructions and conflagrations (mass fires); reveals road conditions, the conditions of bridges on marching routes on which civil defense forces are advancing, and the presence of passages and thoroughfares in the areas of destruction; determines the

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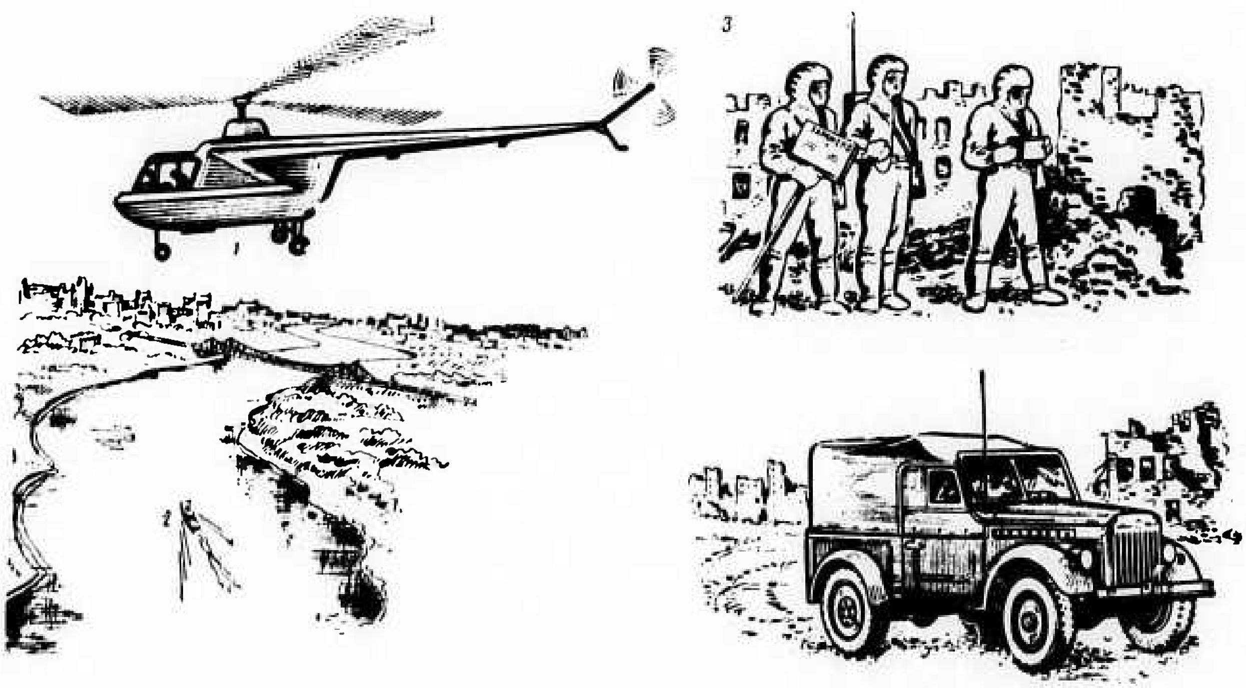

Fig. 114. Types of reconnaissance: (1) air; (2) river or sea; (3) ground.

direction in which the radioactive cloud is moving and the level of radiation. Reconnaissance data are transmitted by radio to the civil defense staff which processes these data.

River (sea) reconnaissance is executed to determine the conditions in the area of destruction in shore regions and at fleet sites.

Ground reconnaissance solves more fully and with greater reliability an entire complex of problems. It is carried out by civil defense [civilian] reconnaissance formations (reconnaissance groups and teams), by subdivisions of troop [military] civil defense reconnaissance units, by meteorological and sanitary-epidemiological stations, and by observation posts.

Reconnaissance groups from civil defense staffs are created to fulfill the tasks of ground reconnaissance at national economic facilities, and reconnaissance teams are created within the organizations of rescue divisions and separate commands. Depending on the type of facility, the number of workers and employees, and the size of the area involved, one or several reconnaissance groups may be created at a facility.

The reconnaissance group consists of three to five teams; three to four persons make up a team. From 13 to 25 persons are included in a reconnaissance group (see Fig. 7). The reconnaissance group is equipped with means to conduct reconnaissance and with means of individual protection, communication, and transportation. The basis for organizing a reconnaissance group is a facility — laboratory, design department, or other productive organization — the workers and employees of which can be quickly trained to conduct reconnaissance with the use of technical instruments. The basic assignment of these reconnaissance groups is to conduct reconnaissance in dispersal areas, on marching routes, and in centers of destruction. In addition, groups may become involved in dosimetric control, that is, in checking the degree to which people — as well as technical equipment, property, food, and water — are contaminated.

To successfully complete the tasks of conducting reconnaissance by personnel, the reconnaissance organization must:

1. be well acquainted with the workings and operating principles of radiation and chemical reconnaissance instruments; know how to conduct reconnaissance rapidly and correctly and to record their findings in a log book and on a dose chart; and know how to draw up plans and how to report the results of reconnaissance;
2. know how to quickly gain entry into obstructed blast and fallout shelters, establish communications with persons taking refuge in them, and find victims under the rubble;
3. know how to determine the character and degree of destruction of buildings and structures and put up signs indicating dangerous places and areas;
4. be well acquainted with the measures and means of antiradiation, antichemical, and antibiological protection and strictly observe these when working on contaminated terrain.

10.2 ORGANIZING AND CONDUCTING RECONNAISSANCE

Organizing reconnaissance is a primary duty of all civil defense chiefs, their staffs, and service personnel. The [local] civil defense chief defines the survey tasks. The civil defense chief of staff of the installation designates more specifically the reconnaissance tasks, establishes the sequence in which they are to be fulfilled, and the places into which basic forces must be concentrated, determines the order for maintaining communication with the staff and other formations, the times for making reports, and the composition and place of dispersal of reconnaissance reserves. The immediate superior [officer] for all reconnaissance measures is the reconnaissance chief (assistant chief of staff for reconnaissance), who works out the plan (Appendix XIX) and reconnaissance orders (Appendix XX) and carries out the decisions of the civil defense commander and the instructions of the chief of staff.

The reconnaissance plan of the facility's CD staff is developed in peacetime and is made more specific with the announcement of a threat of attack and [again] after the enemy has used weapons of mass destruction. The reconnaissance plan is supplemented by a map, a large-scale diagram of the facility, and a map of the region selected for the dispersal of workers and employees of the facility. These show command posts, the location of reconnaissance formations at the facility, in the living area [of the workers] and in the areas where the off-duty shifts are located; [they also show] observation posts, marching routes for moving reconnaissance groups and teams, the order of their operations, and assembly points after completion of tasks. The plan of the facility and the dispersal area also shows the location, number, and capacity of protective structures, the marching routes for formation movement, and the sequence of operations for reconnaissance group teams. The reconnaissance tasks delineated in the plan will determine what services are specified by the appropriate service chief, with consideration of the actual overall situation, and are presented to the superior by means of oral or written reports.

When attack threatens, an observation system is organized by the CD staff of the facility: observation posts are set up; reconnaissance formations are made ready; full military strength and instrumentation is achieved; transportation, communication facilities, individual means of protection, and large-scale plans of the facility and dispersion areas are prepared.

10.2.1 Operations of the Observation Posts

The observation post consists of two or three observers; one of these is the chief. The post is provided with individual means of protection, observation instruments, means for radiation and chemical monitoring, clocks, compasses, maps (drawings or plans), and an observation journal (Appendix XXI). When the tasks for an observation post are formulated, the post composition is indicated, as well as its allocation, the zone, or the observation sector to which special attention is paid, and the sequence for reporting the results of the observations. An observation post is situated in a structure specially equipped for observation, assuming a good field of vision and at the same time good shelter, protected from the harmful effects of a nuclear blast. It must have reliable communications with the CD staff or chief who organized the post.

Upon receiving the "air alert" signal, the observers of the site take cover in protective structures, and after the enemy has made the nuclear strike, they resume their places for observation and continuously observe the moving radioactive cloud and, periodically consulting the radiation and chemical monitors, track the readings. When radioactive contamination is detected, the observation post chief immediately reports this finding to the CD chief of staff of the facility (or the reconnaissance chief) and gives the warning signal as directed, and the post personnel give the command "don protective equipment." When chemical contamination is detected by the instruments, the observation posts give out a different warning signal.

Outward signs of the use of toxic materials and biological media may be (see Figs. 27 and 28):

1. less sharp, unusual reports [detonations] than from conventional munitions;
2. formation of a cloud of smoke or fog when the munition explodes;
3. presence of liquid droplets or powdery material on the soil, plant life, and local objects where these dull explosions are heard;
4. dispersion of toxic materials from planes, which can be detected by the appearance of a dark, rapidly disappearing contrail behind a plane and by the settling of droplets or vapors of toxic materials on the terrain and on local objects.

If these signs are evident and chemical monitoring instruments do not indicate the presence of toxic materials in the air and on the terrain, then the use of biological substances by the enemy must be suspected. The characteristic indications of the use of biological media, in addition to those enumerated are: the presence of bomb and rocket fragments on the ground and various devices with aerosol equipment, as well as the presence of insects, mites, and wo d beetles where bombs and various containers have fallen.

The reports and dispatches from observation posts and observers are one of the basic sources through which the CD staff and command organization obtain data on areas of destruction and contamination.

10.2.2 Reconnaissance Group Operations of a Facility When Conducting Reconnaissance

The reconnaissance groups of a facility are basically intended to operate on behalf of the CD staff of that facility, that is, at their own facility. But sometimes, in accordance with the requirements of a higher civil defense chief, these groups are included in the organization of a higher level of a staff entrusted with higher-level duties. When charged with the task of conducting reconnaissance on behalf of a higher-level civil defense staff, the commander of the facility's reconnaissance group explains the task, studies the route of movement and the reconnaissance area, establishes the sequence for implementation, and presents the task to the team commander (commander of the reconnaissance vehicles).

The commander of the reconnaissance group (team) conducts the reconnaissance personally. To establish the boundaries and the radioactive (or chemical) contamination level, the nature of road damage, and the damage to structures and other obstacles, reconnaissance is conducted from vehicles and, when this is impossible, on foot. The scouts execute their tasks with the aid of radiation and chemical monitoring instruments or by direct inspection of the terrain. When radioactive or chemical contamination is detected on the marching route, the commander of the reconnaissance group (team) establishes the radiation level (level of contamination) and immediately reports this by radio to the appropriate superior.

To decrease the exposure of the reconnaissance group (team) personnel, the contaminated regions are traversed at the maximum possible speed and with the minimum number of stops. As a rule, the reconnaissance group (team) avoids zones of high-level radioactive and chemical contamination; when this is impossible, these zones are crossed using individual means of protection. The boundaries of contamination zones and bypasses of contaminated zones are well marked with visible signs.

In centers of destruction the reconnaissance groups (teams), avoiding or overcoming the obstacles, measure the radiation level, determine the nature of the damage and the locations of conflagrations (mass fires), and, without lingering for detailed inspection of the sites of the rescue work, move swiftly ahead to the final reconnaissance point. The commander of the reconnaissance group (team) reports the results of the reconnaissance to the chief who gave the assignment. The report must be short and indicate the time, place, and nature of the observations, the location of the reconnaissance group (team), and the decision of the group commander. After completing its tasks, the reconnaissance group, with the permission of the chief, is returned to receive further orders from the CD chief of staff of its own facility and proceeds to act in accordance with instructions.

To conduct reconnaissance on behalf of the CD staff of the facility, the reconnaissance group (team) of installations (formations) of the national economy (not included in the composition of the higher-level reconnaissance of the higher-level CD staff) begin moving toward the center of destruction, obeying the commands of the CD chief of the installations or the commanders of the facility's formation. The commanders of the reconnaissance groups and teams are issued charts (azimuthal maps) of the facility (Appendix XXII) on which are plotted all the protective structures with their complete descriptions, accurate information regarding their location, and the methods of communicating with them, as well as the location of public power networks of the economy.

The reconnaissance groups (teams) move swiftly to their own facilities; specify the radiation levels in the vicinity of the facilities; determine the condition of the protective structures, the most convenient access routes to them, the areas of destruction and the rescue conditions, and the nature of destruction of buildings, industrial structures, and public power networks.

Moving forward to the site of the rescue work, the commander of the reconnaissance group, in accordance with the sequence of activities described earlier, assigns concrete tasks to the teams and also indicates the direction of the reconnaissance work, what data are to be obtained and when, the location of protective shelters, the extent of the damage, and the access and approach routes, as well as the sequence for reporting reconnaissance results. After receiving their task, the teams move forward toward the reconnaissance site assigned to them, carefully inspecting the territory along their route and searching for protective structures or accumulated surface damage.

In the event of complete destruction of ground structures, protective structures can be located with reference to predetermined landmarks to which they are attached or by means of inspecting the destroyed buildings. Shelters set up in the basements of buildings can be detected by outward signs of staircases (projecting remnants of walls, steps of destroyed flights of stairs, etc.). When the staircase of a shelter is observed, the emergency exit must be searched for. If the shelters are occupied, scouts must do everything possible to establish contact with the occupants. If the emergency exit is obstructed, the scouts must try to make small openings in it for communication and access to air. The locations of protective structures, access routes to them, rubble, detours, and contaminated zones are indicated by special or improvised signs.

If the people in a shelter are endangered by flooding or gassing due to the destruction of municipal systems, a scout immediately reports this information to the reconnaissance group commander, and measures are taken to eliminate or reduce the hazard. In turn, the reconnaissance group commander immediately reports this information to the CD staff commander. The reconnaissance group (team) commander reports reconnaissance data to the civil defense staff chief of the facility (the reconnaissance chief) by radio and [also] makes a report in the form of a sketch with the results of the reconnaissance plotted on it.

After completing their tasks, reconnaissance group personnel go to the assembly point, reorganize, and, if necessary, carry out partial decontamination treatment, decontaminating clothing and instruments. Furthermore, depending on the situation and the exposure dose, the reconnaissance group prepares to execute new tasks or proceeds to an outer zone for complete decontamination and rest. When the personnel arrive at the site of rescue work, all the chiefs (commanders) personally reconnoiter and establish observation posts to check on changes in the radiation, chemical, biological, and fire conditions.

10.3 SPECIALLY DESIGNATED RECONNAISSANCE FORMATIONS (SPECIAL RECONNAISSANCE)

Radiation, chemical, fire, engineering, medical, biological, and veterinary reconnaissance is organized and executed in order to obtain more precise data on the character of radioactive, chemical, and biological contamination of areas, air, water sources, food, and forage; on medical, veterinary, and fire conditions; on the nature of destruction on the marching routes and in centers of destruction. For this purpose, reconnaissance groups (teams) created from the appropriate formations of special designation of the civil defense facility (rescue, medical, fire fighting, etc.) are prepared in advance.

10.3.1 Radiation and Chemical Reconnaissance

Radiation and chemical reconnaissance is executed continuously by observation posts, by all formations, and by specially prepared groups and teams. It establishes the level and presence of radioactive and chemical contamination of terrain, air, and water sources; it specifies marching routes and areas with reduced levels of radiation in zones of radioactive (chemical) contamination (concentrations of radioactive substances); it monitors changes in the level of contamination of terrain, air, food, and water sources.

Examination of contaminated terrain along marching routes, at national economic facilities, and in populated areas is accomplished by reconnaissance groups from the facility staff and teams in automobiles and on motorcycles. The order of their operations is determined by what is to be done, special features of the site of the reconnaissance, radiation levels, and existence of travel routes. The reconnaissance group conducts reconnaissance in areas of radioactive contamination up to the [maximum] radiation levels specified for them. The terrain is considered contaminated if it has a dose rate of 0.5 R/hr or higher. As a rule, reconnaissance on foot is continued to a dose rate not higher than 30 R/hr; in automobiles to a dose rate of not more than 100 R/hr. Reconnaissance of regions with higher radiation levels is carried out by reconnaissance groups (teams) only on special order by the chief who ordered the reconnaissance. Localities with higher dose rates, up to 200 R/hr, can be reconnoitered only in tanks or armored transports, and higher than 200 R/hr in helicopters or in airplanes; such reconnaissance is conducted by higher CD staff officers. If necessary, the civil defense staff of a facility can obtain reconnaissance data on areas from the staff superiors.

The reconnaissance group (team) conducts reconnaissance with the aid of radiation and chemical monitors and uses signs to mark the boundaries of radioactively contaminated areas (sections) [contaminated] at the 0.5-R/hr level, as well as at levels indicated by the chief who ordered the reconnaissance, [and to mark] the limits of areas contaminated with toxic materials, and the route for bypassing contaminated areas (regions). The reconnaissance data are systematically reported by radio. When advancing through contaminated areas, the reconnaissance group must measure the radiation level every 50 to 100 m; moreover, the dosimetric instruments must be held at a uniform distance above ground level, for example, at a height of 1 m, and at the same distance from the surface of the object being scanned; otherwise the reading will not reliably report the dose or the level of contamination. In populated regions, the radiation level is measured some distance from buildings in order to avoid their shielding effect.

The actual contamination of earth, water, buildings, and various objects [while being] subjected to direct radiation exposure in the radiation zone cannot be determined because of the radiation (gamma background) of the surrounding contaminated objects. Therefore, samples are taken from the contaminated objects (things, water, products, earth) and then scanned outside of the contaminated region. The specimens are taken in places of high radiation levels, as well as in those where persons are working or are located, in warehouses, and in places containing animals. The results of each radiation level measurement and sampling (smears) by the reconnaissance group (team) commander must be recorded on a special card indicating the place and time of sampling and measurement of each sample.

The actual order of activities when conducting radiation and chemical reconnaissance is determined by the tasks assigned to the reconnaissance group (team). When reconnoitering a marching route, the reconnaissance group (team) operates from a motor vehicle. The commander of the reconnaissance group (team) sits next to the driver, giving orders on direction and speed, supervises the group (team) operations, and maintains communications with the appropriate superior. On the orders of the group (team) commander, the scouts periodically turn on their radiation and chemical reconnaissance instruments in order to detect the radioactive and toxic materials on the routes over which they are moving. The scouts simultaneously conduct visual observation to detect the presence of macroscopic contamination from toxic and biological media.

The distribution of duties among scouts in the zone may be as follows: No. 1 to handle the roentgenometer, No. 2 to handle the chemical reconnaissance instrument, No. 3 to post signs showing the boundaries as ordered by the commander, and No. 4 to sample contamination from the ground (objects) as ordered by the commander. Observing contamination by toxic materials, the scout determines the type (group) of toxic materials and designates the forward boundary of contamination. The group (team) commander reports to the appropriate superior on the detection of contamination and indicates [the affected area] on the map.

When radioactive contamination is detected, the reconnaissance group (team) continues to move to the boundary where the dose rate reaches 0.5 R/hr. When the dose rate is determined from a moving vehicle by the roentgenometer located in that vehicle, it is necessary to take into account the attenuation factor of the vehicle body. This factor can be more precisely determined by making two measurements in the same area (place), inside and outside the vehicle; in both cases, the roentgenometer must be at the same height above ground level while the readings are taken. For example, when taking readings inside the vehicle, the dose rate is 5 R/hr, and when measuring outside the vehicle 10 R/hr. Dividing the second value by the first, the attenuation factor of 2 is obtained.

Fig. 115. Operations of a reconnaissance team when detecting radioactive contamination on a marching route.

Upon reaching a contamination boundary with a dose rate of 0.5 R/hr, the group (team) commander orders the scouts to put on their individual means of protection and post the sign (boundary sign) which designates the type of contamination, the radiation level, and the time of the reading. As a rule, the boundary sign is posted on the right shoulder of roads, in places where it is noticeable (Fig. 115). The group (team) commander denotes on the marching route map the place, the radiation level, and the time of detection and reports this information by radio to the appropriate superior. A group (team) deals with other types of contamination in the same sequence. After designating the beginning of a contaminated area, the reconnaissance group (team) continues to move along the given marching route, measuring the radiation level while moving and during brief stops, periodically checking for the presence of toxic materials and posting directional signs.

When detecting radiation levels on a marching route that are dangerously high for personnel, the reconnaissance group (team) commander reports by radio to the appropriate superior and, as ordered, reconnoiters a detour around the dangerous radiation zone, designating it by signs and markers. The group (team) commander plots the detour on a map of the marching route (Fig. 116). If there are no detours, the group (team) commander reports this information to the appropriate superior and proceeds in accordance with any additional instructions.

As a rule, radiation reconnaissance in populated areas is conducted along streets and alleys; if necessary, reconnaissance is conducted on individual premises, in yards, basements, underground structures, etc. Under these conditions, the reconnaissance team is assigned a reconnaissance area of two to three blocks; in some cases the reconnaissance area has a width up to 800 m (Fig. 117).

When their tasks have been completed on foot, the team may operate as follows: Scouts Nos. 1 and 2, moving in a specified direction, determine and indicate the contamination level with dose rates up to 0.5 R/hr, and also post precautionary signs in places having other radiation levels, indicating what these levels are as they do their work. Scout No. 2, if necessary, takes samples, observes the signals of the other scouts, and reports them to the team commander. Scouts Nos. 3 and 4, moving right and left of the main direction, determine and designate the beginning of contamination and indicate the dose rates.

At national economic facilities, radiation and chemical reconnaissance is performed to determine the dose

ORNL DWG. 73-4751

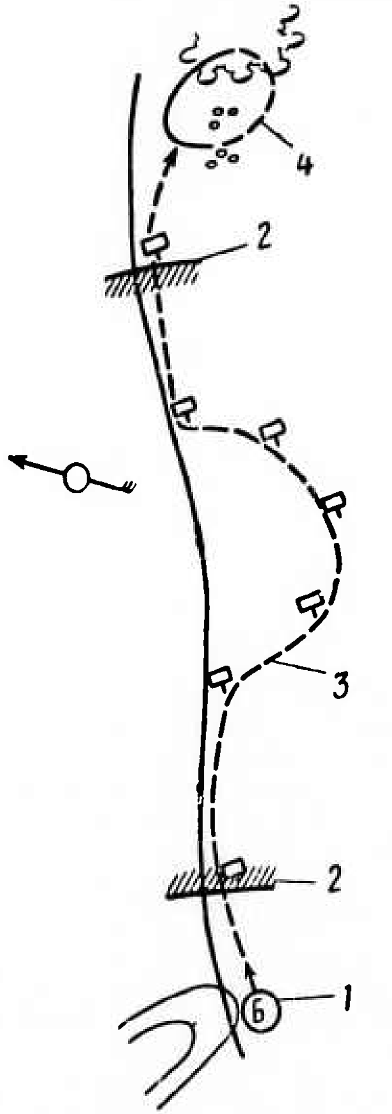

Fig. 116. Operations of a reconnaissance group (team) when detecting high radiation levels on a marching route: (1) home base; (2) contamination boundary with dose rates 0.5 R/hr; (3) boundary of given radiation level; (4) place of partial decontamination.

ORNL DWG. 73-4752

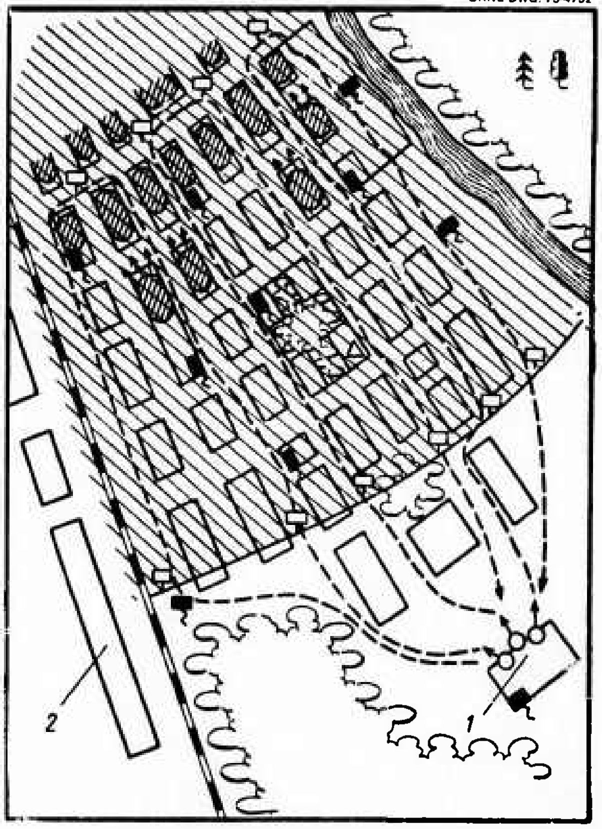

Fig. 117. Radiation reconnaissance in a populated area: (1)' reconnaissance group; (2) reconnaissance sector of neighboring reconnaissance group.

rate and the level of contamination with radioactive or toxic materials on the premises of the facility, on the approaches to the facility, and at places where rescue and urgent emergency-restoration work is to be carried out; records are kept of changes in the radiation and chemical conditions and the conduct of rescue work. The main base for reconnaissance is designated near the premises of the facility. At the main base, the commander of the reconnaissance group (team) first makes himself familiar with the situation, then specifies tasks for the team to reconnoiter the facility. Variations in the operations of the scouts at a national economic site are shown in Fig. 118.

In reconnoitering a facility, the scouts check the facility's premises for contamination by radioactive or toxic materials, determine the dose rate and [extent of] contamination, determine the level of contamination of structures, fallout shelters, blast shelters, and various objects, and post notices of contamination by appropriate signs on the grounds and on the sketch of the facility. In places where radiation levels are higher and in places where people are located, the scouts take samples from the ground and smears from buildings and equipment, noting the locations of the site on a diagram and recording the place where they took the sample on a card.

The character and level of contamination by radioactive and toxic materials are finally determined in accordance with the measurements and are reported to

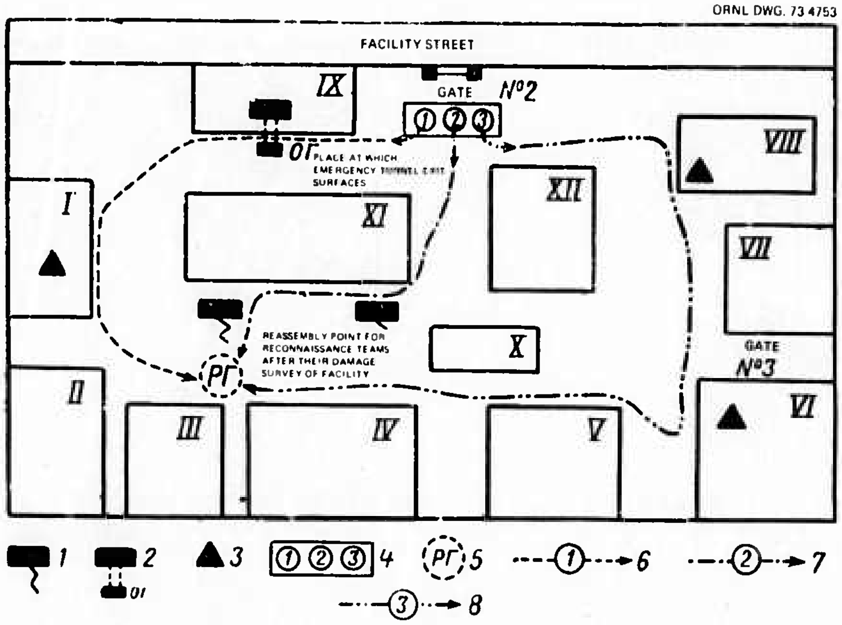

Fig. 118. Drawing of the operations of a reconnaissance group when reconnoitering the premises of a facility (variation): (1) detached shelter; (2) basement shelter with exit; (3) basement fallout shelter; (4) main base; (5) assembly place when reconnaissance is completed; (6,7,8) routes of reconnaissance teams Nos. 1, 2, 3.

the CD chief of the facility so that a decision can be made with regard to decontamination.

When determining and reporting the results of a reconnaissance, the reconnaissance group, depending on the circumstances and their exposure dose, organize a watch to detect changes in the radiation conditions and to conduct dosimetric checks of the exposure of formation personnel performing rescue work at the facility. After conducting reconnaissance, reconnaissance group personnel who were exposed to a large radiation dose go into an outer zone for complete decontamination and rest.

10.3.2 Engineering Reconnaissance

Engineering reconnaissance is organized and conducted to determine: (1) the condition of roads, bridges, and crossings over which civil defense forces advance from the main base into the center of destruction, (2) the degree and nature of damage resulting from an enemy nuclear strike and the condition of protective structures and the public power network, (3) the extent and conditions for executing rescue and urgent emergency-restoration work, and (4) the methods for most effectively utilizing the forces and facilities of the engineering corps. Successful performance of the engineering reconnaissance tasks is achieved through advance study of the characteristics of the buildings, the location of protective shelters, their interior equipment, and their capacity and conditions of occupancy; the networks and structures of the public power system near a city; highway systems and their condition; the character of water obstacles and the possibilities for crossing them if bridges and other crossings are destroyed; the places where construction materials are stored.

When organizing engineering reconnaissance, it is necessary to take into account the conditions and the tasks which must be executed after the enemy has used nuclear weapons. For example, the CD staff of the site organizes engineering work to determine the general character of the destroyed facility, to determine the state of blast shelters and fallout shelters, to designate their identifying signs, to establish the condition of the public power networks, etc. But in the majority of cases, these reconnaissance data will not be sufficient for the formation commander in charge of undertaking rescue and urgent emergency-restoration work. Thus, independent of the reconnaissance, the CD staff commanders of rescue and emergency-technical formations organize internal reconnaissance work at the facility. Consequently, engineering reconnaissance is conducted by the CD staff, the formations, and the detachments, thus ensuring progress.

The engineering reconnaissance group (team) is organized on the base of the Technical Engineering Service, while technical personnel are included in it, assigned from the internal formations of these facilities, to reconnoiter [the extent of] destruction and the technical condition of power networks, gas distribution systems, chemical plants, and other industrial structures. From the facility plans they supply copies with entries which indicate the landmarks for blast shelters and fallout shelters, instruments and equipment, warning signs, individual means of protection, radiation reconnaissance and dosimetric monitoring instruments, and other equipment required to execute the tasks.

The following are described when a task is assigned to a group (team) of engineering reconnaissance: a summary of the characteristics of the situation and the site, as well as landmarks; necessary information, and tasks requiring special attention; the marching route for reconnaissance; the procedure for identifying obstructed blast shelters, fallout shelters, and rubble in which victims have been found; the period from beginning to completion of reconnaissance; the assembly point [at which to gather] after completion of the tasks; the procedure for maintaining communications and submitting reports.

Depending on the tasks and the nature of the center of destruction, reconnaissance groups can proceed in vehicles or on foot. When reconnoitering, they inspect the terrain and destroyed and damaged buildings and structures; they listen at blast shelters and fallout shelters. Their primary task is to determine the location of obstructed fallout shelters and blast shelters, as well as that of damaged buildings where people may be trapped, and to set up safe approaches to them.

When inspecting the territory and the damaged buildings and structures in zones of high and medium destruction, special attention is paid to sites where victims may be entrapped; someone should call to them, listen, attempt to communicate by tapping, and if possible question the other victims found in this area. First, reconnaissance groups must determine the condition of walls and the projections of damaged buildings (balconies, cornices, and the like), as well as of stairwells, staircases, and landings. Moreover, it should be kept in mind that damage to individual parts of a building may occur a considerable time after the blast. Thus, to approach walls and other parts of damaged buildings, it is necessary to carefully, continuously listen to characteristic sounds (noise, crackling) which indicate the possibility of structural weakening. When inspecting the interior of a building, one should first determine the condition of the interior supporting walls, columns, and partitions, then determine where the victims are located and the possible methods for evacuating them from the building. Multistory buildings can be inspected from the lower floors so that, if necessary, proper measures can be taken to reinforce weakened structures. If signs have been posted indicating threats to human life (water, gas leaks, etc.), then reconnaissance groups inspect the internal water system, the gas pipes, the electric lighting, and the sewer and heating systems, and take measures to limit these hazards.

When an obstructed, damaged building or structure is detected, it is necessary to establish communications with the people inside and determine their condition, as well as their air, water, and food supply. It is necessary to report immediately to the commander who ordered the reconnaissance on the location of obstructed or damaged blast shelters (fallout shelters), as well as on breakdowns of public power plants threatening the lives of the victimized population. Inspecting obstructed basements, blast shelters, and fallout shelters, as well as the entrances and emergency exits from shelters, the reconnaissance group (team) must determine the condition of the shelters, the extent and distribution of the rubble, and the possibility of working manually to clear away the rubble from louver gratings or the overhead hatch of the emergency exit. Signs are posted at the entrances of blasts shelters and fallout shelters that are found, as well as at the emergency exits. Trouble spots in utility systems and in public utility structures are also designated with special or improvised signs.

After completing its tasks, the engineering reconnaissance group (team) goes to the assembly point; the commander of the group (team) summarizes the reconnaissance data, prepares a report in the form of a sketch, and reports to the chief who ordered the reconnaissance. Depending on the conditions and the exposure dose, the group (team) participates in rescue work or proceeds to the suburban zone for complete decontamination treatment and rest.

10.3.3 Fire Reconnaissance

Fire reconnaissance is organized and executed to specify the fire conditions on the marching routes which the formations use to reach the areas of fires and destruction. To conduct fire reconnaissance on each marching route, a fire reconnaissance group consisting of two or three fire detachments is sent out. The fire reconnaissance group operates independently or in conjunction with other formations, assuming the access of civil defense forces to the site of rescue work in the area of destruction.

The commander of the fire reconnaissance group personally leads the reconnaissance and sends out individual vehicles to determine the directions in which fires are being propagated. Having identified the fire zones, the commander immediately reports to his appropriate superior and discovers detour routes and the most convenient boundaries for localizing the fire so the formations and units will have access to the site of rescue work. In the area of nuclear destruction, the fire reconnaissance group organizes a fire-fighting service with all formations and subdivisions. It determines the extent to which the fire is spreading and also the direction of spread, locates water sources and assesses the feasibility of using them to put out the fire. It also determines advantageous positions for fighting the fire.

10.3.4 Medical Reconnaissance

Medical reconnaissance is conducted with all medical formations, subdivisions, institutions, and specially designated medical reconnaissance groups. The makeup of the medical reconnaissance group and its equipment is determined by the nature of the reconnaissance missions. Usually it consists of a group commander – a doctor (surgeon's assistant), two or three scouts – doctors (surgeon's assistants), and one or two teams of decontamination squads.

Medical reconnaissance groups determine the sanitary-epidemological condition of the main base and the location of off-duty shifts, as well as the disposition of the evacuated population in the outer zone, the marching routes for advancing civil defense forces, and the territory of the area of destruction. They determine the number of casualties and their condition, find places and accommodations for reconnoitering medical formations and evacuee reception subunits, determine the extent of work and the required quantity of medical service forces and facilities, and establish safe places for staging the injured before loading them on transports for evacuation to medical facilities. The medical reconnaissance groups inspect the terrain directly, gather information on casualties, the local population, and the personnel maintaining the medical formations (facilities); they trace toxic materials and nonspecific biological media; if necessary, they take samples from outside areas; they study current data received from the staffs and civil defense services.

10.3.5 Biological Reconnaissance

Biological reconnaissance is organized in special formations and subdivisions. It reconnoiters terrain, air, water sources, food, and forage contaminated with biological media; it traces biological media, determines the boundaries of the area of contamination, the number of people exposed to the effects of biological media, and the extent and nature of work involved to eliminate the secondary effects of biological attack. Reconnaissance is accomplished by taking samples of air, soil, and plant life, washings from the surfaces of various objects and samples of munitions discovered, and specimens for studying of insects, ticks, and wood beetles.

The job of determining the type of pathogen used and the boundaries of the contaminated territory is carried out by epidemiological groups formed of specialists of sanitary-epidemiological stations, immunization institutes and stations, epidemiological and microbiological, and vaccine and serum institutes, as well as service institutes for protecting animals and plants.

10.3.6 Veterinary Reconnaissance

Veterinary reconnaissance is conducted by reconnaissance groups formed of specialists of veterinary institutions. It sets up boundaries for the area of biological contamination, determines the degree of damage to plant life and animals, determines evacuation routes for animals to veterinary institutions, and specifies the epizootic condition of regions where animals and their pastures and watering places are located.

10.3.7 Taking Samples and Smears to Determine Contamination

Contamination of various materials and objects can be monitored by taking samples and smears and then, in an uncontaminated location, measuring the level of their contamination. The samples and smears, depending on their type, are placed in different vessels (jars, bottles, packages) with labels which indicate the number of the sample, where and when it was taken, and the radiation level of the sampling site.

A soil sample can be taken with the aid of adhesive tape. For this, a 10 X 15 cm piece of tape is applied with its sticky side to the ground, a sheet of newspaper (or something else) is put over it, and it is uniformly pressed down with the sole of the foot. Then the tape with the adhering soil (sample) is put into a jar or package. If no tape is available, the sample can be taken by scooping a sample from the surface to a depth of 0.5 cm over an area of 150 cm^2 and placing it in a glass jar.

Smears from the surface of objects and structures are taken with the aid of cotton or rag tips wrapped on wooden sticks. The diameter of the tip must be 20 to 25 mm and length 40 to 50 mm. A smear is taken from a 10 X 15 cm surface using cardboard templates with a rectangular opening of the indicated dimensions. The template is placed on the contaminated surface, and radioactive substances are collected [within the opening]. The sample tip is placed in a jar or packet.

To measure the radioactive contamination of a [soil] sample on adhesive tape, the soil adhering to the tape is scraped onto a piece of plywood or cardboard; a soil sample from a jar is scattered uniformly onto an area of 10 X 15 cm. Then the radiometer probe is lowered to the specimen, placed over the center of the specimen area (along the lower side) with the window facing the sample at a distance of 0.5 cm, and the level of radiation is determined on the reading scale of the radiometer.

Samples of food and forage with a weight of 100 to 200 g are collected in the following sequence:

1. bulk products (flour, barley, salt, etc.) stored in bags are removed with a scoop from a layer adjacent to the bag, and a specimen is taken to a depth of about 1 cm; when these products are stored in a depot, a sample is taken from three or four places in the surface layer with a thickness of about 1 cm;
2. samples of concentrates, baked goods, dried fruit, vegetables, etc., stored in sealed packages are removed with a scoop from various places in the surface layer which directly touch the contaminated surface of the package;
3. meat, fish, sausage, cheese, butter, and solid fat samples are taken with a knife, removing a layer of the product having a thickness of about 0.5 cm; food products in a package must be sampled from the side touching the contaminated area of the package;
4. fresh vegetables and fruits are sampled from four or five fruits and cabbage from one or two small heads;
5. baked bread is sampled in whole loafs; liquid products (vegetable oils, etc.) are sampled from the bottle after shaking;
6. hay samples are taken from various places on the upper layer of the stack or the upper bale of the pile.

As a rule, two water samples are taken, one from the surface of the source (well, pond, lake, spring), scooped out with a clean vessel (jar, jug, etc.), the other from the bottom of the source. A half-liter bottle is suitable for taking specimens from the bottom of the source. A weight of not less than 1 kg is attached to the bottom of the bottle and two pieces of twine are attached, one to the neck, and one to the cork stopping up the bottle. As the water at the bottom of the well becomes turbid, the bottle is dropped into the source; when it reaches the bottom, the twine tied around the cork is pulled, removing the plug, and the bottle, now full of water, is retrieved.

After removal from the contaminated area, the food product samples are scattered or spread on an uncontaminated sheet of plywood, cardboard, or other material with an area of 150 to 200 cm^2 and sides of 10 to 15 cm; in addition, the samples of fresh vegetables and fruit are cut into two parts as equal as possible and placed with their cut sides down. After this, with the use of a radiometer the surface contamination of the specimen is measured.

The specimens of water and liquid products are poured into a clean vessel having a height of about 15 cm and a capacity of 0.5 to 0.6 liter. To measure the contamination, the probe head, with a rubber cover placed over it beforehand, is lowered to the sample being scanned and an instrument reading is taken.

10.4 DESIGNATING CONTAMINATED AREAS OF TERRAIN

Precautionary and directional signs are used to designate boundaries and passages in contaminated areas. The sign used to designate the boundaries of a contaminated area is a rectangular plywood or metal panel, yellow in color, with dimensions of 30 X 22.5 cm, mounted on a stake (Fig. 119). On the stake there are two metal brackets for inserting the cardboard or paper triangles. In the left bracket is placed the triangle on which the nature of the contamination is written

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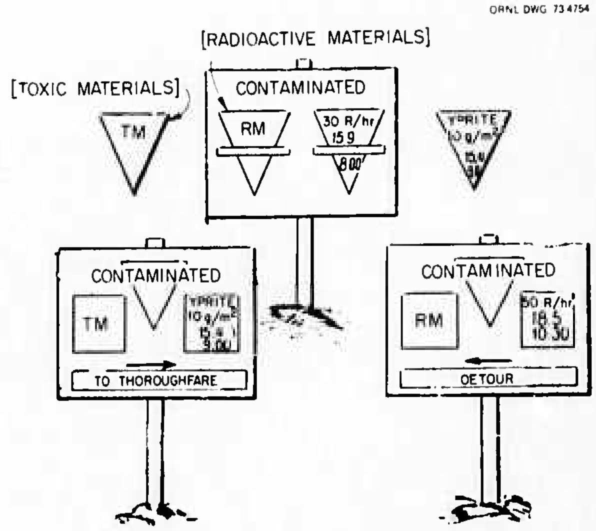

Fig. 119. Special cautionary signs for designating the boundaries of contaminated areas.

simply in pencil RS, TM, BM (radioactive substances, toxic materials, or biological media). In the right bracket is placed the triangle indicating the radiation level or the type of toxic material and the contamination level, as well as the time at which the contamination was determined (date, hour, and minute). A flashlight is suspended over the sign to illuminate it at night.

Warning signs indicating the contaminated areas are posted in the following cases: to mark [the boundaries] of areas which, in the event of contamination with radioactive substances, have radiation dose rates of 0.5, 5, or 30 R/hr or [have] a radiation level as high as that for which reconnaissance has been ordered or at which protective measures are required; to safeguard areas contaminated with toxic materials, [by marking] along the boundary of the contaminated section (the limit of propagation of toxic material vapors).

On roads passing through contaminated areas, precautionary signs are posted on road shoulders 50 m from the boundary of the contaminated area with their fronts toward the uncontaminated area. These signs will serve to warn personnel moving into these areas. In populated areas, the areas contaminated by radioactive materials can be designated by hanging signs on wires suspended across contaminated streets. In the absence or shortage of standard signs, the contaminated areas, safe passage routes, and detours can be designated with improvised signs written on local objects (walls of houses, fences, doors, road signs, etc.) (Fig. 120). In addition to the warning signs, signs with the word "passage" are used designating safe passage routes, posted along the edges of the routes and with arrows indicating the direction to move along the route.

ORNL DWG 73 4755

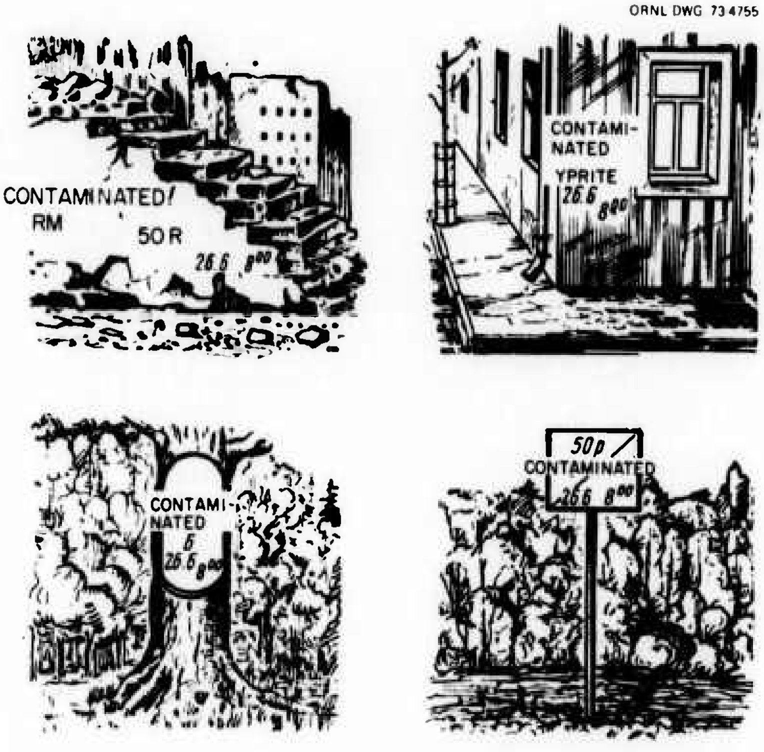

Fig. 120. Designations of contaminated areas with the use of local materials.

11. Rescue and Urgent Emergency-Restoration Work

11.1 FORCES, EQUIPMENT, AND THEIR DEPLOYMENT IN THE LOCAL AREAS

Civil defense forces are organized to conduct rescue and urgent emergency-restoration work in centers of destruction as well as in areas of natural disasters. These forces consist of formations created from workers and employees of national economic facilities and of military civil defense units. Civil defense formations are organized in divisions, commands, groups, brigades, squads, and teams in national economic facilities, institutes, institutes of higher learning, collective farms, and state farms. They are supplemented, as in industry, by workers and employees, collective farm hands, teachers, and other able-bodied persons.

The basic civil defense forces are constituted of formations recruited from the facilities and specially designated formations. The civil defense formations are equipped by the national economic facilities with means of protection, instruments, vehicles, and machinery. Technical equipment provided to the formations is used to conduct rescue and urgent emergency-restoration work at important centers of destruction. The large volume of work in a center of nuclear destruction cannot be completed in a short time without the use of diverse technical equipment. Only widespread mechanization of all types of work makes possible the timely rescue of nuclear blast victims.

Rescue operations at a center of nuclear destruction may entail use of all types and forms of construction and highway vehicles and machinery available in the national economy, as well as technical equipment of the urban municipal economy: tractors, dump trucks, single-scoop power shovels, bulldozers, rabblers [fire shovels], caterpillar and self-propelled cranes, belt conveyers, jacks, winches, and automotive equipment, as well as water drainage equipment.

11.1.1 Technical and Tactical Data Regarding Vehicles and Machinery

Vehicles and machinery are appropriately chosen for the type of work to be done and are classified into the following groups.

Vehicles and machinery for razing and removing debris and for hoisting, hauling, and transporting loads. This group of vehicles and mechanisms includes excavators, tractors, bulldozers, automobile cranes, trailers, winches, pulleys, combination pulleys, and jacks.

Excavators can be used to clear away ruins, to load debris on dump trucks, to open obstructed blast shelters and fallout shelters, and to uncover buried communication lines. The basic data describing excavators are presented in Table 34.

Bulldozers can be used to raze debris and make passages when clearing shelter exits (hatches) and when performing other types of work. The basic data describing bulldozers are given in Table 35.

Tractors can be used to recover structural members of various lengths when clearing away ruins, demolishing individual parts of a building which is in danger of collapsing. The most widespread use is made of caterpillar tractors with a tractive force on the hook: DT-54, 2.8 tons; C-80, 8.8 tons; T-140, 13.7 tons.

Table 34. [Excavators]

Excavator make	Scoop capacity (m^3)	Height of excavation (m)	Capacity of rubble (m^3/hr)	
			Straight scoop	Reverse scoop
E-255	0.25	4.5	15–20	20–30
E-302	0.30	6.0	20–30	30–40
E-505	0.50	8.0	40–50	50–60

Table 35. [Bulldozers]

Type of bulldozer and tractor	Dimensions of the blade	Maximum speed (km/hr)	Capacity	
			According to clearing rubble and hauling debris (m^3/hr)	According to slicing a path through rubble (km/hr)
D-522 Tractor T-140	4.40 1.10	10.9	50–100	2–4
D-275 Tractor T-140	3.18 1.55	11	80–100	1.0
D-259 Tractor C-100	4.15 1.10	9	30–80	1.5–2.0
D-290 Tractor T-140	5.0 1.10	11	100–150	2–4

Table 36. [Cranes]

Type of crane	Hoisting capacity (tons)	Length of crane boom (m)	Speed (km/hr)	Capacity (tons/hr)
K-32 on ZIL-150	3.0	6.8	35–40	15–20
K-51 on MAZ-200	5.0	7.8	20–35	25–30
K-104 on YAAZ-210	10.0	10.5	30	35–40
K-124 on pneumatic tires	12.0	20.0	10	40–50

Table 37. [Pneumatic tools]

Type of tool	Weight (kg)	Operating pressure (atm)	Drilling depth (mm)	Drilling speed (mm/min)	Strokes per minute
RP-17 hammer drill	17.5	5	400	110–160	
OMSP-5 pneumatic drill	9.5	4			75
OM-10 pneumatic drill	10.0	5			50

Motorized cranes can be used for loading-unloading work and for removing large, heavy debris when clearing the entrances to blast shelters, fallout shelters, and emergency exits. The data for motorized cranes are given in Table 36.

The set of pneumatic tools includes a compressor unit with a hammer drill and a pneumatic drill.

The compressor unit ensures operation of the pneumatic tools. The most widespread type of compressor unit is the ZIF-55 trailer-mounted compressor. The assemblage includes 3-RP-17 hammer drills, 4-OMSP pneumatic drills, and a set of drill rods, boring bits, and air hoses with a diameter of 16 mm.

Basic data of the ZIF-55 are: operating pressure, 7 atm [103 psi]; buildup time, 20 min; compressor capacity for producing compressed air, 5 m^3/min.

The hammer drill (manual drill) is used to drill in stone, brick, and concrete walls and in the ceilings of obstructed shelters to allow entry of air. The pneumatic drill is used to dismantle brick ruins and concrete walls and to make openings to rescue victims from obstructed shelters, as well as to break up large pieces of debris. The basic data describing the pneumatic tools are given in Table 37.

Metal cutting equipment. Large metal pieces which are difficult to extract from ruins can be reduced in

Table 38. [Kerosene torches]

Characteristics	Number of interior nozzles			
	1	2	3	4
1. Thickness of steel to be cut, mm	20	20–50	50–100	100–200
2. Oxygen consumption, m^3/hr of operation	5.4–7.6	7.6–9.8	9.8–20.2	20.2–32.6
3. Kerosene consumption, kg/hr of operation	0.7–0.8	0.8–0.9	0.9–1.1	1.1–1.3
4. Cutting speed, mm/min	300–450	150–300	100–150	75–100

size. Torches using kerosene and gasoline can be used for this. The data on the kerosene torch K-51 are given in Table 38 [see note *].

Water pumping machinery. This type of machinery includes the pumps and pump motors used to pump water from floo'd shelters and cover. Data concerning the water pumps are presented in Table 39.

Table 39. [Water pumps]

Type of pump	Suction (m)	Head (m)	Capacity (m^3/hr)
S-245 automatic intake	6	20	120
S-247 automatic intake	6	20	35
S-205 membrane	6	6	12
M-600 mechanical pump	5	50	30

11.1.2 Deployment of CD Forces and Equipment in an Outer Zone [See Note †]

To ensure the protection of civil defense personnel and rapid organized movement to the rescue work sites, formations of special designation are led into the outer region upon the threat of attack. The dispersal area is designated beyond the zone of possible destruction by a nuclear blast, near a town in the area which offers natural cover and throughroutes to the facilities where the rescue work is to be done.

Specially designated formations and civil defense subunits are deployed in the outer zones close to the travel routes [back to the stricken city]. Plans are developed for rapid departure via the travel routes. An assembly point is designated [in the area] where the off-duty shift is located to organize the movement of the formations to those national economic facilities where operations are continuing. Formation assembly points are selected in the immediate vicinity of travel routes. Personnel assembles by order of the commander or on the signal "air raid warning lifted." The formations of a facility where production has stopped, as well as the formations of small cities and formations organized among the evacuees, proceed to the assembly point on the order of municipal and rural CD chiefs.

To execute rescue and urgent emergency-restoration work in the outlying zone, CD task forces are organized which include reconnaissance groups and formations to ensure movement of the first, second, and subsequent echelons. Reconnaissance groups are commissioned to find [problem] situations which have resulted from the enemy's use of weapons of mass destruction. They consist of reconnaissance patrols, reconnaissance groups of national economic sites, and formations of reconnaissance teams. The Mobilization Support Division operates on the marching routes behind the reconnaissance groups and facilitates prompt movement of civil defense forces to rescue work sites. The division can consist of

[*Oxykerosene and oxygasoline torches are described in "Handbook of the Mechanic," by P. G. L'vovskii, Metallurgy Press, Sverdlovsk-Moscow, 1953, p. 845. These are similar to oxyacetylene torches, achieve lower temperatures, but can cut carbon steel. The above book has a fairly detailed discussion, diagrams, and data. These are cutting torches only, not welding.]

[†The terms "outer region" (or "outer zone"), "dispersal area," and "assembly point" may cause confusion to the uninitiated. According to the Soviet plan, each national economic facility must create and train its own civil defense formations (brigades). These formations are comprised entirely of the facility's supervisory staff, working force, service personnel, and other personnel and are trained at the facility. When the Soviet government gives the order for dispersal, the formation members are dispersed, together with their families, to an "outer region" — a town or rural area beyond reach of potential blast damage if the city or facility is targeted. Should a nuclear strike then occur, the formations are to gather in the "dispersal area" at a preselected location ("assembly point") and mobilize to set out for their plant or factory, etc., and perform vital rescue and emergency-reclamation work there. Thus, the terms "outer region" and "dispersal area" are synonomous. The "assembly point," on the other hand, refers to a specific location within the "dispersal area," at which formation members gather for mobilization. Understandably, the "assembly point" is located near roads and railroads leading to the factory.]

construction or road crews, supplemented by fire fighters, medical task forces, and decontamination teams.

The formations of a facility may be divided into shifts. Their organization usually includes reconnaissance groups, rescue teams, and specially designated reinforcement formations. Civil defense formations of a national economic facility advance to conduct rescue work in the following sequence: the reconnaissance group leads the way, followed by the advance rescue divisions with reinforcement facilities; the reinforcement formations follow the advance divisions.

The rear is organized to repair, decontaminate, and provide fuel and lubricant to disabled vehicles, as well as to provide medical assistance to personnel. These units include mobile repair and evacuation facilities, medical staffs, and tank trucks.

Marching route movement is regulated by the national economic facility's CD staff. Control posts are established at assembly points, on trails, at crossings, at sharp turns, and in streets of populated areas through which formations pass.

11.2 ASSURING THE PERFORMANCE OF RESCUE WORK

The performance of rescue work is assured beforehand by the appropriate services and is executed by the staff in response to the civil defense chief's decisions. The basic types of supportive equipment and measures consist of antiradiation and antichemical, material, medical, fire-fighting, and engineering equipment, as well as transportation equipment. These provisions are located at the facility itself, in dispersal areas for off-duty shifts of workers, employees, and their families, and on marching routes leading to centers of destruction, including nuclear as well as chemical and biological contamination.

Means and measures are available to afford prompt protection of personnel and the general public from radioactive and toxic materials. Radiation and chemical support is the task of the Radiation and Chemical Defense Bureau. Radiological, chemical, and meteorological observation is organized in the area of the facility and in places where the off-duty shifts of workers and employees are located. To warn personnel of radioactive and chemical contamination, signal relay and communication facilities are established.

Individual means of protection are prepared, the formation is readied to fulfill its tasks, and in deployment areas measures to protect against radiation are taken.

Radiological and chemical reconnaissance executed on marching [travel] routes to centers of destruction determines the need for taking protective measures by formation personnel and also establishes detours around the contaminated zone. In the case of radioactive (chemical) contamination, the decontamination command, included in the Mobilization Division, decontaminates individual zones of the terrain needed for civil defense force operations. Radiation reconnaissance and dosimetric monitoring of exposure and contamination, as well as decontamination, are organized in areas of nuclear contamination.

Individual dosimeters are issued to monitor the exposure of formation personnel, and then dosimetric surveys of groups are made. Contamination is monitored by a radiometer when the formation leaves a center of destruction. In addition, preventive measures are implemented, such as the use of drugs to increase the resistance of personnel to radiation. To prepare for the possibility of another nuclear strike and radioactive contamination, the available blast shelters and fallout shelters are adapted for the working shifts.

Shifts and schedules determined on the basis of the radiation level are organized for working at the centers of destruction. Decontamination posts are set up for decontamination of personnel after they complete their work. Chemical reconnaissance and warning systems are organized in areas of chemical contamination, and preventive measures are implemented.

Observing safety measures and using special protective means (protective clothing) are especially important. Decontamination of the transport facilities, technical equipment, and property is undertaken when work is completed and the formation is leaving the area of contamination; decontamination is provided for personnel.

Medical support is provided to protect the health of formation personnel and the public and give prompt medical assistance to the sick and wounded. Medical services are provided by the medical unit and are executed by medical task forces. Medical reconnaissance of the region is organized at the facility site and in places where workers and employees are located; medical care is provided to the sick and wounded. These measures are executed by medical personnel dispatched for this purpose by the medical service.

When advancing into an area of destruction, medical reconnaissance is conducted on the marching routes, as well as in regions where the off-duty shift is resting; medical checks are made to ensure that people are adhering to sanitary-hygiene rules. Before passing through the contaminated zone, formation personnel use individual means of medical protection (antidotes, antiradiation drugs). Medical reconnaissance of the rescue work site and medical protection of personnel are performed at the centers of destruction; in addition, prompt medical aid is given to formation personnel.

The fire fighting service is organized to quickly isolate and extinguish fires, as well as to protect plants and materials from fire. This service is provided by the fire department and is implemented by fire fighting task forces. In the area of the facility and in dispersal regions where workers and employees are located, fire fighting includes implementing fire preventive measures and preparing forces and equipment to extinguish fires; it also includes protecting formation personnel from weapons of mass destruction. When advancing into a center of destruction, the fire fighting equipment is prepared to extinguish fires which could impede advancement of the formations. At a center of nuclear destruction, fire fighting service is provided by the fire fighting formations, which conduct fire reconnaissance, delimit safe passage routes in the conflagration zones so that the formations can leave for the work sites, and isolate and extinguish fires hindering rescue work.

Engineering support is organized by the technical emergency service for the protection of formation personnel and for the successful execution of rescue work at centers of destruction. Engineering support is given by all civil defense forces and by the population. At the facility site and in areas where workers, employees, and the evacuated population have been dispersed, technical engineering measures must ensure reliable protection of the population and of technical equipment from weapons of mass destruction and must also ensure rapid egress of civil defense forces to rescue work sites. These measures must be initiated immediately after arrival of the formations, workers, employees, and evacuated population in the dispersal region. Moreover, engineering equipment is to be constantly maintained in good condition.

The following are provided in the dispersal regions:

1. radiation protection for formation personnel and the population;
2. command posts;
3. roads, bridges, and crossings;
4. water supply stations.

Engineering work is performed in order of importance, thereby assuring maximum protection for the people. It is executed by all formations, subunits, and the population with maximum use of mechanized equipment and local materials. On the marching routes for advancing to a center of destruction, engineering support is supplied by the Mobilization Support Divisions (one division on each marching route) whose tasks include:

1. organizing engineering inspection of roads and highways;
2. preparing the primary and secondary supply routes and maintaining them in passable condition;
3. helping formations and subunits to pass through difficult regions and providing detours.

When formations and subunits are advancing directly to rescue work sites, engineering support is provided by forces from the formations of these sites themselves. Engineering support at a center of nuclear destruction includes:

1. conducting engineering reconnaissance at the rescue work sites;
2. providing trails and passages in the rubble;
3. clearing the ruins;
4. opening obstructed blast shelters and fallout shelters;
5. fortifying or razing buildings in danger of collapse;
6. preventing and eliminating trouble on public power networks.

Transportation support is organized to transport civil defense forces to a center of destruction and to evacuate the wounded into hospital bases in the outer zones. Transportation support is given by the transportation service and is achieved with motor convoys based on the municipal motor pool. The convoys are assembled near the marching [travel] routes and the assembly points, and, as a rule, each convoy travels along one marching route. To escort the convoys from the assembly points to the dispersal region, representatives are appointed from plants, institutions, and organizations whose personnel are being transported.

As a rule, civil defense formations of an outlying area are transported to the center of destruction by the equipment used to disperse the workers and employees. The wounded are evacuated to first aid stations in motor vehicles specially dispatched for these purposes. Motor convoys, as well as individual motor vehicles, usually convey the wounded without delay. In special cases, the wounded are evacuated by railroad, river, and sea.

Material and technical support of CD formations is one of the most important conditions for successfully performing rescue and urgent emergency-restoration work. This support is organized by the chief of the technical material supply service, which sets up technical material stores, warehouses, and supply stations.

Transportation of drinking water and food and the technical support of their transport is organized in dispersal regions of workers and employees. For this purpose, mobile supply stations, mobile material stores, water transport teams, mobile filling stations, and laboratories to check for food contamination are formed. Formation personnel involved in performing rescue and urgent emergency-restoration work must be provided with hot food before they advance into a center of destruction.

Technical support includes inspecting the technical equipment which is used, checking motor vehicles, and giving technical assistance, as well as supplying fuel and lubricants. Technical assistance is organized on marching routes for advancing to a center of destruction. For this purpose, repair facilities are included in the reinforcement convoy. Fuel and lubricants are provided for the technical equipment by mobile filling stations deployed at outposts. The formation is provided with water and food at a center of nuclear destruction. Water is delivered by water transport teams in airtight containers.

Food preparation is organized in uncontaminated areas or, if conditions permit, on terrain with a radiation level not exceeding 1 R/hr. If radiation levels are less than 5 R/hr, kitchens are set up in tents; in the event of higher radiation levels, food is prepared in decontaminated premises or in shelters. Cooking equipment and utensils and supply stations contaminated beyond the permissible level of radiation are used only after decontamination. Eating in the open is permitted at radiation levels up to 5 R/hr. At higher radiation levels, the food must be eaten in a decontaminated place or in specially equipped motor cars and shelters. Food preparation and eating are not permitted in an area of chemical contamination.

At a center of nuclear destruction, damaged vehicles are repaired as fast as possible. First, mechanized equipment is repaired which is used for rescue and urgent emergency-restoration work, as are motorized transportation units engaged in evacuating the wounded. Technical equipment not restored at the site of damage is transferred to the collection station for damaged vehicles (CSDV) and to repair plants. Technical maintenance and repair of vehicles exposed to radioactive and chemical contamination is performed after special treatment. Technical equipment used at a center of destruction is serviced with fuel and lubricants at stations and warehouses in the outer zone before proceeding to the rescue work sites.

As a rule, the radiation dose is checked at working places.

11.3 ROLE OF THE CIVIL DEFENSE CHIEF AND STAFF OF THE FACILITY IN ORGANIZING AND CONDUCTING RESCUE WORK

11.3.1 Organizing Rescue and Urgent Emergency-Restoration Work

The performance of rescue and urgent emergency-restoration work is planned in advance by the CD staff of the facility and made more specific after the enemy has inflicted a nuclear strike. When the civil defense forces of the facility reach the assembly point, the civil defense chief of staff specifies the grouping of forces and orders the formation to advance to the center of destruction. Moreover, as a rule, the civil defense formation moves in to execute rescue work at its own facility. The CD chief of the facility defines the task for the formation commander, indicates the composition of the task force, and the sequence in which the formation should advance when the enemy inflicts a nuclear blow, issues orders concerning engineering equipment for the assembly point, creates an observation post, and organizes communications.

The CD chief of staff organizes observation and communications posts and checks on all the orders issued by the head of CD of the facility to ensure that they have been executed by all formations.

After the enemy has inflicted a nuclear strike, the CD chief immediately deploys reconnaissance groups and support divisions in a given direction to ensure movement and issues orders concerning the forward movement of formations of the advance task forces. The CD chief sends out the reconnaissance group to the site of destruction (to the installation) and brings the formations of the first shift into complete readiness; [then] with himself at the head, he leads them out to the site of destruction.

The chief of staff issues an order for the CD formation which constitutes the next task force to prepare to advance into the center of destruction. The rescue work task is assigned by the CD chief of the facility to the chief of a mobile or auxiliary command post. The following are enumerated when assigning tasks:

1. tasks of the civil defense facility formation; the time to start work; the quantity, composition, and duration of the working task forces;
2. measures for protecting personnel and permissible exposure doses;

3. assembly points after concluding work or after the personnel has received its permissible exposure dose;
4. location of first aid stations and special processing points.

When the CD chief of the facility receives the orders, both the task and situation are evaluated and a decision is reached concerning rescue work before the order is transmitted to the formation command. The CD chief, who makes decisions and assigns tasks, must not allow his work to delay the rapid departure of the formation to rescue work sites.

The CD chief of staff of the facility organizes the assembly of all data for the CD chief to facilitate decision-making. First, data are gathered on the nuclear blast and the characteristics of the center of destruction. The chief of staff receives these data from civil defense staff superiors, reconnaissance groups, and other sources. The gathered and correlated data concerning the center of nuclear destruction and the marching routes and conditions must be reported to the site's CD chief by the formation chief of staff.

In explaining the task, the CD chief of the site specifies:

1. the character of nuclear destruction at the site; the purpose of deploying formations to the center of destruction and onto the marching routes;
2. the condition of the formations, the forces, and the reinforcement facilities;
3. the time available for executing the task.

The following points are considered when evaluating the situation:

1. the character and dimensions of the center of destruction (contamination), that is, radiation, engineering, and fire conditions are evaluated;
2. the presence and location of the injured;
3. the extent to which formations and public networks of the site have been damaged;
4. the condition of the formations and the possibility of using them for rescue work;
5. the season and the time of day and how they might affect work at the center of destruction.

It is especially important to evaluate radiation conditions in order to correctly deploy the task forces and determine the working time for each of them.

11.3.2 Evaluating Radiation Conditions

Frequently, civil defense forces must operate in contaminated regions. Thus a necessary part of the work of chiefs and civil defense formation commanders is to evaluate radiation conditions; this is done to establish the dose rate and the radioactive contamination of the ground and to determine their possible influence on the safety of formation personnel and the population during the period of work. Evaluating the radiation conditions includes:

1. determining zones of radioactive contamination of different radiation levels;
2. plotting the contamination zone on a map (diagram);
3. determining the permissible exposure dose and evaluating the possible losses of formation personnel and of the population due to radioactive contamination;
4. determining the most expedient formation operations and methods for directing the population over contaminated ground to ensure the least possible danger of radioactive damage.

Determining the various dose rates in zones of radioactive contamination is accomplished through the use of tables, together with reconnaissance data, for greater precision.

Radioactive contamination is forecast after the enemy has used nuclear weapons in order to determine the time and character of the contamination and a method for handling the population. The basic initial data for such predictions are (1) the power and type of the blast, the coordinates of the epicenter [ground zero], and the time of the blast and (2) the velocity and direction of the average wind in the layer from the earth's surface to the elevation of ascent of the upper surface of the radioactive cloud.

Data on the blast are given to municipal civil defense observation posts. These data will be available to the civil defense staff of the site. Data on the wind and other meteorological conditions are issued by the meteorological service. The site's CD chief of staff is obligated to deliver all these data in time to civil defense staff superiors.

The forecasts may give only approximate data which may differ essentially from the actual data. Thus predicted radiation conditions must be made more precise by radiation reconnaissance. On the basis of the forecasts, measures are taken for the protection of the population. As a rule, the CD staff of the facility and the formation command evaluate the radiation conditions on the basis of radiation reconnaissance data. They receive general information concerning dose rates at the center of destruction from the superior chief.

After the enemy has inflicted a nuclear strike, the CD chief of the facility and the chief of staff determine which facility was struck, the dispersion region, the assembly point in the contamination zone, and the actual time contamination started. The time when contamination begins (the time the radioactive cloud arrives) is determined by the formula

$$t = \frac{D}{v},$$

where t is the contamination initiation time (hr), D is the distance from the center of the blast to the location in question (km), and v is the wind velocity (km/hr).

After establishing the actual contamination initiation time, the CD chief determines the defense measures and issues instructions to the chief of staff concerning operations of the formation and of the population. The chief of staff instructs the observation posts; the CD chief of the site issues orders to the population and to the formation commander.

The dimensions of the zones with moderate, high, and dangerous radioactive contamination (length and width) are determined with the aid of special tables. These zones are plotted on maps (sketches), with dotted lines to represent forecasts and solid lines to indicate determinations from reconnaissance data.

Surveys with dosimeters determine the actual radiation levels. The relation between the dose [integral dose] D_∞ and the radiation level [dose rate] in the area is approximated by the equation

$$D_\infty = 5\, P_f t_f ,$$

where P_f is the radiation level [dose rate in roentgens per hour] at the moment of fallout of the radioactive substances [the measured initial dose rate at the given location] and t_f is the time [in hours] after the explosion when radioactive substances first appear at the given location.

It is considered that radiation doses over the entire decay period of substances 40, 400, and 1200 R correspond to radiation dose rates (levels) of 8, 80, and 240 R/hr measured 1 hr after the explosion or 0.5, 5, and 15 R/hr measured 10 hr after the explosion. [In other words, this is the integral dose in roentgens, delivered at a certain point by the "complete" decay of the fallout.]

The dose rate at any given time may be determined by the appropriate table (see Table 9, p. 34). The radioactive contamination zones can be plotted on the map according to dose rate measurements in the area converted to a given time after the blast.

Sequence of mapping work:

1. The center of a nuclear blast is plotted on the map (with an arbitrary symbol the map is provided with a legend (type, power, and time of blast).
2. A straight line (axis of the cloud track) is drawn from the center of the blast, corresponding to the average wind direction.
3. The length and width of the zone of moderate-A, high-B, and dangerous-C radiation are determined by tables or with the aid of a radiation scale.
4. These zones are plotted on a map with the aid of a ruler (zone A, blue; B, green; C, brown).

The determination of the dose incurred in crossing the fallout track. The radiation dose received while crossing the track of the radioactive cloud is determined approximately by the equation

$$D = \frac{tR_{max}}{4K},$$

where R_{max} is the maximum dose rate encountered along the trip (R/hr), K is the coefficient of attenuation of the dose rate of the vehicle used, and t is the time elapsed in crossing the contaminated area (hr).

The radiation dose incurred during presence in a contaminated area is approximated by the equation

$$D = \frac{tR_{average}}{K}.$$

However, in calculating the allowable duration at work by this equation, there arises an error in connection with the fact that the dose rate does not remain constant. However, the error is conservative in that the allowable duration obtained is on the low side and therefore on the safe side. To determine the allowable elapsed shift time at work accurately it is better to use a radiation slide rule.

The determination of shift time work duration in a contaminated area. The elapsed times allowable in a contaminated area can be determined by (1) a slide rule RL or (2) tables of values. The basic data for this determination are:

1. the time of the explosion;

2. the measured radiation level at some elapsed time after the explosion;

3. the time of entry into the "hot" area [affected area] after the explosion;

4. the established allowable dose that may be incurred (received) by personnel.

An example. The nuclear explosion occurred at 6.00 hours [o'clock]; the radiation level of 20 R/hr is measured at 8.00 hours [o'clock]; the time of entry into the "hot" zone is 8.00 hours [o'clock]; the established allowable dose is 40 R. Determine the working time of a shift on contaminated area. According to the radiation scale the working time of a shift is 4 hr. According to Table 40 we find the ratio D/R = 40/20 = 2, and the time for entering the focal area is 2 hr. When the convoys cross the boundary, the time of entry is about 2 hr and the ratio D/R = 2; according to Table 40, we find the working time is 4 hr.

After determining the working time of a task force and evaluating the circumstances, the CD chief of the facility makes a decision on the basis of which orders can be given to the formation commander. The following are indicated:

1. concise information concerning the conditions (the dose rate) and the degree of destruction of buildings and structures;

2. the rescue work site and the order of movement to it;

3. the beginning and duration of task force's working period, measures for protecting personnel, permissible exposure dose, and sequence for checking radioactive exposure;

4. the location of first aid stations and stations for evacuating the wounded;

5. the location of the command post and the sequence for maintaining communications.

Having set the task, the CD chief of the facility personally leads the subordinate personnel to their own facility and deploys and supervises the rescue work.

In turn, the commander of any formation upon receiving an order formulates the task, evaluates the circumstances, makes a decision, and presents the problem to subordinates. In evaluating the conditions, for example, the division commander determines the nature of the damage to the facility, the existence and location of the injured, the nature and volume of the imminent work, and explores the special features of the terrain on which personnel must operate. In addition, the commander studies the condition and the security of his own, and assigned, formations and the operations of neighboring installations, as well as the effect of the weather,

Table 40. Permissible exposure time in an area contaminated by fallout resulting from a nuclear blast

D/R value[a]	Time of entry into the contaminated area (from the time of the blast) (hr)												
	0.5	1	2	3	4	5	6	7	8	9	10	12	24
	Exposure time (in hours and minutes) for which the determined value D/R is obtained for different times of entry into the contaminated area, referred to the blast time.												
0.2	0-15	0-14	0-13	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12
0.3	0-22	0-22	0-20	0-19	0-19	0-19	0-19	0-18	0-18	0-19	0-18	0-18	0-18
0.4	0-42	0-31	0-27	0-26	0-26	0-25	0-25	0-25	0-25	0-25	0-25	0-21	0-24
0.5	1-02	0-42	0-35	0-34	0-32	0-32	0-32	0-31	0-31	0-31	0-31	0-31	0-30
0.6	1-26	0-54	0-44	0-41	0-39	0-39	0-38	0-38	0-38	0-37	0-37	0-37	0-37
0.7	2-05	1-08	0-52	0-49	0-47	0-46	0-45	0-45	0-44	0-44	0-44	0-44	0-43
0.8	2-56	1-23	1-02	0-57	0-54	0-53	0-52	0-51	0-51	0-51	0-50	0-50	0-49
0.9	4-09	1-42	1-12	1-05	1-02	1-00	0-59	0-58	0-58	0-57	0-57	0-57	0-55
1.0	5-56	2-03	1-23	1-14	1-10	1-08	1-06	1-05	1-05	1-04	1-04	1-03	1-02
2.0	1562-00	11-52	4-06	3-13	2-46	2-35	2-29	2-24	2-20	2-18	2-16	2-13	2-06
2.5		31-00	6-26	4-28	3-48	3-28	3-16	3-08	3-03	2-59	2-55	2-51	2-40
3.0		96-39	9-54	6-09	5-01	4-28	4-10	3-58	3-49	3-43	3-38	3-30	3-14
4.0		3124-00	23-43	11-05	8-12	6-57	6-16	5-50	5-33	5-19	5-10	4-58	4-26
6.0			193-19	35-35	19-48	14-43	12-19	10-55	10-02	9-24	8-57	8-19	7-01
10.0				728-49	124-00	59-18	39-34	30-39	25-42	22-35	21-32	17-52	13-08

[a] D/R equals permissible dose in roentgens divided by the dose rate R/hr at the moment of entry into the contaminated region.

the time of day, and the season on the work to be done.

When giving assignments to subordinate units, the division commander states:

1. the situation at the site;
2. the location and extent of the work;
3. the tasks of subordinate formations and the times for their execution; the permissible exposure dose;
4. the working sequence with cooperation between subdivisions and neighboring units;
5. instruction and warning signals; the sequence and the time for submitting reports and the place where they are to be submitted.

The commanders of various subunits, on receiving orders for performing rescue work, present the tasks to personnel, indicating the equipment, the means, and the time for completing the work.

11.3.3 Supervising Rescue and Urgent Emergency-Restoration Work

To direct formations and subdivisions in the performance of rescue work, the civil defense chief of the facility sets up a command post for which blast shelter, fallout shelter, and other available structures may be used. Communication facilities are used at the command post (telephone, radio, and mobile facilities). The CD chief of the facility personally supervises subordinate formations via a staff and the civil defense service. Where work is performed, cooperation is organized with various other units; general efforts are directed toward the primary task — rescuing people. The fire fighting formation isolates and extinguishes fires which impede rescue work; the rescue divisions open obstructed shelters; emergency technical formations solve problems in municipal power networks; and the medical formation renders medical assistance to the wounded.

The CD chief of staff of the installation is responsible for ensuring that the orders of the civil defense chief of the facility have been implemented and evaluates the progress of rescue work. All data concerning rescue work and circumstances at the center of destruction are correlated by the chief of staff and periodically reported to the CD chief of the facility, as well as to higher-ranking staffs.

In the course of executing work at a center of destruction, the CD chief of the facility may issue additional orders to the formation commander, ensuring that specified measures for protecting personnel from radioactive, chemical, and biological contamination, as well as orders concerning material and technical supplies for working units, are carried out.

The formation commander directly supervises the personnel at the rescue work site, maintaining an established working schedule and strictly observing protective and safety measures. During the course of work, he observes any change in the situation, gives additional orders to subordinates and, if necessary, redistributes forces and facilities. The formation commander reports to the CD chief of the site on the progress of work and on changes in the situation.

11.3.4 Task Force Replacements of Formations and Subdivisions

The civil defense chief of the site ensures that the task force replacements of formations and subdivisions are carried out smoothly. Formation and subdivision personnel are replaced when the shift time of personnel working at a center of destruction is over, when the personnel receives the permissible exposure doses, or when the personnel must rest or eat. Such replacements are organized so that the performance of rescue work is not interrupted. The sequence of shifts is set up beforehand; the appropriate commander is instructed by the CD chief of the site on the location of rescue work, the time, and the sequence of the replacement of shifts.

The commander of the formation to be replaced updates the arriving commander on the performance of rescue work, the sequence of measures to be followed, the radiation conditions, the work accomplished and the work yet to be done, the location on the site of the civil defense chief's command post, and the layout of the communications system.

The arriving replacement formation halts in the immediate vicinity of the site. The commander familiarizes himself with the situation, gives the assignments to the personnel, and conducts them to the working site. The formations that are being replaced stop the vehicles, machinery, and instruments at the working sites. If necessary, these are partially decontaminated by the arriving formation. While rescue workers at the site are being replaced by fresh ones, the commander of the previous formation is in charge.

If necessary, the replaced formation undergoes complete decontamination and then proceeds to the rest area to eat. To prepare for subsequent operations, if necessary, repairs are made and individual means of protection are replaced; depleted technical material and medical supplies are replenished. Persons who have received the maximum permissible exposure dose during the course of work are used thereafter only for work in uncontaminated areas.

11.4 METHODS FOR CONDUCTING RESCUE WORK

Formations in centers of mass destruction must perform a large amount of rescue and urgent emergency-restoration work under complex conditions with a time limit for saving people trapped in obstructed blast shelters and fallout shelters, in burning buildings, and in regions of contamination and flooding. In addition, the formations must work under conditions of radioactive, chemical, and biological contamination, group fires, destruction, and rubble – all the while under constant threat of repeated nuclear strikes and repeated radioactive, chemical, and biological contamination by the enemy.

The basic principles to ensure the successful rescue of victims at a center of nuclear destruction are as follows.

1. Rapid deployment of forces and facilities for implementing rescue work. For this purpose, all the civil defense formations, especially rescue, fire fighting, technical, emergency, and medical formations, immediately begin to rescue victims. The rescue work begins before reconnaissance data are complete. The latter is included in the rescue work of the formation arriving at the facility with the first task force. The working intensity then increases as new task forces arrive together, if necessary, with rural formations.

2. Rescue of victims in a short time is furthered by the fact that the formation, arriving at the facility, begins to work immediately; it must act decisively and rapidly, also displaying initiative. It is necessary to attempt to pump air into obstructed or damaged shelters in the first 3 or 4 hr after the nuclear blast; in the first 12 or 14 hr it is necessary to render medical assistance to the majority of victims; the basic rescue work should be completed by the end of the first few days. Thus, the work must proceed continuously (day and night) with great exertion of effort and at high speed.

3. The use of task forces and facilities in densely built-up zones of cities, at the site where the majority of victims is located, may turn out to be very difficult. The primary purpose of the forces and facilities will be to render assistance to a large number of victims and to achieve maximum results.

4. Work at the center of destruction is implemented by extensive use of machinery and is done manually only when mechanized equipment is lacking. Since a large volume of work can be performed in a short time only with a maximum use of mechanized equipment, it is necessary to take all measures to bring such equipment to the site of the work along with fuel.

5. The specialists of the civil defense formations are utilized to enable each formation to do the work for which it is best suited at a center of destruction. This use of formations promotes a high degree of efficiency and rapid completion of work. Performance of work by nonspecialists is permitted only in extreme cases.

6. As a rule continuity of rescue work at a center of destruction is assured by organization into two or more shifts. Working time of the working shift is determined by the formation commander on the basis of the circumstances and the dose rate in the area.

7. Strict safety measures are observed when working in a center of destruction, especially when operating in dangerous zones and in contaminated regions.

8. Rescue and urgent emergency-restoration work forces are deployed extensively and the work is carried to completion. Rescue work at centers of mass destruction includes:

1. reconnoitering the area of destruction;
2. isolating and extinguishing fires on approaches to the site and conducting rescue work at the site;
3. making paths and passages through the ruins;
4. rescuing people from destroyed shelters, from under rubble, and from burning and partially destroyed buildings;
5. leading people from regions of radioactive or chemical contamination and flooded areas;
6. sanitary processing of people and decontamination of their clothing;
7. decontaminating territory, structures, transportation, and special technical equipment.

11.4.1 Reconnoitering the Center of Destruction

Organizing reconnaissance is the primary duty of the chief and the civil defense staff of the facility.

The civil defense chief of the facility and the formation commander determine the reconnaissance tasks and when they are to be executed, and they provide the necessary equipment. The basic CD reconnaissance formation at the facility is comprised of the reconnaissance group and the reconnaissance teams of rescue divisions.

The reconnaissance group advances immediately to the center of destruction, first determining the presence of radioactive contamination on the marching routes and on the grounds of the facility, and then determining the extent of the conflagration zone and the direction in which it is spreading and the extent of destruction to buildings and structures, and then immediately reporting this by radio to the CD chief of the facility.

When organizing rescue work at a center of nuclear destruction, engineering reconnaissance is very important. Engineering reconnaissance is organized by the CD staff of the site and the commander of the engineering, rescue, and technical emergency formations. Reconnaissance is undertaken before the rescue and urgent emergency-restoration work are organized, and it is executed simultaneously with that work. Reconnaissance groups and teams, which include specialists in emergency-restoration work, are used to conduct reconnaissance.

The tasks of engineering reconnaissance include establishing the location of damaged and obstructed shelters, determining the nature of damage to buildings, structures, and power lines, estimating the volume of work and the methods for its performance, and selecting approach and access routes to the working place. Reconnaissance personnel are supported by transportation facilities, individual means of protection, equipment and instruments, and warning signs.

Engineering reconnaissance is conducted by inspecting the damage, listening at shelters, and identifying these findings with special signs. Engineering reconnaissance groups inspect rubble and damaged buildings, uncover obstructed and damaged shelters, determine the nature of the damage to power lines and the problems which have resulted, and estimate the amount of work to be done. The general volume of work includes clearing rubble, uncovering obstructed shelters, and correcting problems in power lines. On the basis of reconnaissance data, the CD chief of the facility decides what working methods will be most effective in a specific case and determines a work sequence and schedule.

11.4.2 Isolating and Extinguishing Fires

Fires interfere with saving victims and increase the number of wounded as a result of a nuclear burst. To perform rescue work in buildings, it is first necessary to assure access of formations to the center of destruction and isolate and then extinguish fires. Thus, rescue work also includes active fire fighting. Work in isolating and extinguishing the focal area of fires is organized by the fire fighting service and is accomplished by fire fighting units (with fire commands and volunteer fire fighting squads) while other types of rescue work are in progress. The fire fighting unit uses high-powered mechanized fire fighting equipment to extinguish fires (automatic pumps, hose trucks, and compressor units). Isolating and extinguishing fires are performed first along marching routes where civil defense forces are moving into the center of destruction, on rescue work sites, and on routes for evacuating the wounded. Civil defense forces enter the conflagration zone by routes opened by the advance fire fighting forces.

The occurrence of group fires depends on the character of municipal construction and on meteorological conditions, as well as on the fire-prevention measures which have been taken. To prevent individual fires from merging into conflagrations, measures are taken to isolate the fires. Fire breaks are placed in the paths of the fires to prevent their propagation. For this purpose, burnt-out structures in the path of the spreading fire are razed and demolished, and easily combustible materials and vegetation are completely removed from the fire break. The fire break must have a width of at least 50 to 100 m. Constructing the fire break, although requiring much time and labor, is performed rapidly by formations equipped with bulldozers and other technical equipment.

11.4.3 Clearing Paths and Constructing Throughways in Ruins

Available roads are used by civil defense forces to approach rescue work sites. If roads are unavailable or impassable, trails are made by the Mobilization Support Division. A trail is a primitive path on unpaved ground.

Constructing trails and thoroughfares through rubble. The destruction of buildings and structures by an urban nuclear blast generates rubble which impedes the passage of technical equipment and formations into the center of destruction and prevents evacuation of victims. Rubble also impedes the performance of rescue work. Thus, clearing the rubble and creating passageways is a very important task of engineering civil defense formations. A special condition of this work is that it must be executed quickly in order to assure prompt access of rescue formations to the work sites and rapid assistance to the victims.

In zones with local [scattered] rubble, paths are cleared to the road surface itself if the depth of the rubble does not exceed 1 m (Fig. 121*a*). In zones of continuous rubble and where the depth of the rubble pile is more than 1 m, a path is made through the very extensive rubble (Fig. 121*b*). Moreover, the width of the path for single-file [vehicular] movement must be not less than 4 m. Widened zones are constructed at intervals of 150 to 200 m (wherever necessary) so that vehicles can pass each other.

The work of constructing paths can be performed by the rescue group, reinforced by bulldozers, in the following order: One team selects and marks the route and reconnoiters for hazards in the passage; two groups, following the first, clear the width of the path from bulky pieces which hinder operation of the bulldozer (metal parts are cut and removed, heavy blocks are split); the bulldozer moves behind them and levels the path (Fig. 122). The path is compacted by passing vehicles (tractors, automobiles, and other technical equipment). The final step is to erect traffic signs and posts.

ORNL DWG 73-4756

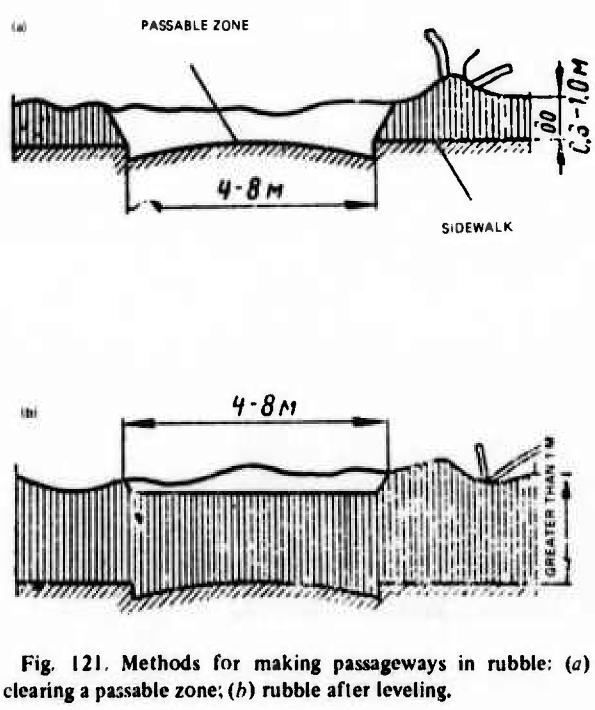

Fig. 121. Methods for making passageways in rubble: (*a*) clearing a passable zone; (*b*) rubble after leveling.

ORNL DWG 73-4757

Fig. 122. Clearing a passage with a bulldozer.

When there are rivers, canals, and other water obstacles in the city hampering the movement of rescue formations to the center of destruction, it is necessary to construct crossings and temporary bridges to replace those destroyed by the nuclear blast. This work is performed by special bridge-building task forces, which are used to construct ferry docks, floating bridges, barges, and river vessels and to prepare lanes for wading through the water and in winter for crossing ice.

11.4.4 Rescuing Victims from Destroyed Shelters, from Under Rubble, and from Burning and Partially Destroyed Buildings

The basic task of civil defense formations when operating in centers of mass destruction is to rescue people quickly. The success of their operations depends on the conditions under which they are working.

Rescuing victims from obstructed blast shelters and fallout shelters. The shelter may be damaged (destroyed) due to the effect of the blast wave from a nuclear burst and may be obstructed with rubble from destroyed buildings. Those taking refuge in such shelters may find themselves in a difficult situation. Thus, it is necessary to quickly pump air inside, and then to provide exit from the obstructed or damaged shelters.

Blast shelters and fallout shelters are considered obstructed if the occupants in them cannot get out without help. In this case, an underground shelter will be obstructed by damage to stairwells, and emergency exits (hatches) will be obstructed when the rubble over them exceeds 0.5 m in depth. Obstructed exits may occur in zones having an overpressure exceeding 0.7 kg/cm^2 [10 psi] when the damaged parts of a building (installation) are carried away from the building over an area of tens of meters by the air blast. Rescuing victims from obstructed blast shelters and fallout shelters is a complex, difficult task which should be performed in the following order:

1. find the shelter in the obstructed part of the city (site);
2. establish communication with the people in the shelter and determine the situation within the shelter;
3. supply air to the obstructed or damaged shelter (if this is necessary);
4. provide approaches to the obstructed shelters on major thoroughfares and clear a place to locate mechanized equipment;
5. open obstructed shelters;
6. provide an exit for persons from the shelter, render first aid to the injured, and evacuate them to a first aid station;
7. identify the opened blast shelter (fallout shelter) with some sign.

Locating a shelter which exists within damaged buildings in a city is possible by means of local landmarks and with the aid of maps available to civil defense staffs, as well as by means of special radio facilities. Radio transmitters are placed in shelters to emit signals which will be received by special radio stations.

Communicating with the people in a blast shelter (fallout shelter) and determining their situation is possible by means of telephone or radio if these are operational. If it is impossible to communicate by telephone or radio, air inlets and other openings, or a slightly opened door, may be used for this purpose. Also, communication can be established by tapping on pipes.

After communications are established, the necessary air should be supplied. To accomplish this, remaining air inlets and apertures must be found and cleared. If inlet systems are damaged or heavily obstructed, an attempt must be made to clear and open the shelter door slightly and clear the openings and top hatches of emergency exits. If necessary, an opening is made in the wall or roof.

To make an opening manually, it is possible to use a hammer, a sledge hammer, a crowbar, or other equipment. It is best to make the opening mechanically (with a pneumatic drill or a hammer drill). In addition, it is very important to select the right place for the opening. It can be made in an outside wall under the roof, in a wall adjoining another shelter or the basement, or in the ceiling (Fig. 123).

Air is pumped into the shelter with a compressor or blower, or air may diffuse naturally through the opening which was made. Approaches and other means of access to the shelter are cleared of rubble, and a passageway from the shelter to transportation facilities is cleared. The methods used for opening shelters depend in each individual case on the character of the rubble, the construction of the shelter, and the condition of individual shelter components.

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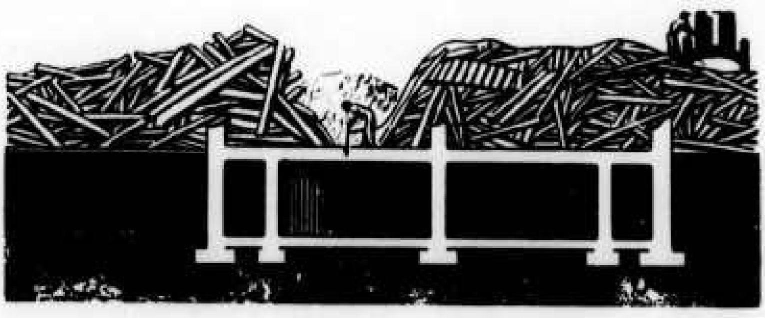

Fig. 123. Making an opening in a roof with a manual drill.

as well as on the available equipment of the rescue formation (subdivision).

Depending on the character of destruction to the buildings and structures under which the shelter has been built, the shelter can be opened by one of the following methods:

1. clearing rubble from the main and emergency entrances;
2. clearing obstructed or damaged hatches or trap doors of the emergency exits;
3. making openings in the walls or in the roof of the obstructed shelter from the surface; making openings in the shelter walls from an underground tunnel.

Opening shelters by clearing rubble from the main entrance. In obstructed or damaged shelters the main entrances are cleared whenever there are no emergency exits (mostly in basement-type shelters) and when the nature of damage to the building stairwells and the volume of rubble around the entrances make it possible to use this method. After the entrance is successively clear of individual bulky refuse from destroyed stairwells with the aid of motorized cranes or winches or manually, it is then manually cleared of small fragments and debris, and the doors are opened (Fig. 124).

Opening the shelter by clearing rubble from trap doors and hatches of emergency exits. Opening the shelter by this method may be most expedient for shelters equipped with emergency exits. It is known that trap doors (hatches) of emergency exits are located at a distance from the building walls not less than half the height of the building. The pile of rubble in the zone of the trap door, as a rule, may be smaller than along the walls of a destroyed building.* However, its size also depends on the nature of the construction in the area and the proximity of structures to the center of the blast. There may be instances when a rubble pile over the trap doors (hatches) is higher than at the walls (for example, in zones with an overpressure greater than 0.7 kg/cm^2 and with dense construction of multistory buildings).

Clearing rubble from the trap doors (hatches) is done either manually or by machinery. When it is done manually, it is sufficient to clear rubble from the exit opening in the trap door, the closed jalousie grating, or from above the hatch through which the people in the

*At the walls, a pile of rubble may amount to one-fifth the height of the building.

Fig. 124. Opening a shelter by clearing the main entrance.

shelter may exit to the surface. To free the trap door (hatch) exit of rubble, a trench is dug in the rubble to the freed exit (Fig. 125). If a bulldozer is used for the work, then (if the rubble is on one side) fragments are successively cleared away from the side of the trap door (hatch) until the exit opening (Fig. 126) is cleared. When the rubble is continuous, a trench is dug with the excavator.

Opening a shelter in one of the walls or in the ceiling. Openings are made in walls whenever there is no emergency exit and also when clearing the main or emergency exits requires more time and effort with the given method than can be expended. To provide an exit for those in the shelter, an opening with a cross section of not less than 0.6 × 0.8 m is made in the shelter wall. Such an opening makes it possible to exit from the shelter and does not require a great deal of effort. But before it can be made, access must be provided to the wall which, as a rule, is located below street (sidewalk) level. Thus, in order to be able to make an opening in the wall, it is necessary to first dig a trench in the rubble along the sidewalk surface and then dig an access with a cross section of 1.5 × 1.5 m and a depth of 1.5 to 1.7 m from which the opening in the shelter wall (basement wall) is made. The cross section of the access hole must be large enough to afford access to pneumatic tools. For the opening, a wall area with a minimum amount of rubble is selected.

The trench may be dug with an excavator equipped with a reversing scoop, with a bulldozer, or by hand. As a rule, the ditch is dug by hand or with a pneumatic drill.

The opening in the shelter wall is made with a pneumatic drill or a crusher, depending on the material in the wall, and if these are not available, it is made manually (wedges, rakers, sledge hammers) (Fig. 127).

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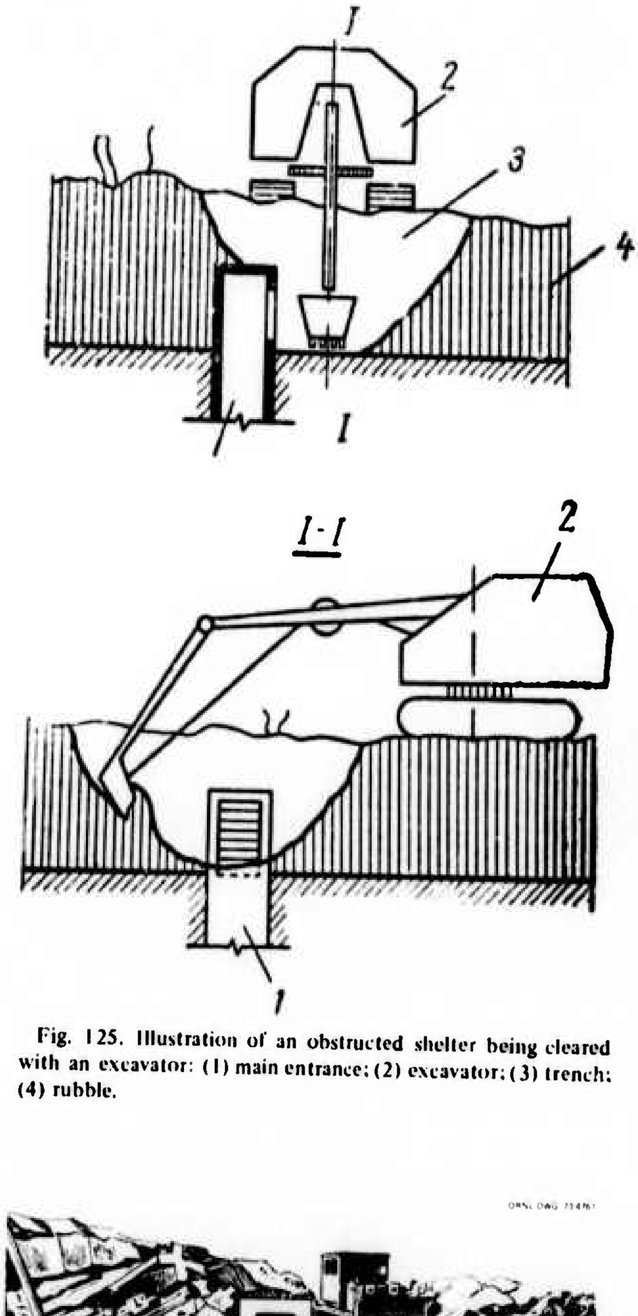

Fig. 125. Illustration of an obstructed shelter being cleared with an excavator: (1) main entrance; (2) excavator; (3) trench; (4) rubble.

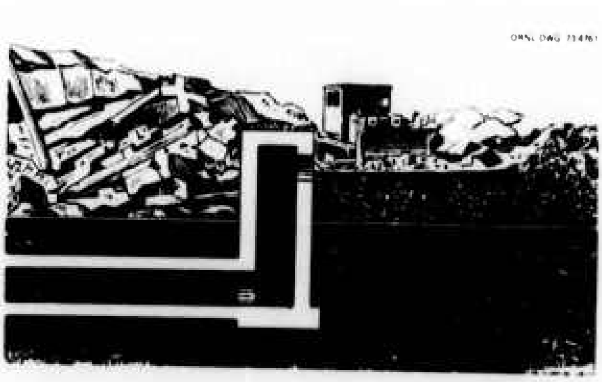

Fig. 126. Clearing the trap door with a bulldozer.

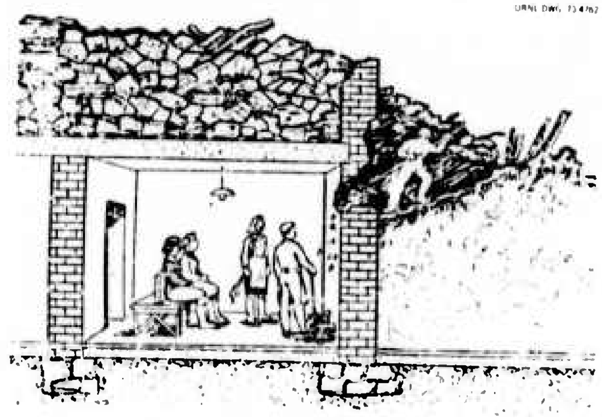

Fig. 127. Making an opening in the shelter wall.

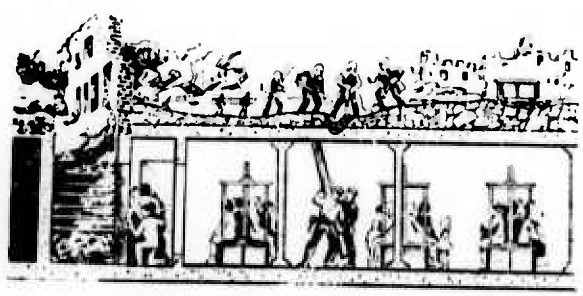

Fig. 128. Opening a shelter through holes in the roof.

The shelter can be opened through the ceiling when the latter consists of materials which will yield to demolition with a pneumatic tool or manually and, if possible, where access to the roof surface is available (Fig. 128). When the shelter is to be opened by this method, the roof must first be freed of rubble over an area of 1.5 X 1.5 m to enable work to be done with pneumatic tools. Next, an opening should be made in the roof with a cross section of at least 0.6 X 0.8 m.

Opening the wall of an obstructed shelter from an underground excavation. Opening a shelter by this method is used in extreme cases when no other methods can be used successfully, that is, when there is so much rubble that to break through it would take too much time. A vertical shaft is dug beyond the rubble to provide access to the shelter; the shaft has a cross section of 1.0 X 1.0 m, and its depth depends on the depth of the shelter floor, as well as on the position of the shelter ceiling. A horizontal excavation with a cross section of 0.8 X 1.2 m is made from the lower part of

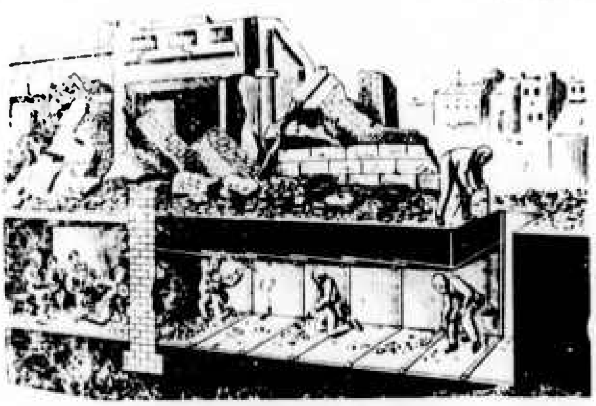

Fig. 129. Opening a shelter through holes in the wall made from an underground tunnel.

the shaft up to the side of the shelter, and openings are made from it in the shelter wall, through which the people in the shelter can be helped and the wounded can be carried out (Fig. 129).

The shaft and the tunnel (excavation) are made manually with pickaxes and shovels or with the aid of a mechanized tool, with subsequent removal of soil by buckets, drums, or bags. As the shafts and tunnels are sunk, they are reinforced with boards or log frames (see Fig. 129).

When an obstructed shelter is opened by means of either of the enumerated methods, it is first necessary to disconnect (if possible) all damaged pipes and lines running through or near the shelter — water pipes, sewer pipes, gas pipes, and electrical power lines — as these may create an additional hazard for those in the shelter and for those performing rescue work.

In order to lead or carry out victims from a blast shelter (fallout shelter) to a receiving center, a passageway 1 to 1.5 m wide is made. After the people are helped from the shelter, the wounded are given first aid and are evacuated to a first aid station.

Rescuing victims buried under rubble. In case of a sudden enemy attack, persons who were unable to leave their homes and take refuge in a nearby shelter may find themselves trapped under rubble from buildings destroyed as a result of the nuclear blast. Rescue work in extracting the injured from rubble is extremely complicated. It must begin with an inspection of the rubble, selection of an approach to it, and determination of operating procedures. At the same time, measures are taken to prevent further collapse; if possible, the gas and electrical lines and the water supply to the damaged building should all be shut off. Subsequently, the rescue formation provides the tools, depending on the type of destruction and the location of the victim in the rubble.

To rescue people in the upper parts of the rubble, the rubble on top is carefully separated. Moreover, it is necessary to see that weakened parts of a structure do not shift and settle. To extract the injured, the fragments and debris are removed manually to prevent causing additional injury. It is better to start digging near the head of a victim, subsequently freeing the shoulders, the body, and the legs (Fig. 130). After this, the victim is given first aid and carried from the danger zone.

To rescue people from the rubble located beside and within buildings, it is necessary to construct a narrow passage in the rubble itself. When such a passage is constructed, cracks and crevices, which are always present between destroyed parts of a building, must be used. Constructing a passage between large blocks is dangerous and is possible only when the blocks are kept stable, without collapsing or tilting. The entire passage is reinforced with supports and braces (Fig. 131). The

Fig. 130. Extracting victims from rubble.

Fig. 131. Providing access into the rubble.

passage is made 0.6 to 0.8 m wide and 0.9 to 1.1 m high to allow access through it. The injured are carried through the constructed passage by whatever methods are feasible under these conditions: by hand, on overcoats, on blankets, on plywood boards, on rope hammocks, etc.

Rescuing victims from partially destroyed and burning buildings. In the zone of moderate damage of a center of nuclear destruction, there may be partially destroyed buildings with rubble or fires and with people in the exits. Rescuing people from such buildings is performed by various methods, depending on the character of the damage and the position and the conditions of the victims on the various levels. The following methods are recommended in these cases:

1. construct temporary passages (escapes) using simplified chicken-coop-type ladders (gangways);
2. make openings in walls and partitions from adjoining, undamaged premises;
3. clear obstructed entrances (especially on the first stories);
4. use boards, scaling rope, fire ladders and other ladders, and rescue lines (Fig. 132). It is especially difficult to rescue people caught unawares by fire. Moreover, it is very difficult to find people in smoke. It is also difficult to find children. Often children who are frightened will hide in the most unexpected places, while the aged and injured caught unawares by fire cannot escape without help from the outside.

The rescue and the fire fighting formations must know not only how to locate people, but also how to rapidly lead or carry them from the center of the fire. Several methods are used to carry victims out. The selection of one method over another depends on the overall circumstances.

Giving first aid to victims. Rendering medical aid to the injured is one of the main aspects of rescue work. The lives of many of the victims depend on prompt performance of this work. Rendering first aid to victims is organized by the medical service and is carried out by task forces of the medical service formations, operating in close cooperation with rescue and other civil defense units. First aid at a center of nuclear destruction is rendered to victims on the spot. The sequence and methods for giving aid depend on the condition of the victims. Usually, the victims are found and removed by rescue units, and medical assistance is given by sanitation squads working with them. The victims are given first aid as they are being evacuated to the first aid station. First aid units (FAU) are sent out to a center of nuclear destruction to treat victims and give first aid.

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Fig. 132. Using a ladder to rescue victims from burning buildings.

11.4.5 Helping People Escape from Regions of Radioactive and Chemical Contamination and from Flooded Areas

High radiation levels and contamination with toxic materials present a serious hazard to persons not housed in shelters equipped with filtering systems. Thus, under such conditions, it may become necessary to evacuate the population into a safe zone. In the damaged area of a surface nuclear burst, the CD first aid staff evaluates the radiation conditions, determines how the people shall conduct themselves, and informs the civil defense staff where these regions are; the population is informed of the rules of conduct and the protective measures to be taken against radioactive contamination.

In many cases at high radiation levels, the population may be evacuated into uncontaminated areas since strict observance of the rules of conduct over an extended period of time involves great difficulties and deprivations. The population is led out expediently two or three days after radioactive contamination of the locale in order to prevent individuals from sustaining large exposure doses during loading and on the way. The people must remain in shelters until they are evacuated. Evacuation must be accomplished rapidly, with transportation being prepared in advance, and the population warned.

In case of chemical attack by the enemy, chemical reconnaissance is sent out, and on the basis of the data so obtained, rules of conduct are established for the people, as well as protective measures depending on the type of toxic materials and the contamination level on the terrain. All people having gas masks but not protected in specially equipped shelters are evacuated from the center of destruction as quickly as possible. People in shelters with filtering equipment are removed only if necessary and in an established order. In the focal area of chemical contamination, the medical unit renders medical assistance to the injured and evacuates them to a first aid station. Decontamination of the locality and of persons is then begun.

If there is an immediate threat of flooding due to the destruction of hydrological structures, evacuation of the population into safe areas is organized. The municipal CD staff prepares the civil defense forces, concentrating them outside the flooded region. The prepared units establish order and help the population which is being evacuated.

11.4.6 Decontamination of Persons and Clothing

Radioactive, chemical, and biological contamination presents a serious hazard to the population and formations conducting rescue work. Thus decontamination of the population is organized together with rescue work. Decontamination is effected at stationary washing stations which are based on baths, laundries, and showers, but in the summer season they are located in the open air near uncontaminated reservoirs. Decontamination is organized by the Community Utility Service and is executed by the personnel of the stationary washing station, deployed by orders of the medical service chief. The footwear and clothing of the population are decontaminated in the mechanical laundries and dry cleaners of the decontamination departments of the laundries.

11.4.7 Decontaminating Areas, Structures, and Technical Equipment

Work in decontaminating areas and structures can be implemented along with rescue work. Technical equipment is decontaminated when work in the focal area of destruction is concluded. Work on decontaminating areas, structures, and technical equipment is organized by the Community Utility Service and is executed by special decontamination units. The order for undertaking this work depends on the extent and character of the area which must be decontaminated (degassed, disinfected). Parts of an asphalt-covered area are decontaminated in the following order: fragments and debris are removed; the area is swept with sweeping-harvesting machines and washed abundantly with water; decontamination is checked with a roentgenometer. In addition, it is possible to decontaminate by scraping away and removing the upper layer of contaminated soil (snow). This method is used to construct passageways on contaminated territory.

11.4.8 Conducting Urgent Emergency-Restoration Work

Urgent emergency-restoration work is executed to ensure rapid rescue of persons and to prevent harmful secondary effects of malfunctioning equipment and damage. This work includes:

1. reinforcing and demolishing buildings interfering with safe movement along streets and with rescue work;
2. restoring power lines and assuring the water supply in buildings;
3. rectifying damage in gas, electrical, and water supply and sewer systems;
4. restoring damaged communication lines.

Reinforcing and demolishing buildings which interfere with safe movement on streets and with rescue work. It is necessary to prevent a damaged building from collapsing onto passable parts of streets or onto an opened shelter. To forestall this danger of falling debris, the building must be temporarily reinforced or demolished.

After the damaged building and the individual parts are inspected, they can be reinforced, depending on their height, as follows: walls up to 6 m high are reinforced by setting up simple wooden or metal struts at an angle of 45 to 60° to the horizon (Fig. 133). Walls with a height of 12 m or more are reinforced with

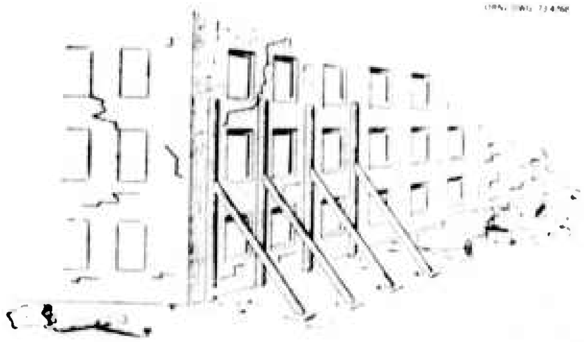

Fig. 133. Reinforcing an unstable building.

Fig. 134. Demolishing an unstable structure with a tractor.

double struts. In both cases, the number of struts is determined by the stability of the building to be reinforced. Usually, struts are placed against each load-bearing wall of the building.

Building walls can also be reinforced with the aid of braces erected between inclined walls and a stable building or structure. Parts of a damaged building or structure may be used for reinforcement: metal and wooden beams, girders, boards, and logs. Building walls and individual parts can be reinforced with cable bracings. When it is possible to demolish unstable parts of buildings which are in danger of falling, winches and cables or tractors are used for the job. First, the structure in danger of falling is inspected, and the proper working method chosen. Outsiders should not be allowed in the work area (this area is roped off). The winch is set up at a distance not less than twice the height of the structure to be demolished, and a cable is fastened to the structure. Then, if possible, the cross section of the wall is weakened by making horizontal or vertical cuts in the wall on the side opposite the demolition. On a signal by the foreman, the winch cable is tightened and the structure is pulled down (Fig. 134). An unstable building may also be destroyed by blasting.

Repairing damaged water supply lines. Due to the effect of a nuclear blast, underground water lines, approved wells, and other lines into the home may be destroyed, possibly leading to flooding of shelters and basements and to destruction of the parts of the building and structure surviving the blast, thereby undermining their bases. The basic method for confining damage to water supply lines is to block off the damaged sections, feeders, and standpipes in buildings. For this purpose gate valves are used for undamaged, approved wells, and shutoff valves are used in basements of buildings.

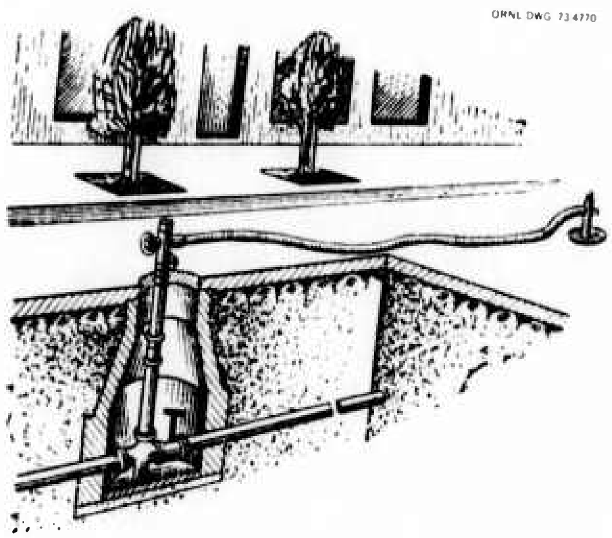

Fig. 135. Repairing breaks in water supply lines by constructing a bypass line.

If there is local damage and it is not possible to use shutoff mechanisms (because of the obstruction of approved wells), the following procedure is recommended: Determine the location of the damage from external signs (appearance of wet spots, surface leaks); dig a trench or ditch along the water pipe; pump out the water, determine the location and the nature of the damage, and remedy it; install a bypass line, enabling the water line to be used to extinguish fires (Fig. 135). If the water pipe is broken on both ends, drive in wooden plugs. Methods for inserting the plugs are shown in Fig. 136. If longitudinal cracks appear, apply plaster patches as coatings, securing them with a metal strap on top and collars along the perimeter of the pipe about every 20 to 30 cm.

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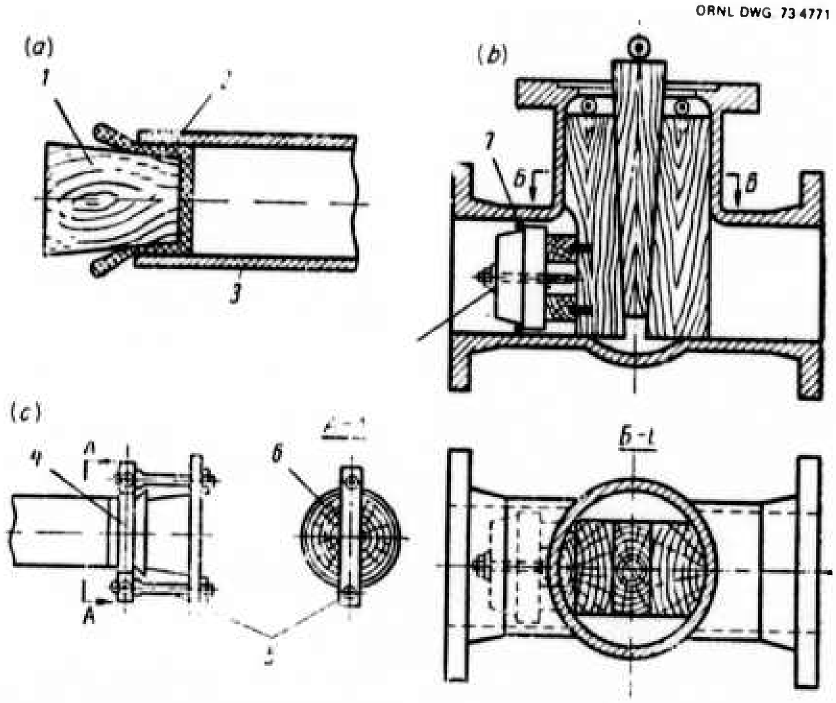

Fig. 136. Installing plugs in broken pipes: (*a*) in a low-pressure pipeline; (*b*) in a high-pressure pipeline; (*c*) in a fire plug: 1,6, wooden plug; 2, burlap; 3, pipe; 4, collar made of iron strap; 5, anchoring bolts; 7, rubber gasket; 8, rubber washer.

Repairing damaged sewer lines. The survivability of sewer lines is much lower than that of water lines; thus sewer lines are destroyed at even greater distances from the center of the nuclear blast than are water lines. Due to the destruction, obstructions occur in the system and in all higher wells (near buildings), and sewage backs up and may enter the sanitary facilities in basements of buildings and in blast and fallout shelters, as well as in basements where people are taking cover and on the surface in the immediate vicinity of wells. In cases such as these, backed-up water must be prevented from settling in lower places where it can cause contamination. For this purpose, gutters from the wells or wooden troughs are laid down, as are pipes and bypasses, to conduct the sewage away. If eaves troughs (for rain water) have survived, they can be used to carry sewer water away (Fig. 137).

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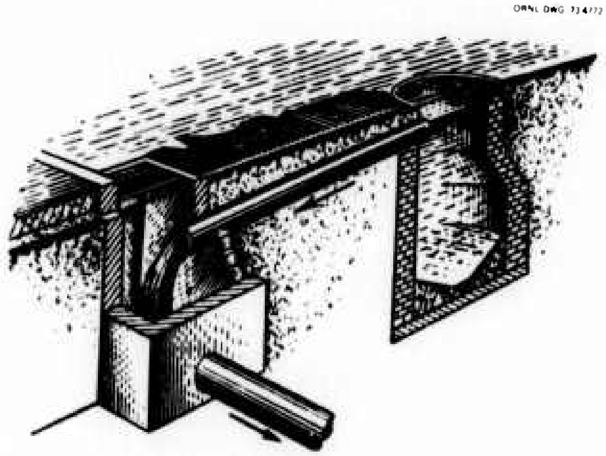

Fig. 137. Constructing a gravity bypass.

Remedying damaged gas lines. The destruction of gas lines constitutes danger of poisoning, fires, and explosions. Thus, damage to the gas lines must be remedied first. Gas lines, like water lines, may be destroyed or damaged by a nuclear explosion, depending on the distance from the center of the blast. The pipes may be damaged completely or partially. Specialists can locate the damage to the gas lines by using a leak detector or by noting a specific odor. Since gas leaking from a damaged line can easily be ignited by an accidental spark, the area around the damaged gas line must be roped off, and open fires are forbidden.

The basic method for confining damage to gas lines is to isolate the damaged sections and feeders or the entire network of a district if it does not interfere with continued operation of undamaged plants. Near residences, the damaged part is shut off at the site of damage at the house inlet, on the standpipe, or at the appliance. If local damage to a gas line should occur outside a place of residence or during work on water lines, then stoppers (plugs) should be inserted. However, if these are insufficient, dry clay must be applied around the area (to stop the flow of gas through leaks in the stopper) (Fig. 138). Rubber balls can be used to temporarily prevent the gas from escaping. Work to contain damage to gas lines is done in isolating gas masks, since the conventional filtering gas masks (GP-4U) do not protect from gas leaking through the gas mask box.

Rectifying damage to central heating networks. The problem of establishing the nature of the damage to heating networks and confining this damage will be similar to the problems in dealing with damaged water supply lines. However, it must be borne in mind that the presence of hot water in the pipe line (up to 130° at high pressure) constitutes an additional hazard at the site of the damage. The other measures to be taken are the same as those for water supply networks.

Remedying damage to electrical power lines. Damaged electrical power lines can lead to short circuits, causing electrical fires or injury to people. Isolating the damage from high-tension lines can be done only by trained electricians. This work involves providing simple grounded connections in the area where rescue work is proceeding (Fig. 139) and in setting up metal and wooden supports (posts) to rapidly restore temporary power for the most important sites (if the power plant has not been damaged); on low-tension lines, work involves switching off the damaged portions of the network, disconnecting by fuse cutouts or cutting off cables from the network, and replacing fallen wires or raising them on temporary supports.

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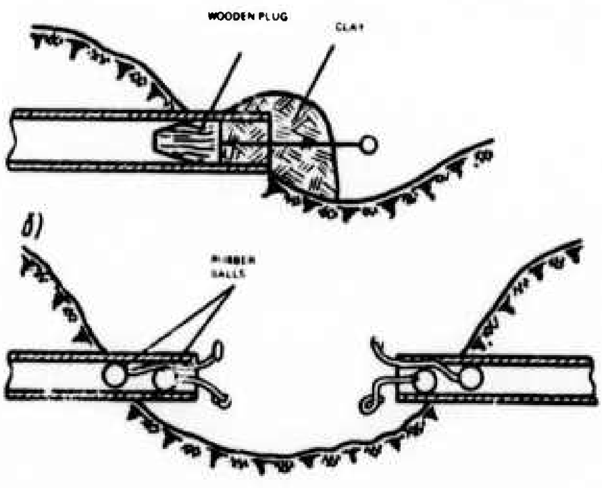

Fig. 138. Repairing breaks in gas lines: (*a*) driven-in wooden plugs; (*b*) shutting off the gas flow with inflated rubber balls.

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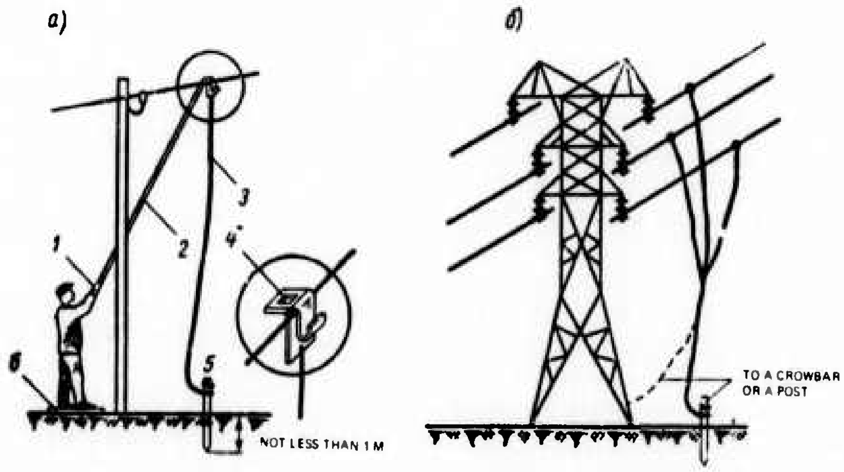


Fig. 139. Grounding damaged electrical power lines: (*a*) with wooden poles; (*b*) with metal poles; 1, rubber gloves; 2, pole; 3, ground wire; 4, opening for pole; 5, crowbar; 6, dry wood panel.

Trained electricians from the municipal power service are also used in repairing electrical power lines; they must wear rubber gloves and insulated footwear and have special tools. In addition, the electricians must be trained to give first aid to those injured by bare wires.

Restoring damaged communication lines. Communications are very important for the administration of civil defense and especially for supervising CD forces and facilities while rescue work is proceeding in the centers of destruction. Thus, communications, along with rescue and urgent emergency-restoration work, include the repair of communication lines damaged from the nuclear blast; this work is organized by the chief of the communications service, using available communications units.

Temporary lines may be erected to establish communications between damaged areas, but damaged communication lines should be fully restored whenever possible. Radio facilities are used when communication lines are completely destroyed and serve to direct rescue work at centers of destruction.

11.5 ORGANIZATION OF POLITICAL PARTY WORK

Under conditions of stress, political Party work is very important since war conducted with weapons of mass destruction creates extremely complex circumstances, causing a large number of victims, destruction, and fires. A high morale, as well as firmness and preparedness for self-sacrifice in the name of defending the Socialist Motherland, is required of all staffs of services and civil defense formations.

Political Party work calls for assuring the conscious and active participation of formation personnel and the population in performing civil defense measures, and especially in conducting rescue and urgent emergency-restoration work. Performing rescue and urgent emergency-restoration tasks under conditions of nuclear attack entails extremely great danger for the lives of formation personnel, more so now than in the past. Thus, each person is required to fulfill an obligation to the party by performing all tasks which arise.

This situation predetermines the special importance of conducting continuous, purposeful, and flexible political Party work to promote Communist awareness and development and to reinforce a high political morale and combat readiness in civil defense personnel, thereby guaranteeing that all measures will be carried out. In the civil defense system, political Party work is organized on the basis of programs and CPSU regulations, decisions of TSK CPSU and the Soviet government, directions of the USSR civil defense chief, and decrees and directives of the local Party organizations.

Among the service personnel and civil defense units, political Party work is organized and executed with Party organizations under the supervision of local Party units. At the national economic facilities, political Party work is conducted by the Party Committee of the facility, and also by the Party organization of those organizations and institutions which are the base of the services and civil defense formations. The more complex and difficult the conditions under which the civil defense formation is operating, the more continuous, purposeful, and active the political Party work must be.

The civil defense chief of the facility, the service chiefs, and the formation commanders must personally concern themselves with the political education of those under their supervision, making their work have a bearing on Party organizations, and using their influence in full measure to successfully execute the tasks which they must confront. Constantly communicating with subordinates, thoroughly instructing them in matters of political morale, and [setting] a personal example of manhood and courage are most important duties of all commanders and civil defense chiefs. The organization and conduct of political Party work in a civil defense system is a complex and tedious endeavor. It can be successfully fulfilled only through the efforts of the general forces of Party units and the Party organizations, as well as all staff in command and authority.

Party units and Party organizations are obligated to be familiar with their task; they must thoroughly examine and actively support all aspects of civil defense, guarantee daily Party influence on the activities of all its teams, improve the caliber of civil defense staff work and of services, resolutely seek out the defects in the organization and execute civil defense measures, educate and train the formation personnel, and help the commanders and the civil defense chiefs at all levels to improve civil defense. The main tasks of Party units and organizations in the civil defense system are to realize the objectives of the CPSU program in strengthening the civil defense capabilities of the country and the Party policies in civil defense problems, and to guarantee the combat readiness of all civil defense forces and facilities and the successful completion of all plans and civil defense measures in peace as well as in wartime.

Civil defense formations are the basic forces executing rescue and urgent emergency-restoration work. In view of this fact, in peacetime the Party units conduct political Party work with the personnel of the formations and direct their efforts to a high state of readiness for carrying out rescue and emergency-restoration work. Party political activity is directed toward ensuring that the personnel of the formations study methods of performing rescue and urgent emergency-restoration work. Emphasis on proficiency with regard to technical matters and instruments is stressed.

On threat of enemy attack, a particular concern of the Party units is to maintain the formations in a constant state of wartime readiness. To further this goal, the requirements regarding orders and directions from command posts and the civil defense staff are explained to the personnel; the principal role of the members of the Communist [Party] and the Young Communist League in executing all the demands of wartime readiness is stressed. When the order is given for the dispersal of working and service personnel to the outlying zone, the Party political work is directed to assuring the organized transport of shifts of working and service personnel, the preparation of shelters, and the constant readiness of formations to perform rescue and urgent emergency-restoration work. When the formation moves out to a center of destruction, the task of the Party, trade union, and Young Communist League organizations is to marshal all personnel to expedite the prompt arrival of the formation at the center of destruction, ready to carry out rescue and urgent emergency-restoration work.

On receiving their orders on mobilization, the political Party workers are directed to rapidly evaluate the situation, complete assigned tasks, determine marching routes, organize military formations, and give direction signals, as well as to prepare the personnel and technicians to fulfill their assigned tasks. Formation personnel focus attention on maintaining discipline and organization on the march, increasing alertness, and safeguarding technical equipment and property. Reconnaissance groups move in advance of the formation toward the center of destruction. The reconnaissance subdivision staff can include personnel who perform concrete political Party work. All scouts will have a profound understanding of the importance of reconnaissance tasks and a high feeling of responsibility in doing them well.

Brief group or individual meetings are held with scouts, and they are apprised of the importance of promptly obtaining information on the center of destruction. The importance of speed in their operations is explained to all scouts. It is necessary that each scout reconnoiter as rapidly and as well as possible and deliver the authentic data to the commander so that rescue and urgent emergency-restoration work can be performed. Work with scouts is especially important since they are the first to enter into the zone of contamination. Prompt measures to protect the lives of many people depend on their rapid and intelligent operations. For these reasons commanders and political workers and Party and Young Communist League workers must select the best prepared and seasoned people from the staff of the radiation supervisors, preferably from the Communist Party and the Young Communist League, and train and educate them carefully.

The main obstacle to the successful solution of problems at a center of destruction by a formation will be large separate focal fires, as well as rubble in streets, passageways, and thoroughfares. Thus, an important task of political Party work will be to mobilize personnel to rapidly overcome obstacles in the paths to a center of nuclear destruction and to make possible highly organized work by the fire fighting, engineering, and community utility units, who must in turn do their work rapidly to enable the formation to enter the center of nuclear destruction.

In the course of preparing for the march and its completion, special attention is paid to working with the drivers of automobiles, bulldozers, tractors, and other work vehicles. These drivers are taught the right way to drive a vehicle in a convoy, observe proper distance, refrain from passing, and carefully inspect the vehicles on stops. Personnel are also prepared to cope intelligently with great difficulties in the course of the march; to overcome possible mass fires, blocked streets, destroyed bridges, flooded areas, and radioactive contamination of the terrain; and to rapidly move into a center of destruction.

As a rule, during the course of the march, political Party work is done on long and short stops. If the circumstances permit, brief meetings are held with formation personnel concerning tasks to be accomplished at the center of nuclear destruction. When work is organized at a center of destruction, full responsibility for executing political Party work with personnel falls to the group commanders and their assistants in political departments. Thus, the Party unit workers give them special assistance, recommending those measures, forms, and methods of political Party work which best assure the combat readiness of formations. Political Party work is directed toward prompt and organized delivery of the formations into the centers of destruction. Moreover, the political work of the Party and Young Communist League organizations is directed primarily to reducing the time for executing the rescue and urgent emergency-restoration work.

It is very important for formation personnel to be able to cope with hazards connected with local radioactive contamination. Thus before they perform their combat tasks, the special characteristics of radioactive contamination, the means of defense against it, and the fact that the dose rate decreases with time should all be stressed once again. Such emphasis reinforces faith in the reliability of protective facilities and the feasibility of working in contaminated areas. Most important is the personal example of commanders, political workers, Communists, and members of the Young Communist League. They must display proper conduct at the center of destruction. Furthermore, the exposure dose is monitored so that the doses received do not exceed the permissible levels.

Civil defense is charged with the difficult responsibility of conducting rescue and urgent emergency-restoration work at centers of nuclear destruction. This obligation explains the growing role of political Party work at any level. The basic tasks of political Party work in the course of conducting rescue and urgent emergency-restoration work are:

1. mobilizing the personnel of all civil defense formations for bold initiative and decisive action at centers of destruction;
2. maintaining high morale, organization, discipline, and order among the personnel;
3. organizing competition among formation personnel and assuring the performance of urgent emergency-restoration work with the highest possible degree of competence and speed;
4. guaranteeing ready cooperation and combat collaboration within the formation, as well as between the [civilian] formations and [military] troop subdivisions;
5. giving constant guidance and ensuring the enforcement of safety measures in conducting rescue and urgent emergency-restoration work;
6. concerning themselves with the rest and feeding of civil defense formation personnel;
7. conducting educational and organizational work among the people of an attacked city in order [1] to induce them to work at centers of destruction, as well as [2] to avert panic and other undesirable events.

When conducting the rescue and urgent emergency-restoration work, it is very important to observe and actively support new progressive methods and modes of work. When formations are being replaced, the political Party work is aimed at organized conduct of the changeover and at removal of personnel from the centers of destruction with no losses. In this period, the political Party work is conducted during brief rests, when the personnel is out of the center of destruction and on the way to a new designated place. Once they have moved out of the center of destruction, formation personnel and technical equipment are subjected to careful, special treatment. The main concern of the political Party workers at that time is the prompt preparation and clear-cut organization of work at special treatment posts, as well as the organization of rest periods for the formation personnel.

12. Training the Population in Civil Defense

12.1 PROBLEMS AND OBJECTIVES OF CIVIL DEFENSE TRAINING AT NATIONAL ECONOMIC FACILITIES

Training the population in civil defense is one of the most important programs of the Communist Party and the Soviet Government, its objective being the protection of the Soviet people from weapons of mass destruction. Civil defense training is applicable to everyone and compulsory for Soviet citizens. Compulsory, nonexempt training in methods of protection against weapons of mass destruction constitutes one of the basic tasks of peacetime civil defense.

12.1.1 Objective of the Training

The basic objectives of training the population in civil defense at national economic facilities are [1] to arm the personnel with a knowledge of the principles of civil defense and expertise and experience in independently solving the problems of defense from weapons of mass destruction; [2] [to instruct them in the] organization of the facility's CD structure; [3] to instruct personnel to respond in a clear-cut and organized manner to civil defense orders and to know how to conduct rescue and urgent emergency-restoration work in the centers of destruction; [4] to work on continuous improvement of essential methods for protecting workers and employees; [5] to carry out measures increasing the functional stability of the facility in wartime.

12.1.2 Organization and Training Program

For training in methods of protection against weapons of mass destruction, the population of the Soviet Union is organized into several categories. The first category includes students of the five grades of the public elementary and middle schools and the Pioneers [a youth organization comparable to our Boy Scout and Girl Scout organizations]. The students of the five public school grades are prepared in a course of 15 hr of instruction per year, including 3 hr of CD movies and field exercises in applied civil defense. Work with these students is carried on outside the classroom by teachers in charge of class supervision [homeroom teachers].

The responsibility for medical training of the students of the five grades, which is a part of the program, belongs to the heads of municipal and regional health departments, the chief medical officers of rural regions, and local public health agencies, along with Red Cross committees and the Red Crescent [Society]. Medical students are assigned to these programs as are teachers of biology and other disciplines in secondary education, such as in the prenursing curriculum.

Civil defense training in the public schools occupies an important place in preparing the people of our country for protection against weapons of mass destruction and furthers the military-patriotic education of the students. In the process of civil defense training, the students of the five grades learn basic principles of defense against weapons of mass destruction. They must know the individual and collective means of defense and how to use them, and, in addition, they must learn to help themselves and others.

National educational agencies and civil defense staffs must render the necessary assistance to school principals on problems of better program organization and on the principles of class supervision; they must provide teaching plans and manuals, filmstrips, and movies. They also are in charge of checking on the progress of the civil defense training program in the schools.

Civil defense instruction is oriented toward the development of practical skills and procedures for protection against weapons of mass destruction. The classes are conducted in such a way as to make the material readily accessible to the students – with the compulsory use of charts, posters, filmstrips, and movies.

Children are also prepared for defense against weapons of mass destruction while they are in summer Pioneer and health camps. They are taught about the destructive nature of weapons of mass destruction and the methods of protecting themselves against them — how to use individual and collective means of defense, how to respond to civil defense signals, and how to help themselves and others when there are injuries. The children are instructed by means of discussions, practical exercises, field trips, and civil defense games appropriate to their age. Discussions are supplemented by educational films, filmstrips, and posters.

All civil defense classes are conducted in a simple and interesting manner which is understandable to Pioneers, arousing their interest and competitive spirit in the training course and games. In the training classes, contests, and civil defense games, extensive use is made of individual means of defense, timeboards, first aid exercises, and available tools (spades, crowbars, pick axes). All activities in the training classes and games are conducted in the presence of doctors or nurses.

The second category includes workers, employees, collective farm workers, and the unemployed. Workers and employees of national economic facilities and collective farm workers are required to learn civil defense skills. In addition, they must acquire skills in conducting rescue and urgent emergency-restoration work as a part of the CD organization of the facility. Activities are organized and implemented at the place of work, where the supervisors of plants, institutions, collective farms, and state farms learn to teach by assisting in civil defense courses.

Persons employed in industry learn the minimum general compulsory civil defense skills in their off-duty hours. The civil defense chiefs of national economic facilities, institutions, organizations, state farms, and collective farms are responsible for organizing and training the population. Workers, employees, and collective farm workers receive training by lectures and by applied exercises with the use of technical equipment, tools, and other available means depending on the subject. To remain up-to-date on the subjects they have learned and to acquire practical experience in defense against weapons of mass destruction, workers, employees, and collective farm workers attend annual refresher courses in accordance with the USSR Civil Defense Policy.

Training of the citizens who do not hold jobs outside their homes (homemakers, invalids, retired people) is the responsibility of the local civil defense units, municipal (rural) and regional CD supervisors, and small village councils, and is implemented by civil defense courses. The training program is organized on the basis of group activities and individualized instruction using the manual, "Everyone Must Know This," and [also] presentations of movies, filmstrips, textbooks, and special discussions. The general compulsory training program must provide every citizen with the following minimum civil defense skills:

1. knowledge of the damaging characteristics of nuclear, chemical, and biological weapons and individual methods of protection against them;
2. use of collective and individual means of defense;
3. familiarity with the rules and sequence of action, according to civil defense signals;
4. knowledge of the sequence of action and rules of conduct during dispersal and evacuation to an outer zone;
5. appropriate behavior in zones of radioactive, chemical, and biological contamination;
6. skills in giving first aid to oneself and others;
7. familiarity with the principles and methods of conducting rescue and urgent emergency-restoration work in centers of mass destruction.

The third category includes students in the ninth grade of public schools, in professional and technical schools, and in universities. Ninth grade public school students [merely] improve their knowledge of defense against weapons of mass destruction, as the elementary principles were [already] obtained in the fifth grade and at Pioneer camps. Boys are prepared for work in reconnaissance, while girls are trained to work in the sanitation squads. Combat supervisors and "civil defense" teachers, as well as medical workers at medical institutions, conduct programs established by the Public Health Department.

Ninth and tenth grade students must learn the damaging factors of nuclear, chemical, and biological weapons, know how to conduct themselves in response to civil defense signals, and be skilled in first aid and self-help procedures and treatment of the sick; they must be taught methods of protecting food and water, of decontaminating clothing and equipment, and of decontaminating people.

In the special secondary schools male students are trained to become junior supervisors of civil defense units at their schools in accordance with their specialized training, while female students are taught sanitation squad work. In addition, students in rural schools are trained to protect animal life and agricultural plants.

Students in professional and technical schools study civil defense according to a special program designed for them on the basis of their major curriculum. They are prepared as regular members of the civil defense organization at a given facility. They must learn defense against weapons of mass destruction, study radiation and chemical reconnaissance instruments and obtain practical skill in their operation, and be able to function in the civil defense organization with consideration of their educational specialty. Civil defense studies in professional and technical schools are important in furthering the initial combat readiness of youth who will serve in the Armed Forces, strengthening the defensive capability of the country, facilitating military patriotic training, and preparing the students for defense against weapons of mass destruction and for functioning in the civil defense organization.

Thirty-five hours are allotted for civil defense training in schools with a 2-year program or longer, while 20 hr are allotted in schools with a 1- or 1½-year program. Students in a program of 2 years or more must also study measures to increase the operational stability of national economic facilities in wartime and gain skill in reconnaissance work and in the performance of their duties as members of observation posts and reconnaissance teams.

In addition to the responsibilities listed above, students of institutes and schools of science and the arts also must know how to give first aid to the injured.

Students of institutes of higher learning [universities, colleges] are trained to be regular team members of the civil defense staff of the national economic facilities. As future industrial specialists, they are prepared for the organization and practical performance of civil defense tasks at such sites and for the duties of formation commanders, depending on their educational specialty. Women students studying humanities and education at the universities are trained as nurses' aides.

During the course of their civil defense training, university students must study the following:

1. organization of civil defense at national economic facilities and practical accomplishment of civil defense measures in peacetime and in wartime, as well as the duties of the formation commanders (as specified);
2. standards in planning technological civil defense measures and measures which increase the operational stability of the national economic facilities in wartime;
3. organization and means of preparing workers, employees, students, and the population for civil defense.

Students of teachers' colleges and universities are trained to instruct middle school students in civil defense.

The fourth category [into which the population is divided for purposes of CD instruction] includes the intermediate supervisory personnel of national economic facilities, collective farms and state farms, government organizations, trade institutes, public utilities, and cafeterias and community services. The purpose of training supervisory personnel is to teach them the basic policies on regulations, instructions, public educational programs, and civil defense organizations. The supervisory personnel are trained to work with the population and civil defense personnel and [also] to direct subunits in conducting rescue work at centers of mass destruction.

12.2 PROGRAMS OF CIVIL DEFENSE COURSES

Depending on their purposes and tasks, course materials for training these groups of the population are developed and approved by the USSR civil defense chief and the heads of various ministries, bureaus, and committees. The course materials given to students of the five grades of the public schools include a course outline, a time schedule, and the method of performing activities, as well as the contents of the course with review questions.

In a model program for teaching children in Pioneer summer camps to protect themselves against weapons of mass destruction, [the counselors are provided with] [1] instructions on organization and method, which include the purposes of the training, the organization, and the sequence of conducting activities, and [2] a course outline with questions on each subject. A list of educational literature and materials is given at the end of the program.

The course materials for preparing the general public for civil defense (compulsory minimum public training) include instructions on the organization and methods for teaching civil defense. The program provides a course outline and a time schedule, as well as the contents of the program by subject. At the end of the course manual is a list of training source references and the literature needed for teaching (classes of 25 to 30 people).

The program for preparing students of professional and technical institutes of higher learning in civil defense provides information on the objectives of training instructions on organization and methods, a course outline and a corresponding time schedule, and the contents for the general course, as well as specialized background [material] corresponding to the school's particular discipline. The program for training students in a 1½-year curriculum consists of one part which gives the individual subject plan and is the same for all schools of this category.

The teaching material for students in intermediate-level technical colleges states the objectives of the course, the method of instruction, the instructors and the text books, a course outline, and a time schedule. The program also includes a list of instructional materials for the special middle schools.

The program of the course for preparing students of higher education institutions in civil defense provides instruction on organization and method, an outline of the general course, and training material according to subject specialty. The program furnishes detailed information on each subject, teaching instructions, and manuals, as well as a table of educational materials for a civil defense course available to institutions of higher learning.

The civil defense program to train intermediate supervisory personnel of national economic facilities provides instructions on the organization and methods of the course, a time schedule giving the number of hours for each training session, and recommends instructional literature and materials.

12.3 TEACHER QUALIFICATIONS

The following qualifications must be met for teaching civil defense to workers, employees, and other teachers and students to enable them to protect themselves against the effects of weapons of mass destruction: awareness and interest in training; organized and systematic educational background; capability of intelligent and clear presentation of material; collective and individual teaching approach.

12.3.1 Loyalty to the Communist Party and Pragmatism in Instruction

Teachers must follow Party instructions and present the civil defense course from the viewpoint of the ideology and the politics of the Communist Party and the Marxist-Leninist position. To give civil defense training courses in accordance with the requirements of the Communist Party and pragmatism means to be responsible for increasing the educational aspect of training and to expose the reactionary views of bourgeois ideology on questions of war. The requirement of teaching the necessary principles of protecting the population and national economic facilities from the effects of weapons of mass destruction obliges teachers to be informed on theoretical and empirical fundamentals of civil defense for protecting the population and increasing the stability of national economic facilities. They must have skills and knowledge in conducting rescue and urgent emergency-restoration work in centers of mass destruction. They must study and resolve the major practical questions concerning civil defense at the national economic facility under conditions as realistic as possible.

Training awareness consists of a deep understanding of the purposes and duties of defending the Motherland. The program supervisor must believe deeply in the power of knowledge and know-how and in the theory and practice of civil defense; understand the role of civil defense in strengthening the defense capability of our country; and instill this belief in his students. Training awareness must arouse interest in educational materials and activities and ambition to master the necessary civil defense skills. V. I. Lenin pointed out: "Our Red Army Soldiers bear burdens which would never have been borne by a czarist army. This is explained by the fact that every armed worker and peasant knows the reason for being there; they will gladly shed their blood in the name of justice and socialism. This awareness of the masses of the purposes and causes of war has tremendous importance and guarantees victory" (V. I. Lenin, 4th ed., vol. 31, p. 115). These pronouncements of V. I. Lenin apply fully to training the population for civil defense. If the teacher explains the nature of nuclear war and the necessity of training the population of the country in the methods of protecting themselves from its harmful effects while there is still peace, then this may ensure the success of these activities under given conditions.

Training awareness first of all means the creative mastery of skills. Civil defense training does not require "cramming" as much as an understanding of the essential principles of defense against weapons of mass destruction and their practical effect. Without a proper learning attitude, it is impossible to expect successful preparedness of civil defense formations, who at any moment and under any conditions must have the capability to perform rescue work at centers of mass destruction.

Continuity and a systematic approach in activity makes the training process at a national economic facility harmonious and organized; thus, it becomes possible to impart the minimum necessary skills in civil defense required by the program. When workers and employees learn the harmful effects of weapons of mass destruction, they will have a more profound understanding of the methods of defense against them, and on receiving the necessary training in methods of conducting rescue work, will acquire the reliance on their strength and endurance which is necessary under wartime conditions. A systematic approach and continuity must be observed in every activity and in the entire training program. The study of new material should not begin until the previous subject has been completely mastered.

Intelligent and clear presentation facilitates the acquisition of knowledge and of substantial civil defense expertise. This requirement obliges the civil defense teacher to know the educational level of the trainees and their background knowledge on questions of protection against weapons of mass destruction. In the course of training, it is also necessary to explain terminology to workers and employees of the national economic facility who do not have combat preparation. Trainees with a low educational level must have the damaging effects of weapons of mass destruction explained to them in a form understandable to them, with graphic illustrations in textbooks not dealing with the theoretical aspects. This requirement should be carried out as fully as possible in the civil defense training system at national economic facilities, since the instructor is the oldest member who is well acquainted with the educational level of each worker and employee of the unit.

In teaching workers and employees to conduct rescue work, exercises are first devised under simple conditions with no time limit. Then they proceed to working with limited time under complex conditions. The teaching method, from simple to complex, and training under simulated conditions which approach real ones represent the optimum teaching approach for facility workers and employees who are learning civil defense activities.

The individual approach to civil defense training is very important. The individual approach derives from a thorough knowledge of people. The teacher must know the workers and employees of the formation, their strengths and weaknesses, their needs and spiritual requirements. It is necessary to create within the program conditions permitting everyone to master skills and at the same time allowing each person to be considered as an individual. In the course of training, the teacher must evaluate the trainees in how they are mastering skills, knowledge, and civil defense practices, and what is easy and what is difficult for each. Each must be helped to solve the most difficult problems and to acquire practical skills.

During the course of training, it is very important to point out errors in trainee performance promptly; otherwise, an incorrect method may become habitual. To discover mistakes, it is necessary to carefully observe the performance of each trainee throughout the program.

12.4 ORGANIZING AND PLANNING TRAINING

The purpose of organizing and planning civil defense combat training at national economic facilities is to provide a constant increase in the level of combat readiness of staffs, services, and civil defense formations. Organizing and planning combat training of personnel at the national economic facility is based on orders of the CD chief of the site. Combat training is planned for an entire academic year.

The following aspects are considered in planning combat readiness at a national economic facility:

1. the order of the facility's civil defense chief based on the total combat training given in the previous year and assignments for the new training year (Appendix XXIII),
2. the plan for combat training of civil defense personnel at the site in a training year (Appendix XXIV);
3. program schedule for personnel of all trainee categories (Appendix XXV).

Combat training schedules for the month are based on an annual plan and are included in the monthly work plan of the CD staff under the special classification "Combat Training." Records of combat training must be current and must objectively reflect all measures taken to train the personnel of a national economic facility. The CD staff of the site must keep the following records:

1. a record of the sessions held for the formation commanders, as well as workers and employees, by shops (in sections, departments, districts, brigades, shifts) (Appendix XXVI);
2. a report of the CD training, staff training, and civil defense contests (Appendix XXVII);
3. a report of the readiness of civil defense personnel at a national economic facility;
4. an individual report on the training of the higher-level civil defense personnel obtaining civil defense training outside of the economic facility.

The responsibility for keeping a record of combat readiness is entrusted to the CD chief of the site. The

CD staff organizes constant checks on the progress of combat readiness and the results are recorded in the log of activities. The report of combat readiness is prepared in conformity with the priority report form. It must strictly reflect the status of combat readiness at a given time. The basis of the reports is authentic data in accordance with the report forms, supplemented by brief descriptions which must contain the following:

1. performance of organizational and preparatory measures for combat readiness before the start of a new training year;
2. the general status of combat readiness at the national economic facility;
3. departments, plants, services, and sections which achieved the best results in combat training;
4. a brief account of the characteristics of the training program at the facility and the training of the formations, both strengths and weaknesses;
5. the status of basic instructional material and how it provides quality combat readiness;
6. the status, forms, and methods of the propaganda to promote civil defense skills; the use of radio, movies, and the press; the organization of exhibits, lectures, meetings, and discussions of civil defense problems;
7. fundamental shortcomings in combat readiness occurring in the corresponding training period, indicating concrete examples of reasons for these shortcomings;
8. general conclusions, proposals, and requests for improving combat readiness.

Training the workers, employees, and collective farm workers at the national economic facilities is based on the principle "the older train the younger." The selection and training of civil defense instructors is one of the basic tasks of the staff. The superior command personnel and civil defense services and staff specialists of the facility are called upon to prepare the instructors of the average command unit.

To improve the readiness of workers and employees and train the population not engaged in industry, the civil defense staff of the site, together with public organizations under the supervision of the Party committee, conducts propaganda, promoting the defense activities against weapons of mass destruction by speeches and graphic methods, using the press, radio, and movies for these purposes.

12.5 PREPARING CIVIL DEFENSE TEACHERS AND DEVELOPMENT OF TEACHING MATERIALS

Preparing supervisors to teach the programs is one of the necessary conditions to ensure successful civil defense training for a site. V. I. Lenin said, "No controls, no programs, etc., are as absolute in their power to change the direction of life as is the influence of those who teach them" (V. I. Lenin, 5th vol., vol. 47, p. 194). From this statement of V. I. Lenin it is clear that the teaching staff, its teaching method, its philosophy, and its skill and erudition belong among the crucial parameters of civil defense training at a facility.

Teacher training consists of studying the training program; selecting and studying the literature (regulations, instructions, manuals, and textbooks); determining the purposes of the training activity; formulating training problems; scheduling time for studying these problems; selecting the teaching method by subject; preparing the course outline (concept of plan and method or presentation) and submitting it for approval; arranging for auditorium facilities, graphic manuals, and teaching aids where needed.

The CD instructor, in studying the programs, literature, and the instructional material, must not skim over it mechanically but must thoroughly investigate the positions taken, the subject matter, and the training problems, and, in scheduling the program, must evaluate the general extent of the sequence for studying the problems of the course.

An equally important part in the preparation of CD instructors is their use of materials related to teaching methods. In reviewing the instruction material with regard to teaching methods, the instructor determines what subjects to present in lectures, how to combine explanation and demonstration, and what data and illustrated handbooks to use. When workers and employees at a national economic facility are trained in civil defense programs, it is recommended that training consist mainly of applied teaching methods with the use of technical equipment; tools; charts and other material; demonstrations by photo slides, filmstrips, and other graphic methods.

For programs which illustrate the harmful factors of nuclear weapons, methods of protection against weapons of mass destruction, evacuation and dispersal of workers and employees, conduct in accordance with civil defense signals, bases for organizing and performing rescue work, the rules of conduct and activities at centers of nuclear destruction, and of chemical and biological contamination, it is recommended that the observational method be used along with movies, film strips, and posters. The program content and the clarity of its presentation depend largely on the type of factual material used. Thus, when preparing the program, the instructor must study the material of the 23rd Congress of the CPSU and the CPSU program concerning defense problems of our country. In addition, it is necessary to select topical subjects so that facts are distinguished from fancy, and the instructor will be aided in demonstrating the aggressive character of the imperialists. However, it is not necessary to overload the program with details.

As a rule, applied activities and civil defense exercises are conducted after lectures, discussions, and other classroom projects. It is desirable that the trainees study the recommended literature independently. Lectures, discussions, and classroom projects equip the workers and employees with facts, conclusions, and correlations based not only on theory but also on civil defense practice; they make general training of the student possible.

To correctly conduct civil defense courses it is necessary to study and understand the teaching methods and forms.

12.6 TEACHING METHODS AND FORMS

The basis of civil defense training is Marxism-Leninism, which arms supervisors, workers, and employees with a method of scientific investigation and discloses problems and purposes of training and preparing defenders of the socialist Motherland. The guiding principle of our teaching methods is the Party and acceptance of its leading role in creating and perfecting civil defense. Commitment to the Party obliges the supervisory personnel of plants, the Party, the trade union, and political organizations to examine the civil defense training and education of workers and employees as a part of the basic measures of protection from weapons of mass destruction. The organization of the training process must guarantee the union of theoretical knowledge with practical skill in the civil defense of a national economic facility.

It is through *training methods* that the supervisor transmits, and the trainees acquire, knowledge, expertise, and skills in civil defense; methods of training also include the exercises of formations composed of workers, employees, collective farm workers, teachers and students, soldiers, and civil defense commanders.

The concept of *forms of training* refers to the organizational aspects of the educational process. These forms specify the composition of the classes, the structure and the method of conducting activities, the location and duration of the classes, and the role and specific assignments of the trainees. Thus, the concept of the training form is broader than that of the training method in the sense that one form may include several methods of civil defense training. The enumerated methods and forms are used in various sequences, depending on the concrete problems and the training conditions. Any method may become generalized, but it is necessary to use different methods and forms to contribute effectively to the training and education of highly motivated and active civil defense workers and commanders.

The *lecture* in the training program is a developed scientific analysis of the basic problems or groups of problems, theories, and facts of civil defense. As a teaching method, the lecture plays a large role in civil defense activities. Lectures must not be loaded with superfluous details and exercises. A lecture must clarify for a class the differences between theory and practice and the measures that must be taken to protect against weapons of mass destruction. Lectures concerning basic problems, theories, and practices of civil defense are read either by the facility civil defense chief or by a highly qualified civil defense worker of the facility.

Organizationally, the lecture is usually broken down into three component parts: introduction, body, and conclusions. In the introduction, the speaker acquaints the listeners briefly with the subject and the basic problems. In the main part of the lecture, the theoretical ideological aspects of the subject are presented. The accomplishments of science and experience in the area of civil defense are examined. Generalizations are made and conclusions drawn. In the conclusions, which must be short, the contents of the lecture are reviewed in brief, and general theoretical and practical conclusions are presented. The lecture must motivate the trainees to deepen their own independent effort in studying civil defense problems.

The *class problem* is used as a form of training in educational institutions offering civil defense courses; it does not involve the study of a technique and does not require a simulation of the practical methods and operational procedures at centers of mass destruction. Rather, in this activity the instructional material is put to use as it is taught, by solving problems of the stability of the installation under the damaging effects of a nuclear explosion and by determining the optimum conditions for the survival of a population in a zone of radioactive contamination. Such a project is supplemented by graphs, posters, charts, testing units, models, and teaching machines.

The *exercise* is one of the basic methods of civil defense training: it helps support theoretical knowledge; it inculcates practical skills in using radiation, chemical, reconnaissance, and dosimetric control instruments and individual and collective means of defense; it also provides some experience in performing calculations to evaluate radiation, chemical, and bacteriological conditions and to determine the necessary forces and civil defense facilities for conducting rescue work at centers of mass destruction.

The *seminar* is a training form which makes it possible to deepen and broaden previously lea ed material and to verify the extent to which this n aterial has been assimilated. The seminar begins with brief introduction by the instructor. After the introduction, the program supervisor directs the discussion with active, intelligent participation; moreover, he attempts to ensure that the listeners not only enumerate the facts, but also analyze them, reflect upon their own relationship to them, politically evaluate them, and see that there is educational value in them. All this must be done to draw the conclusions necessary to solving practical problems at the facility itself.

The most important obligation of the supervisor is to keep the discussion on the subject after basic problems on the subject have been solved. A series of classes should not end with a speech in which the educational background of the trainees is neglected. They must be taught articulate expression of their thoughts.

The *conference* is a teaching method intended to deepen knowledge of problems and practices of civil defense and to assist trainees in method and organization. The form of the conference may be either group or individual. In educational institutions, conferences are held with students before a group project is undertaken and before a "civil defense" examination.

Field trips are part of the training program, intended to familiarize workers and employees with the civil defense organization, collective means of defense, the command post, and civil defense techniques. Each field trip must not only be instructive but must also connect theory with practice.

News reports allow a lively descriptive presentation of the subject matter. As a training method, they deal with a specific subject and are distinguished by colorfulness and current interest. In a lively report, the instructor acquaints the trainees with decisions of the Party and of the government on strengthening the national defense and with orders of the USSR civil defense chief, ministry, or department.

Dialectic is also a method of training. It is characterized by a consistent system of arguments and comparisons.

Discussion is a method of instruction by which the supervisor and the trainees deepen the knowledge they have acquired earlier in serious dialogue or examine problem questions. The discussion must be conducted so that instructors can express well-formed opinions derived not just by rote learning, but by deduction. Conducting a discussion entails directing the conversation into the necessary channels, critically analyzing the statements of the trainees, connecting theory with practice, and involving the installation with practical problems of civil defense.

Exhibits and *demonstrations* as teaching methods have a standard pattern which must be followed by the trainees. Just like the teacher, the trainees follow the same short and true path to mastering civil defense skills, study the use of instruments and protective clothing, and execute rescue work as rapidly and reliably as possible in demonstrations; in this way under the teacher's guidance they reveal their understanding and successful mastery of training. Practical civil defense experience cannot be obtained without demonstrations. The training goal can be expected to have been reached only when the trainees can properly practice what has been taught. Initially, when techniques, instruments, and methods of conducting rescue work are studied, demonstrations and model demonstrations are performed slowly and in a simplified manner. Later on, primary attention must be concentrated on performing demonstrations under conditions simulating combat as closely as possible.

Exercises and *practice sessions* consist of intentional repetition of practices and procedures. This method may prove to be of crucial importance for civil defense for : operations at a center of destruction. To save people in zones of radioactive contamination from destroyed and burning buildings and obstructed shelters and not receive a dangerous exposure dose oneself, every minute and second count, that is, one must act rapidly and decisively. Rapidity and decisiveness are acquired in the exercises and practice sessions. Exercises and practice sessions, although requiring persistent work and intellectual and physical exertion, are reliable methods for achieving a high degree of mastery and strength of will for civil defense fighters. The civil defense training program requires continuous performance of exercises and practice sessions under simulated conditions and CD instruction at the national economic facility. Exercises and practice sessions can be classified into two types: individual and group. Individual skills are developed in the individual exercises and practice sessions. In group sessions, the goal of harmonious cooperation by teams, groups, commands, divisions, and civil defense formations is pursued.

Independent study is a training method which makes it possible to broaden and deepen one's basic knowledge of civil defense and to increase specialization. This method is especially necessary for training supervisory and civil defense command personnel. The most important feature of independent study is the use of books as the primary source of knowledge.

The *group exercise* is one of the basic forms of civil defense training in tactical operations. Group exercises teach the development of skills in interaction with teams, groups, commands, and divisions when defensive measures are taken at the facility in peacetime and when rescue and urgent emergency-restoration work is done at a center of mass destruction [in wartime]. In group exercises, persons assigned to command positions learn to direct subdivisions and formations under conditions simulating reality. Special attention must always be paid to organizational questions, reconnaissance, and rescue work.

Group exercises may be worked out on plans, maps, models, in a sand box (model of site), or directly at a national economic facility. To develop the group training project, all the workers and employees are arbitrarily assigned a single responsibility most typical of the given theme. The trainees (two or three people) propose their solution for each problem. Conducting activities with a model of the locality (model of the national economic facility) is a progressive form of civil defense training, making it possible to develop training problems more fully and carefully. It is possible to simulate the operations of reconnaissance subunits, mobilization support action, organization of rescue and urgent emergency-restoration work, the sequence for changing subdivisions, deployment of forces, and other problems in great detail in a sand box, since under these conditions it is possible to simulate real situations. With the aid of arbitrary signs and models of the activities, it is possible to study methods of conducting reconnaissance, forming columns on the march, advancing formations to a center of destruction, overcoming zones of contamination and fires, the sequence for conducting forces into the area of destruction, organizing work into shifts, and other training problems.

Examination (comprehensive testing) is part of the teaching process which concludes the training program in the theory and practice of civil defense.

Staff training is intended mainly to increase harmony and cooperation in the operation of the staff of the civil defense services of the facility. It is executed with charts or a plan.

Advanced civil defense studies are the highest and most complex form of training a formation, its commanders, the civil defense staffs, and the entire population in organizing and conducting rescue and urgent emergency-restoration work. These studies are conducted in the final stage of training to strengthen the knowledge obtained and to perfect skills in defending against weapons of mass destruction, as well as to check the civil defense personnel and equipment of the national economic facility. Advanced studies are useful only when conditions closely simulate reality. In all advanced studies, it is necessary to verify the real defense plan of the site and on this basis devise the most expedient method for solving the complex problems of civil defense, thus increasing combat readiness.

In order to have advanced civil defense studies at a national economic facility, appropriate teaching materials must be used: plans, assignments, maps, and supplements to them. Advanced study projects cover subject title, training goals, total time spent on a subject, training problems and estimates of time required to solve them, place for conducting the activity, composition of the trainee group, the initial conditions, progress of the activity, methods and means used to solve the training problems and to achieve the goals, and variants of activities and problem solutions under study.

The plan is prepared graphically on a map or diagram of the national economic facility and explained with legends, tables, and graphs.

Trainee assignments are made in complete correspondence with the project. The assignments include subject title, general information concerning enemy activities and conditions prevailing at the start of the activity (conditions existing when training problem design began), and information on the status and operations of civil defense at the national economic facility and in the city (region).

The second group of assignments includes information about the conditions arising at the facility, the limits within which problems must be solved, information concerning injured people, damage to buildings, and fires at the national economic facility, contamination of the locality on routes the formation is following and in the area where rescue work is being done, the position and operations of civil defense forces at a given time, and also the operations of neighboring units, forces, and facilities provided for reinforcement. This information can be communicated to the trainees in the form of directives or orders from the civil defense chief of staff.

It can be given as information from neighboring units or reports of subdivision commanders at the working place.

The third group of assignments includes information concerning the condition of formation forces and facilities of the site, their political morale, equipment, and subdivision personnel replacements, and condition of the command post, communication facilities, and roads which the formation is using. Meteorological data are also communicated — the velocity and direction of the average and surface wind, temperature, possibility of rain, duration of daylight hours, and cloud conditions at various points.

At the end of the assignment, the literature to be read is either recommended or ordered in preparation for the drill: this material must be completed before the start of a drill in order to be prepared (to solve problems, to report conditions, etc.). Diagrams of the conditions, tables, and forms with which the trainee must be familiar are attached to the assignment.

The following are indicated in the general plan of a drill: subject, objective, time, training problems, progress of activity, work of the trainees, and various prospective solutions based on the initial conditions and the activity selected.

In selecting the advanced study program, the instructor examines the following questions: subject, objective of the advanced study program, schedule of activities for the trainees, evaluation of their activities, and instructions for dealing with observed shortcomings and civil defense training problems at the national economic facility.

The methodological approach is discussed by the CD staff. They primarily examine its theoretical depth and structural clarity. All parts (sections) of the approach used must be interrelated and characterized by strict logic and very strong documentation, simplicity, and clarity of presentation. The following requirements comprise the basis of the approach:

1. conformity with the decisions of the Communist Party and the Soviet government, with the orders of the USSR civil defense chief, the Ministry, and the department, and with statutes and instructions, as well as with the civil defense training program.
2. disclosure of the leading and organizational role of the CPSU in improving civil defense, propagandizing the achievements of the Soviet people in strengthening defense, relentlessly conducting merciless criticism of bourgeois theories, and educating the trainees to hate enemies and be devoted to their own people and to the Communist Party;
3. instruction of students in accordance with the Marxist-Leninist world outlook and a pragmatic philosophy in establishing a determined scientific and logical order, and in association with previous and subsequent subjects of the training program;
4. the creation of interest in knowledge, expertise, and civil defense skill of the trainees;
5. systematic support of the course on a level consistent with the final requirements of the USSR CD chief's instructions and the advancement of science and technology;
6. the bringing of theoretical positions into harmony with the practical preparation of personnel and with experience gained by civil defense at national economic facilities;
7. the use of theory to generate solutions for unsolved problems;
8. conformity of the subject with a coherent and logical development of its basic problems on a scientific level;
9. the reinforcement of theoretical knowledge by activities at the national economic facility in the potential area of destruction.

12.7 PROPAGANDIZING CIVIL DEFENSE INFORMATION

At the present time, a great deal of work is being done on propagandizing civil defense information at national economic facilities to reach the point where each worker, employee, and collective farm worker will learn and be thoroughly informed on the characteristics of weapons of mass destruction and, mainly, individual methods and means of protection from them and practical application of the methods in a center of mass destruction.

In the resolution of the Central Committee of the CPSU and the USSR Soviet Ministry on the conditions and measures for improving the work of DOSAAF,* it is stated: "Increasing the level of mass defense among the population must be considered one of the most important tasks of the Soviet Communist Party, trade unions, and Young Communist League organizations."

The most important method of mobilizing Communists, the Young Communist League, and the trade unions is to establish active social organizations where problems concerning the reinforcement of defense

*All-Union Voluntary Society for Assistance to the Army, Air Force, and Navy of the USSR.

capability and the improvement of civil defense at the national economic facilities are discussed. At national economic facilities propaganda can take such well established forms as [setting up] civil defense exhibits which show the progress of socialistic competition in civil defense in plants and departments of the facility, organizing meetings, presenting civil defense movies, and interviewing teachers, workers, employees, and collective farm workers on local radio stations and enabling them to exchange information on the organization and conduct of civil defense in various sections of the facility.

Traveling civil defense exhibits showing municipal, national, and other programs are also recommended; these are then followed by discussions of the subject, for example, the instructive nature of the visited exhibit and the improvements to be made in the civil defense organization at the facility.

APPENDIX I

Basic chemical weapons [CW] of the U.S. Army

CW available to the U.S. Army	Temperature (°C)		Combat state, color, odor	Average active lethal dose		Latency to onset of first symptoms	Physiological effects	Protective devices	Antidote	First aid
	B.P.[*]	F.P.[*]		Through the respiratory organs	Through the skin					
Sarin	150	−50	Colorless or yellowish liquid, almost odorless	5 min exposure to 0.05 mg/liter	3–7 mg/kg of body weight	About 30–60 min by rapid inhalation or direct skin contact	Nerve-paralytic	Gas mask and protective clothing	Ammoniacal-alkali sol. or soln. of bleaching powder or calcium hypochlorite (DTS-GK)	Individual antichemical kit, syringe, atropine
Soman	+200	−80	Colorless liquid, weak camphor odor	10 times more potent than Sarin		Same as Sarin	Same	Same	Same	Same
V-gases	High-boiling		Aerosol or liquid, odorless	100 times more potent than Sarin		Same as Sarin	Same	Same	Aq. soln. of bleaching powder or calcium hypochlorite	Same
Yperite (mustard gas)	+217	+14.5	Vapor or liquid, weak garlic odor	30 min exposure to 0.67 mg/liter	50 mg/kg of body weight	4–24 hr	Skin vesicant		Bleaching powder and other compounds with active chlorine and their solns.	Individual antichemical kit
Hydrocyanic acid	+26	−14	Gaseous, bitter almond odor	1 min exposure to 0.4 mg/liter		Immediate	General toxicity	Gas mask	Not required in the open air, ventilate buildings	Antidote: amyl nitrite
Phosgene	+8	−120	Gaseous, colorless, rotten hay odor	10 min exposure to 0.5 mg/liter		Immediate	Toxic for respiratory organs	Gas mask	Same as above	Rest, heat, oxygen

[*] F.P. = freeze point, °C; B.P. = boiling point, °C.

APPENDIX II

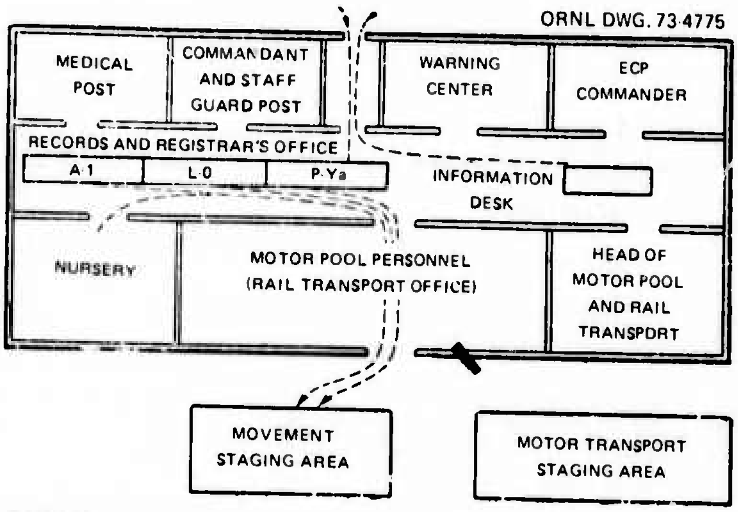
Primary infectious pathogens which may be used by the enemy as biological weapons

Type of pathogen	Mean incubation time (days)	Contagiousness	Observation period (days)	Quarantine period and conditions
		Biological infections		
Bubonic plague	1–3	Very dangerous		6 days
Anthrax	1–3	Not very dangerous	8	8 days in an epidemic and the infection by contact
Rabbit fever	3–6	Not dangerous	6	Not applicable
Spurious glander (melioidosis)	2–3	Dangerous	14	8 days in an epidemic and the infection by contact
Malleomyces	2–3	Dangerous	14	Same
Cholera	1–3	Very dangerous		6 days
Botulism toxin	2–24	Not dangerous	2	Not applicable
		Rickettsiosis		
Exanthematous pathogens	10–14	Dangerous with pediculosis	23	23 days under epidemic conditions with pediculosis
Q fever	10–20	Not dangerous	26	Not applicable
Rocky mountain fever	3–10	Not dangerous	14	Same
		Virus infection		
Smallpox	13–14	Very dangerous		17 days
Equine encephalomyelitis	2–10	Not dangerous	21	Not applicable
Yellow fever	3–6	Dangerous in the presence of mosquito vectors	12	12 days under epidemic conditions and in the presence of mosquito vectors
Psittacosis	8–15	Dangerous	15	15 days only in case of epidemic and with contact contagion
		Mycosis		
Coccidioidomycosis	10–14	Not dangerous	15	Not applicable

APPENDIX III

Floorplan of an Evacuation Collection Point (ECP)

Evacuation collection points are located near railroad stations, landings, and other sites for movement of evacuees



ECP Staff

1. ECP commander–1
2. Assistant ECP commander–1
3. Warning group 15-20
4. Recorders and registrars 6-9
5. Information desk–1
6. Security guards–2
7. Commandant and staff–5
8. Medical post–2-3
9. Motor pool staff–2-3
10. Rail transport staff–2
11. Nursery–2

Total: 39-49 people

Appendix III (a). ECP Staff Duties

The ECP commander supervises the work of all members of the center in accordance with instructions. The assistant commander establishes the political organization and the political Party work. The commander's staff organizes the work of the warning group and of the registrar and recorder, keeps abreast of the movement activities, and reports to the ECP commander on the number of persons evacuated in a given period of time.

The work schedule for the recorder's office is based on the actual situation. If workers and employees live near a plant, some of the alternatives are as follows: The warning group warns the public, workers, and employees; delivers evacuation permits to the citizens; explains to each when to appear at the ECP; and reports on completion of assignments (warning) to the ECP director.

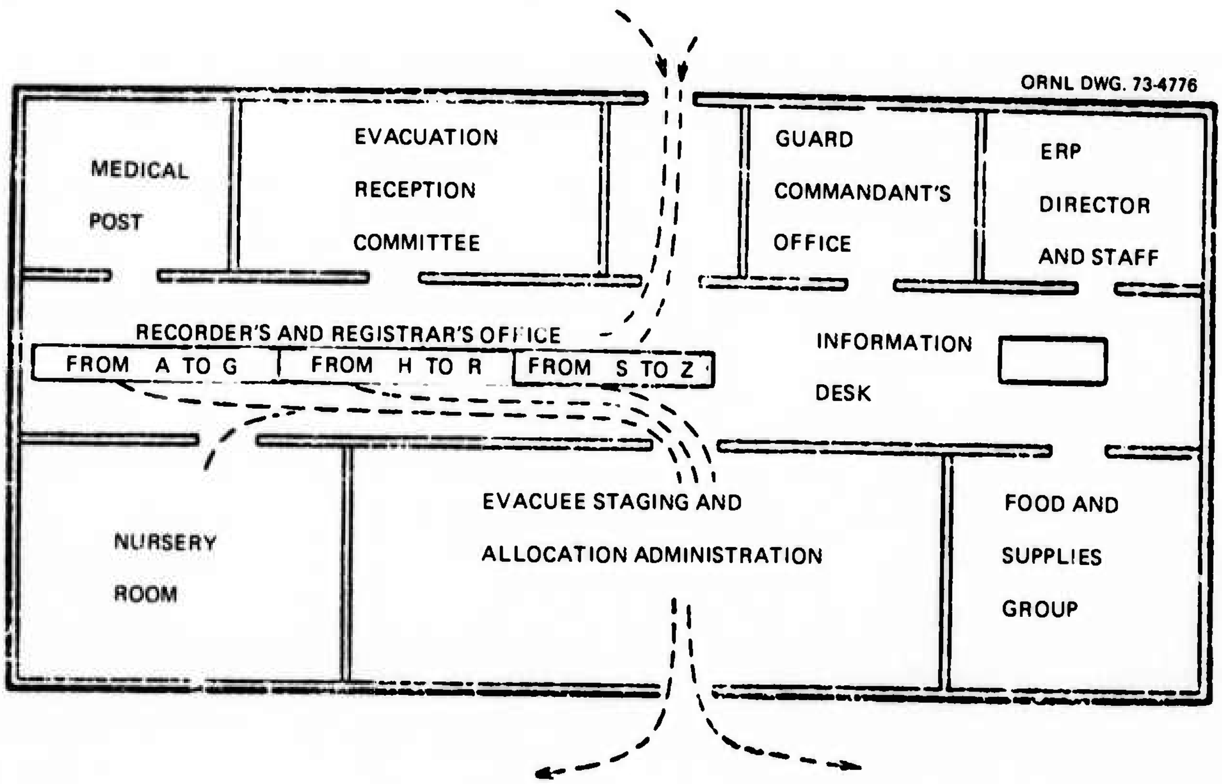
In other cases, warning may be implemented via plant workers and employees or with the help of technical communication facilities. Moreover, the completed evacuation permit may be returned in advance or at the assembly point.

The registrar's and recorder's office record those arriving for evacuation or dispersal, send them to the correct staging areas, and keep a record of each individual. The manager and staff handle the formation of evacuation convoys, maintain order in the convoys, appoint the lead vehicle (or railroad car), direct the convoys to the staging site, and keep the ECP commander informed of each motor convoy (railroad echelon). The security guards guarantee order and safety at the ECP. The medical post gives first aid to the sick and monitors sanitary conditions at the ECP site. The nursery assists children and mothers with children. The motor convoy chief (railroad echelon) fulfills all duties in conformity with instructions.

APPENDIX IV

Layout of an evacuation reception point (ERP)

Evacuation Reception Points are organized in rural locations for receiving and accepting evacuees. The ERP registers and records the arriving evacuees and assigns and transports them to settlement areas.



ERP staff:

1. ERP director, 1
2. Assistant ERP director, 1
3. Evacuation reception committee, 16–21
4. Registrar's and recorder's office, 9–11
5. Evacuee assembly and dispatch administration, 9–11
6. Commissary, 6–7
7. Information desk, 1
8. Nursery room, 2
9. Medical post, 3
10. Guard commandant's office, 10
11. Manager, 1

Total of 69 to 81 persons

Appendix IV (a). ERP Staff Duties

The ERP director organizes and supervises the work of all groups at the center in accordance with instructions. The evacuation reception committee maintains constant communication with the railroad disembarkation personnel; it coordinates the personnel (motor convoy) and the movement of individuals; it renders assistance to the aged, to invalids, and to women with small children on arrival and accompanies them to the reception point. The registrar's and recorder's office registers and records the arrivals, distributes them to settlement areas, registers the incoming people, and distributes them for conveyance to the settlement points. The evacuee staging and allocation administration organizes the motor convoy, completes the embarkation, and dispatches persons to settlement points. The medical post gives medical aid to the sick and controls the sanitary conditions of the center. The security guards keep order and provide for the safety of the citizens at the evacuation reception point. Nursery personnel assist mothers with small children.

APPENDIX V

Amount of materials necessary to convert a basement into a shelter with a space allotment for 100 people

Material type and dimensions	Quantity (m^3)	Weight (kg)
Beams, 22 cm diam	10	7,000
Beams, 20 cm diam	5	3,500
Beams, 19 cm diam	0.83	581
Beams, 16 cm diam	0.26	182
Beams, 14 cm diam	3.68	2,576
Beams, 12 cm diam	0.2	140
Freight pallet, 8 cm diam	0.08	56
Rods, 5–7 cm diam	0.51	357
Girders, 5 × 10 cm	1.22	732
Boards, 5 cm thick	3	1,800
Boards, 4 cm thick	7	4,200
Boards, 25 cm thick	4.76	2,856
Plywood, 1.5 mm thick	0.02	14
Sand, graded 0.5–1 mm (70–95%)	25.2	
Finely graded gravel, 5–10 mm	0.36	
Coarse gravel, 25–30 mm	1.44	
Graded backfill	4.2	
Solidly packed soil	1.6	
Roofing materials	278 m^2	
Rags		1.5
Fiber insulation		4.5
Cement-sand solution	0.006	12.6
Brackets, 300 × 100 × 10 mm, No. of pieces	560	174
Brackets, 200 × 80 × 8 mm, No. of pieces	40	5.6
Nails, 50 mm length		16.4
Nails, 70 mm length		1.6
Nails, 100 mm length		31
Nails, 120 mm length		7.4
Nails, 150 mm length		1.4
Wire, 2–3 mm diam		1.8
Wire, 4 mm diam		2
Door hinges, No. of pieces	4	
Wood screws, No. of pieces	24	0.03
		24,568

About 625 labor hours [man-hours] are required to modify a basement into a shelter. Seating capacity is 100, sleeping capacity is 26, and floor space per person is 0.66 m^2; the volume per person is 1.46 m^3 [50 ft^3]; [there are] one entrance and two simple emergency exits.

APPENDIX VI

Material for fabricating a simplified filter-ventilation system with a capacity of 300 m^3/hr [170 cfm]

Materials	Quantity
Sand, graded at 0.15–2 mm, m^3	12
Gravel, graded at 5–40 mm, m^3	0.85
Beams, 100–150 mm, m^3	0.9
Boards, 40–50 mm thick, m^3	0.5
Thin planks (in the absence of boards), m^2	0.4
Roof sheeting or tar paper, m^2	25
Material for the airtight seal of bellows (oilcloth, rubberized fabric, etc.), m^2	5
Material for cases (bellows, wear-resistant fabric), m^2	5
Sheet steel 1 mm thick, kg	1.5
Steel [illegible] 6 mm gauge, m	30
Strip iron 0.15 mm thick, kg	1.5
Nails, 4 × 100 mm, kg	1.2
Casein or joiner's glue, kg	0.5

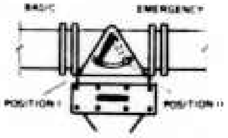
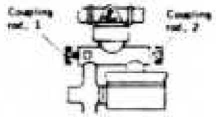
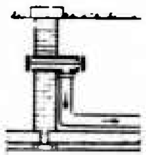
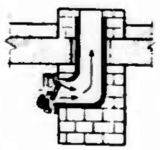
APPENDIX VII

Shelter log form

Operating dates of the filter-ventilation systems	Operating times of the filters and absorbers (hr)	Amount of air supplied (m^3/hr)	Air pressure in shelter (mm H_2O)	Relative humidity (%)	Condition of the other ventilation system units and condition of shelter equipment	Remarks

APPENDIX VIII

Operating sequence of filtering and other interior equipment in the shelter with a standard FVA-49 filter-ventilating system

Name of equipment	Design of equipment	For daily use of the structure	During ventilation	According to civil defense signals: "Air raid," "threat of radioactive contamination"	"Close the protective structure"[a]	Immediately after nuclear blast	"Chemical fallout," "radioactive contamination," "biological contamination"	"Air raid lifted"	Official responsible
Knife switch (magnetic starter) of starting mechanism on the ERV-49 electric motor		Off	On not more than 30 min per day[b]	On	On	On[c]	On	On	Post No. 2
Handle of the butterfly valve on the PPF-49 dust filter		In position I (basic air intake valve closed)	In position II (basic air intake valve open)	In position II	In position II	In position I	In position II	In position II	Post No. 2
Coupling rods 1 and 2 of the double airtight valve GK-2-100		Coupling rod 1 closed, coupling rod 2 closed and sealed	Coupling rod 1 open, coupling rod 2 closed and sealed	Coupling rod 1 open, coupling rod 2 closed and sealed	Coupling rod 1 closed, coupling rod 2 open	Coupling rods 1 and 2 closed	Coupling rod 1 closed, coupling rod 2 open	Coupling rod 1 open, coupling rod 2 closed	Post No. 2
Protective airtight sealing valve of the emergency air intake duct		Closed	(open when the primary air intake is damaged)						Post No. 2
Overpressure valve (KID-150 of KID-200) on the bathroom flue		Open	Open	Open	Open (to maintain the air pressure in the structure at 5 mm H_2O)	Closed	Open (to maintain the air pressure in the structure at 5 mm H_2O)	Open	Post No. 2

[a]The protective, airtight shelter doors are closed immediately after the shelter is filled or after the signal "close protective structures."
[b]The filter-ventilating system must be turned on after a preliminary check and after manually checking the operation of the electric fan motor.
[c]Immediately after a nuclear weapons blast, the filter-ventilating system is turned off for 1 hr and then turned on and operated at the signal "chemical fallout."

APPENDIX IX

List of recommended documents to be available in the shelter

Nos. in sequence	Documents	Form (contents)	Location	Remarks
1	Specifications for shelter contents	Poster or brochure	Posted over the shelter entrance or FVC [filtration and ventilation chamber]	
2	List of shelter equipment		FVC (or in one of the sections)	Often the list of shelter equipment is printed in "Specifications for shelter contents"
3	Shelter plan with adjacent basement premises and shelters	Drawn on sturdy paper. The floor plan shows the shelter layout and adjacent basements and shelters, the interior and exterior water pipes, the heating and sewer system, electrical power lines and their cutoff device, and possible sites for breaking through the walls when the entrance is obstructed.	FVC	
4	Daily log	According to the form given in Appendix VII	FVC	
5	Order of operation for filter-ventilation and other internal equipment	Poster	FVC	
6	Psychrometric [relative humidity] table	Table	Posted or kept with the psychrometer [hygrometer]	
7	Instructions for correct use of dosimetric and chemical monitoring devices	Brochure	With the instruments	
8	Telephone directory	The directory must include the telephone numbers of: the staff of the blast shelter and fallout shelter service on the site (region), the nearest shelters, the team personnel of the shelter, etc.	FVC	

APPENDIX X

Sample list of shelter equipment

Axes	2
Jumpers (borers)	2
Crowbars	2
Chisels	2
Pickaxes	2–3
Manual drill with a set of large-diameter bits	1
Shovels	2
Metal hack saw with spare blades	1
Sledge hammers	1
Hammers	2
Chisels	2–3
Wire binders	1.5 kg
Pocket flashlight with four to five spare batteries per section	
Emergency lighting	1
Candles	2
Wooden wedges and liner	5–7
Fire extinguishers	1–2
Telephone	1
Loudspeaker	1
Hydrostatic or inclined manometer	1
Psychrometer or moisture meter [hygrometer]	1
Table	1
Benches or cots	according to number in the shelter
Small tanks for boiling water with jugs	2
Buckets for water overflow	2
Refuse cans with lids	2–3
Containers for refuse (with lids)	1 liter per person
First aid kits	2
Medical thermometer	1
Rubber gloves	2 pair
Crumbled clay	20 kg per section
Hand sprayer	1
Rags or burlap	1 kg
Lysol	2 kg
Ammonium sulfate	1 kg

NOTES: 1. Lysol, ammonium sulfate, and the hand sprayer are needed to disinfect the shelter.
2. The number of items is calculated for 300 sheltered persons.

APPENDIX XI

Civil Defense Plan of a Production Facility (Leather Factory) [or Tannery] (One Version)

Order
of the Facility director on the organization and introduction of civil defense

25 May | No. 05 | Place

To organize and administer civil defense tasks on the site, it has been decided:

TO ESTABLISH A CIVIL DEFENSE ORGANIZATION AT THE FACILITY

To organize and maintain in constant readiness dispatch units and onsite civil defense formations with the following composition:

(a) Assistants to the CD director: for the political section; for dispersal and movement; for technical and engineering safety; for technical material safety.

(b) CD staff organization: Director, assistants to the director for operations and reconnaissance, assistants to the director for combat readiness, assistants to the director for the residential section.

(c) Evacuation committee organization: Chairman, assistant to CD director for dispersal and movement; committee members — plant and department heads of the site; operational group for dispersal and movement headed by the manager of leather board plant No. 14.

(d) Combat estimates of the civil defense command post (CP) on the site including: operational CP, management group, reconnaissance group, communications group, public security group; shelter group; CD service group.

(e) Civil defense services: communications based on the plant communications system; security guards based on the militia and the operations division; fire fighting based on the fire department and the volunteer fire-fighting squad; technical emergency based on the department of the master mechanics; blast shelters and fallout shelters based on the supervisory staff; medical based on the outpatient clinic; radiation and chemical protection based on chemical laboratories; technical material security based on the supply department; transportation based on the transport department.

(f) Civil defense formations: A rescue division is organized at each plant, one per shift, a total of 12 rescue divisions, each with a typical staff of 60% workers and employees on each shift. Two scouting groups are formed in each plant, one per shift. The reconnaissance group makeup is based on the typical staff.

Methods for Protecting Workers and Employees

The protection of workers and employees of the site from the harmful effect of weapons of mass destruction is achieved by: sheltering the working shift in onsite protective structures with commercial and reinforced equipment, according to the calculated allotment; dispersing the workers and employees of the nonworking shift into an outer zone in the region of Maslovka, Karpova, and Lopuchova, with subsequent protection in fallout shelters according to allotment.

The protection of workers and employees en route to the outer zone and back to their place of work and the protection of formations en route to an area of mass destruction are realized by using the relief of the terrain and also by using individual means of protection. In the case of repeated enemy strikes, protection of formations while performing rescue and urgent restoration work is accomplished by having them take cover in remaining protective structures and using individual means of protection and not permitting personnel exposure to exceed the permissible dose. If necessary, partial or complete decontamination is given to personnel in the zone of radioactive contamination.

In case of unexpected attack by the enemy, workers and employees of the on-duty shift are protected in shelters on the ground of the facility. The workers and employees of the off-duty shift take cover in protective structures near their homes.

Organization of Command, Warning, and Communications

Supervising civil defense force operations at the facility and organizing and directing their efforts toward successful and rapid execution of civil defense tasks in all stages of leadership are necessary on the facility grounds [command post] CP in shelter No. 13, on the route for moving workers and employees to the outer zone; to the dispersal area; on the advancing, as well as return, marching route into the center of mass destruction from mobile command post rail car No. 3 (bus No. 5); and in the dispersal region with the CP of the 557th high school, Maslovka village.

In order to ensure consistent, continuous, and flexible command, civil defense forces are trained in peacetime, and two command posts are established when attack threatens: the command post in shelter No. 13 on the facility grounds and the command post in the 557th high school, Maslovka village, in the region where facility workers and employees are dispersed. The mobile command post is deployed along the march route of the CD rescue forces when they are proceeding toward a center of mass destruction. This CP also follows the working and service personnel into the dispersal region and back – in an echelon (motor column), railroad car No. 3 (bus No. 5).

Combat schedules should be organized and prepared for site civil defense command post tasks, allowing three shifts for each CP and one shift for the mobile command post.

Under threat of attack and in wartime, the person on duty at the command post arranges 24-hr combat schedules for three shifts.

On the command post there are radio and wire communications with the civil defense staff superiors, the office, the formation cammander, and neighboring formations. In order to communicate with the staff superiors and with the office, radio stations R-105 and R-109 are used; communications with the formation commander are established via radio station R-106. Wire communications with the formation division commander and with the plant chief are established by appropriate communication lines. The communications sign-on is the signal 333.

Addendum to the Order of the CD Director of Facility No. 5

1. Site characteristics.
2. Plan for dispersing the workers and employees and evacuating members of their families from the national economic facility (see Appendix XII).
3. Design calculations for shelter allotments of workers and employees of the national economic facility (see Appendix XIII).
4. Plan for converting the facility to a primary civil defense center (see Appendix XIV).
5. Estimating safety of formations, workers, and employees of the facility with regard to individual means of defense (see Appendix XV).
6. Organization of command, warning, and communications systems at the facility (see Appendix XVI).
7. Schedule of the basic civil defense measures of the facility (see Appendix XVII).
8. Plan for conducting rescue and urgent restoration work at the national economic facility (see Appendix XVIII).

CD head of the facility – the director of the leather plant

(signature)

Characteristics of the Facility

Overall floor area, 800 X 200 = 160,000 m^2
Total workers at the facility, 3600 persons
Plant (factory) works in two shifts
Largest shift, 2000 persons
Number of shelters, 5 for 300 persons each
Basements, 2, 1 for 110 persons and 1 for 150 persons

Buildings and Structures

1. Machine repair shop of the transport plant, brick, one story.
2. Automotive workshop, block, one story.
3. Machine shop, block, one story.
4. Technical library, professional and technical school, brick, two stories.
5. Stamping plant, frame, one story.
6. Machine repair shop, block, one story.
7. Administrative building, brick, four stories.
8. School, brick, five stories.
9. Residence, block, four stories.
10. Residence, block, four stories.
11. Passageway, brick, one story.
12. Dispensary, brick, three stories.
13. Leather board plant, frame, one story.
14. Leather board plant, frame, one story.
15. Carton plant, frame, one story.
16. Boiler, steam power plant. one story.
17. Warehouse for adhesives, brick, one story.
18. Raw materials warehouse, brick, one story.
19. Spare parts and equipment warehouse, brick, one story.
20. Finished products warehouse, brick, one story.
21. Residence, block, four stories.

22□. Transformer station, reinforced concrete, one story.
23○○. Fuel and lubricants storage, reinforced concrete, one story.

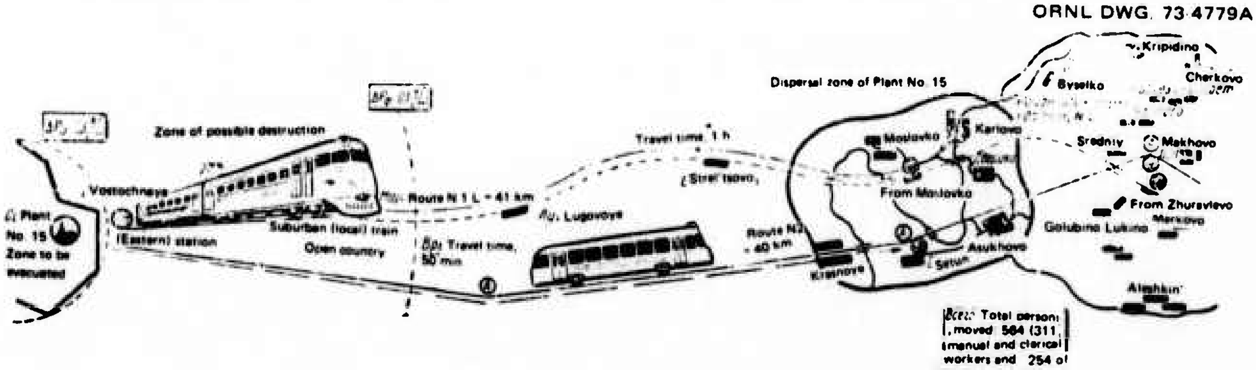
APPENDIX XII

Plan for the Distribution of Manual and Office Workers and the Evacuation of Their Families from a National Economic Facility

1. Zone of possible destruction
2. Plant No. 15 zone to be evacuated
3. Vostochnaya* (eastern) station
4. Suburban (local) train
5. Open country
6. Route N1L = 41 km
7. Travel time, 1 hr
8. Dispersal zone of plant No 15
9. Travel time, 50 min
10. Lugovoye
11. Strel'tsovo
12. Route N2L = 40 km
13. Krasnoye
14. Setun'
15. Total persons moved, 564 (311 manual and clerical workers and 254 of their family members)
16. Asukhovo
17. Golubino Lukino
18. Aleshkin'
19. Markovo
20. Sredniy
21. Cherkovo
22. Byselko
23. Karlovo
24. Moslovko
25. From Moslovka
26. Kripidino
27. Makhovo
28. From Zhuravlevo

*The following are place names: 3, 10, 11, 13, 14, 16, 17, 18, 20, 21, 22, 23, and 24.

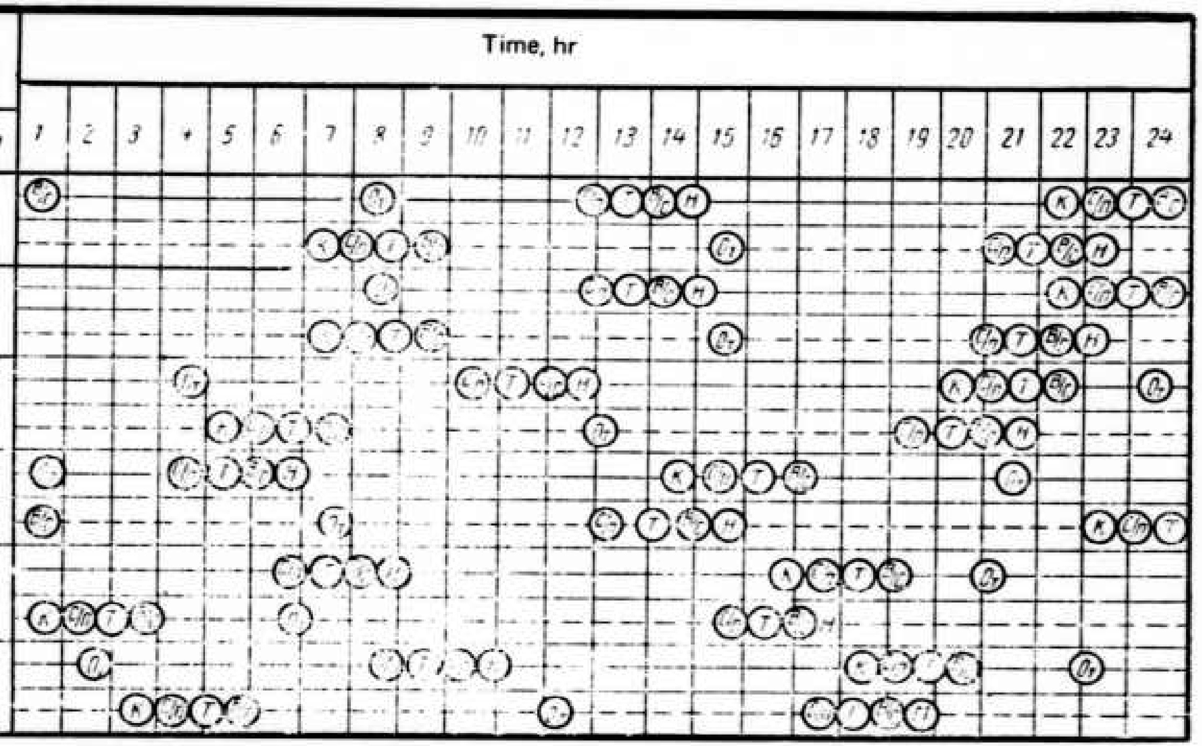
ORNL DWG. 73-4779A



ORNL DWG. 73-4780

Chart for the dispersal of work^rs and employees of the facility

Name of plant and department	No. of workers and employees: Всего	Shifts: 1 - я	Shifts: 2 - я
Machine repair shop	75	50	25
Transportation department	175	100	75
Stamping plant	700	400	300
Leather board factory NN 13, 14	1345	800	545
Board factory	913	488	425
Technical library, warehouses	392	162	230



Nomenclature:
- Start of shift
- Travel time
- End of shift
- Unloading, travel to working place or home, first shift, second shift.
- Staging, loading of shifts into transportation facilities.

Schedule for evacuating family members of workers and employees of the facility

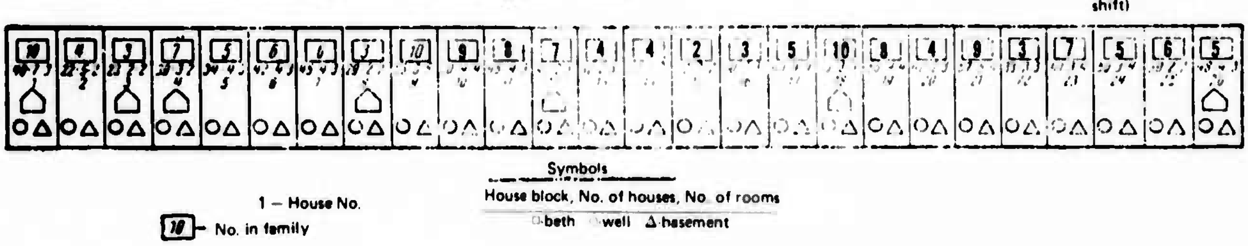
Name of plant section	Number of evacuated family members	Echelon No. Motor convoy No.	Staging area, ECP	Loading station	Unloading station, ERP	Evacuation destination	
						Intermediate destination	Dispersal site
Machine repair shop	150	Echelon No. 1, rail car No. 3 Motor convoy No. 1, 6 vehicles	1	Eastern railroad station	Zhuravlevo station Makhovo	Makhovo	Krapivinov
Transportation department	200	Echelon No. 1, rail car No. 4 Motor convoy No. 2, 8 vehicles	1	Eastern railroad station	RR station Zupavlevo Makhovo	Makhovo	Chernava
Stamping plant	464	Echelon No. 1, rail cars Nos. 5–8 Motor convoys Nos. 3–4, 16 vehicles	2–3	Eastern railroad station	RR station Zupavlevo Makhovo	Lukino	Vyselki
Board factory	700	Echelon No. 1 Motor convoys 5–6, 12–16 vehicles	4–5	Eastern railroad station	RR station Zupavlevo Makhovo	Srednie	Aleshkino
Leather board factory	650	Echelon No. 1, rail cars No. 13–15 Motor convoys No. 708, 13 vehicles	6–7	Eastern railroad station	RR station Zupavlevo Makhovo	Golovino	Markovo
Technical library, warehouse	350	Echelon No. 1, rail cars No. 15–16 Motor convoys No. 9, 14 vehicles	8	Eastern railroad	RR station Zupavlevo Makhovo	Pavlovo	"Daybreak" state farm

CD director of the facility (signed)

ORNL DWG. 73 4781A

Total distribution 564 people (311 workers and 253 employees of the shift)

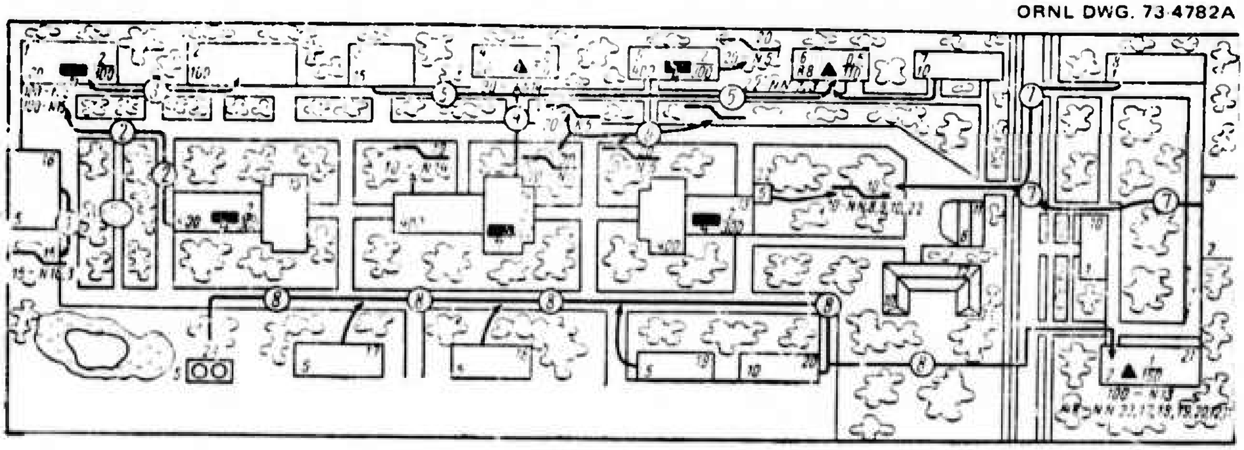
Distribution of workers and employees in the stamping plant facility



APPENDIX XIII

Shelter utilization plan for workers and employees at the national economic facility

ORNL DWG. 73-4782A



1/100 2/300 1 – N buildings, 100–number of workers in the largest shift
2 – shelter stability ΔP_{ϕ}, kΓ/cm².
300 – capacity, persons
100 – N2
100 – N15 – 100 – number sheltered
N2 u N15 – NN refugee receiving center

20/5 – N17 – fallout shelter

20 – capacity, 5-N17-number sheltered and N buildings

Travel route to and number of the protective structure.
CD director of facility (signed)

Shelter utilization plan

Plant No.	Name of shop or department	Number in the largest shift	In case of unexpected enemy attack: In highly equipped shelters	In shelters with simplified equipment	In radiation-proof fallout shelter	Irregularities in the terrain	After CD measures, executed during the period of threat of nuclear attack: In shelters with advanced equipment	In shelters with simplified equipment	In protected space
1	Machine repair shop	50	0/0	30	20/0		0/0	30/0	20/50
2	Transportation	100	100				100/0		0/100
3	Stamping	400	300			100/0	300		100/400
13, 14	Leather board	800	600	190	10		600	170	30/800
15	Board	488	400	88			400	88	0/488
	Other departments, warehouses	162	100	62			100	62	0/62
	Total	2000	1500	370	30	100	1500/0	370/0	150/2000

Note: The numerator shows the number of working shift personnel; the denominator shows the shelter space available for workers and employees in the dispersal region. On the travel routes primitive protection exists in the folds of the terrain.

CD director of the site (signed)

APPENDIX XIV (continued)

Plan for converting the facility to a basic civil defense regimen

No. in sequence	Plant, department	Executed measures	Completion time (min)	Official responsible	Order of execution
		In the event of unexpected sudden enemy attack			
1	Machine repair shop	Stop work completely. Workers proceed to shelters.	15	Shop foreman	Shelter utilization plan for workers and employees
2	Transportation department	Stop work completely. Workers and employees proceed to shelters.	15	Department head	Shelter utilization plan for workers and employees
3	Machine department	Work is not stopped. Machines are turned down. Workers proceed to shelters, attendant mechanics remain on duty.	15	Department head	Instruction to turn down the machines
4	Technical library, professional-technical schools	Library and school close. Co-workers and students proceed to shelters.	15	Chief librarian, school director	Shelter utilization plan for workers and employees
5	Stamping plant	Heating furnaces and conveyor continue operation, but are converted to a lower operating level. The workers and employees proceed to shelter. The attendants remain on duty.	15	Plant chief	Instruction how to turn down furnaces
6	Machine repair plant	Stop work completely. Workers proceed to protective structures.	15	Plant chief	Shelter utilization plan for workers and employees of facility
7	Leather board plants 3, 14, and 15	Furnaces and conveyors continue work, but are turned down. The workers and employees proceed to shelters; skilled attendants remain on duty.	15	Plant manager	Instruction on how to turn down furnaces and conveyors
8	Boiler, steam, power plant	Work is not stopped but scaled down. Workers and employees proceed to shelters. Skilled attendants remain in boiler room.	15	Plant chief	Instruction in turning down the heating furnaces and conveyors
9	All warehouses	Work is discontinued. Doors are closed and bolted. Co-workers enter protective structures.	15	Warehouse manager	Calculate shelter for site workers and employees
10	Transformer station	Turn down operation.	15	Station attendant	Instruction to turn down transformer-station
11	Departments, services	Work is stopped. Valuable documents and money are stored in the safe. Co-workers proceed to shelter.	15	Department, service head	Shelter utilization plan for workers and employees of the facility
12	Off-duty workers and employees and their families continue to live on the site in the residential area	Residential buildings are vacated. Electricity and gas are shut off. Proceed to protective structures.	15	Housing director	Shelter utilization plan for family members of workers and employees at the facility
13	Guard gate	Closes. Security guards proceed to shelters.	15	Head guard	Instruction to turn down operation

APPENDIX XIV (continued)

No. in sequence	Plant, department	Executed measures	Completion time (min)	Official responsible	Order of execution
		Under threat of enemy attack			
1	General plant measures	(a) All plants and departments convert to a two-shift operation.	24	Plant director	Plan for converting the object to a basic CD regime
		(b) Production is stopped according to general program.	24	Chief engineer	Instruction
		(c) Construction at the facility is stopped. Construction material is diverted to building shelters.	24	Assistant director of MTS [Materials and equipment supply]	Plan for constructing shelters at the facility
		(d) Conference of the superior civil defense staff on problems of converting the facility to special operating programs.	2	CD director of the facility	Plan for converting the facility to a basic operational CD regime
		(e) Planning continuous presence of CD specialists and staff at the facility.	2	CD director of the facility	CD plan of facility
		At command post.		CP director	Plan for organization, communications, warning, and administration of verbal orders
		In main control room.		Head dispatcher	
		In VOKhR [Military Police].		VOKhR chief	
		In plant and departments.		Heads of plants and departments	
		In the shelters.		Team, division commanders	Verbal orders
		In radio stations.		Communications group commander	Verbally
		(f) Fire-prevention measures; in the plants, departments and warehouses; the halls and hallways are cleared; loft areas are put in order.	12	Heads of plants and departments, fire warden of facility.	Fire-prevention training
		(g) Water reservoirs and containers are replenished, wells are prepared to supply the plant.	4	Chief fire warden of the facility	Fire-prevention training
		(h) Valuable sophisticated and specialized equipment, apparatus, and power systems are protected.	12	Chief engineer	Instruction
		(i) Measures are taken to guarantee safe and reliable storage of chemicals and flammables or explosives. Oxygen tanks and compressed air tanks are placed in fire-proof storage.	12	Plant manager Technical safety engineer of facility	Fire protection for facility
2	Measures taken in plants, departments, and warehouses: Machine repair shops	Dismantle and remove flammable partitions and temporary construction.	24	Shop chief	Instructions
	Transportation department	Concentrated work on vehicle repair. Allocate transportation and parking spaces.	24	Plant manager	Instructions

APPENDIX XIV (continued)

No. in sequence	Plant, department	Executed measures	Completion time (min)	Official responsible	Order of execution
	Machine shop	Shelter facilities are prepared for attendants. Inflammable material is covered.	2	Department head	Instructions
	Technical library	Valuable publications and documents are moved to basement. Part of the library is moved to the dispersal region.	12	Librarian	Instructions
	Professional-technical schools	Work is stopped; students are sent to the plant to replace the workers enlisted in the army.	24	Department head	Instructions
	Stamping plant	Measures are implemented to stop plant operations safely according to CD signals.	4	Plant manager	Instructions for non-emergency stoppage of plant operation
	Machine repair plant	Furnaces are prepared for planned shutdown according to CD signals.	6	Plant manager	Instructions to shut down furnaces and conveyors
	Leather board factory 13, 14, 15	Furnaces and conveyors are prepared for smooth shutdown according to CD signals.	6	Plant manager	Instructions to shut down furnaces and conveyors
	Boiler, steam generating plant	The regular production program is stopped; more dangerous units are covered with protective shields.	2	Plant manager	Instructions to turn plant and boilers to standby operation
	Warehouses, except for fuel and lubricant storage	Finished production is packed for shipping to customers. The walls of the premises are banked.	24	Warehouse manager	Instructions
	Warehouse for fuel and lubricant storage	Bank completely. Spill pipes are prepared for covering according to CD signals.	5	Warehouse manager	Instructions
	Transformer station	Production turned down according to plan of the facility. Prepare to cut off the power supply in entire plant according to CD signals where possible.	2	Chief engineer	Instruction for smooth turndown of transformer station to standby operation
	Sections, services	Workers of departments transferred to the dispersal region. Only the attendants remain at the facility.	24	Department head	Plan for dispersing workers and employees of facility
	Workers and employees of off-duty shift and their families subject to evacuation	Move toward the dispersal region.	12	Chief of the evacuation committee	Plan for dispersing the workers and employees of the site and evacuating members of their families
	Guard gate	Increased control of admission to facility. Delivery and shipping of valuable materials and automobile trips are undertaken only with the permission of the site CD chief.	15	Head guard	Instructions

CD director of facility (signed)
Chief engineer of facility (signed)

APPENDIX XV

Estimate for providing formations, workers, and employees with individual means of defense

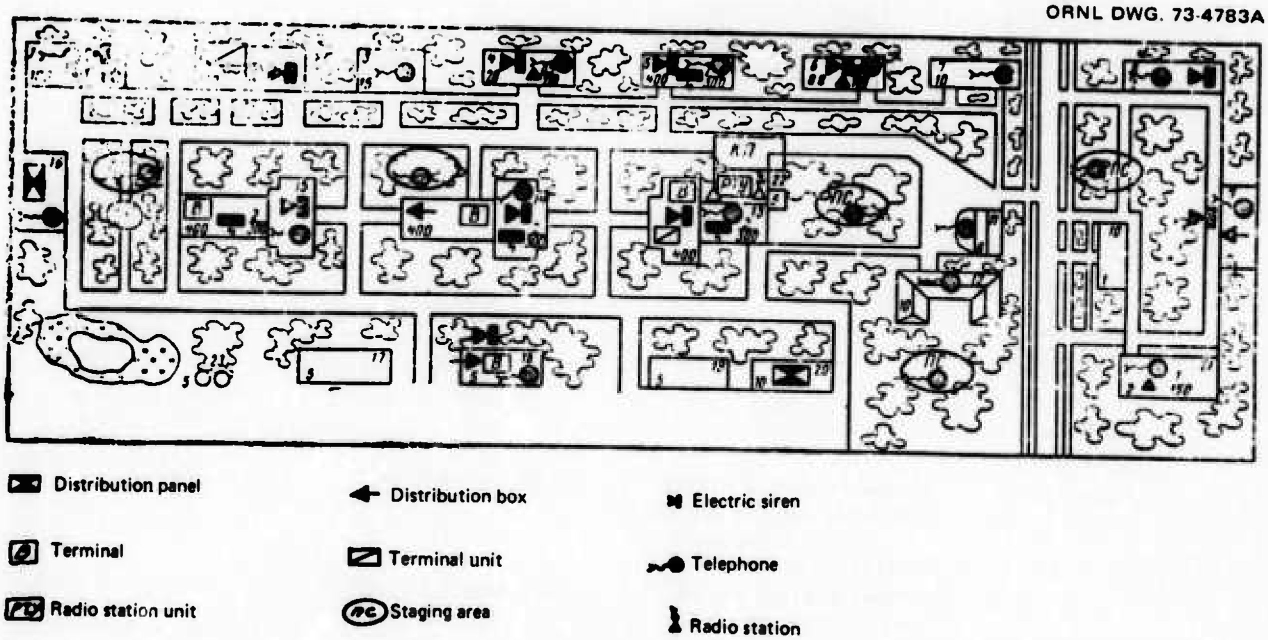
Name of plant or department	No. of workers and employees (total)	Presence of PKhZ* chemical instruments with current supply			Distribution of facilities from reserves		Place where materials are delivered
		Gas masks	Protective stockings	Protective gloves	Gas masks	PIM-1*	
Machine repair shop	75	75	75	75			Warehouse with current supply
Transportation	175	175	175	100	175		Inventory warehouse
Stamping plant	700	700	700	400	400		Inventory warehouse
Leather board factory No. 13	725	725	725	400			Warehouse with current supply
Leather board factory No. 14	620	620	620	400			Reserve warehouse
Leather board factory No. 15	913	913	913	200			Warehouse for means of protection against [poisonous] chemicals
Other departments, warehouses	392		392	125	150	242	Warehouse for means of protection against [poisonous] chemicals
Total	3600	3600	3600	1865	1075	292	

Note: PKhZ, chemical protection. PTM-1, cloth dust mask. CD director for supplies. (Signed)
*Chemical defense.

APPENDIX XVI

Diagram of the organization of command, warning, and communications at the facility

ORNL DWG. 73-4783A



CD director of facility (signed)
CD communications director of facility (signed)

Communications organization

CD staff
Regional office
Short wave "R-105"
"Wave" telephone No. 9517501
CP 10 of the site, telephone No. 343
Commander of the rescue division, Telephone No. 342
Commander of the reconnaissance group No. 376
Commander of the communications group, telephone No. 304
Commander of the rescue squad 1, telephone No. 354
Commander of the rescue squad 2, telephone No. 311
Commander of the rescue squad 3, telephone No. 310
Deputy CD chief for dispersal and evacuation, telephone No. 305
CD service chief of the site:
- communications
- technical emergency
- fire fighting
- blast shelter and fallout shelter
- medical
- radiation protection
- security guards
- technical material supply
- direct transportation

CD of facility
Telephone No. 341
Short wave "R-105"

Command unit	Communication facilities			
	R-105	R-109	R-106	Telephone
Command post, shelter No. 13		1		6
Command post, school No. 557		1	1	4
Mobile command post (bus, rail car)	1		1	
Observation post				1

CD director of facility (signed)

Warning

CD regional staff
Telephone No. 951750

CD director of the facility, I. P. Ctraxov. Telephone No. 1233454. Address: Residential sector, D5, kv.33. Notify by telephone. Messenger: I. V. Sidorov, laboratory worker.

Deputy CD director for the political section, V. M. Chesunov. Telephone No. 1240555. Address: Residential sector, D3, kv.45. Notify by telephone. Messenger: Seleznev, courier.

Deputy CD director for dispersal and evacuation, A. G. Nikitin. Telephone No. 1255331. Address: Residential sector, pom. 3, kv.12. Inform by messenger: A. M. Vasil'evym, supply agent.

Deputy CD director for technical engineering safety, I. I. Korolev. Telephone No. 1211882. Address: Residential sector, D5, kv.7. Inform by messenger: N. Z. Sereginym, H. Z., staple commodities.

Deputy CD director for materials and equipment supplies, N. V. Cpirin. Telephone No. 1231456. Address: Residential sector, D3, kv.21. Inform oy messenger: A. M. Doshtoyan, locksmith.

CD chief of staff of the facility, D. I. Yurasov. Telephone No. 1288444. Address: Residential sector, D2, kv.112. Notify by telephone: No. 1233164. Messenger: Pozdnyakov, supply agent.

Manager of the CD rescue division of the facility, V. V. Kulakov. Telephone No. 1131987. Address: Residential sector, D2, kv.49. Notify by telephone. Messenger: Kitaigorodskaya, librarian.

Manager of the reconnaissance group of the facility, N. N. Pavlov. Telephone No. 171234. Address: Residential sector, D5, kv.47. Notify by telephone: No. 2313164. Messenger: L. V. Cergeeva, timekeeper.

Communications group manager, L. I. Tankov. Telephone No. 19492. Address: Residential sector, D5, kv.39. Notify by telephone: No. 2317010. Messenger: V. I. Smelkov, telephone operator.

CD chief of staff of the facility (signed)

APPENDIX XVII

Schedule of the primary official civil defense measures at the facility

Measure	Official responsible for execution	Time required
	Period of attack threat	
Assigning and explaining the task	CD director of the facility	30 min
Alerting workers and employees of threat of attack and their civil defense obligation	CD staff, head of communications service	30 min
Conference of supervisory staff of facility.	CD chief of staff, head of communications service	1 hr
Defining CD plan of the facility	CD director, chief of staff, service head	2 hr
Assembling CP combat estimates. Organizing 24-hr duty on command posts, shelter No. 13	CD chief of staff, head of communications service	2 hr
Presenting tasks to facility personnel	CD chief of staff	2 hr
Keeping public order at facility, in the dispersal region, and on the marching routes when dispersing workers and employees	Head of the security guards	2 hr
Setting up 24-hr duty schedules:		
On-duty by shift in plants and departments	CD chief of staff, heads of plants and departments, CD service head	2 hr
Attendant details in CD formations	CD chief of staff for reconnaissance	
Organizing continuous monitoring at the facility for radiation, chemical, and biological contamination		
Dispatching operational groups into the dispersal and evacuation regions	CD staff of the facility	2 hr
Providing facility reserve personnel with individual means of defense (PKhZ 1075)	CD staff, deputy CD director for materiel and supplies	6 hr
Release facilities occupied for economic needs: shelter No. 1, basements in buildings 4, 6, and 21; prepare to shelter workers and employees	Head of shelter and protection service	12 hr
Prepare simplified respiratory protection (PTM-1, cloth dust mask)	Head of materiel and supplies	6 hr
Converting the primary plant to CD operations	Deputy CD director for technical engineering safety	72 hr

Measure	Official responsible for execution	Time required
Taking preparatory measures for PKhZ, PBZ, and PRZ,* foods as well as fire prevention; checking the technical condition of wells	CD chief of staff of facility, heads of medical service, chemical warfare defense, fire prevention	6 hr
Performing technical engineering measures which limit or prevent the occurrence of secondary damage from the utility services	Head of technical emergency service	
Taking preparatory measures to equip the dispersal region	CD director, chief of staff, deputy CD director for dispersal	12 hr
Moving family members of workers and employees to outer zone	Deputy CD director for dispersal	
Dispersal of workers and employees to outer zone	Evacuation committee	72 hr
Construction of protective structures for the facility in the dispersal region according to plan	Evacuation committee	72 hr
Providing protection for and removal of hazardous materials	Deputy CD director for materiel and supplies	72 hr
Providing food stocks, fuels and lubricants, drugs, in outer zone, and bringing formations and technical equipment to the dispersal region	Deputy CD director for materiel and supplies	72 hr
	At the civil defense signal, air raid (AR)	
1. Duplicate the AR signal	Command post	Immediately
2. All work in plants, departments, services stops; workers and employees proceed to shelter	Heads of plants, departments, services, warehouses	10 min
3. Shut off gas and power lines at the feeder to the main	Electrician on duty	2 min
4. Seal furnaces airtight. Shut off the fuel oil line. Shut off the air supply to kilns and furnaces.	Specialists on duty	5 min
Specialists on duty for plants and equipment proceed to shelter.	Specialists on duty	5 min
5. Cover all red hot metal with slag or sand	Specialists on duty	8 min
	Air raid lifted (ARL)	
1. ARL signal is given	CD staff of facility	According to orders of staff superiors
2. Surveying radiation and chemical and fire conditions near shelters	CD chief of staff of facility	According to survey data
3. Release of occupants from protective installations	Shelter managers	After surveying radiation and chemical conditions at facility
	Threat of radioactive contamination (TRC)	
1. TRC signal is given: the zone and the start of fallout and possible radiation levels are determined	CD chief of staff of the facility	15 min
2. Conditions under which personnel must remain in radioactive contamination zone are announced. On signal "radioactive contamination," personnel prepare to take shelter	CD formation commander	2 min

*Chemical defense, bacteriological protection, and radiological protection, respectively.

Measure	Official responsible for execution	Time required
3. Measures taken to protect drinking water and food supplies	CD formation commander	15 min
	Radioactive contamination (RC)	
1. Give RC signal	Observation post, observer	At start of fallout
2. Workers, employees and their families don individual means of protection and enter shelter	CD chief of staff of facility	RC signal
3. Organize plan for workers, employees, and their families for remaining in zone of radioactive contamination	CD staff of facility	20 min
4. Present plan for remaining at center of destruction to workers, employees, and their families	Surveying group manager	30 min
5. Control conditions for remaining in the focal zone of contamination	Head of security guard	Continuous
	Chemical fallout (CF)	
1. Give the CF signal	Observation post	At detection of chemical contamination or on order of CD staff superiors
2. Workers, employees, and their families outside the shelter don their individual means of protection and enter shelters	Formation manager	On CF signal
3. Develop the plan for personnel remaining in zone of chemical contamination	CD staff of the facility	20 min
4. Organize plan for remaining in zone of chemical contamination determined by the CD staff of the facility and present to personnel	Survey group manager	According to directions of CD staff
5. Control observation of rules for remaining in the zone of chemical contamination	Survey group manager	According to directions of CD staff
	Biological contamination (BC)	
1. BC signal is given	Observation post	According to survey data
2. Suitable conduct in the zone of contamination is determined	CD staff of the facility	15 min
3. Give the rules to personnel for conduct in the zone of contamination, and enforce adherence to same	CD staff of the facility	According to directions of CD staff
	After damage has occurred at a facility	
1. Surveying the area of destruction at the facility	Survey group manager	2 hr
2. Rescue and urgent emergency-restoration work	Director of the facility	2 hr
Limiting fire damage at the most important structures	Fire department commander	2 hr
Extracting persons from rubble and giving first aid to the injured	Heads of rescue squad and sanitary squad, of medical service, and of decontamination formations	6 hr
Supplying air to obstructed shelters	Head of the technical emergency squad (TES)	3 hr
Opening of obstructed blast shelters and fallout shelters	Head of technical emergency squad	

Measure	Official responsible for execution	Time required
Evacuating casualties to assigned relocation zones, localizing hazardous power line damage	Commander of sanitation squad Head of technical emergency squad	
Decontaminating plant and technical equipment	Heads of chemical defense service and decontamination squad	
Antiepidemic measures in zones of biological contamination (if present)	Head of medical service	6 hr
Preparing shelter in case of repeated attack	Head of blast shelter and fallout shelter service	4 hr
Conducting sanitary treatment of casualties and rescue personnel	Decontamination squad commander	2 hr

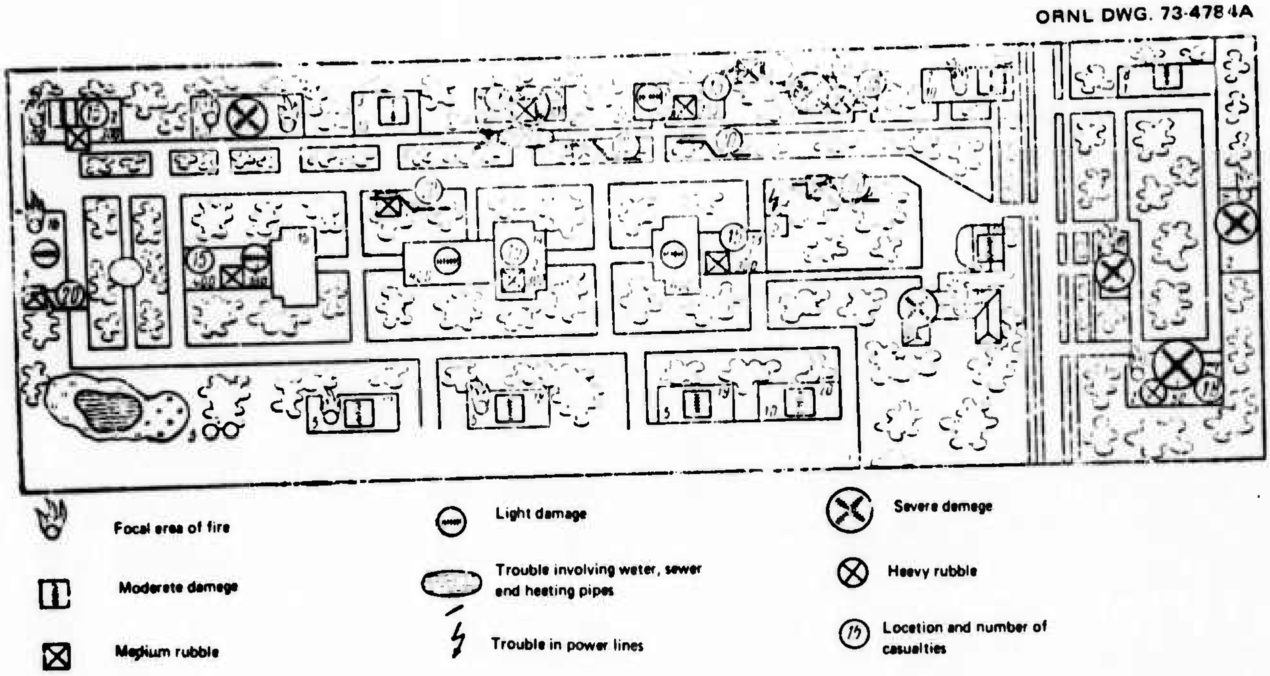
CD chief of staff of facility (signed)

APPENDIX XVIII

Plan for rescue and urgent restoration work at a national economic facility

Variant $\Delta P\phi = 0.3–0.4$ kg/cm^2 [4–6 psi]

ORNL DWG. 73-4784A



Assessment of expected condition of facility in center of destruction at $\Delta P\phi = 0.3-0.4$ kg/cm^2

Personnel losses of the largest shift (%)

Nature of protection		Total losses	Nonrecoverable	Clinical losses: Total	Degree of contamination: High	Medium	Low
Blast shelter	%	5		5	1	2	2
	No.	75		75	15	30	30
Fallout shelter	%	35	5	30	5	10	15
	No.	130	19	111	18	36	57
Outside cover	%	50	15	35	10	10	15
	No.	65	20	45	13	13	19
Total		270	39	231	46	79	106

Possible fires at the facility

Nature of the structure		Focal area
Multistory stone buildings	%	80
	No.	5
Single-story stone buildings	%	50
	No.	6
Frame industrial buildings	%	20
	No.	1
Total		12

Possible destruction at the facility

Protective structures		Degree of destruction: High	Medium	Low
Blast shelter	%		40	60
	No.		2	3
Fallout shelter	%	20	60	20
	No.	2	6	2
Total		2	8	5

Possible damage to buildings at the facility

Type of structure		Degree of damage: Severe	Moderate	Light
Multistory stone building	%	20	60	20
	No.	1	4	1
One-story stone building	%	10	40	50
	No.	1	5	6
Frame industrial buildings	%		20	80
	No.		1	4
Total		2	10	11

CD forces for conducting rescue work at facility on shift

Type of work	Volume of work	Required CD forces
1. Locating and extracting casualties from rubble	270 persons	27 teams of rescue squads
2. Giving first aid	230 persons	23 teams of sanitary squads
3. Opening obstructed entrances and shelters	15 entrances	17 teams of technical emergency squads
4. Containing fires	12 areas	12 detachments of the fire-fighting squad
5. Eliminating trouble in utilities	2 emergencies	2 teams of technical emergency squad
6. Guard duty	1 work region	Guard squad for primary defense zone

Working schedule of the rescue division with consideration of radiation conditions

		Time of postblast work initiation and duration of hours of shift																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Outside of contamination zone	P				First							Second								Third					
Outer boundary of zone "A"	A						First					Second								Third					
Middle of zone "A"	3						First					Second								Third					
Outer boundary of zone "B"	B						First			Second			Third				Fourth								Fifth
Middle of zone "B"	E										First		Second			Third					Fourth		Fifth		
Outer boundary of zone "C"	A														First		Second	Third				Fourth			
Boundary R = 500 r	K																								First
Boundary R = 1000 r	A	Work can start in 36 hr																							

$D_y = 20$ r

Chief of staff of facility (signature)

APPENDIX XIX

(Variant)

Confirmed CD director
factory N
(signature)

Surveying plan for factory N

Purpose of the survey: to assess the effects of the nuclear blast and give chemical and biological contamination warning. Surveying forces: survey group in three teams.

No.	Purpose of survey	Forces and facilities	Methods and tasks	Communication facilities and reporting sequence of survey results
		I. Under threat of attack		
1	Observing the radiation and chemical conditions	Observation post consisting of two observers from the survey group with instruments DP-63 and PKhR. Twenty-four hour watch	One of the observation post monitors the plant grounds, the other the dispersal village M	Communications by telephone; reports every hour and immediately upon threat of destruction and contamination
2	Giving warning of chemical and biological contamination			
3	Repeating warning signals by urban observation posts			
		II. In case of nuclear strikes and other means of mass destruction		
1	Determining the direction of the radioactive cloud	Observation post (two persons)		
2	Determining the nature and extent of destruction, the radiation level, the presence of chemical, biological, and radiological contamination on the facility's grounds	Survey group of two teams each in motor vehicle with instruments DP-5, BPKhR, and DKP-50	Direct survey of the factory grounds	Communication by radio every 30 min. Report when the survey is completed
3	Determining the condition of the protective structures and the number of casualties and their location			
4	Clearing routes to stricken zones to enable rescue-restoration workers to get in and injured people to be evacuated			

Appendix 1. Map (diagram) of the location of off-duty shift in the outer zone and marching routes to city (to plant).
2. Plan of the urban area, in the region where the plant is located.
3. Plan of the plant showing the blast shelters, fallout shelters, communal and industrial communication systems, and telephone lines.

CD chief of staff of the facility (signed)
Director of survey (signed)

APPENDIX XX

Report of Survey No.
19___ City Map___

Reporting location, date, month, year; scale of map, year of publication.

1. Brief description of conditions
2. Surveying tasks
3. Surveying task forces and facilities
4. Times of task performance and reporting sequence

CD chief of staff (signature)
Survey commander (signature)

APPENDIX XXI

(form)

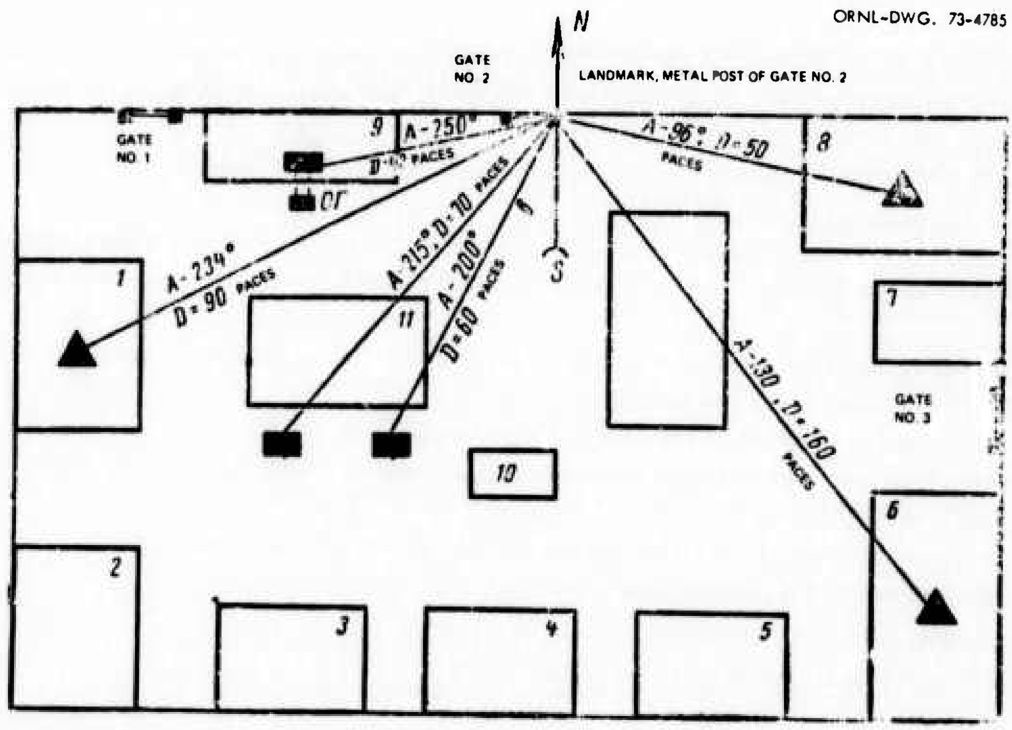
Log of post no.

No.	Observations, location	Observer, time	To whom reported, time

APPENDIX XXII

Azimuthal map of the survey team commander

ORNL-DWG. 73-4785



Note:

1. A survey team is assigned to survey 2 to 3 shelters, located at a distance of not more than 500 m, and 1 to 2 shelters at greater distances.
2. Distance from landmark to shelter is shown in paces [two steps].

APPENDIX XXIII

DIRECTIVE

of the civil defense director of the facility
No.___

"______" ____________________yr. City____________________
Re: results and problems of civil defense combat training from 19__ to 19__of the school year.

The Directive shall consist of a statement and instructions.

I. The statement of the Order will reflect:

1. General results of combat training of the past school year. Mode of execution of the instructions of the ministry (office) and the staff superiors concerning combat training.

2. Training of the formation command staff (division commanders, squad plant managers, and department heads). Number trained and where (%). Number of workers and employees prepared in the 21-hr program (%). Quality of training. Amount and quality of CD training given (facilities, plants) to formations (rescue, medical, communications, technical emergency, etc.). Number of workers and employees included in the training program (percent of the total number of workers and employees enlisted in the formation).

3. Plants, brigades, sections, services, and their formations, indicating improved combat preparation in the past academic year.

4. Measures implemented to propagandize CD information (lectures, reports, meetings, CD films, use of facility communications system, CD articles in newspapers, organization of exhibits, and other forms of propaganda).

5. Organization and performance of war games in Pioneer camps of the facility (description, results, indication of the superior brigade, Pioneer leaders, etc.).

6. CD teaching materials (those used, those improved and developed; training methods to prepare CD formations, workers and employees).

7. Shortcomings in combat training in the past academic year. Analysis of reasons for shortcomings. Give concrete examples (plants, sections, shifts, formations, services) of unsatisfactory organization and performance of combat training.

II. The following objectives are assigned as a part of the directive for the next academic year:

1. Combat readiness of all facility personnel.

2. Training of the command staff, the supervisory staff of the intermediate-level team, workers, employees, and the population of the residential sector, with indication of the training group and the training dates for each category.

3. CD training for formation personnel according to plants, sections, shifts, and CD services.

4. Programs for students during Pioneer camping period.

5. Organization and methods for disseminating CD information.

6. Provision of the necessary teaching materials for CD and instructions for their use in training formation personnel, workers, and employees.

7. Encouragement of heads of departments, plants, services, and of formation commanders to achieve the best results in combat training in the academic year.

Civil defense chief of the facility (signature)
CD chief of staff of the facility (signature)

APPENDIX XXIV

"Confirmed"
Civil Defense Director of the Facility

(date, signature)

"Approved"
Secretary of Party committee)
(Party bureau) of the facility

(date, signature)

PLAN

Combat training of civil defense personnel (academic year 19__)

(name of the facility)

No.	Measures implemented and trainee categories	Total in given category	Recruited for training in year	Training program employed	No. of hours	Month			Training site, organizer, and trainer
						September	October	November	
	I. Training of the superior command personnel								
1	CD chief of the facility	1	1	CD course	40	40			CD course
2	Chief engineer	1	1		40		40		
3	Chief of staff of the facility	1	1		72		72		
4	Formation commanders								
	II. CD training of workers and employees								

CD chief of staff of the facility

(date, signature)

APPENDIX XXV

"Confirmed"
CD director of facility

____
(date, signature)

Activity Schedule

By CD for ________________
name of training category

____
(plant, department, formation, group)

from "___" ______ to "___" ______ 19__ yr.

Date, month, time	Subject	Method of presentation	Place of presentation	Instructor

Note:

1. The activity schedule according to the above form applies to all trainee categories at the facility.
2. Description of activities of formations (group of workers and employees), to be prepared and signed by the formation commander (plant, department head, etc.).

CD chief of staff of facility

____
(date, signature)

APPENDIX XXVI

Log of civil defense activities

____
(name of trainee category)

____
(name of facility)

Group No. ________

Group supervisor ________________
(position, last name, initials)

Start of activity "___" ______ 19__ yr.

End of activity "___" ______ 19__ yr.

No.	Last name and initials	Attendance record, months and days	Date	No. of hours	Subject and training method	Remarks of activity supervisor

Note: The activity log in the form given applies to heads of plants, divisions, brigades, foremen, shift engineers, and formation commanders according to training groups.

APPENDIX XXVII [see note *]

APPENDIX XXVIII

Account of instruction, staff training, and civil defense competition conducted at an industrial facility of the national economy

No.	Type of instruction, training	Persons recruited					Remarks
		Planned (No.)	Performed (No.)	Date performed	Formation	Workers and employees	
1	Objective training						
2	Practical training						
	Rescue						
	Technical emergency						
	Medical						
	Fire prevention						
	Decontamination						
	Surveying, etc.						
3	Staff training						
4	Competition						
	Sanitary squad						
	Command						
	Disinfection, etc.						

Note: In column 8 (remarks) corresponding to Item 1, "Objective training," the formations recruited for the training program are indicated.

CD chief of staff of the facility.

(date, signature)

[*The original Russian handbook goes from Appendix XXVI to Appendix XXVIII, neglecting to provide any appendix numbered XXVII.]