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Civil Defense Research Section

HEALTH PHYSICS DIVISION

TWP 1966

TECHNICAL DIRECTIVES FOR THE CONSTRUCTION OF PRIVATE AIR RAID SHELTERS AND THE 1971 CONCEPTION OF THE SWISS CIVIL DEFENSE

Swiss Federal Department of Justice and Police
Office of Civil Defense

Edited by

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PART II. THE 1971 CONCEPTION OF THE SWISS CIVIL DEFENCE

Editor's Preface

When the United States civil defense posture is compared with that of the Soviet Union, China, Switzerland, or Sweden, one notices a strange anomaly. The wealthiest nation in the world cannot "afford" more than a token effort toward passive defense. An essentially "no-cost, fallout only, existing structures only" program is all we can muster. Meanwhile, two potential enemies and two passionately neutral countries have taken steps to provide considerable quantities of blast-resistant fallout shelters for their citizens.

The recent declassified Gaither Report which was prepared (and classified "Top Secret") in 1957, recommended a $20 billion fallout construction program and called for at least consideration of 30-psi blast shelters in the cities. The fallout construction program was claimed to be able to reduce casualties from 70% to about 47% of the population. An additional $20 billion spent on 30-psi blast shelters for cities could bring the casualties down to 20%. Later studies performed by contractors for the Defense Civil Preparedness Agency (and predecessor agencies) have shown that much better protection than that is possible with a $40 billion budget for fallout and blast-resistant shelter systems.

The small book of Technical Directives for the Construction of Private Air-Raid Shelters was issued by the Federal Department of Justice and Police Office of Civil Defense of Switzerland in 1966–67 to implement and supplement the Federal regulation which requires creation of blast-resistant shelters in all new construction and all renovation. Contributions by the Federal Government (i.e., subsidy of the construction) are limited to the incremental costs due to the shelter with a maximum of 5% of the construction cost permitted. The 5% limit can be exceeded only in special cases where the additional costs are deemed to be in the public interest.

The Swiss Office of Civil Defense has authorized the Oak Ridge National Laboratory, as agents of the U.S. Atomic Energy Commission, to reprint and distribute their English translation of TWP 1966 to individuals in the United States. The illustrations have been redrawn with the translated captions. All units are given in both English and metric units purely for the convenience of the users.

In 1971 the Swiss Federal Council reviewed the civil defense concept as defined by existing Federal laws and as shown in TWP 1966. They found that the conception could be substantially maintained (in 1971) but with certain modifications and additions. The "Report of the Federal Council to Parliament on the 1971 Conception of Civil Defense (of August 11, 1971)" details their findings and recommendations. An English translation (supplied by the Swiss Office of Civil Defense) is included in this publication as Part II.

The English translation of this book has been edited locally and is being published to provide the American civil defense establishment with ready access to information about what one country is doing to protect its citizens against nuclear war. We believe this information will be particularly valuable when the American public and its leadership finally take a realistic attitude toward modern preparedness.

It should be noted that Switzerland has essentially the same per capita wealth as the U.S. and is technologically comparable. Therefore, it is not true that all wealthy nations cannot afford adequate passive defense. Rather, the Swiss are demonstrating a real pragmatism in maintaining their independence. They are using solutions to civil defense problems that Americans would do well to emulate.

The editorial changes are minor. They consist primarily of modifying nomenclature to be more consistent with American usage and providing approximate English unit equivalents for all metric dimensions.

G. A. CRISTY

Preface

For as long as wars have been waged, man has always devised an appropriate defense for every new weapon developed. Accordingly, in the nuclear age modern science and technology are not only used to develop weapons but also to serve in the research for the necessary defense measures. The present level of shelter construction techniques, applied conscientiously and with technical skill, makes it possible to save the lives and permit the survival of a great number of people even in a modern war. The following directives are based on the latest knowledge of the present level of weapon development.

Shelters may be built more strongly than these directives require, but this would demand a considerably greater financial outlay. In order to save as many human lives as possible, it is better for a country with a fixed expenditure for civil defense to build many cheap shelters rather than a few expensive ones. The present directives are based on this premise.

In the first chapter, the assumptions and conditions which must be considered in the design and the effect of the weapons are reviewed. The second chapter is primarily intended for architects and contains, in addition to general planning principles and building dimensions for the preliminary designs, data concerning space requirements, ventilation, furnishings, and installations. In the third chapter rules for design and construction are summarized for the use of structural engineers.

These three chapters contain information for the construction of private Civil Defense shelters. Of necessity, this information contains compulsory regulations, general rules, and suggestions.

In the Appendix the most important data are briefly summarized as a convenient memory-aide. It also contains a compilation of definitions of the most important terms used in the text. Finally, there is an example of the design of typical small defense shelters, which could be used for structures of lesser importance. It would not, however, be in the interest of an economically efficient shelter construction to use the Appendix independently from the first three chapters as the sole basis for defense-shelter construction. If we concentrate only on adhering to regulations, we will never succeed in finding a creative and appropriate solution for each individual case.

These Technical Directives were prepared during the year 1965–66 by a committee under the direction of Mr. G. Rossetti, Section Chief Head of the Federal Office of Civil Defense at the request of the office of Civil Defense. The members of this committee were the Authorities in Civil Defense construction from the Cantons; namely J. Huser (Ct.* Nidwalden), A. Schafroth (Ct. Zürich), H. Schmid (Ct. Basel-City), J. Stocker (Ct. Bern), P. Truniger and F. Hiestand (Ct. St. Gall), as well as, in later phases, F. Sager, head of the Construction Section of the Federal Office of Civil Defense and M. Brugger (Ct. Freiburg). The preparation of the directives was accomplished by the engineering offices of Basler and Hofmann, Zürich, and W., R. & Dr. W. Heierli, Zürich.

*Ct. = Canton.

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LIST OF ABBREVIATIONS AND SYMBOLS

BZS	Federal Office of Civil Defense
TWP	Technical directives for private shelter construction
BMG	Federal law of 4 October 1963 concerning measures to be taken for civil defense construction
BMV	Decree of 15 May 1964 concerning measures to be taken for civil defense construction
MZS	Civil defense information sheet
SEV	Swiss Electrotechnical Society
SIA	Swiss Society of Engineers and Architects
EMPA	Federal Bureau for Testing Materials
SR	Shelter room
RE	Decontamination room
S	Air lock
T	Toilet
PT	Blast door
PD	Blast hatch
DT	Pressure door
FW	Escape passage
NA	Emergency exit
FR	Escape tunnel
MD	Wall break-out panel
MDS	Wall exit
H	Height from ground level to roof (gutter)
NL	Natural ventilation
FRL	Fresh air ventilation
FIL	Ventilation through gas filters
LF	Air intake
AL	Air outlet
ESV	Explosion protection valve
VF	Primary filter
GF	Gas filter
VA	Ventilating apparatus
UV	Excess pressure valve (blast valve)
UK	Lower level
OK	Upper level
P	Pressure (force per unit area)
g	Acceleration of gravity
g_e	Weight of the structure
σ_{Bzul}	Allowable soil pressure under peace conditions
σ_{fld}	Stress in the plastic range due to dynamic loading of the reinforcing steel
β_w	Compressive strength of concrete cubes
μ	Percent of reinforcing steel in the concrete section
m_x^+, m_y^+	Bending moments in the plastic range per unit length around the major and minor axes at the center of a concrete slab
l_1, l_2	Short and long span of a rectangular slab
d	Depth of concrete slab or beam
h	Effective depth of concrete to reinforcing
λ	Degree of plastic fixity, relation of m_x^- to m_x^+
x	Ratio of the plastic bending moment in the minor and major axes $x = m_y^+ : m_x^+ = m_y^- + m_x^-$

Part I. Technical Directives for the Construction of Private Air Raid Shelters (of 15 November 1966)

Technical Directives for the Construction of Private Air Raid Shelters (of 15 November 1966)

The Federal Office of Civil Defense, as authorized by Article 20, Paragraph 2, of the Federal Regulation dated 4 October 1963[1] concerning Building Measures for Civil Defense, issues the following

DIRECTIVES:

Article 1

The following Technical Directives of 15 November 1966 for the Construction of Private Shelters come into effect on 1st January 1967.

With the enactment of these Directives all regulations which contradict with them are cancelled, in particular:

1. The Recommendations for the Construction of Air Raid Shelters of February 1949 issued by the Air Defense Section of the Swiss Federal Military Department.
2. The Provisional Technical Regulations for near-miss-resistant shelters of the Air Defense Section of the Federal Military Department issued 14 December 1957 (reprinted 9 November 1959[2]).
3. The Circular No. 6/63 concerning concrete quality and reinforcing with end hooks for shelters of 6 October 1963[2] of the Federal Office of Civil Defense.
4. The Authorizations of the Federal Office of Civil Defense to individual Cantons concerning the approval of shelter designs for more than 50 persons.

Article 2

As of 1st April 1967 only projects conforming to the Technical Directives of 15 November 1966 for the Construction of Private Shelters may be built.

Projects approved on the basis of earlier regulations may still be built if construction is begun before 1st January 1968. If construction is started after this date, the projects must be made to conform to the Technical Directives of 15 November 1966 for the Construction of Private Shelters.

Article 3

The Technical Directives of 15 November 1966 for the Construction of Private Shelters are also to be applied accordingly to the design of shelters for public buildings and government offices until corresponding regulations are issued.

Article 4

The Federal Office of Civil Defense, in application of Article 7, Paragraph 2 of the regulation of 15 May 1964[3] concerning Building Measures for Civil Defense and Article 24, Paragraph 2 of the Regulation of 22 October 1965[4] concerning Civil Defense in Federal Services and In Licensed Transport Companies, relinquishes its powers to approve the construction of shelters up to and including a capacity of 100 persons in favor of Cantons or those authorities mentioned in Article 24, Paragraph 2.

The Federal Office of Civil Defense
The Director:
Walter König

1. MZS 1,27. MZS = Mitteilungsblatt des Zivilschutzes (Information of Federal Office of Civil Defense).
2. Not published in MZS.
3. MZS 1,63.
4. MZS 3,19.

Chapter 1. Basic Data and Assumptions

1.1 LEGAL BASIS AND DOMAIN OF APPLICABILITY

Article 2 of the Federal Law of 4 October 1963[1] concerning The Construction of Civil Defense requires the creation of the necessary shelters in all new structures and for all renovation for the protection of the population. According to article 8 of the same law the additional costs attributable to civil defense should not comprise more than 5% of the total building cost (not including land). Contributions can be paid toward further increases in civil defense costs when they are technically justified. This is the case when an improvement in the shelter or its furnishing is in the public interest (Article 10 of the law of 15 May 1964 concerning the Construction of Civil Defense[2]).

These instructions apply to the construction of private defense shelters with a protective range of 1 to 3 atmospheres pressure. They are applicable to cast-in-place concrete shelters of approximately rectangular floor plan and section which are to be constructed as a part of a new building.

The preparation of directives requires a number of simplifying assumptions by their very nature, especially as regards the effect of weapons and the effectiveness of many parts of the shelter. These simplifications are especially evident in Appendix C which contains practically complete solutions for typical small shelters These solutions can therefore only be applied directly to small shelters without further study. For shelters with more than 25 occupants the arrangement and dimensions must be determined according to chapters 2 and 3.

Large installations, multi-purpose structures, tunnels, and prefabricated shelters as well as installations for civil defense units require special attention. Until the issue of appropriate technical directives for the design of such installations and equipment, the guideline published by the Federal Office of Civil Defense of 23 April 1965[3] and the supplement of 4 March 1966[4] shall apply. Detailed data may be obtained from the Weapons Effect Handbook (1964 Edition, Office of Civil Defense).

Deviations from these Technical Directives for Civil Defense Shelter Construction may only be made on the basis of competent and recognized sources which can prove that the prescribed extent of protection can be achieved by economical means.

1.2 EXTENT OF PROTECTION

The extent of protection for private shelters will, in general, be determined for one atmosphere of overpressure. (See the Recommendations of the Federal Office of Civil Defense of 23 April 1965[3] concerning minimum requirements for construction.)

The possibility is thereby left available to the Federal Department of Civil Defense to set other limits of protection (3 atmospheres as a rule) at the request of a Canton in special cases. In judging the protection offered by a civil defense shelter one must avoid the conception that a 3 atmosphere design, for example, is worth three times as much as a one atmosphere shelter. It can be shown that for an equivalent population density the probability of survival is increased by only about 25% when the limit of protection is raised from 1 to 3 atmospheres.

The following may be considered as special cases in which the Federal Office for Civil Defense maintains their normal contribution even for a limit of protection of three atmospheres:

1. The increase of the protection limit from one to three atmospheres does not increase the cost of the shelter more than 25%.
2. The 5% rule (article 8, paragraph 1 of the Federal Law of 4 October 1963[1]) is still respected.

1.3 ASSUMED USE OF THE SHELTER

It has been assumed that the concept of entry, habitation, and leaving of a shelter will probably be different than, for instance, it was during the last world war. For the planning of shelters it is advantageous to distinguish between the following four phases of shelter use and to investigate their requirements on shelter space separately.

1.3.1 Peace Phase

During peacetime the shelter will be used as a cellar or storage room. With reference to the economy of civil defense measures these peacetime uses should be impeded as little as possible. These requirements should especially be considered by the arrangement and design of the entrances, the lighting, the moisture-proofing, sanitation, furnishing, utilities, and the natural ventilation.

1.3.2 Pre-Attack Phase

The time between the recognition [and arrival] of approaching bombs or rockets, the so-called warning time, has been assumed to be very short and is not sufficient to move into the shelter.

The authorities will therefore instruct the population to live in their shelters during any threatening or existing state of war. It must be possible to prepare the shelter for war within 24 hours for habitation by the occupants. This changeover from the peacetime to the pre-attack phase requires the accomplishment of the following works:

1. Evacuation of all objects unnecessary to civil defense.
2. Introduction of all the necessary supplies such as food, water, sanitary supplies, etc., that are not already stored in the shelter.
3. Furnishing of the shelter with seats and bunks, communication equipments (battery radio), and tools to dig out with.
4. Sealing of all openings of the shelter, as well as checking the ventilation equipment, the air intake, and the emergency exit.

Until the attack or the "all clear (Endalarm)" days or weeks may pass. During this time of occupation there is a limited traffic between the shelter and the outside world, which may permit the execution of the most important work as well as the supply of food.

1.3.3 Attack Phase

This is the phase when the shelter is actually subject to the effect of weapons such as thermal and light radiation, primary nuclear radiation, air pressure and concussion, falling debris, shrapnels, fire, and gas.

1.3.4 Post-Attack Phase

If an atomic explosion has taken place close to the ground one must assume a stay in the shelter of several days or even weeks because of the radioactive fallout. This stay may be interrupted immediately after the attack or after several days in order to accomplish the most necessary work, but only for a limited period. Gradually the time spent outside of the shelter may be increased according to the recommendations of the ABC service of the civil defense corps and may be used for cleanup work, for example. The different operational phases often place conflicting requirements on the arrangement of the shelter. The more thoroughly the designer analyses these requirements the closer he will come to a balanced and economical solution for any individual project.

1.4 APPLIED FORCES ON THE SHELTER DURING THE ATTACK PHASE

1.4.1 Assumed Threat

It is assumed that the civilian population is primarily threatened by atomic weapons of medium to large size but also secondarily by chemical, biological, and conventional weapons. Although the design and dimensions are principally determined for atomic weapons it can be established that a good atomic shelter offers good protection against chemical, biological, and conventional weapons whereas the converse is not always true.

1.4.2 Protection against Atomic Weapons

1.4.2.1 Development of the explosion. In the instant of explosion a strong radiation of heat and light lasting several seconds is emitted. Simultaneously the initial nuclear radiation begins. The shock wave strikes the shelter several seconds after the explosion. With its arrival a wind several times stronger than a hurricane begins. This lasts as long as the excess pressure, that is to say a few tenths of a second or a few seconds for large bombs. At the same time large quantities of debris are hurled through the air. Flammable material will be ignited by the heat rays. If the explosion is near the ground radioactive fallout can begin after half an hour and last many hours or days.

1.4.2.2 Mechanical effect. A 1 atmosphere shelter can withstand the effects of an atomic explosion at that level distance where the maximum atmospheric over-

Table 1-1. 1 and 3 atmo. distances for low level explosions

Energy equivalent	Distance for a pressure of	
	One atmosphere	Three atmospheres
1 KT[a]	0.3 km (0.2 miles)	0.2 km (0.15 miles)
10 KT	0.6 km (0.4 miles)	0.3 km (0.2 miles)
100 KT	1.2 km (0.8 miles)	0.7 km (0.4 miles)
1 MT[b]	2.6 km (1.6 miles)	1.5 km (0.9 miles)
10 MT	5.6 km (3.5 miles)	3.2 km (2 miles)
100 MT	12.0 km (7.5 miles)	7.0 km (4.4 miles)

[a] 1 KT = 1 kiloton = energy equivalent of 1000 tons of TNT (trinitrotoluol).
[b] 1 MT = 1 megaton = energy equivalent of 1 million tons of TNT.

pressure is 1 atmosphere. The bomb size and ground distances for which an overpressure of 1 and 3 atmospheres occur for a low level bomb are listed in Table 1-1.

For comparison, the bombs dropped on Hiroshima and Nagasaki in 1945 were 12 and 22 KT respectively.

Figure 1-1 shows the magnitude of the overpressure acting from all sides as function of the distance from the explosion center of a low level bomb of 1 KT and 1 MT equivalent energy.

The air pressure creates a pressure wave in the ground similar to that of an earthquake. The approximate strength of this shock is given in Table 1-2. These are indicative values which apply to unfavorable, that is, soft ground. In a hard ground the velocities and

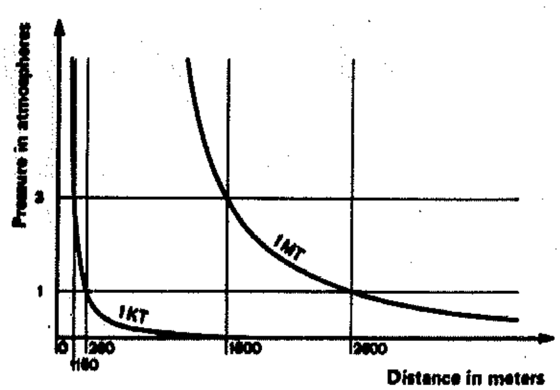

Fig. 1-1. Maximum overpressure as a function of the distance from the explosion center for a ground level explosion.

Table 1-2. Concussion on a shelter due to an atomic explosion

	Concussion of the shelter	
	1 atmos.	3 atmos.
Acceleration	2 g[a]	6 g
Velocity	0.5 m/s (1.5 ft/s)	1.5 m/s (4.5 ft/s)
Displacement	0.5 m (1.5 ft)	0.7 m (2.8 ft)
Relative displacement between shelter and ground	5 cm (2 in.)	7 cm (3 in.)

[a] 1 g = gravitational acceleration = 9.81 meters/sec^2 (32.2 ft/sec^2).

deformations are smaller. Higher instantaneous accelerations than those given in Table 1-2 occur. These peak values can generally be neglected in the design.

1.4.2.3 Initial nuclear radiation. The initial nuclear radiation is propagated outward from the fireball of the explosion in a similar way as light. The following radiation intensities are created by the explosion of an atomic bomb:

1. At a distance corresponding to 1 atmos. pressure for a 10 KT explosion, explosion height zero: 20,000 roentgens.
2. At a distance corresponding to 3 atmos. pressure for at 10 KT explosion, explosion height: low 70,000 roentgens.

For larger bombs the radiation in the 1 and 3 atmos. pressure zones is less, and by smaller bombs it is more than the values indicated.

The permissible radiation in the shelter has been set at 100 roentgens. For bombs bigger than 10 KT the radiation protection offered by shelters designed according to these Technical Directives is greater than necessary; for smaller bombs it may be too little. In addition the radiation intensity (for a given pressure) is dependent on the explosion height and the direction of the explosion with respect to the shelter.

1.4.2.4 Radioactive fallout. The radioactive bomb debris, which is mixed with vaporized material from the ground in the case of ground level explosions, are blasted upward and condense to dust and sand-like particles after cooling. These are precipitated after hours or days and give maximum local radiation doses of 20,000 roentgens. The maximum rate of dosage is to be reckoned as 5,000 roentgens per hour. Shelters which are dimensioned according to these Technical Directives provide sufficient protection against this slightly penetrating radiation so that the dosage inside the shelter resulting from secondary radiation is generally negligible.

1.4.2.5 Projectiles, debris, and dust. The shock of the atom bomb hurls whole sections of buildings and installations through the air. The shelter walls resist this effect, which can present one of the greatest dangers for the unprotected person near an atomic explosion.

The load caused by the debris from collapsing houses occurs only after the air pressure from the shock has diminished and is carried by the shelter.

An enormous quantity of dust is created from this debris. This dust must be kept out of the shelter by the airtight walls and the filter for the artificial ventilation.

1.4.2.6 Thermal effect. The heat and light radiation from atomic bombs – which is one of the greatest danger for the unprotected person – is not influential for the occupants of a shelter. Burning or glowing debris can, however, heat the roof and walls which are not against the earth to such an extent that it could be a determining factor for the design of a shelter.

1.4.3 Protection against Chemical and Biological Agents

The constant positive pressure which is maintained by the artificial ventilation in the interior of the shelter as well as the gas filter and air locks used for large shelters offer a relatively good protection against the penetration of biological or chemical agents into the shelter.

1.4.4 Protection against Conventional Weapons

Shelters which are designed according to these directives are approximately equivalent to types of shelters used in the past as regards the threat from conventional weapons. They are in general not safe against a direct hit by a demolition bomb. Protection is nevertheless offered against concussion and fragments from bombs and shells which fall within a distance corresponding to approximately the conical radius of the explosion, i.e., 5 yards for a bomb with 500 pounds of explosive. Firebombs will not generally be able to pierce the shelter. The shelter roof can also be heated for only a relatively short period by a fire bomb so that this heating is less critical than that caused by the smoldering debris mentioned in article 1.4.2.6.

1.4.5 Protection against Secondary Effects

1.4.5.1 Flooding

1. Limited flooding may be caused by broken conduits or the backing up of destroyed sewers. The proper positioning of the air inlet for the ventilation and attention to the seals around other apertures can protect the occupants against the penetration of this water.
2. Atomic explosions in a lake can cause a flood wave in the area near the shore or down the valley. Since this is of relatively short duration a catastrophic penetration of water into the shelter is not possible. What is important is the drainage of the escape passageways and the connecting cellar.
3. The destruction of a dam could create a flood wave of longer duration in the valley downstream unless this danger is avoided by the precaution of previously lowering the water level. The ventilation can be turned off for approximately 5 hours due to the required minimum volume of the shelter specified by article 2.1.1.3. This and the airtightness of the shelter will provide a certain amount of protection against this type of flooding.

1.4.5.2 Landslides

1. The pressure wave of an atomic explosion can cause landslides or rockfalls in mountainous terrain which may endanger the occupants by blocking the exits.
2. Near lakeshores which consist of shock sensitive soils such as chalk the shelter may be endangered by landslides triggered by the shock wave caused by an atomic explosion.

The Federal Office of Civil Defense is publishing special directives for those areas which are especially endangered by secondary effects. Until their release measures will be determined for each case.

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1. MZS 1.27.
2. MZS 1.64.
3. MZS 2.91.
4. MZS 4.

Chapter 2. Shelter Planning

2.1 DESIGN ELEMENTS FOR THE SHELTER SHELL

2.1.1 Shelter Size

2.1.1.1 Types of shelters

1. The single shelter consists of one cell with a capacity of up to 50 people (Fig. 2-1a).
2. The shelter group is divided into groups of cells each containing a maximum of 50 people and has a total maximum capacity of 200 persons. The cells are surrounded by only one exterior shell and have only *one* entrance (Fig. 2-1b).

Several shelter groups may be situated next to or on top of each other if decentralization is not possible. For

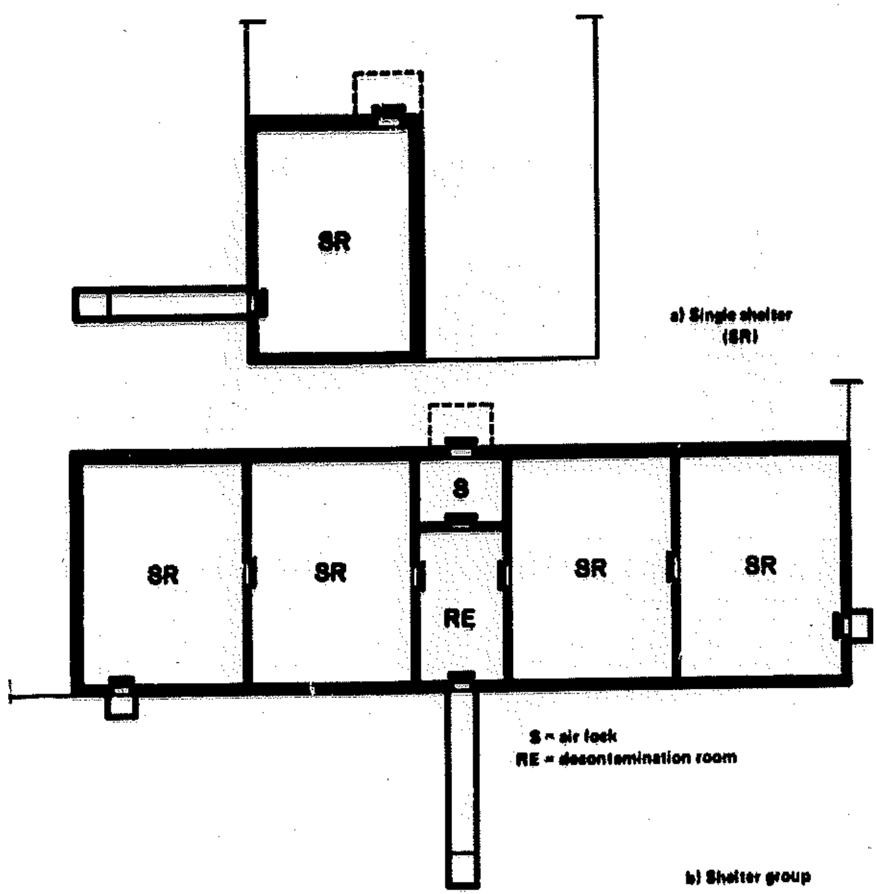


Fig. 2-1. Floor plans of the two shelter types.

large installations a more appropriate solution can often be found by considering the special local conditions as well as the uses rather than simply stringing together standard shelters.

2.1.1.2 The number of places in the shelter. The number of places in the shelter should be equal to the number of persons who normally occupy the building. The requirements for different types of buildings are indicated in Table 2-1. Deviations above or below this number may be authorized by the cantons in individual cases for special reasons. In this case the number of shelter spaces available in a fixed area should be taken into consideration.

Table 2-1. The required number of places in a shelter

Type of building	Number of places in the shelter[a]
Homes and vacation houses	1 per room
Hospitals and nursing homes	1 per bed
Hotels	⅔ per bed
Restaurants, places of amusement (movies, theatres, etc.), schools, auditoriums, and assembly halls	⅔ the number of seats
Churches	½ the number of seats
Offices, administration buildings; industrial and commercial business (factories and shops)	⅔ the number of working places
Stores, warehouses	1 per 20 m² (200 sq ft) floor space
Storehouses, permanent exhibitions	1 per 150 m² (1500 sq ft) floor space

[a]The figures listed in article 2.1.1.2 are offered here only for the sake of completeness. They cannot be the object of a technical directive since they are affected by the civil defense concept. It is expected that they will be modified at some later date.

2.1.1.3 Minimum space requirements. The following declarations for floor space and volume are provided as a guide:

1. Space requirements per shelter place:	
floor space	1 m² (10.8 sq ft)
volume	2.5 m³ (88 cu ft)
2. Additional space requirements:	
floor space for each ventilator	1 m² (10.8 sq ft)
floor space for air lock	0.05 m² (0.54 sq ft) per shelter place
floor space for decontamination room	0.07 m² (0.76 sq ft) per shelter place
floor space for combined air lock and decontamination room	0.1 m² (1.1 sq ft) per shelter place
3. Minimum size regardless of the number of shelter spaces:	
floor space for a shelter	6 m² (65 sq ft)
floor space for an air lock (max. 54 sq ft)	2.5 m² (27 sq ft)
floor space for decontamination room	3.5 m² (38 sq ft)
floor space for a combined air lock and decontamination room	5 m² (54 sq ft)
ceiling height	2.0 m (max. 3.0 m) [6′–6″ (max. 10 ft)]

2.1.2 Location of the Shelter

2.1.2.1 Structural requirements. The position of the shelter must satisfy both structural requirements from the shelter standpoint and the requirements for peacetime use. The following is a summary of the structural requirements:

1. The shelter should be as deep underground as possible. Reason: Protection from radiation and flying projectiles and debris.
2. The shelter should have as much of its external surface against the ground as possible. Reason: Protection against radiation, fragments, and projectiles; conduction of heat generated by the occupants of the shelter, protection from heat caused by external fires. Utilization of the support provided by the surrounding soil.
3. The shelter should be located under the massive parts of the building. Reason: Protection against radiation, conventional bombs, and fire.
4. The shelter should be located as far as possible from potential fuel concentrations such as oil or gasoline tanks, large groups of motor vehicles, depots for flammable materials such as wood or plastics. Reason: Reduction of heating effect, intake of clean and cool air by the ventilation.
5. The shelter should be placed so that short emergency exits and air inlets can be extended on several

sides of the building into zones that are free from debris and as free of danger from fire as possible. Reason: Better possibility of unaided exit and intake of fresh air.

2.1.2.2 Position in relation to ground water. Those shelters shall be termed in ground water where the highest yearly ground water level rises more than 18 inches above the elevation of the shelter floor. When this location for the shelter cannot be avoided the following points must be observed:

1. The parts of the structure lying in the ground water must be protected by a flexible waterproofing which has at least the same ductility as the reinforcing steel at a temperature of 8°C (46°F) (waterproof plaster is insufficient).
2. The parts of the structure under the ground water level are to be designed for a pressure 20% higher than that indicated for saturated ground in order to keep the crack small.
3. The emergency exit must lie above the ground water level.
4. The shelter floor must have a slope of at least 0.5%. A pump sump is to be constructed at least 25 cm (10 inches) deep and 40 cm (16 inches) square. A hand pump is to be installed with a capacity of 0.1 l per square meter (0.025 gallons per minute per sq ft) of external wall surface lying under the water level.
5. Where the ground water level is high the shelter can be partially or entirely constructed above ground. In this case the walls and roofs must be thicker in proportion to the heavier radiation (see section 3.3) and the entrance should have a closed cross section as shown in article 2.2.2.2.

2.1.3 Structural Dimensions for Preliminary Design

For the preliminary design of shelters or for the application for building permits the indicative values for concrete dimensions given in Table 2-2 and Fig. 2-2 can be adopted. This table is based on rough approximations. These values will give an overdimensioned design in many cases, especially in terms of nuclear radiation. Therefore the final determination of the structural dimensions must be done according to the detailed data given in chapter 3. The design for a "typical small shelter" in Appendix C may be used as an alternate solution to the detailed analysis of chapter 3 only for 1 atmosphere shelters of little importance (up to 25 places).

2.2 ENTRANCES AND EMERGENCY EXITS

2.2.1 Purpose

The requirements for protection during an attack phase could best be fullfilled if the shelter were to be completely enclosed by a shell of the necessary resistance. However, the need to penetrate this shell with entrances and exits as well as ventilation conduits during the peacetime phase and the before and after attack phases stands in direct contradiction to this. The consideration of these conflicting requirements makes

Table 2-2. Structural dimensions fo, preliminary design

Structural element	Location	Thickness, cm (inches)	
		1 atm.	3 atm.
Ceilings	Under buildings	35 (14)	55 (22)
	Not under buildings with soil cover of:	55 (22)	85 (33)
	0 cm		
	30 cm (12")	35 (14)	65 (26)
	more than 50 cm (20 inches)	30 (12)	50 (20)
	Between floors	20 (8)	20 (8)
	Between floors and over or under an air lock	25 (10)	30 (12)
Walls	Entirely in contact with soil (ceiling below ground level)	25 (10)	25 (10)
	Partially in contact with soil (ceiling 60 cm (2 ft) or less above ground)	50 (20)	70 (27)
	Exterior wall uncovered (ceiling more than 60 cm (2 ft) above ground)	80 (32)	120 (48)
	Shelter wall against cellar (or partition between shelter groups)	35 (14)	55 (22)
	Partitions between shelter rooms	20 (8)	20 (8)
	Inner walls of air lock	25 (10)	30 (12)
Floors	Foundation slabs	20 (8)	25 (10)

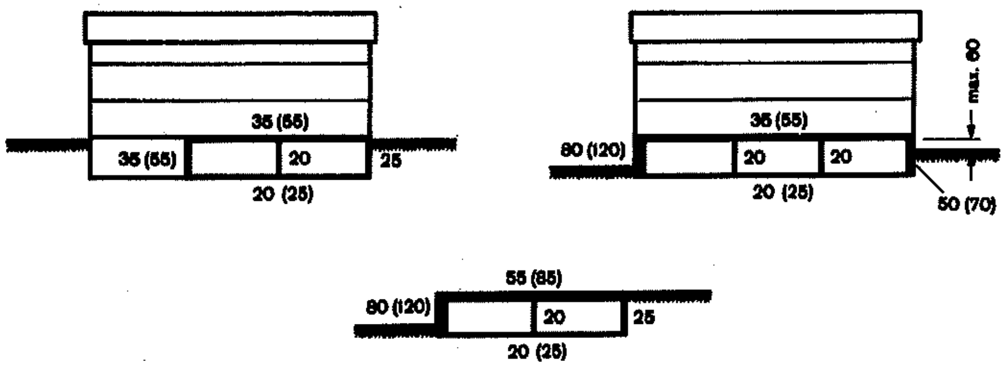


Fig. 2-2. Structural dimensions (in mm) for preliminary design according to Table 2-2. (The values in parentheses are for 3 atm. shelters.)

the design and location of the entrances and exits one of the most difficult jobs of shelter construction. The consideration of the requirements of the various operational phases should include the following facts:

The communication between the shelter and the outside world during the peace and pre-attack phase (and if possible during the post-attack phase) should take place through the entrance (article 2.2.2) passing the air lock and the decontamination room. The emergency exit should only be used if the main entrance is destroyed. The air lock and decontamination room (article 2.2.2.3) will be necessary in the pre-attack phase and in case of contaminated outside air. They will normally be placed in the entrance. The emergency exits (article 2.2.3) improve the possibility of the occupants being able to free themselves after an attack which creates debris. Since all openings represent a weakness in the shelter cover their size and number should be limited to the minimum necessary. Every passageway through the shelter cover should be provided with a closure in accordance with article 2.2.4.

2.2.2 Entrances

The entrance to the shelter consists of the entry way to the shelter, the debris protection for the door, the door itself, and for larger shelters, the air lock and the decontamination room (closures for entrances and exits, see article 2.2.4).

2.2.2.1 Entry way. The entry way must not only serve its purpose as an access but it must also act as an adequate radiation barrier, since even a closed door represents a weak spot in the protection against nuclear radiation offered by the shelter cover. The entry to the

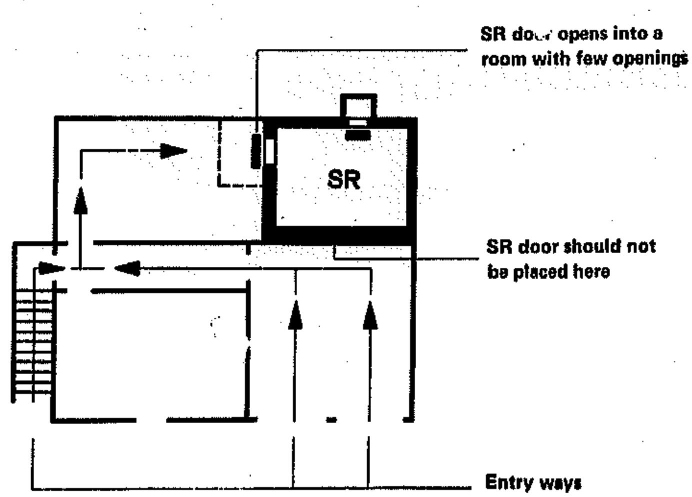


Fig. 2-3. Location of entry ways.

shelter must therefore be arranged in the following manner:

1. It should be as narrow as possible and deep under ground or under some massive parts of a building.
2. It should have the fewest possible openings directly outside or into rooms with many direct openings to the exterior.
3. It should avoid the danger of being buried by debris as much as possible. (There are more possibilities for escape through the piles of debris formed by coherent structural elements such as those made of steel or reinforced concrete than there are through the more tightly packed piles of masonry, plaster, or wood.)
4. When an entrance without an air lock leads through an exterior shelter wall more than 40 cm (16 inches) thick the protection against radiation must be improved by a passage way before the entrance. The wall and roof elements must be at least 20 cm (8 inches) thick and the length of the passage way must be at least four times the width. This passage way may be combined with the debris protection for the entrance door (Fig. 2-5).

Entry ways may be reinforced to become actual emergency exits by constructing them as escape ways (see article 2.2.3.3).

2.2.2.2 Protection of the door from falling debris. In order to improve the possibility of the occupants being able to free themselves the danger of a blockage of entrance to the shelter by piles of debris must be kept to a minimum. For this purpose either an entry way at least 2 meters (6 feet) long must be provided (Fig. 2-5) or a concussion-proof cantilevered slab projecting over the door, which are safe against an air blast. The minimum dimensions of this cantilevered slab are 1.3 X 2.0 m (4 X 6 feet).

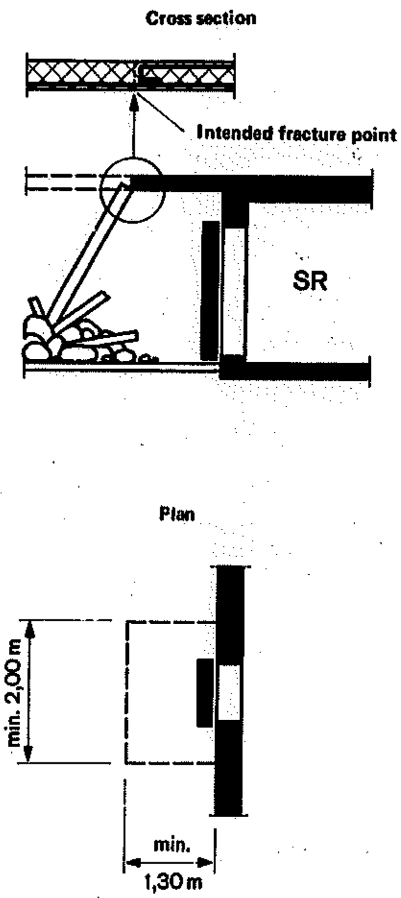


Fig. 2-4. Cantilever slab safe against air blasts as protection of the entrance door against falling debris.

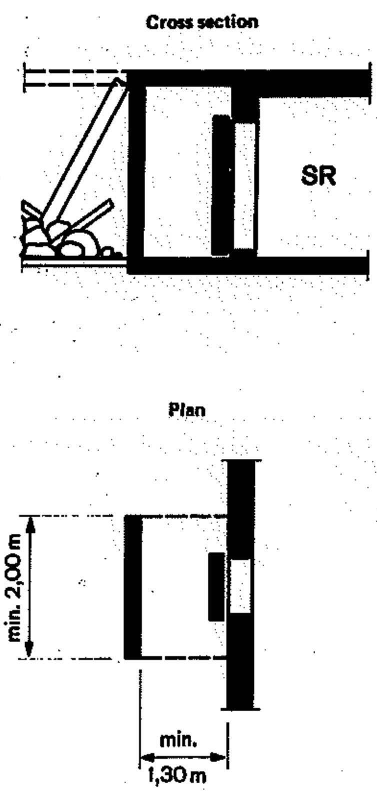


Fig. 2-5. Passage-way safe against air blasts as protection for the entrance against falling debris.

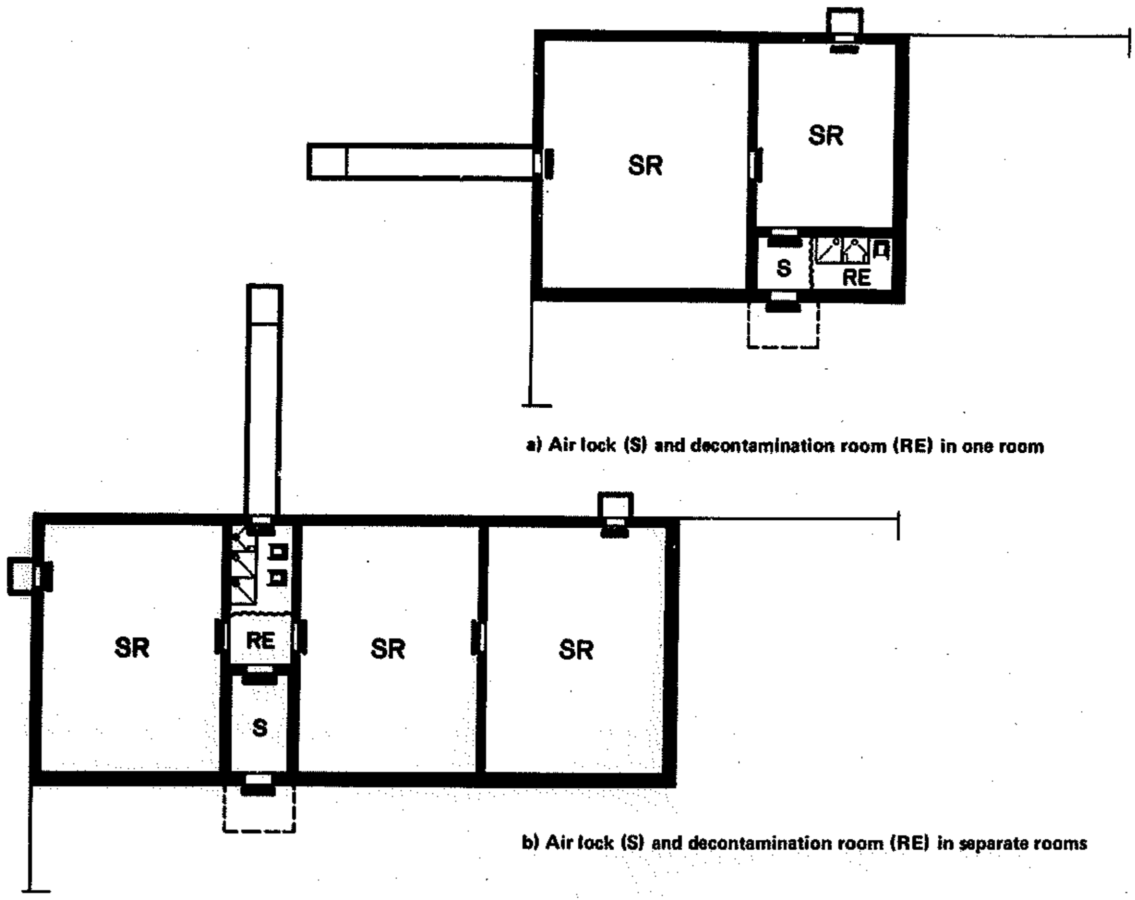


Fig. 2-6. Arrangement of air locks and decontamination rooms.

2.2.2.3 Air locks and decontamination rooms. The air lock is an anteroom with two pressure and gas tight doors (armour-plated) in series which are never to be opened at the same time. Thus even if there is traffic between the shelter and the outside there is never an instant during which the shelter cover is open to penetration by radiation, pressure, or dust.

For a given rate of exhaust air a small air lock is better purged than a large one. The air locks should therefore not be much larger than the suggested minimum dimensions given in article 2.1.1.3 unless there are special traffic problems.

The decontamination room serves as a cleaning and dressing room for persons entering contaminated by poison gas or radioactive dust. (Contaminated clothes should be stripped off and left outside the shelter.) The decontamination room is used also to store the protective clothing (coats, boots, helmets, gloves, gasmasks, etc.) which must be worn at all times by persons leaving the shelter. At least one shower per 100 persons and one toilet for each 30 persons should be built into the decontamination room. Half of the toilets may be built as dry sumps and the rest as latrines.

The air lock and the decontamination room may be combined into a single room for shelters with less than 100 places (see Fig. 2-6a). The requirements for the inclusion of these rooms is determined according to Table 2-3.

Table 2-3. Requirements for the inclusion of air locks and decontamination rooms

Number of places	Inclusion	Air lock and decontamination room
50 or less	Optional	Combined
51 to 100	Required	Combined or separate
101 to 200	Required	Separate

2.2.3 Emergency Exits

2.2.3.1 The requirements for escape without outside help. The occupants of any shelter should be able to free themselves from the shelter after an attack (the principle of escape without outside help). Since the unreinforced entrance may not be passable under some circumstances, other escape possibilities must be provided. The different types of emergency exits are divided into four categories in the order of their dependability:

Category I: Air blast-proof escape passage under the building and through to the outline (article 2.2.3.3).

Category II: Emergency escape-shaft (article 2.2.3.4).

Category III: Escape-tunnel or -chimneys ending within the area of falling debris (articles 2.2.3.5 and 2.2.3.6).

Category IV: Escape-tubes which end outside the debris area or are connected to escape-tube systems (Article 2.2.3.5).

The construction necessary in order to improve the possibilities for the occupants to free themselves depends on the number of places in the shelter and the degree of danger from falling debris. Economic considerations indicate that an expenditure of approximately 10% of the shelter cost is acceptable. The appropriate arrangements of emergency exits for various sizes of shelters are summarized in Table 2-4. These are minimum requirements.

2.2.3.2 Location of the emergency exits. The basic rules for exit arrangement are all derived from the requirements during the attack and survival phase and may be summarized as follows:

1. Emergency exits from the same shelter should end at different sides of the building (if possible opposite sides) and as far as possible from each other.
2. The escape-tunnels should terminate outside the area of falling debris from the building and neighboring buildings if possible (article 2.2.3.5).
3. Escape-tunnels or connections to escape-tunnel systems should be given preference over other emergency exits.
4. The adjacent cellars of row houses should have connecting doors.

Figures 2-7 to 2-10 show the arrangement of emergency exits according to the minimum requirement given in Table 2-4.

2.2.3.3 The design of air blast-proof escape passages. An air blast-proof escape passage from a shelter shall be provided either by a shaft accessible through a wall (Fig. 2-8a) or by passing through an armoured door (Fig. 2-9b) which leads through a cellar out into the open. The shortest possible route should be chosen with the narrowest ceiling span. Examples are given in Fig. 2-11.

Table 2-4. Minimum provisions for escape without outside help

Number of shelter places	Minimum number of emergency exits for category			Figure
	I (escape-way)	II (escape-shaft)	IV (escape-tube)	
13 or less		1		2-7
14 to 50	1	1		2-8a
			1	2-8b
51 to 100		1	1	2-9a
	1	2		2-9b
101 to 200	1	1	1	2-10a
		2	1	2-10b

Note: Emergency exits of category III (escape-shafts and escape-tubes ending in the area of falling debris) may only be used as a partial replacement of category IV exits and only in the case that it is not possible to end the escape-tunnel outside the debris area. In this case a supplementary exit of category I or II is to be added.

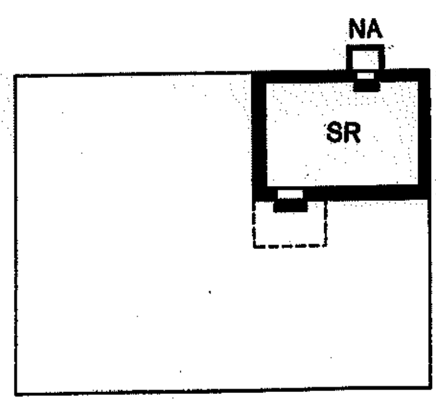
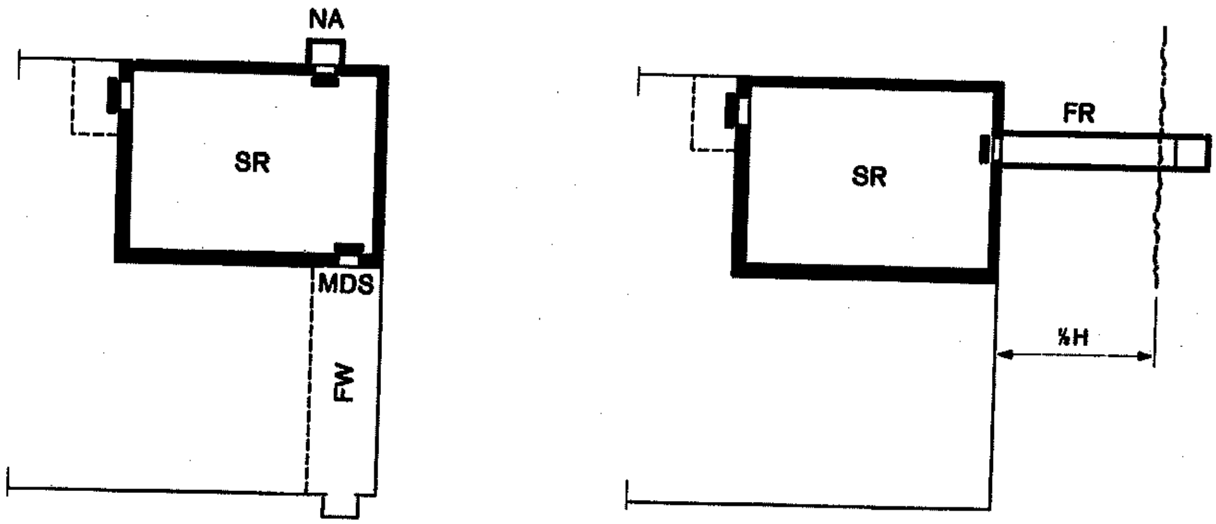


Fig. 2-7. The minimum provisions for the occupants of a shelter of up to 13 places for escape without outside help.



a) 1 Emergency shaft (NA) and
1 escape passage (FW)

b) 1 Escape-tunnel (FR)

Fig. 2-8. The minimum provisions for the occupants of a shelter of 14 to 50 places for escape without outside help.

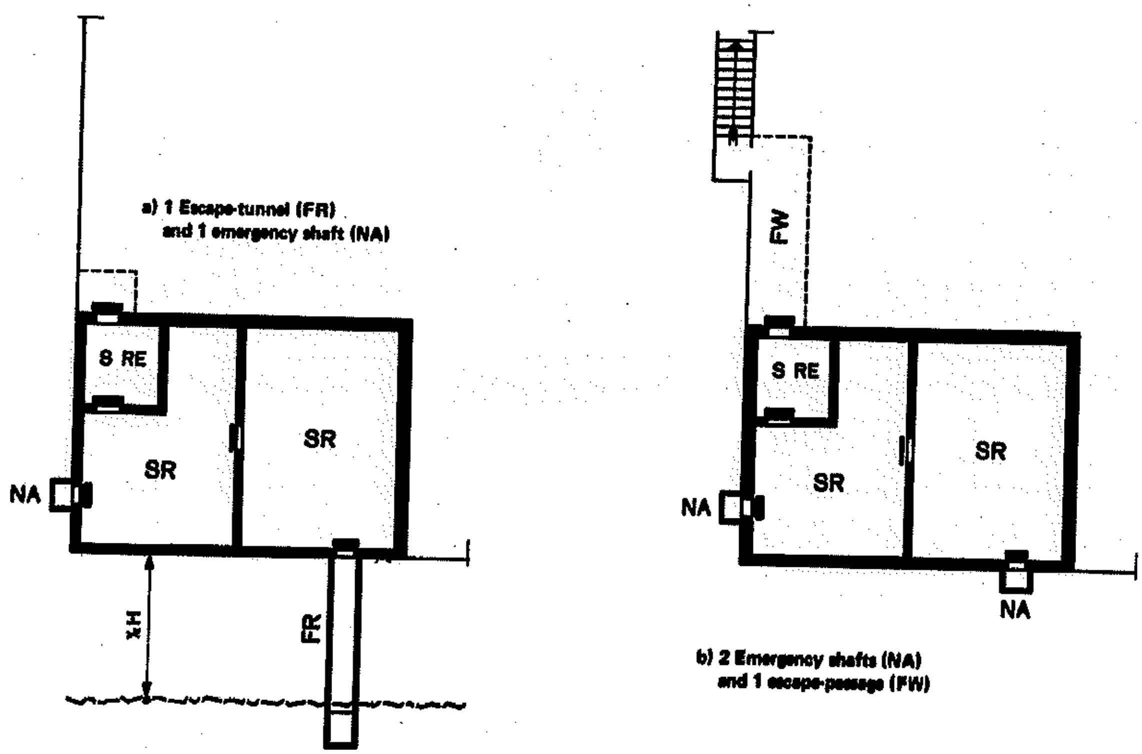
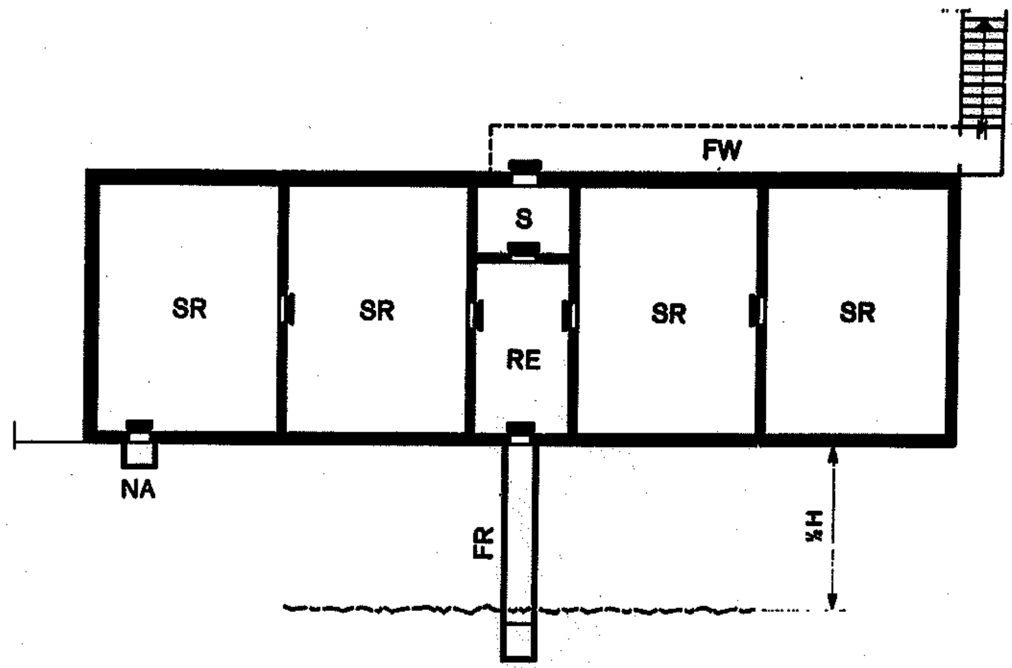
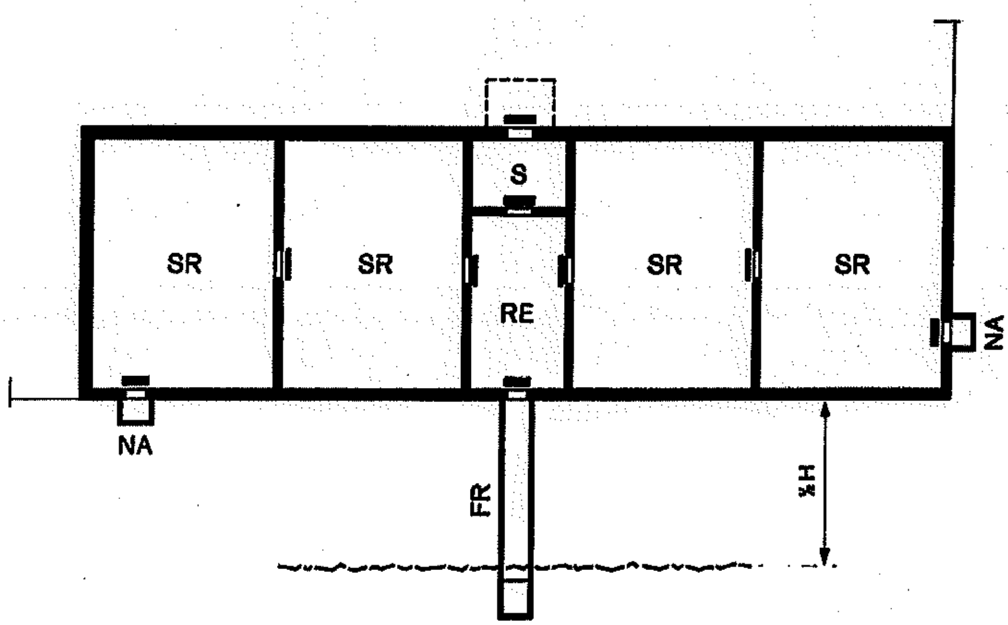


Fig. 2-9. Minimum provisions for the occupants of a shelter of 51 to 100 places for escape without outside help.



a) 1 escape-tunnel (FR), 1 emergency shaft (NA) and 1 escape-passage (FW)



b) 1 escape-tunnel (FR) and 2 emergency shafts (NA)

Fig. 2-10. Minimum provisions for the occupants of a shelter of 101 to 200 places for escape without outside help.

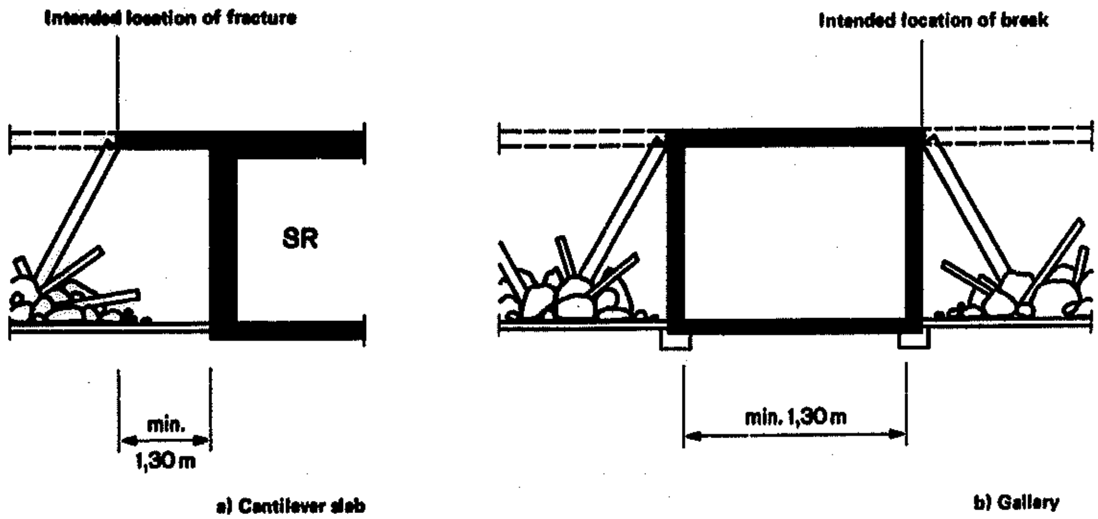


Fig. 2-11. Examples of concussion-proof escape-passages.

?.2.3.4 **Design of emergency escape-shafts.** Emergency escape-shafts lead through the shelter shell directly to the outside. Their cross section must be 60 X 80 cm (2 ft by 2 ft 8 inches). Escape-shafts may be made with or without light shafts. When constructing an escape-shaft *without light shaft* (Fig. 2-12) the following rules should be observed:

1. The position of the exit shaft is to be marked on the outside wall with the following notice "Emergency shelter escape-shaft" (rescue from the outside).
2. An area of 80 X 100 cm (2 ft 6 in. by 3 ft) above the shaft must not be covered with a concrete slab.
3. The height of the shaft may not be more than 2 meters (6 ft).
4. The shaft opening is to be partially concreted as shown in Fig. 2-12. Foamed plastic must be placed at the exterior for this purpose. The concrete is not to be reinforced. The location of the break-out section is to be marked on the inside.
5. The necessary tools to hole through the wall and dig out the shaft are to be made available inside the shelter.

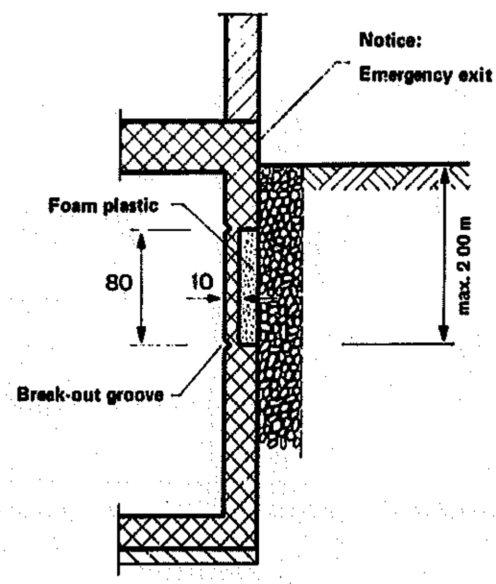


Fig. 2-12. Arrangement of escape-shaft without light opening

When constructing an escape-shaft *with light shaft* as illustrated in Figs. 2-13 and 2-14 the following rules apply:

1. The light shaft is to have a cross section of 60 X 80 cm (2 ft by 2 ft 9 in.) as shown in Fig. 2-14.
2. Rungs are to be placed at 30 cm (one foot) intervals for all shafts over 1.5 m (5 feet) high. If the shaft rises more than 4.5 m (15 ft) intermediate landings are to be built and the cross section must be increased to 80 X 130 cm (2 ft 8 in. by 4 ft).

3. The shaft must be closed at the top with a cover or a grating that is to be removed when the shelter is occupied.
4. The shaft walls are to be made of reinforced concrete but they do not necessarily have to be an integral part of the cellar wall.
5. The opening into the escape-shaft must be deep enough so that the angle of incidence measured from the horizontal to the upper edge of the escape shaft is at least 30 degrees (Fig. 2-13a). If this is not possible empty burlap sacks or plastic bags should be stored in the shelter so that before occupying the

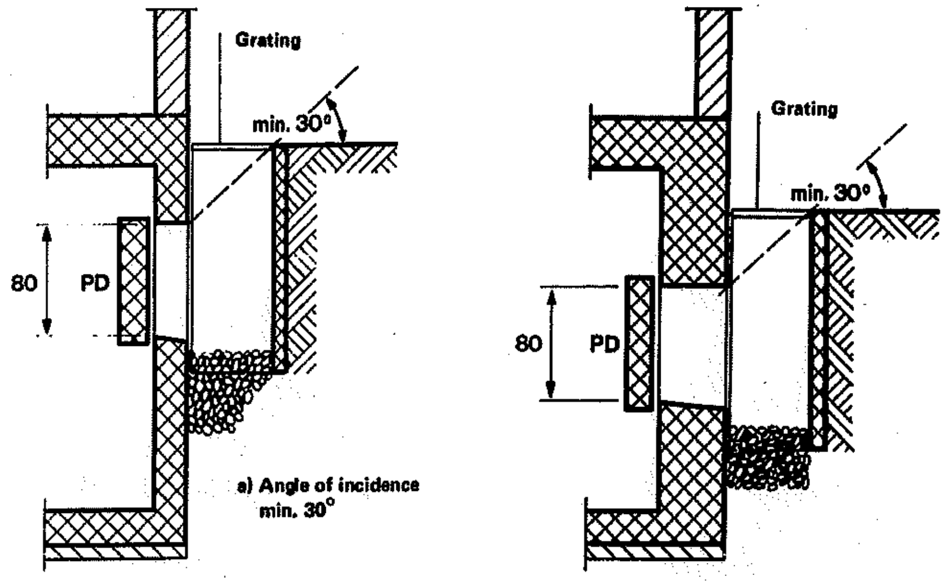


Fig. 2-13. Arrangement of emergency escape-shaft with light opening.

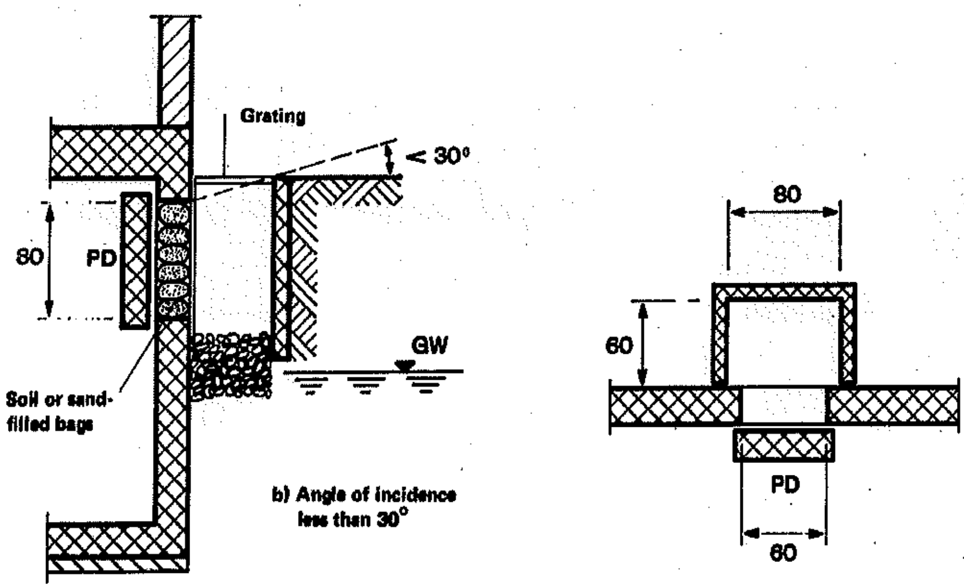


Fig. 2-14. Plan of the light shaft.

shelter they may be filled with earth or sand and placed against the escape shaft opening as radiation protection (Fig. 2-13b).

2.2.3.5 Design of escape-tunnels. Escape-tunnels are the most effective means for escape without outside help. They should end outside the area of falling debris if possible. The area of falling debris is assumed to be a distance out from the outline equal to one half the building height measured under the eaves (see Figs. 2-8b and 2-15).

When designing an escape-tunnel as shown in Fig. 2-15 the following points are to be considered:

1. An armoured cover is to be fastened in place at the shelter end of the tunnel on the inside.
2. Escape-tunnels with exit shafts at the end must have a pressure resistant cover with air holes for air intake in accordance with article 2.3. The occupants must be able to open the cover from the inside. If the exit shaft of the escape-tunnel does not have a pressure

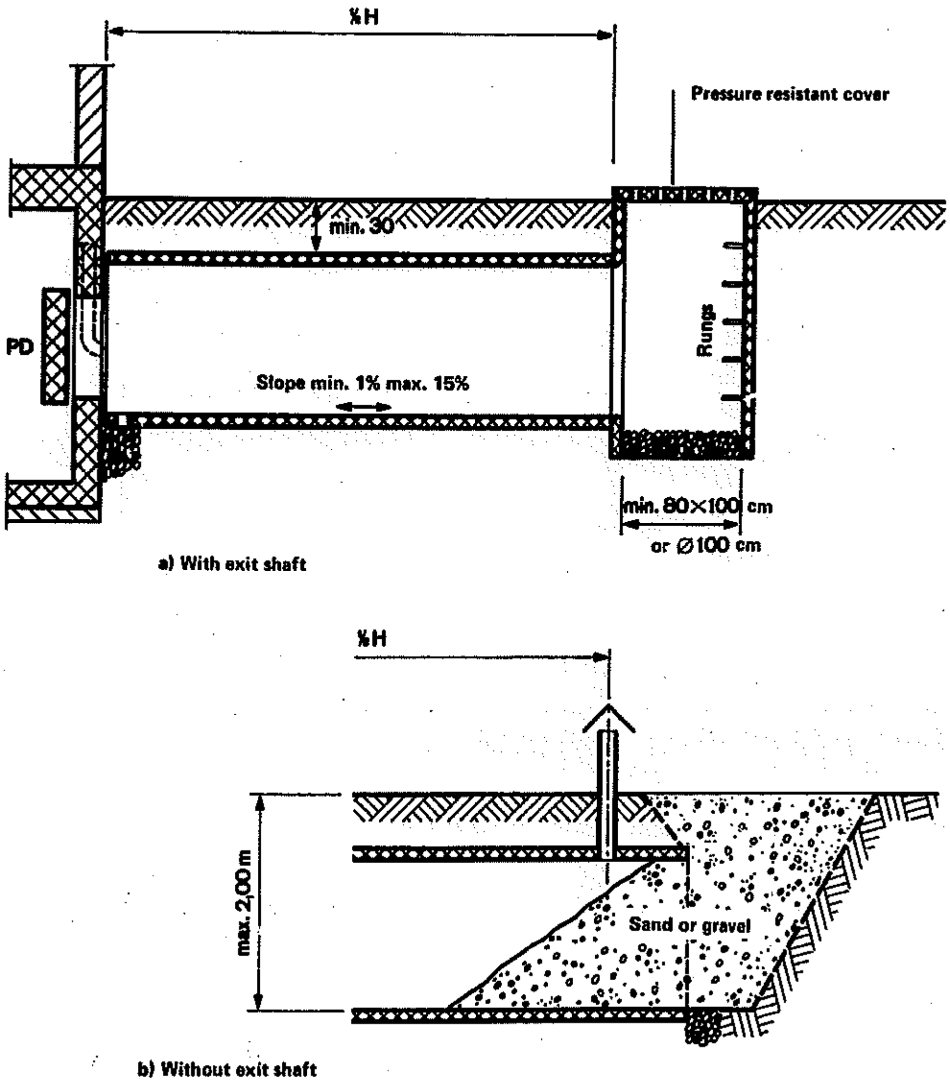


Fig. 2-15. Section showing construction of an escape-tunnel.

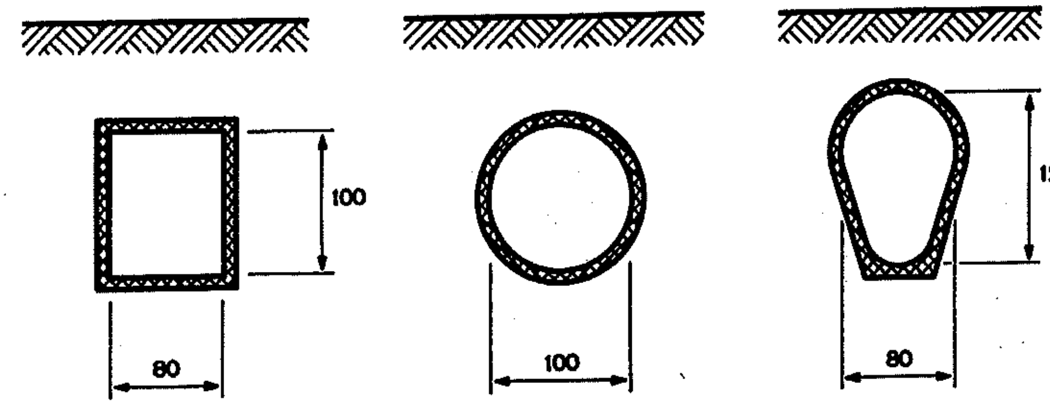


Fig. 2-16. Minimum cross sections for escape-tunnels.

resistant cover the tunnel must be designed according to article 3.4.2.6 as a gallery ending in the open.

3. The exit shaft should have the minimum dimensions of 80 X 100 cm (2 ft 8 in. by 3 ft) or 1 m (3 ft) diameter at the bottom. It may narrow down to 60 X 60 cm (2 by 2 ft) or 60 cm (2 ft) in diameter near the cover. Embedded rungs or a fixed metal ladder must be provided. A shaft over 4.5 m (15 ft) deep must have an intermediate landing and a cross section of at least 80 X 130 cm (2 ft 8 in. by 5 ft).
4. A tunnel end of the type shown in Fig. 2-15b may be constructed as an alternative to the tunnel end with an exit shaft provided that the tunnel is not more than 2 m (6 ft) deep and that the area around the exit is not covered with a concrete slab or a thick pavement.
5. Escape-tunnels must have the minimum dimensions given in Fig. 2-16. In any case the cross sectional area of the tunnel must be at least 0.75 m^2 (8 sq ft).
6. Escape-tunnels with pressure resistant covers or ends as shown in Fig. 2-15b may be realized in the following ways, for instance:

Concrete or asbestos cement pipe	min. diam. 100 cm (39 in.)
Oval pipe	min. 80/120 cm (30/48 in.)
Rectangular concrete pipe	min. 80/100 cm (30/36 in.)

7. The escape-tunnel must be drained and have a slope of 1% minimum and 15% maximum.
8. In densely built up areas a system of escape-tunnels may be formed by interconnecting several shelters and providing different exit shafts outside the area of falling debris (Fig. 2-17). A connection to a system like this is equivalent to an exit outside the debris area as indicated in Table 2-4.

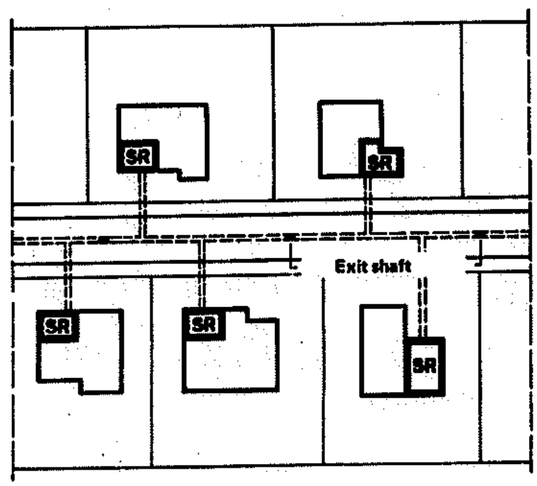


Fig. 2-17. Connection to an escape-tunnel system.

2.2.3.6 Design of escape-chimney. Escape-chimneys are air blast-proof vertical emergency exits which lead up through the expected pile of debris. They will be subjected to very large horizontal forces caused by the collapse of the building under the action of an air blast and may only be proposed in cases where it is impossible to build an escape-tunnel outside the debris area. The following points are to be considered when designing an escape-shaft:

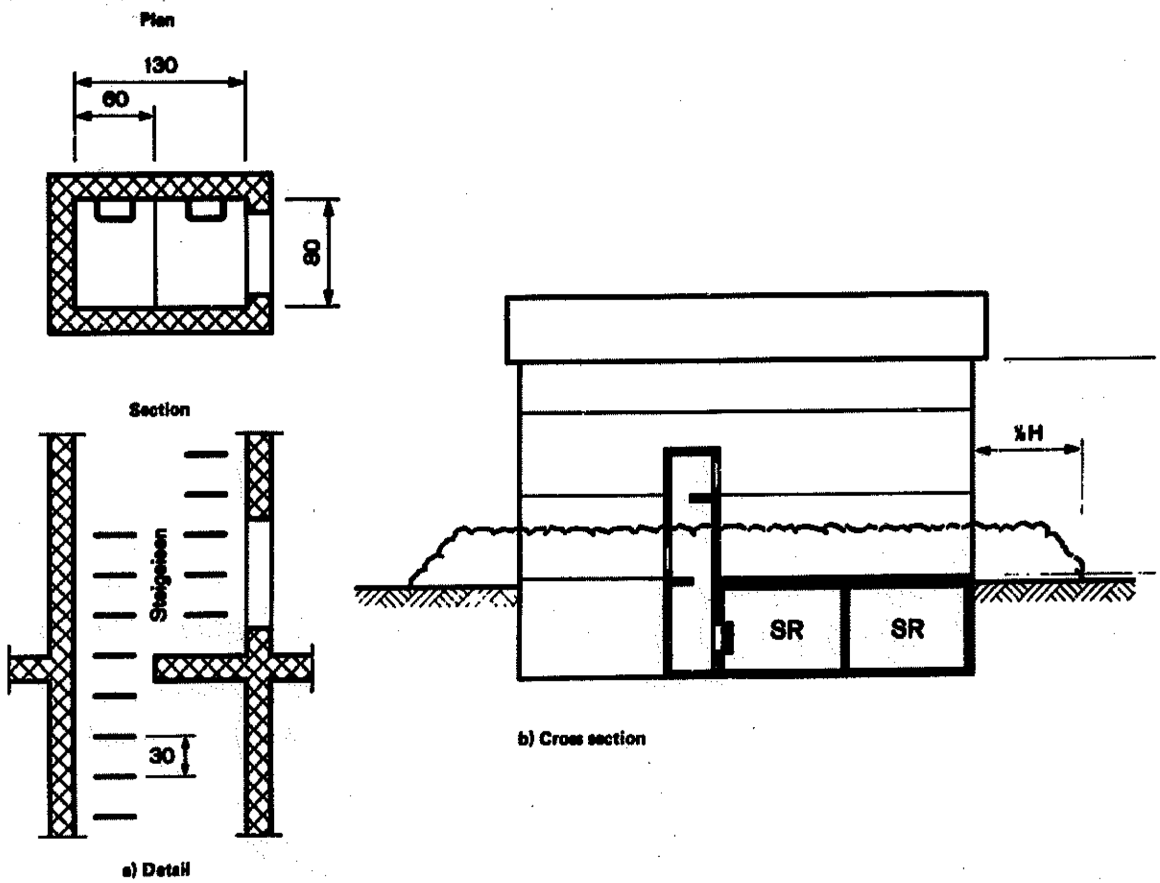


Fig. 2-18. Construction of escape-chimneys.

1. The escape-shaft must lead up at least ¼ of the height of the building as measured under the eaves to above ground level. In addition the end of the shaft must reach at least 1 m (three ft) above the level of the ground floor, but not more than 1 m (3 ft) under the ceiling height of the fourth floor.

2. The shaft should be stiffened as much as possible by existing structural walls and be connected as little as possible to floor slabs.

3. The minimum cross section is 80 X 130 cm (2 ft 8 in. by 4 ft) (Fig. 2-18a).

4. An opening is to be provided at every floor on alternate sides of 60 X 80 cm (2 ft by 2 ft 8 in.). The pressure resistant closure of the shelter is assured by an armoured door (Fig. 2-18b).

5. The shaft is to be equipped with rungs or a fixed steel ladder. Landings are to be placed on alternate sides at every floor as shown in Fig. 2-18b or at least every 4.5 m (15 ft).

2.2.4 Shelter Doors and Covers

2.2.4.1 Door types. Only doors and covers approved by the Federal Office of Civil Defense may be used and they must carry an approval number. These types offer sufficient protection against air blasts and their reflection, radioactive radiation, bomb fragments, dust, gas, and fire in accordance with printed specifications, so that they can be used as indicated in these technical directives in one or three atmosphere shelters. Their interior dimensions are standardized for simplification according to Table 2-5. The door-size 3 is to be considered as an exception and is only to be used where absolutely necessary for peacetime use, such as a passage for lift trucks. This type of door is always to be used with a removable sill.

2.2.4.2 Fastenings for shelter doors and covers. The doors and covers for the shelter are to be fastened in accordance with Table 2-6. From the standpoint of the occupants being able to free themselves the fastenings should be on the inside even for the armourplated PT doors. However, since no internal fastening exists which is sufficiently strong all the fastenings are to be on the outside. The arrangement and opening of the doors is illustrated in Fig. 2-19.

2.2.4.3 The location and installation of doors. The following points are to be considered in the design:

1. It must be possible to open all doors completely, leaving the interior dimensions free.
2. All steelplated doors must have 4 cm (1½ inch) free space both above the floor and under the ceiling.

The following points are to be observed when installing the doors:

1. The doors or covers and their frames and anchors are to be placed in the forms in such a way that they may be concreted with the wall to insure that they are securely held in place. They are to be concreted in place with the door closed and with wedges under it.

Table 2-5. Standardized interior dimensions of shelter doors and covers

Type of closure	Size	Interior dimension	
		cm	inches
Armourplated door PT	1	80 × 185	31½ × 73
	2	100 × 185	39¼ × 73
	3	140 × 220	55 × 86½[a]
	4	60 × 120	23½ × 47
Armourplated cover PD		60 × 80	23½ × 31½
Pressure door DT	1	80 × 185	31½ × 73
	2	100 × 185	39½ × 73
	3	140 × 220	55 × 86½[a]

[a]With removable sill.

Table 2-6. Fastenings for shelter doors

Opening	Door type	Direction of swing
Doors in the shelter shell and air lock	PT	Outward
Emergency exits through the shelter shell leading to escape-tunnels, shafts, or galleries (cellar)	PD	Inward
Interior partition	DT	Either

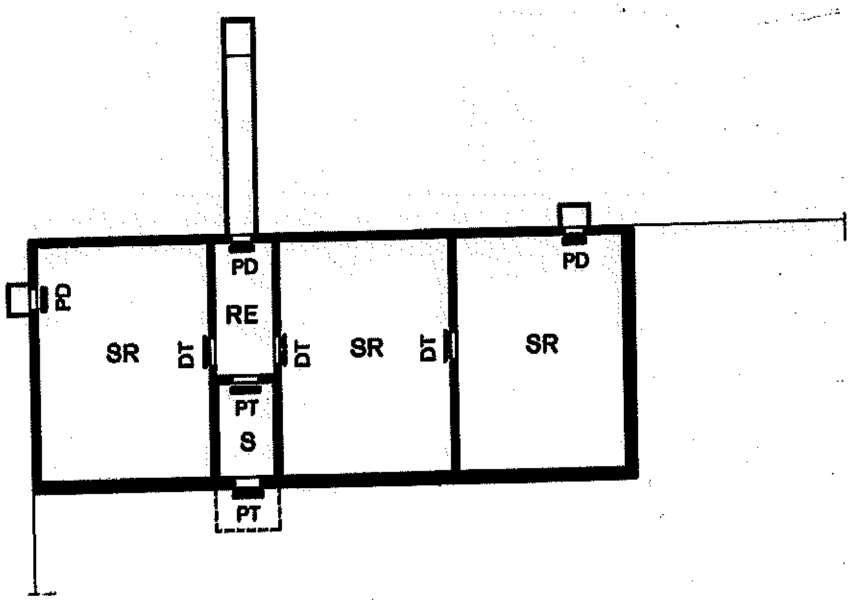


Fig. 2-19. Arrangement of closure elements.

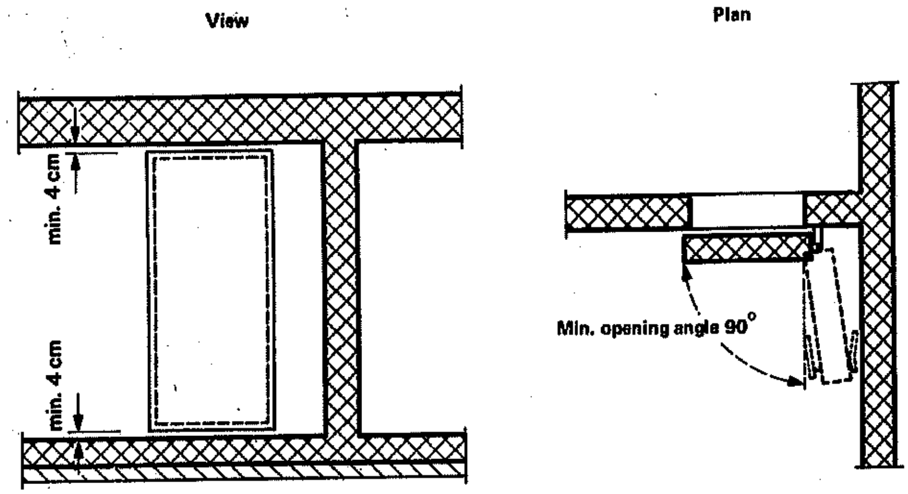


Fig. 2-20. Installation of shelter doors.

2. Steps are also to be taken to prevent any sagging or movement of the door after the forms are stripped (wedges under the door, for instance).
3. During peacetime, the removable door sills must be fixed in a stored position near the door with the hardware for their attachment.
4. All closures must be installed so that they fit tightly enough to maintain an inside pressure of 15 mm (5/8 inch) of water with the ventilation system operating normally bypassing the filters (to be tested at the time of acceptance).

2.3 VENTILATION

2.3.1 Purpose and Requirements

All shelters must be equipped with a ventilating system so that in the interior, even during long periods of occupancy, a physiologically tolerable environment may be maintained. The ventilation apparatus should be able to provide the atmosphere necessary for life, especially oxygen, and exhaust the noxious substances such as carbon dioxide and moisture as well as heat. This exchange must be accomplished in such a way that no damaging effect from weapons can penetrate through the ventilation openings into the shelter. The ventilation apparatus which are authorized and standardized for use in private shelters are designed on the basis of the assumed criteria summarized in Table 2-7.

2.3.2 The Four Types of Ventilation

The four phases of the shelter operation (article 1.3) pose different requirements on the ventilating system which leads to the following types of ventilation:

Natural ventilation (NL)	Primarily for peacetime phase
Fresh air circulation (FRL)	Primarily for pre-attack phase
Filter operation (FIL)	Primarily for post-attack or gas attack phase
Interruption of ventilation	Primarily during attack phase

2.3.2.1 Natural ventilation (NL). During peacetime it must be possible to ventilate the shelter naturally. The ventilation requirements depend on the use to which the shelter is put during this period. In general, sufficient circulation will be created in the shelter by leaving the door and the emergency escape hatch open. If it is necessary to provide better ventilation the additional ducts must be closed with pressure and gas tight covers when the shelter is to be occupied as such. In addition they must be stuffed or covered with sand bags or other material to insure that the protection against radiation is maintained.

2.3.2.2 Fresh air operation (FRL). During the occupancy of the shelter in the pre-attack phase – that is, when the outside air is uncontaminated – the shelter shall be artificially ventilated with fresh air.

The basic minimum capacity for the standard shelter ventilator is based on 6 m^3/hr (3.5 cu ft/min) per person in the shelter. This quantity of air is sufficient to

Table 2-7. Basic criteria for the design of authorized ventilation systems

	Requirements for the shelter atmosphere for long periods	Acceptable for short periods	Desired conditions	A shelter occupant needs or produces:
Oxygen (O_2)	min. 18% vol.	min. 16% vol.	21% vol.	0.018 m^3/hr (0.63 cu ft/hr)
Carbon dioxide (CO_2)	max. 1% vol.	max. 2.5% vol.	0.03% vol.	0.015 m^3/hr (0.53 cu ft/hr)
Room temperature and relative humidity	25°C (77°F) 100% 26.5°C (80°F) 80% 28°C (83°F) 60% 30°C (86°F) 40%	29°C (84°F) 100% 31°C (88°F) 80% 33°C (91°F) 60% 36°C (97°F) 40%	~50 g ~100 g	100 kcal/hr at 20°C (25 BTU/hr at 68°F) (0.1 lb) water hr at 86° (0.2 lb) water hr

Table 2-8. Classification of ventilators

Number of places in shelter[a]	Ventilator classification number	Minimum capacity: Fresh air operation, m^3/hr (cu ft/min)	Minimum capacity: Filter operation, m^3/hr (cu ft/min)	Type of power	Power requirement (watts)
7	VA 20[b]	40 (24)	20 (12)	Hand	40
13	VA 40	80 (47)	40 (24)	Hand and electric	50
25	VA 75	150 (88)	75 (44)	Hand and electric	60
50	VA 150	300 (176)	150 (88)	Hand and electric	120

[a]In exceptional cases the number may be increased 10%.
[b]Only for single family homes.

keep the carbon dioxide level below 1% and to provide enough oxygen for the occupants of the shelter. But only a small portion of the heat which is produced can be carried away by the ventilation, however. A large part of the heat must be dissipated through the shelter walls into the ground. During warm, humid weather when the shelter is fully occupied and if the surrounding earth is a poor heat conductor a strong heating of the shelter is to be expected.

2.3.2.3 Filter operation (FIL). When the outside air is polluted – that is, during and after the attack – the air must be passed through a filter in order to remove the dangerous substances such as gases from chemical warfare or radioactive dust. In order to keep the required quantity of activated charcoal and the cost of the filter to a minimum the ventilation rate is reduced to 3 m^3/hr (1.80 cu ft/min) for each shelter occupant. Even this quantity of air maintains physiologically tolerable conditions. Of course, with this type of operation the increase in temperature and humidity will be even more pronounced than with fresh air operation.

2.3.2.4 Interruption of the ventilation. The ventilating system cannot provide protection from gases produced by fires such as carbon monoxide (CO) or carbon dioxide (CO_2). In case of smoldering fires near the air intake or in case of flooding it must be possible to interrupt the shelter ventilation temporarily. The time required to reach the tolerable limit of 2.5% by volume of carbon dioxide in an unventilated shelter having a volume of 2.5 m^3 (88 cu ft) per occupant will be about 3 hours. The dangerous carbon dioxide content of 4% by volume (candlelight goes out) will be reached in about 5 hours.

2.3.3 The Ventilating System

The ventilators are standardized and divided into four sizes as indicated in Table 2-8. The ventilator must be able to create an excess pressure in the shelter of 5 mm ($3/16$ of an inch) of water pressure so that gas, dust, and smoke cannot penetrate into the shelter through leaks in the shelter shell (cracks around doors or windows, etc.).

The arrangement and components of the ventilation system are illustrated in Fig. 2-21.

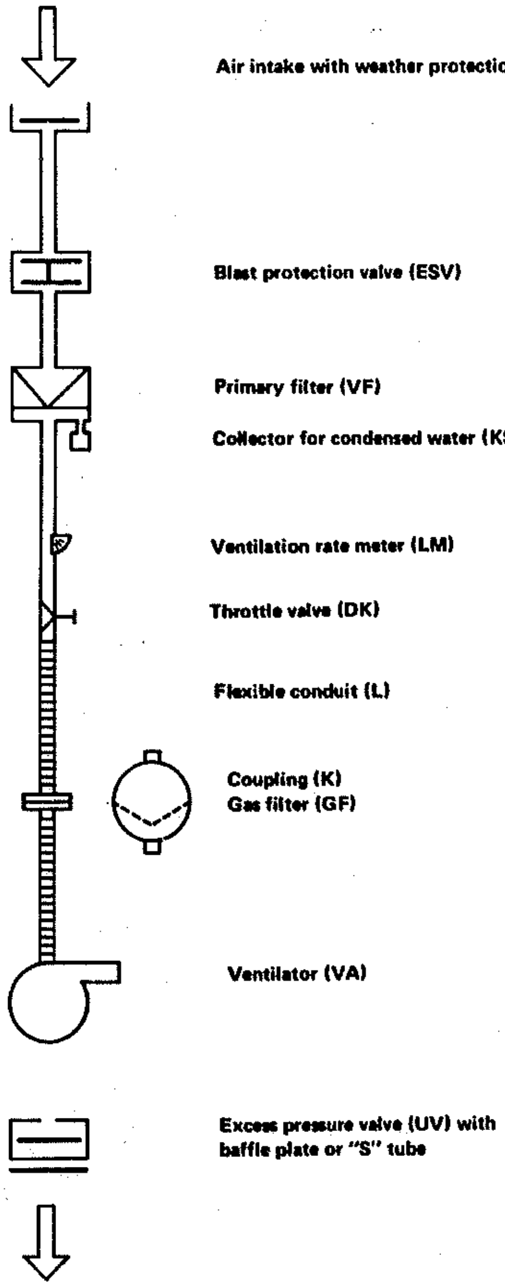


Fig. 2-21. Ventilation system components and arrangement.

2.3.4 Arrangement of the Ventilating Equipment

The ventilating equipment is to be planned at an early stage of the project. The following points are to be considered:

1. All the parts of the ventilating equipment are to be installed in such a way as to be easily accessible.
2. Every shelter is to be ventilated separately.
3. In shelters without air locks or decontamination rooms the exhaust air is to be blown out through the entrance if possible.
4. In order to obtain the best cross ventilation the inlet and the outlet of the ventilating system for the shelter should be located diagonally opposite from each other. If the ventilating conduits are branched they should be provided with regulators so that a thorough circulation of the ventilating air is assured.
5. The air intakes are to be located in such a way that they neither draw air from their own exhaust air outlet or from that of other installations (tank ventilators, exhaust pipes, etc.).
6. Decontamination rooms, toilets, and air locks are to be ventilated with the exhaust air from the shelter. The air lock for a shelter group is to be purged with the exhaust air from not more than two shelters.
7. The ventilators must be located outside of the rented portion of the cellar.

Examples of the arrangement of ventilating equipment are shown in Figs. 2-22 to 2-25.

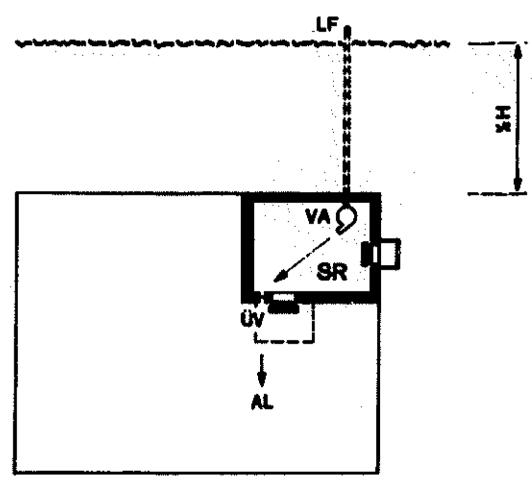


Fig. 2-22. The arrangement of ventilating equipment in a single shelter (up to 50 occupants).

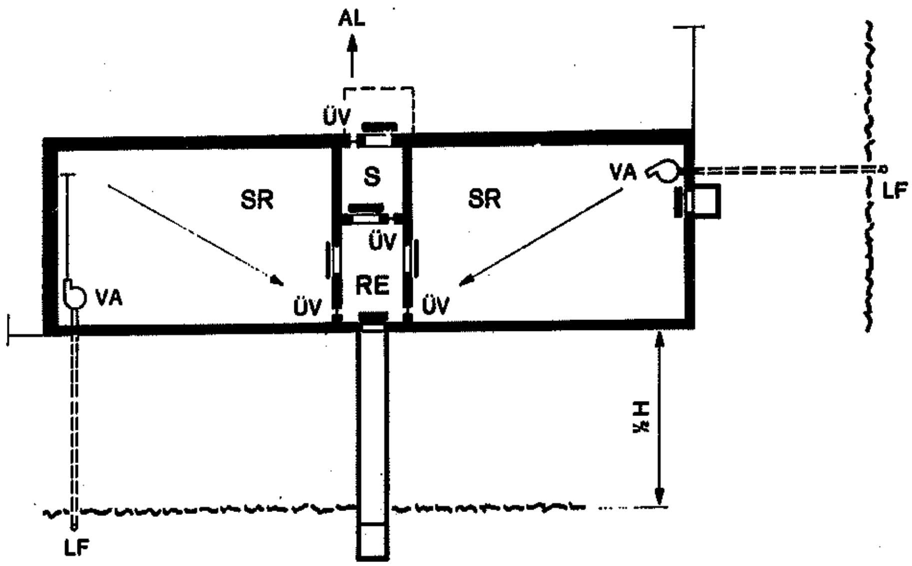


Fig. 2-23. The arrangement of the ventilating equipment in a double celled shelter group (51 to 100 places).

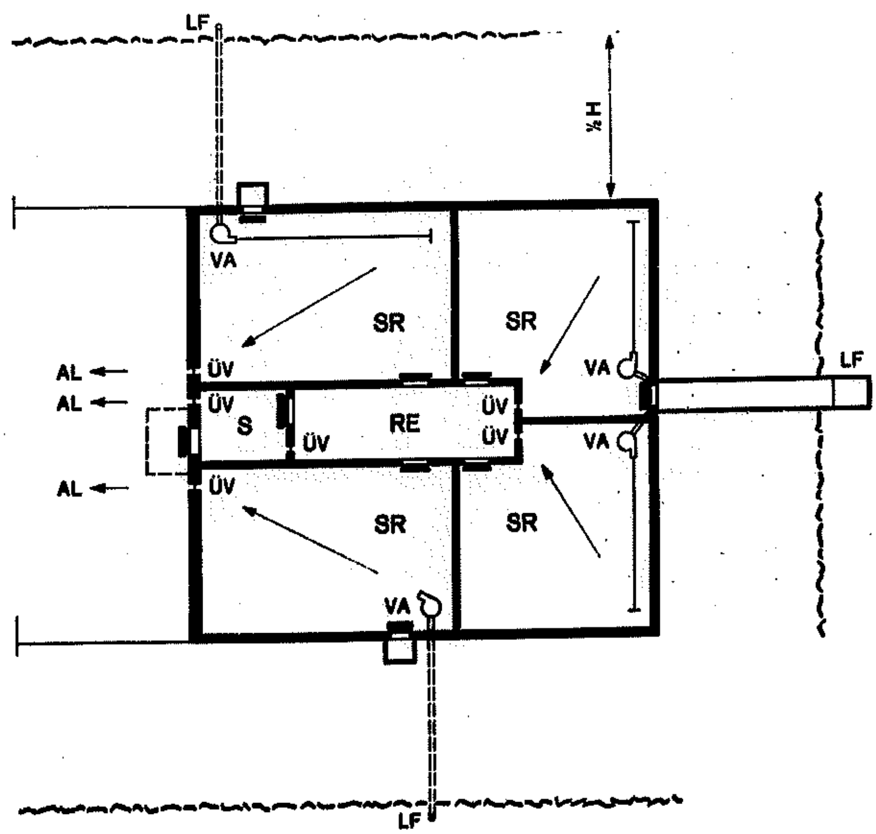


Fig. 2-24. The arrangement of the ventilating equipment in a four-celled shelter group (151 to 200 places).

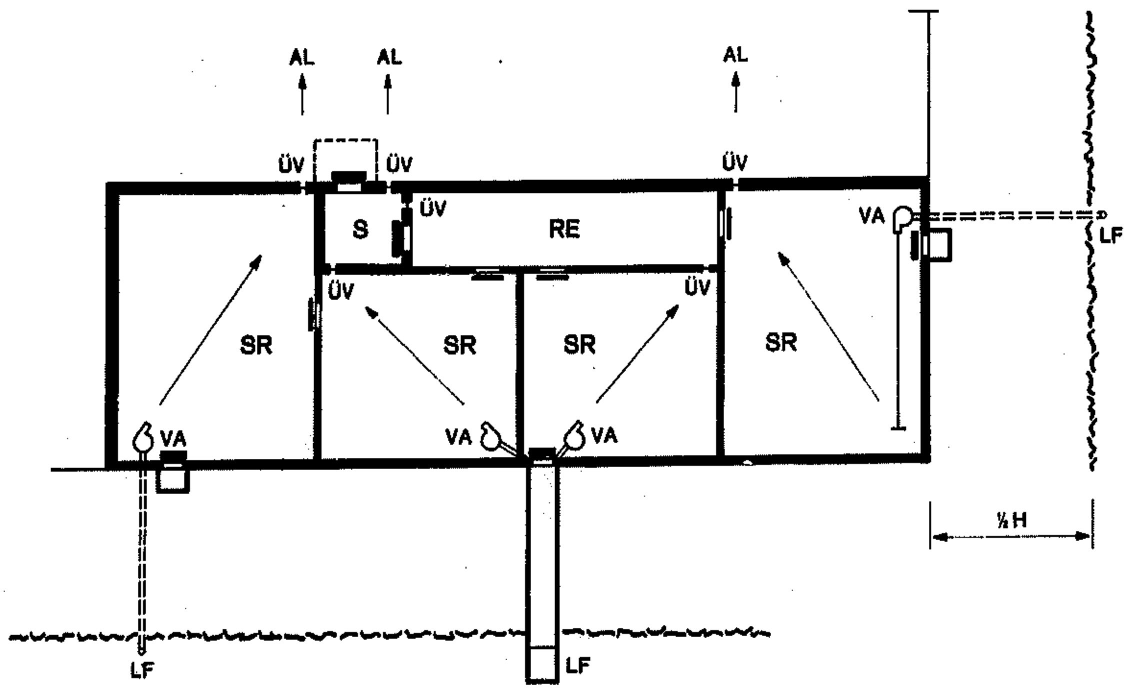


Fig. 2-25. The arrangement of the ventilating equipment in a four-celled shelter group (151 to 200 places).

2.3.5 Components of the Ventilating Equipment

2.3.5.1 Air intake (LF). The following requlations apply to the location and design of the air intake:

1. A separate air intake must be provided for every ventilating system. If this is not possible for structural reasons or the air is drawn from an escape-tunnel then a common ventilating system can be provided for shelter groups of up to 100 places.
2. The air intake is to be located outside the area of falling debris; the air is to be drawn through escape-tubes, for instance (see Fig. 2-26) or through buried, rigid tubes (concrete or asbestos cement pipes) (see Fig. 2-27).
3. If the air intake cannot be placed outside the debris area it may be located as shown in Figs. 2-28a and 2-28b in exceptional cases with the permission of the Cantonal Civil Defense Authority.
4. The connection of the air conduit to the shelter must be done in accordance with section 2.4.
5. The inside diameter of the air intake up to the first filter must be at least:

   100 mm (4 in.) for VA-20 or VA-40 ventilators
   125 mm (5 in.) for VA-75 or VA-150 ventilators
   150 mm (6 in.) for two VA-150 ventilators

   The pressure drop in the conduit and the bends of the air intake up to the first filter and/or explosion-proof valve shall not exceed 10 mm (3/8 inch) of water pressure.
6. The air intakes are to be provided with a removable grill and weather protection on the outside.

2.3.5.2 Blast protection valve (ESV) and primary filter (VF). The purpose of the blast protection valve is to guard the shelter occupants and the ventilating equipment from shock waves and a damaging pressure increase. It must be protected from flying debris and fragments. The primary filter removes the coarse dust (radioactive fallout, airborne dust, and dust from debris) in order to relieve the gas filter. Depending on the construction (i.e., fibre filter, sand, or gravel filter) it is to be placed before or after the blast protection valve.

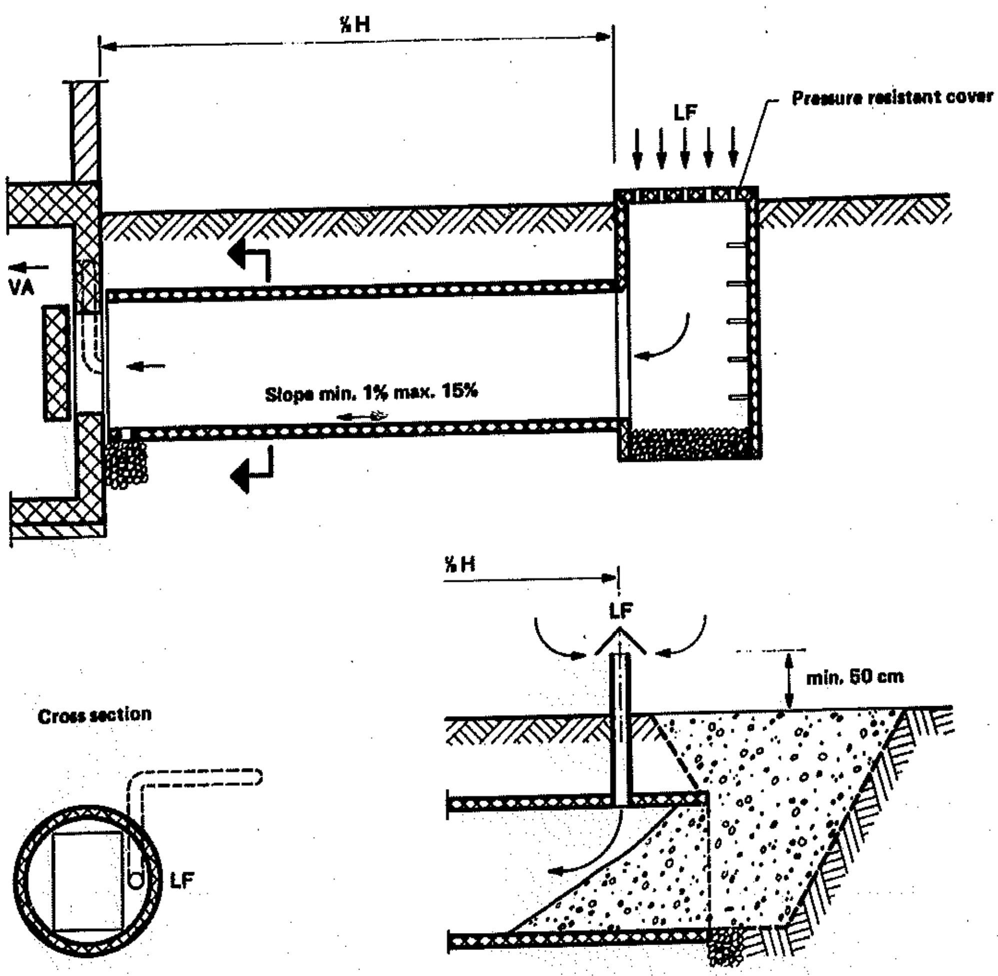


Fig. 2-26. Air intake in escape tunnel.

1. Primary filters, which are placed in the shelter after the blast protection valve, should be as close as possible to the point of entry of the air intake conduit 1.85 m (6 ft) above the floor to make it far enough from the shelter occupants so as not to require special radiation protection.

2. The blast protection valve and the primary filter form a single unit and products of different manufacturers may not be combined.

3. The instructions from the manufacturer approved by the Federal Office of Civil Defense are to be consulted for the installation of the blast protection valve and the primary filter.

2.3.5.3 Ventilator (VA). The space required for ventilators VA 20 to VA 150 are shown in Fig. 2-29.

1. The height above ground of the air intake connection on the shelter side of the pipe is 1.8 m (6 ft) for all ventilators.

2. The instructions for operating the ventilator are to be attached to the ventilator or in the immediate neighborhood.

3. The electrical installation for the ventilator must be in accordance with the household installation code of the SEV.

4. The ventilator and the gas filter m''st be protected with a plastic cover during peacetime.

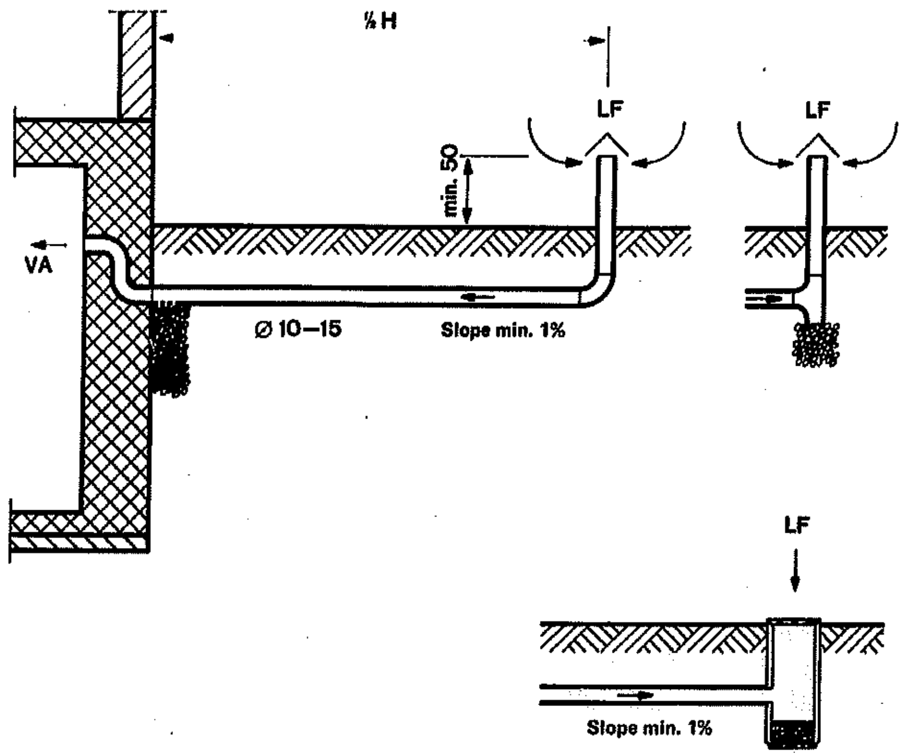
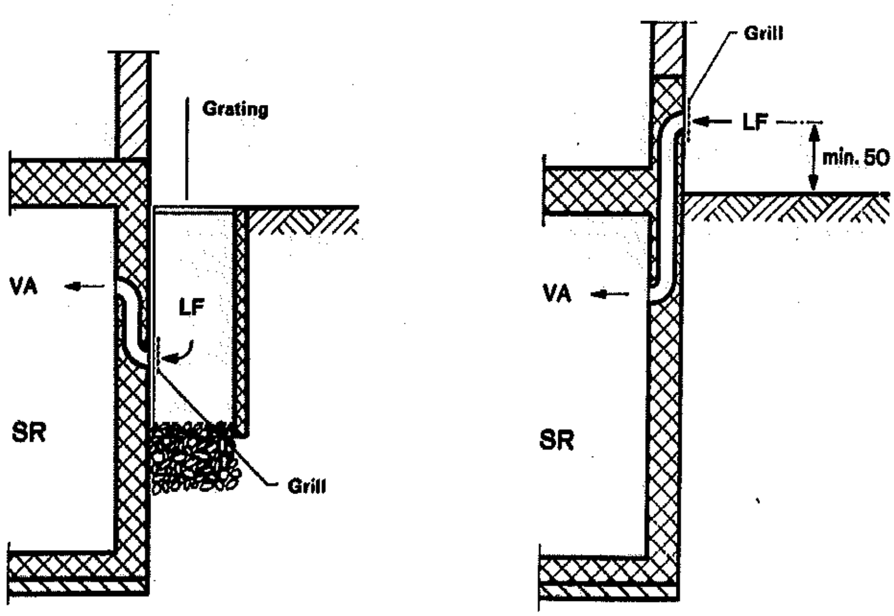


Fig. 2-27. Air intake with pipes outside the area of falling debris.

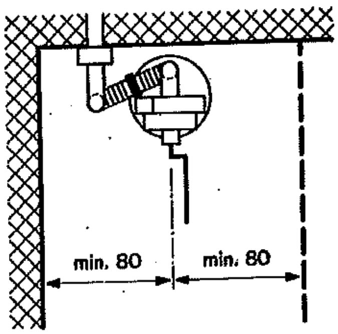


a) Air intake in emergency escape shaft

b) Air intake in concrete wall or column

Fig. 2-28. Examples of air intakes within the debris area (exceptions).

Plan



Elevation

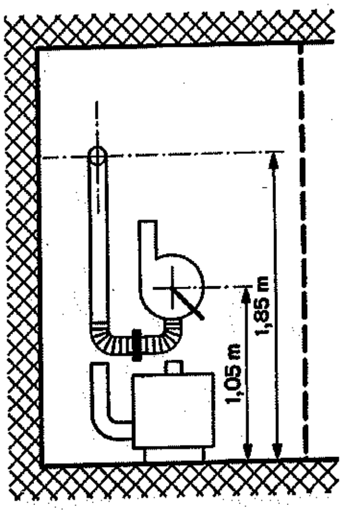


Fig. 2-29. Space requirements for ventilators.

2.3.5.4 The gas filter (GF). The purpose of the gas filter is to retain chemical and bacteriological warfare agents (aerosols, vapors, and micro-organisms). The gas filters are to be mounted in the shelter, closed airtight, and sealed with lead according to regulations. The seal may only be removed at the time that the shelter is occupied.

2.3.5.5 Excess-pressure valve. The purpose of the excess-pressure valve is to close the air outlet opening when the ventilation is shut off or during an explosion as well as to maintain a certain excess pressure in the shelter during operation of the ventilation.

The following openings are to be protected by excess-pressure valves (see Figs. 2-22 to 2-25):

1. Exhaust air outlet in exterior shelter wall.
2. Ventilation openings in partitions.

The excess-pressure valves are to be located as follows:

1. Exterior walls	1.85 m (6') above ground
2. Air lock walls	0.4 m (16") above ground
3. Partition walls	1.85 m (6') above ground

The excess-pressure valve and air outlet placed in series are to be dimensioned to maintain an excess-pressure of 5 to 15 mm of water pressure (3/16 to 5/8 inch) in the shelter during operation of the artificial ventilation. The air outlets which pass through the exterior walls must have either two elbows or a removable shielding plate as protection against fragments and radiation (see Fig. 2-30).

2.3.6 Construction Hints

Only those ventilators, filters, explosion protection valves, and fittings may be installed which have been approved by the Federal Office for Civil Defense on the basis of tests and which are marked with an approval number.*

All distribution pipes, fastenings, etc. are to be made of non-splintering, shatter-proof materials. The materials must not release any gas at a temperature of +60°C (140°F) and must be corrosion resistant or covered with a corrosion protection. The fastenings and anchors for the ventilation must comply with the requirements of article 3.4.2.9.

2.3.7 Functional Test

The ventilator manufacturer is responsible for the installation of the ventilating system according to regulations, and is to test the operation immediately after completion of the shelter. They shall send a written report of the test results to the competent civil defense authority within one month after the test.

*The following instructions of the BZS are applicable to the manufacture of small ventilator systems, their parts, and the testing of these elements:

1. Directive of the BZS concerning technical requirements for small ventilators 15 April 1956.
2. Ditto, VA 20, 1st October 1966.
3. Technical Directive of the BZS concerning minimum requirements for explosion protection valves and primary filters for ventilation systems of 15 October 1966.

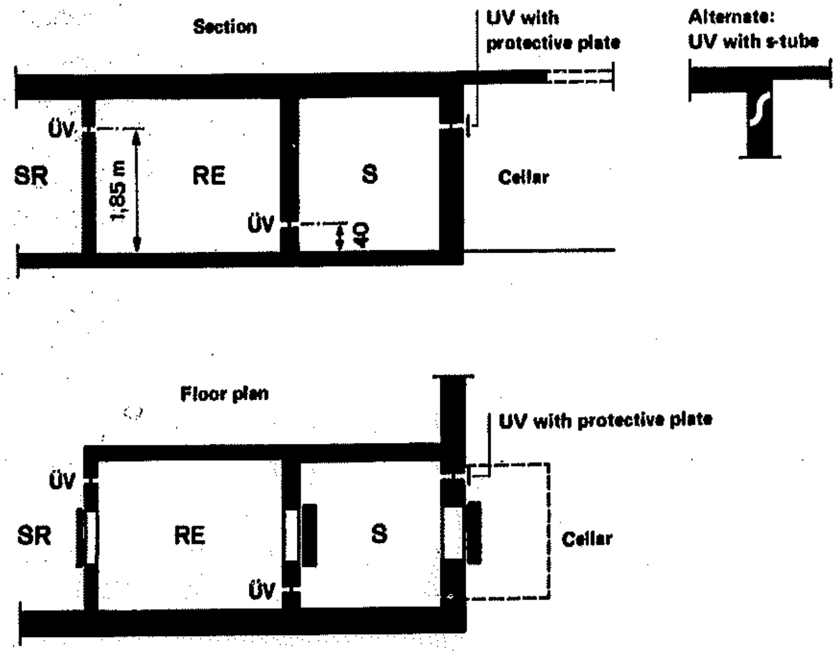


Fig. 2-30. Location of excess-pressure valves (UV).

2.4 FURNISHINGS AND CONDUITS

2.4.1 The Effect of Weapons

The furnishings or conduits which are installed in the shelter will be subject to shocks and vibrations. The more flexible the attachment to the shelter the smaller will be the acceleration forces transmitted.

The conduits which pierce the shelter shell weaken it, especially with respect to the nuclear radiation and the air blast. The number and size of such conduits must therefore be limited.

Air blasts can create excess internal pressure in conduits leading into the shelter.

2.4.2 Furnishings

All furnishings which remain in the shelter during the preattack phase must satisfy the following conditions (for the design see article 3.4.2.9):

1. They must not diminish the protective function, particularly the necessary places available.
2. They may not be made of brittle material such as cast iron, bakelite, or porcelain, etc., due to the high instantaneous accelerations which occur.
3. Furnishings made of brittle materials weighing more than 0.5 kg (one pound) must be shock-mounted on rubber pads at least 5 mm (¼ inch) thick. A special authorization must be obtained from the BZS for furnishings weighing more than 5 kg (10 pounds).
4. The anchors and attachments must comply with the requirements of article 3.4.2.9.
5. All equipment which is not fixed must be able to withstand a free fall of 30 cm (1 ft), equivalent to striking the shelter floor.

2.4.3 Conduits

2.4.3.1 General requirements. All the conduits mounted in the shelter must satisfy the same requirements for shock protection as demanded in article 2.4.2 for furnishings.

In addition conduits passing from the outside under ground through the shelter wall must be enclosed in a soft layer at least five diameters long and 5 cm (2 inches) thick because of the relative movement of the shelter and the surrounding earth, as shown in Fig. 2-31, for example.

As protection against nuclear radiation and air pressure the conduits must fulfill the following conditions in all parts of the shelter shell (with the exception of the floor and walls against the earth):

1. Conduit openings through the shelter shell having a total cross section of more than 600 cm² (93 sq in.) in one wall must be approved by the Cantonal Civil Defense Authorities.

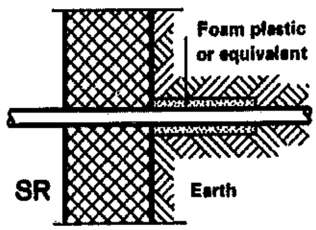


Fig. 2-31. Example of the penetration of an underground conduit.

2. Conduits of more than 250 cm² (39 sq in.) cross section passing through the shelter shell are to be provided with a double elbow as indicated in Fig. 2.32a.
3. Conduits buried in the shelter shell must lie in the outer half. If their cross section exceeds $\frac{1}{4}d^2$, where d stands for the wall or roof thickness, the wall or deck must be thickened locally in order to have the normal wall thickness everywhere as shown in Fig. 2-33.

As a protection against air blasts all blockouts of more than 150 cm² (23 sq in.) cross section for the passage of conduits should have roughened surfaces (Fig. 2-32b). They should not be made with metalforms or asbestos cement pipe, for example, or else they should be conic with the larger end outward (Fig. 2.32c).

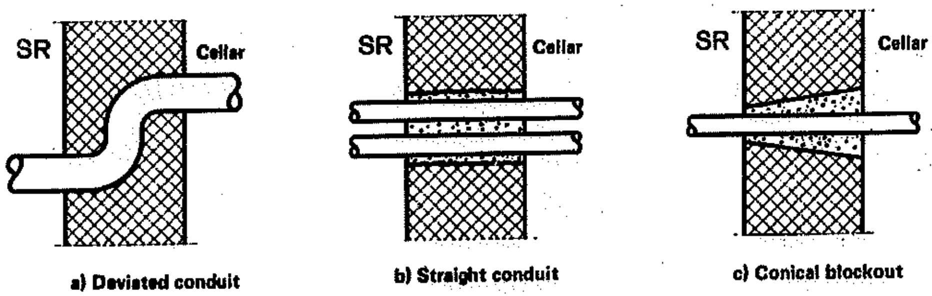


Fig. 2-32. Examples of conduits leading out of a cellar.

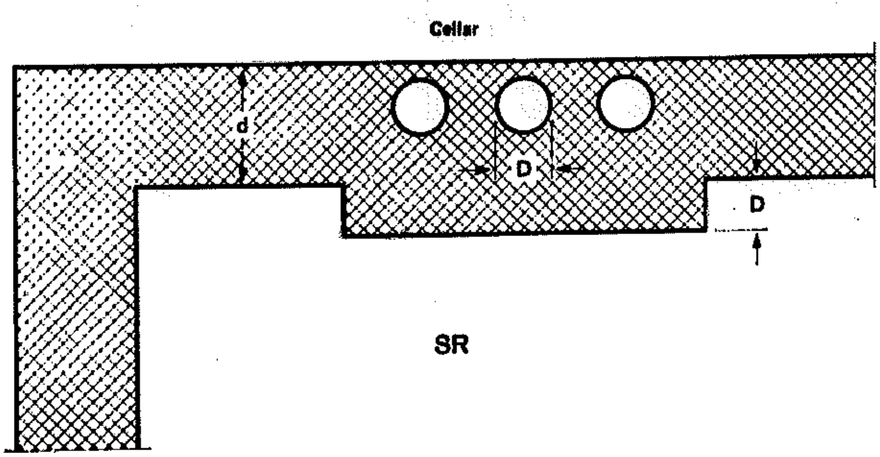


Fig. 2-33. Wall reinforcement around conduits in concrete.

2.4.3.2 Conduits used for civil defense. The following conduits for civil defense purposes are provided besides the ventilation and exhaust air outlet pipes:

1. Water and sewage pipes, if toilets and showers are included in the decontamination room. See article 2.4.3.3 for size limitations. Drains must be provided with covers that may be closed tight due to the danger of water backing up in a blocked off sewer.
2. Communications: A 20 mm (3/4 inch) tube must be placed in the shelter wall leading outside or in the cellar so that communication wires or a radio antenna may be installed at some future time.
3. Electric wires for lighting the shelter and for the ventilator.

2.4.3.3 Non-Civil defense conduits.

1. Water pipes under pressure are permitted in the shelter if there is a drain [max diam 15 cm (6 in.)] and a cut-off valve. Pipes of more than two inches in diameter require a special permission from the Cantonal Civil Defense Authorities.
2. Central heating conduits are permitted in the shelter if there is a drain or if the maximum water level in the shelter will not exceed 50 cm (20 inches) in case of a break in the pipe.
3. Gas, fuel, or chemical lines are not allowed in the shelter. They may enter the shelter only as an exception and then with the special approval of the Cantonal Civil Defense Authorities.

2.4.4 Fuel Tanks

If oil or gasoline tanks are located near shelters, the following items are to be considered besides the pertinent Cantonal Fire Protection and Water Pollution Control Regulations.

2.4.4.1 Underground tank not under building. Between the tank and the shelter wall there must be a thickness of earth material of at least 1.5 m (5 ft), or the wall must be reinforced and 50 cm (20 in.) minimum thickness.

2.4.4.2 Tank under building. For oil tanks with a volume of more than 20,000 l (5000 gal) a special approval of the Cantonal Civil Defense Authorities is required.

Oil tanks up to a content of 10,000 l (2500 gal) and 20,000 l (5000 gal) have to have a distance of 3 m (10 ft) and 5 m (16 ft) respectively from the nearest shelter wall; in case of a leak the fuel must not be able to reach the shelter (i.e., place the tank in a basin).

If an oil tank is located adjacent to a shelter, the pertinent shelter wall must be a 75 cm (30 in.) reinforced concrete wall. In this wall openings are not permitted.

Gasoline tanks require a special approval of the Cantonal Civil Defense Authorities.

Chapter 3. Design and Construction

3.1 DESIGN PROCEDURE

The dimensions given in article 2.1.3 used for the preliminary design must be calculated for the final design after receiving the construction permit and before starting the plans, unless the shelter is a 1 atmosphere design for less than 25 persons. Basically this calculation should take into consideration all the weapons effects described in section 1.4 as well as the peacetime loads. The majority of these requirements may be considered as being fulfilled, however, by the minimum limits for concrete thickness and reinforcement given in this chapter as well as the regulations for the layout given in chapter 2. It is therefore permitted to limit the final design to the consideration of the following four groups of loads:

1. fire,
2. primary radioactive radiation,
3. mechanical loads from weapons effects,
4. peacetime loads.

The final concrete thickness will be determined by the requirements for the resistance to the first two effects in accordance with the values given in sections 3.2 and 3.3. In this respect the basic rule is that the critical loading is the one that requires the greatest concrete dimension. The given values have lower limits such that the requirements for all weapons effects not specifically investigated are already satisfied.

The last two groups of loads influence mainly the reinforcement ratio and only rarely the concrete thickness. The design for the mechanical loads from weapons effects is based on the use of the ultimate static loads given in section 3.4. The peacetime loads may not be critical in any way, but it is still the responsibility of the engineer to assure that the structure satisfies all the recognized rules of construction and in particular the SIA codes for loading and concrete design.

In the same way that certain minimum concrete dimensions were determined for the final design, a minimum reinforcement ratio is required (article 3.4.1) which is already sufficient to resist a large part of the loads from weapons effects. The establishment of these minimum values makes it possible to reduce the design of the concrete thickness as well as the supporting reinforcement to the consideration of a few loading conditions illustrated in Table 3-1.

3.2 DESIGN FOR FIRE PROTECTION

Ceiling slabs and exterior walls not against earth must offer protection against heat from fires in the immediate vicinity of the shelter. The necessary thickness of concrete depends on the fire intensity by flammable

Table 3-1. Design procedure for the major structural elements

Structural element	Critical loading for concrete depth[a]	Critical loading for concrete reinforcement[a]
Slabs and free-standing exterior walls	Radioactive radiation (3.3), fire (3.2) (possibly air blast)	Air blast (3.4.2.1), (3.4.2.4)
Exterior walls against earth	Ground shock (3.4.2.3)	Ground shock (3.4.2.3)
Floors	Ground reaction (3.4.2.2)	Ground reaction (3.4.2.2)
Partition walls and intermediate floor slabs (except air-locks)	Construction requirements, shock (3.4.2.5)	Shock (3.4.2.5)

[a]Not including construction requirements and peacetime loads.

Table 3-2. Concrete depth for fire protection

Fire intensity	Concrete depth for ceiling slabs and exterior walls not against earth
Class A. Great fire intensity	
Large quantities of flammable material near the shelter such as:	
1. More than one wooden floor directly over the shelter.	
2. Superstructure in wood.	40 cm (16 inches)
3. Storage of flammable material such as wood, furniture, plastics, hay, and fuel in one of the first two floors directly over the shelter or next to the shelter.	
Class B. Small fire intensity	
All cases not included in class A, in particular:	
1. One family houses, except wooden houses (walls and floors of wood).	30 cm (12 inches)
2. Apartment houses and office buildings of concrete with the exception of class A3. above).	

material near the shelter. The fire intensities have been divided into two groups (Table 3-2).

The concrete dimensions in Table 3-2 must be increased by 15 cm (6 inches) if it is not possible to leave the shelter for long periods due to the radiation of heat from nearby fuel concentrations such as tanks, lumber yards, etc. The minimum requirements for protection from heat generated by fires in underground tanks in the immediate vicinity of the shelter or tanks inside the building limits are included in article 2.4.4.

When choosing the concrete depth for protection against heat from fires any earth cover may be fully considered.

3.3 DESIGN FOR PROTECTION FROM NUCLEAR RADIATION

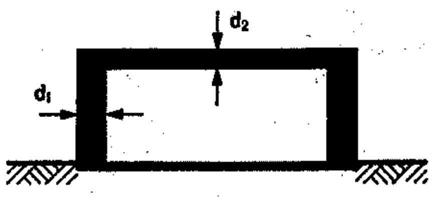
The reduction of the nuclear radiation is accomplished by the mass surrounding the shelter. As a first approximation one can say that it is not so much the type of material but the product of its specific weight times the wall thickness which is important. The radiation protection will subsequently always be given as a thickness of concrete. Other construction materials may be considered on the following basis:

10 cm of earth are equivalent to	7 cm of concrete
4 inches of earth are equivalent to	3 inches of concrete
10 cm of wood are equivalent to	3 cm of concrete
4 inches of wood are equivalent to	1¼ inches of concrete
10 cm of wood are equivalent to	7 cm of concrete
4 inches of masonry are equivalent to	3 inches of concrete

The necessary construction thickness of the shelter shell depends to a large extent on the position of the shelter within the building and relative to the ground. Since the greatest part of the primary radiation strikes just before the shock wave arrives, the building is to be assumed undestroyed.

In the following typical examples the necessary thickness "d" of the shelter exterior is calculated on the basis of the "Handbook of Weapons Effects" (BZS 1964 Edition, Chapter 4). The examples given are sufficient for the needs of private shelters, and appropriate interpolation may be made between two basic types (Fig. 3-1).

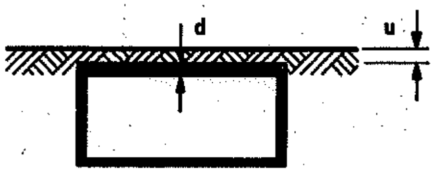
Fig. 3-1. Concrete thickness required for protection from nuclear radiation.



Exposed roof slabs and walls, above ground

	Thickness of shelter shell for	
	1 atmos.	3 atmos.
d_1	= 80 cm (31")	120 cm (48")
d_2	= 55 cm (22")	85 cm (34")

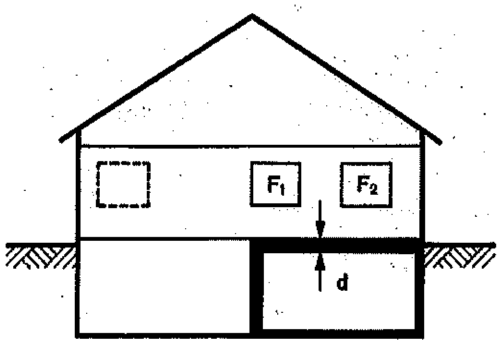
Fig. 3-1a



Roof slabs not under building

	Thickness of shelter shell for	
	1 atmos.	3 atmos.
Earth cover		
u = 0 cm (0") earth	d = 55 cm (22")	85 cm (34")
u = 20 cm (8") earth	d = 40 cm (16")	70 cm (28")
u = 40 cm (16") earth	d = 40 cm (16")	55 cm (22")
u = 70 cm (28") earth or more	d = 20 cm (8")	35 cm (14")

Fig. 3-1b



Roof slabs under building

	Thickness of shelter shell for	
	1 atmos.	3 atmos.
Building over the shelter		
one story	d = 35 cm (14")	55 cm (22")
multistory	d = 30 cm (12")	45 cm (18")

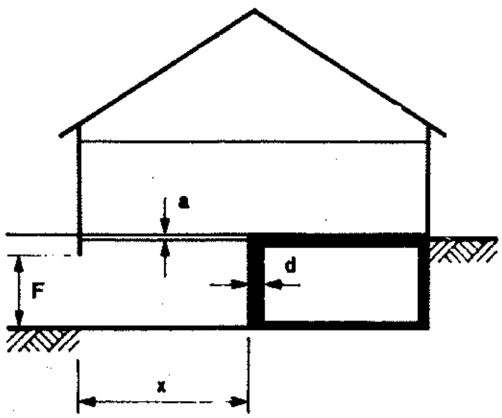
When the floor above the shelter has openings (doors or windows) "F" including more than 50% of the wall surface the values are:

one story	d = 40 cm (16")	60 cm (24")
multistory	d = 35 cm (14")	50 cm (20")

When the shelter is in the second or third basement the sum of the thickness of all the basement slabs above the shelter must have at least the values above.

Fig. 3-1c

(Figure continued on next page)



Cellar walls not against earth

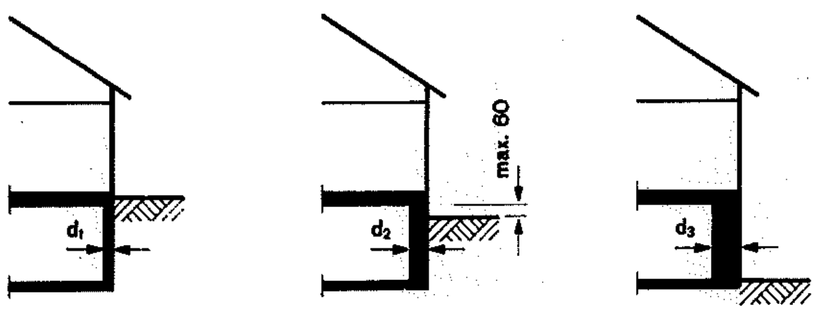
	Thickness of shelter shell for	
	1 atmos.	3 atmos.
a < 15 cm (6") concrete equivalent:		
Z smaller than 0.1	d = 35 cm (14")	50 cm (20")
Z 0.1 to 0.5	d = 45 cm (18")	60 cm (24")
Z more than 0.5	d = 50 cm (20")	65 cm (26")
a > 15 cm (6") concrete equivalent		
Z smaller than 0.1	d = 25 cm (10")	35 cm (14")
Z 0.1 to 0.5	d = 30 cm (12")	45 cm (18")
Z more than 0.5	d = 40 cm (16")	55 cm (22")

F = surface of openings toward the outside (doors, windows) in cellar room adjacent to the pertinent shelter wall.

x = smallest distance from the center of the opening to the shelter wall.

Z = sum of all F/x^2.

Fig. 3-1d



Cellar walls against earth

	Thickness of shelter shell for	
	1 atmos.	3 atmos.
Type of wall		
Completely underground (ground surface not below the underside of the roof slab)	d_1 = 25 cm (10")	25 cm (10")
Partially underground (ground surface not more than 2 ft below the underside of the roof slab)	d_2 = 50 cm (20")	70 cm (28")
Uncovered wall (ground surface more than 2 ft below the roof slab)	d_3 = 80 cm (32")	120 cm (48")

Fig. 3-1e

3.4 MECHANICAL LOADINGS CAUSED BY WEAPONS EFFECTS

3.4.1 Basis for Calculation and Rules for Construction

In order to judge the effectiveness of a shelter it is necessary to know its ultimate resistance when subject to the effects of weapons. To calculate the limit of survival with respect to the mechanical effects of weapons it would be necessary to have a comprehensive knowledge of not only the static resistance but also the permissible energy of deformation and the dynamic characteristics of the structure. Within the scope of these Technical Directives the design may be made in the sense of an approximation by equating the static resistance with the ultimate loads given in article 3.4.2. This ultimate load is composed of the static load equivalent to the weapons effect plus other simultaneous loads (such as the dead load, for example).

The ultimate load capacity may be quickly determined using the plastic design method and the corresponding design charts which are given in section 3.5. Since this design method may not yet be thoroughly familiar it is also permissible to calculate the internal forces and moments resulting from the equivalent static loads using elastic theory and dimension the cross sections for these forces in the condition of rupture. This method generally leads to heavier reinforcement.

1. Resistance of steel: The yield stress for the most commonly used reinforcement steels may be used in the calculations in accordance with the values given in Table 3-3. These values are slightly higher than the normal yield stress since only very quick stress increases are considered. The dependence of the yield stress on the rate of stress increase is a property of steel and is not to be confused with the dynamic behavior of the structure under transient loads.
2. Concrete compressive strength:* The values for compressive strength may be increased by 30% over the usual static test values obtained with cubes, but not more than 100 kg/cm² (1400 psi).
3. Shear and bond strength:* Since the shear and bond stresses may produce brittle failure neither the shear strength nor the bond strength limits may be increased for dynamic loads.
4. Minimum percentage of reinforcement: The supporting parts of the shelter should contain a minimum amount of reinforcement which is to be placed structurally as a main reinforcement. This minimum reinforcement should be at least 0.1% in each direction for any cross section (0.2% of the concrete cross section) with the exception of the undersurface of the floor.
5. When contraction joints cannot be avoided in a shelter they should be placed between partition walls at least 20 cm (8 inches) thick. Openings through these walls must be sealed around the joint with a waterstop.
6. Connections of the shelter with other structures: Other structural elements may be attached monolithically or fixed rigidly to the shelter. These connections or attached structures must be fashioned in such a manner, however, that their collapse does not destroy the shelter shell.

*The values given here for strengths of materials correspond with those in the addendum of 4 March 1966 to the Recommendations of the Federal Office of Civil Defense of 24 April 1965 concerning the minimum requirements for structures. They are to be used in connection with the appropriate SIA codes, especially No. 162 and are valid until the issue of the new appropriate SIA codes.

Table 3-3. Dynamic yield stress for reinforcement steel

Steel type	Yield stress			
	kg/cm²		psi	
			Bar No.	
	7–18 mm diam	20–30 mm diam	3–6	6–14
Reinforcement steel I	3000	2600	43,000	37,000
Reinforcement steel II SIA code 162 (1956)	4200	3800	60,000	54,000
Reinforcement steel III SIA code (proposed 1966)	4800	4600	68,000	65,000
Reinforcement steel IV (up to 12 mm or bar No. 8)	static yield stress		static yield stress	

7. Steel paneling: The steel paneling on the inside of the shelter may not be more than 2 cm (3/4 of an inch) thick. An increased thickness is not allowed because of the danger of popping off.
8. Hooks: End hooks for reinforcement steel may be omitted if a complete load transfer may be obtained without them.
9 No plaster or insulation may be applied to the inside walls or ceiling of the shelter.
10. Relation to the SIA code: All questions of structural form or construction which are not treated by these Directives are to be resolved according to the pertinent regulations of the SIA code.

3.4.2 Assumed Loads

In the following article the static equivalent loads for ground shock and air blast are presented. The former is primarily the governing force for sections of the structure within the shelter such as intermediate floors of walls and attached equipment. The generated loads are distributed in the same way as the dead weight but may be many times as great and act in any direction. The air blast loads act primarily normal to the surface of the shelter shell and create bending and shear stresses in the walls, roofs, and floors. In addition, opposing normal forces occur which must be considered when they reduce the ultimate load of a structural element. For the design of individual parts of the structure (articles 3.4.2.1 to 3.4.2.8) only the loads respectively mentioned need be considered.

3.4.2.1 Shelter roofs. The dead weight of the shelter roof and the weight of the earth cover or live loads are to be added to the static equivalent air shock wave pressure p_v (see Fig. 3-2). On the other hand possible loads from the building above, such as debris load, are not to be included.

	Equivalent static load P_V for air blast of	
	1 atmos.	3 atmos.
Roofs under or outside of buildings	10 t/m^2 (2 kips/sq ft)	30 t/m^2 (6 kips/sq ft)

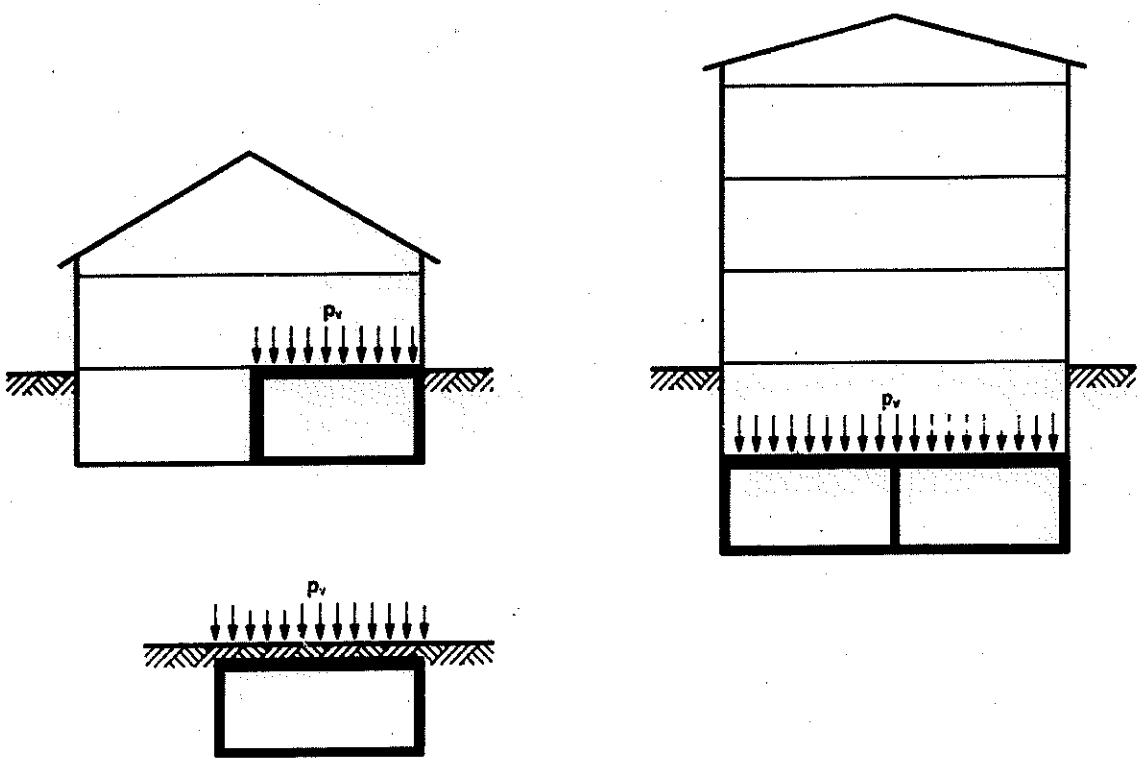


Fig. 3-2. Loads on shelter roofs from air pressure.

3.4.2.2 Floor slabs. The equivalent static load for air blast acting on the floor slab is the same as that acting on the roof (see article 3.4.2.1). The dead weight of the entire shelter (with the exception of the floor slab) and any earth cover are to be included as permanent loads.

These loads are to be assumed as being uniformly distributed over the floor when designing for shear loads.

Type of ground	Equivalent static load p_v for air blast of	
	1 atmos.	3 atmos.
Above ground water	10 t/m² (2 kips/sq ft)	30 t/m² (6 kips/sq ft)
In ground water	12 t/m² (2.4 kips/sq ft)	36 t/m² (7.2 kips/sq ft)

1 kip = 1000 lb.

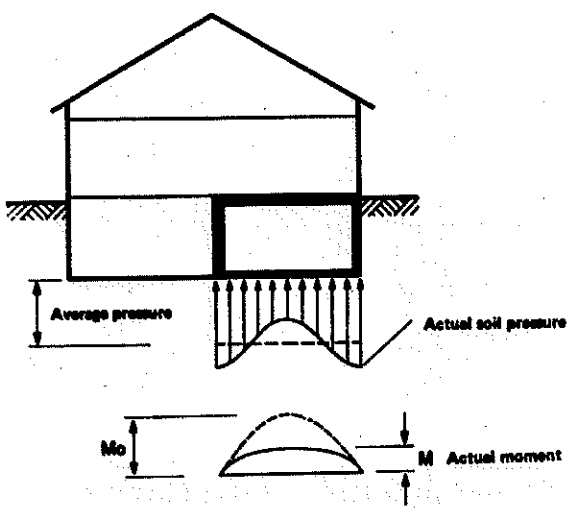


Fig. 3-3. Decrease in the maximum bending moment in the floor slab from moment M_0 to M as a result of the arching effect in the soil.

There is a non-uniform distribution of the ground pressure as a result of the supporting effect of the soil and the actual bending moment M is less than the bending moment M_0 which would result from a uniform soil pressure (see Fig. 3-3). The bending moments may therefore be calculated by assuming the following uniformly distributed equivalent static loads for air blast:

Type of ground	Equivalent static load p_v for air blast of	
	1 atmos.	3 atmos.
Sand or gravel	3 t/m² (600 lbs/sq ft)	10 t/m² (2000 lbs/sq ft)
Silty soils	7 t/m² (1400 lbs/sq ft)	20 t/m² (4000 lbs/sq ft)
Saturated soils	10 t/m² (2 kips/sq ft)	30 t/m² (6 kips/sq ft)
In ground water (see art. 2.1.2.2)	12 t/m²2 (2.4 kips/sq ft)	36 t/m² (7.2 kips/sq ft)

In good soils, especially on rock, the floor slab may be replaced by strip foundations or individual footings wherever the secondary weapons effects described in article 1.4.5 are not possible (Fig. 3-4). In this respect the following applies:

1. The assumption of a uniformly distributed soil pressure for the vertical loading from weapons effects may not exceed four times the allowable soil pressure for peacetime loads, σ_{Bzul}.
2. The foundation must be able to resist the loads transmitted from the walls as a result of the simultaneous occurrence of horizontal soil pressure p_h as described in articles 3.4.2.3 and 3.4.2.4 (see Fig. 3-4).

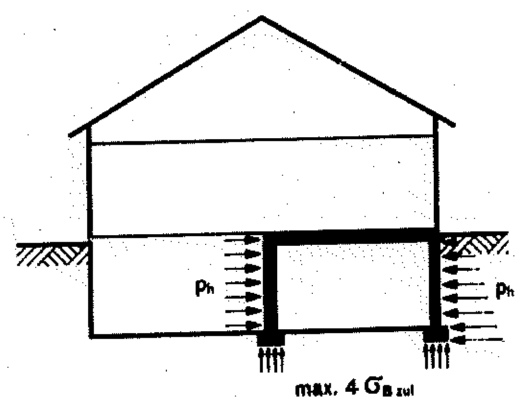


Fig. 3-4. Loads on strip footings for a shelter.

3.4.2.3 Exterior walls against the ground. The earth pressure acting in peacetime is to be added to the uniformly distributed equivalent static load p_h from ground shock indicated in the following table (see also Fig. 3-5).

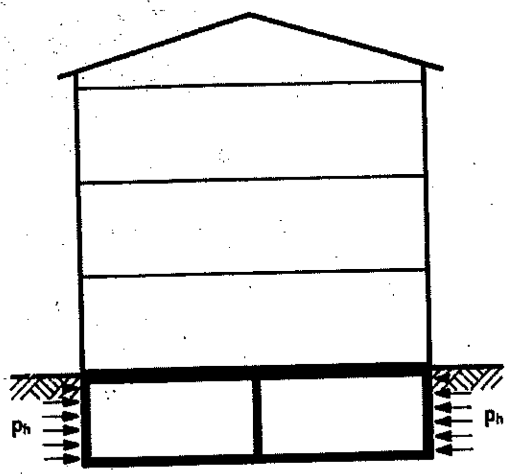


Fig. 3-5. Loads on exterior walls against the ground from ground shock.

Type of soil	Equivalent static load from ground shock for 1 atmos.	3 atmos.
Unsaturated	7 t/m^2 (0.7 tons/sq ft)	20 t/m^2 (2 tons/sq ft)
Saturated	10 t/m^2 (1 ton/sq ft)	30 t/m^2 (3 tons/sq ft)
In ground water	12 t/m^2 (1.2 tons/sq ft)	36 t/m^2 (3.6 tons/sq ft)

3.4.2.4 Exterior walls not against the ground. Exterior walls which are not directly in contact with the ground may also be subject to reflected pressure in addition to the excess pressure acting from all sides. This reflected pressure will be diminished to some extent by the surrounding portions of the building; the pressure p_h is therefore dependent on the area of the openings in the adjacent basement such as doors and windows (Fig. 3-6).

F (%)	Equivalent static load p_h from air blast 1 atmos.	3 atmos.
less than 50	10 t/m^2 (1 ton/sq ft)	30 t/m^2 (tons/sq ft)
more than 50	17 t/m^2 (1.7 tons/sq ft)	60 t/m^2 (6 tons/sq ft)

F = area of openings in the exterior wall of the adjacent basement opening directly outside, in % of the total wall surface.

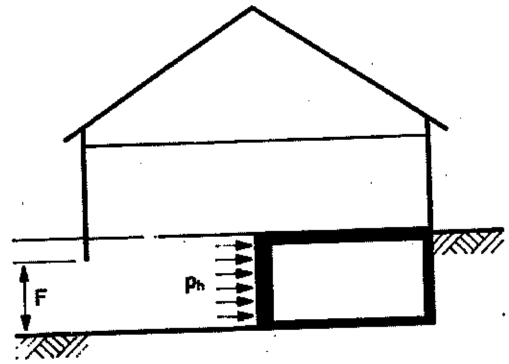


Fig. 3-6. Air blast loads on exterior walls not in contact with the ground.

3.4.2.5 Intermediate floors and partition walls. The ground shock produces accelerating forces similar to seismic shocks which constitute the determining loads from weapons effects for intermediate floors and partition walls. The created loads are distributed in the same way as the dead weight (including all objects fastened to the roof or walls). These loads are several times greater, however, and can act in any direction.

The given loads p are ultimate loads (dead loads are not to be superposed) and are presented as multiples of the dead weight g_e. They are to be assumed as acting perpendicular to the wall or slab and in either direction (Fig. 3-7). Since even greater shock loads than those given may occur for short periods no brittle material such as tile or plaster may be used for intermediate floors or partition walls.

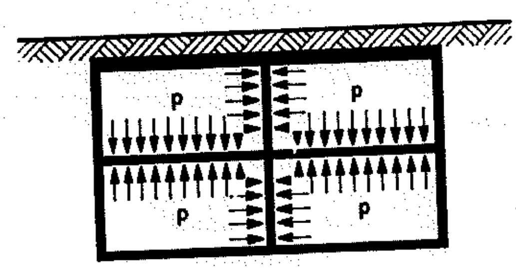


Fig. 3-7. Loads on intermediate floors and partition walls as a result of shock.

	Ultimate static load p for 1 atmos.	3 atmos.
Intermediate floors and partition walls	2 g_e	6 g_e

3.4.2.6 **Open-ended galleries.** Galleries with a closed cross section which are closed at one end and lead out into the open at the other must be designed for excess pressure acting from the outside or the inside which may result from reflected air blast (see Fig. 3-8). Other loads which may act simultaneously such as dead weight and earth cover must be added to the given equivalent static load p resulting from air blast.

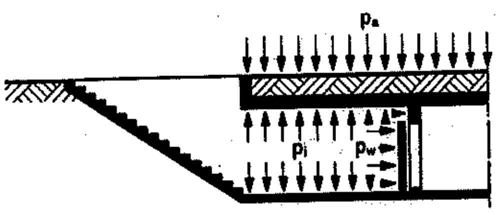


Fig. 3-8. Loads in open-ended galleries resulting from air blast (P_a and P_i do not occur simultaneously).

	Equivalent static load p resulting from air blast for	
	1 atmos.	**3 atmos.**
Net excess outside pressure acting inward	10 t/m² p_a (1.0 ton/sq ft)	30 t/m² (3.0 tons/sq ft)
Net excess internal pressure acting outwards	15 t/m² p_i (1.5 tons/sq ft)	60 t/m² (6.0 tons/sq ft)
Pressure against end wall	24 t/m² p_w (2.4 tons/sq ft)	90 t/m² (9.0 tons/sq ft)

3.4.2.7 **Air locks.** The loads on air locks are the same as those for galleries open at one end (article 3.4.2.6). They must therefore be designed for the net excess internal pressure p_i (see Fig. 3-9). (Dead loads and possible earth cover are also to be added.)

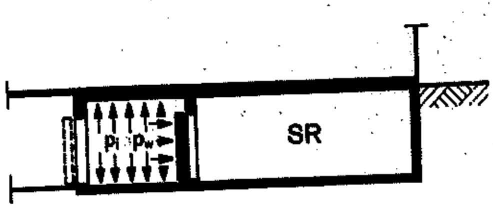


Fig. 3-9. Loads on air locks as a result of air blast.

	Equivalent static load p resulting from air blast for	
	1 atmos.	**3 atmos.**
Walls, roofs, and floors of air locks in the shelter		
In the shelter shell	15 t/m² p_i (1.5 tons/sq ft)	60 t/m² (6.0 tons/sq ft)
Between air lock and SR or RE	24 t/m² p_w (2.4 tons/sq ft)	90 t/m² (9.0 tons/sq ft)

3.4.2.8 **Debris protection for entrances and other supporting structural elements of emergency exits.** The structural elements of escape passages resistant to air blast (article 2.2.3.3) and debris protection of the entrance (article 2.2.2.2), as well as entry ways and cantilever slabs, will be subjected to pressure differences caused by the air blast (Figs. 2-11 and 2-5) and must therefore be dimensioned to resist the following equivalent static loads. These loads may act internally or externally on entry ways and from above or underneath on cantilevered slabs. The dead weight and earth covers are to be added to these loads.

Vertical escape shafts are to be designed as cantilevers fixed in the shelter shell and acted upon by a horizontal pressure from any direction acting perpendicularly to the projected area similarly to a wind pressure.

Covers for the exits of escape tunnels (article 2.2.3.5) are to be dimensioned in the same way as shelter roofs:

Structural element	Equivalent static load p from air blast for	
	1 atmos.	**3 atmos.**
Debris protection of the entrance	7 t/m² (0.7 ton/sq ft)	20 t/m² (2.0 tons/sq ft)
Air blast-proof escape tunnels	7 t/m² (0.7 ton/sq ft)	20 t/m² (2.0 tons/sq ft)
Escape shafts	15 t/m² (1.5 tons/sq ft)	40 t/m² (4.0 tons/sq ft)
Covers for the exit of escape shafts	10 t/m² (1.0 ton/sq ft)	30 t/m² (3.0 tons/sq ft)

3.4.2.9 **Furnishings and conduits.** The furnishings and conduits and their fastenings which are mounted in the shelter must be able to resist the forces of acceleration caused by shock. These forces act at the center of gravity of the object (and may be assumed as being distributed in proportion to the mass) and can act vertically up or down or in any horizontal direction.

Permanent forces (dead weight) are included in the equivalent static load.

	Ultimate static load p for	
	1 atmos.	3 atmos.
Furnishings and conduits	4 g_e	12 g_e

3.5 DESIGN OF RECTANGULAR REINFORCED CONCRETE SLABS BY THE ULTIMATE LOAD METHOD

In this section the engineer will find charts (Figs. 3-10 to 3-14) which indicate the ultimate uniformly distributed loads for underreinforced rectangular concrete slabs. They are based on the classic yield line theory, that is, the ultimate load method for reinforced concrete slabs, and consider only the bending resistance. If the shear stresses have a significant influence on the behavior of beams or slabs at failure these stresses must be considered in the design. The charts may be used for sections without shear reinforcement up to a nominal ultimate shear stress τ_{br} (calculated at the supports) of:

$$\tau_{br} = \frac{Q}{b \cdot h} \leqslant \begin{cases} 0.06\,\beta_w & \text{for } \frac{l}{h} \leqslant 8 \\ \frac{\beta_w}{3}\left(1 - 0.1\frac{l}{h}\right) & \text{for } \frac{l}{h} < 8 \end{cases}$$

where:

l = span length

h = effective slab thickness

β_w = ultimate compressive strength of concrete cubes.

The charts are based on an assumed distributed load of p = 1 atmos. and a (dynamic) yield point of 4800 kg/cm² (68,000 psi) for the reinforcement steel. For other values of p or σ_{fld} the amount of reinforcing varies according to the following proportion:

$$\frac{p}{1 \text{ atmos.}} \cdot \frac{4800 \text{ kg/cm}^2}{\sigma_{fld}} \quad \text{or} \quad \frac{p}{1 \text{ atmos.}} \cdot \frac{68{,}000 \text{ psi}}{\sigma_{fld}}$$

The charts are prepared on the basis of the EMPA formula for calculating the plastic moment m per unit width in underreinforced slabs.

$$m = \mu h^2 \sigma_{fld} \left(1 - \frac{2}{3} \frac{\sigma_{fld}}{\beta_w} \mu\right) \leqslant 0.2\beta_w h^2$$

in which μ is the ratio of longitudinal-reinforcement area to total cross section area above it and σ_{fld} is the dynamic yield stress for the reinforcement. The parameter for the curves is the degree of plastic fixity, that is, the ratio of the plastic moments over the supports m^- and at mid-span m^+. This plastic degree of fixity λ^-, unlike the elastic degree of fixity, is not dependent on the elastic characteristics of the building. It is determined by the distribution of the necessary reinforcement in the span and over the supports, and may therefore be selected to a large extent by the engineer.

In Fig. 3-10 the ordinate gives the required percent of reinforcement μ^+ for the span which may be read directly as a function of the slab slenderness ratio:

$$\frac{\text{span width}}{\text{effective slab depth}}$$

For a given value of l/h and λ^- the necessary percent μ^- of reinforcement may be read from the diagram.

For the design of rectangular plates supported on four edges four different plastic moments must be differentiated: the longitudinal span moment m_x^+ and edge moment m_x^- and the transverse span moment m_y^+ and edge moment m_y^-. A new parameter, a ratio of the side lengths l_1/l_2 is also introduced. Figures 3-11 to 3-14 are applicable for the four degrees of plastic fixity m_x^-/m_x^+ and m_y^-/m_y^+ equal to 0, 0.5, 1.0, and 1.5 whereby zero represents the rectangular plate with simply supported edges. (The degree of fixity is assumed to be the same in both directions.) The ordinate represents the percent of reinforcement steel μ_x^+ in the direction of the principle span and the abscissa is the slenderness ratio l_1/h where l_1 is the shorter span length and h is the effective slab depth. The curve parameter is the ratio of span lengths l_1/l_2 with a chosen fixed ratio of the plastic moments in the principle and secondary direction $\chi = m_y^+/m_x^+ = m_y^-/m_x^-$. This ratio is chosen as 1.0 for the square slab and decreases linearly with the span ratio l_1/l_2.

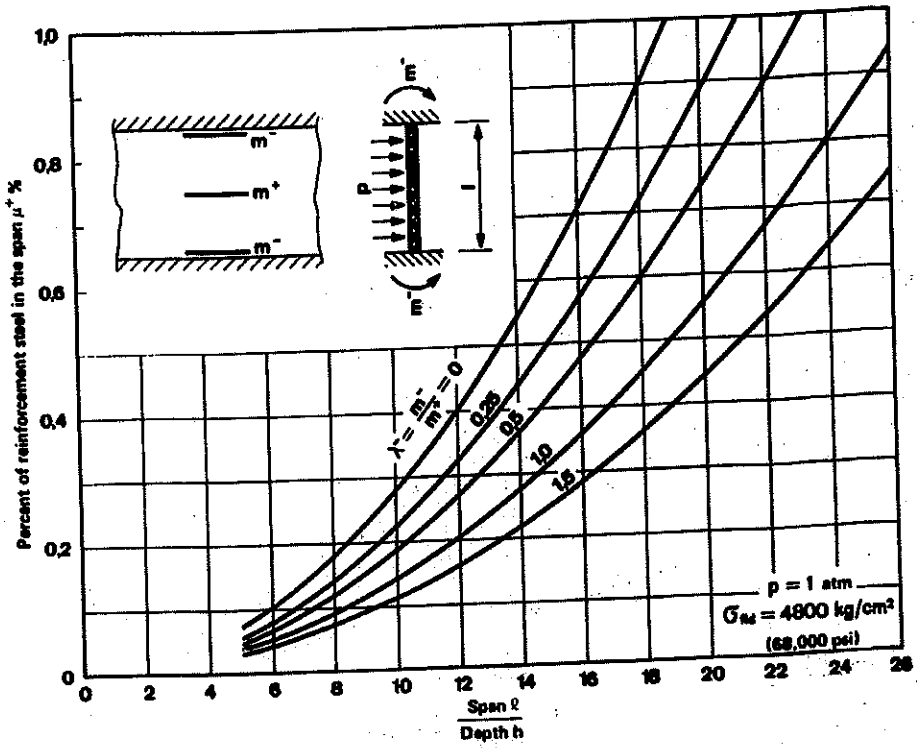


Fig. 3-10. Ultimate load design for a reinforced concrete slab supported on two edges.

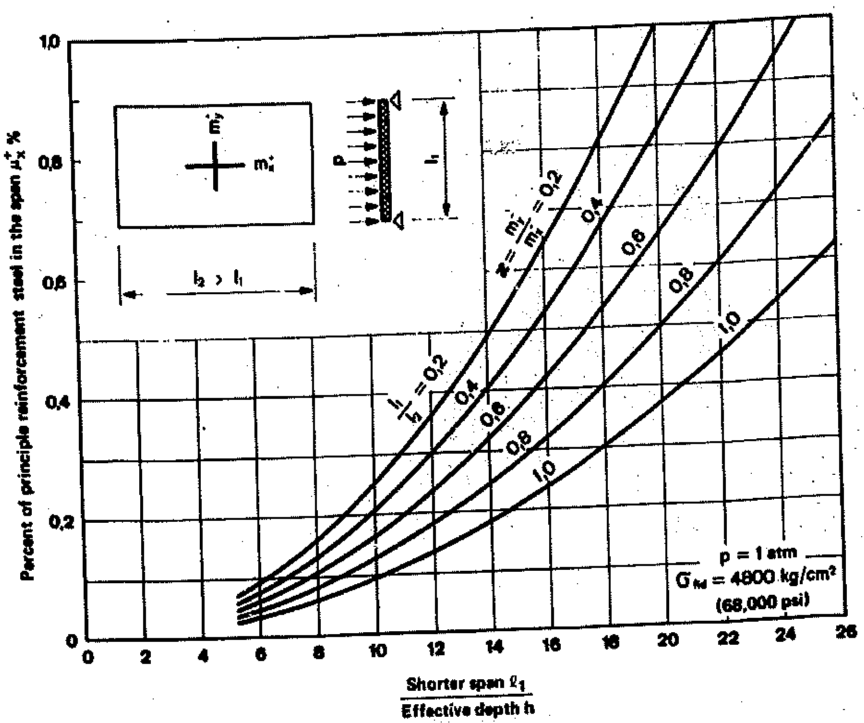


Fig. 3-11. Ultimate load design for a reinforced concrete slab simply supported on four edges.

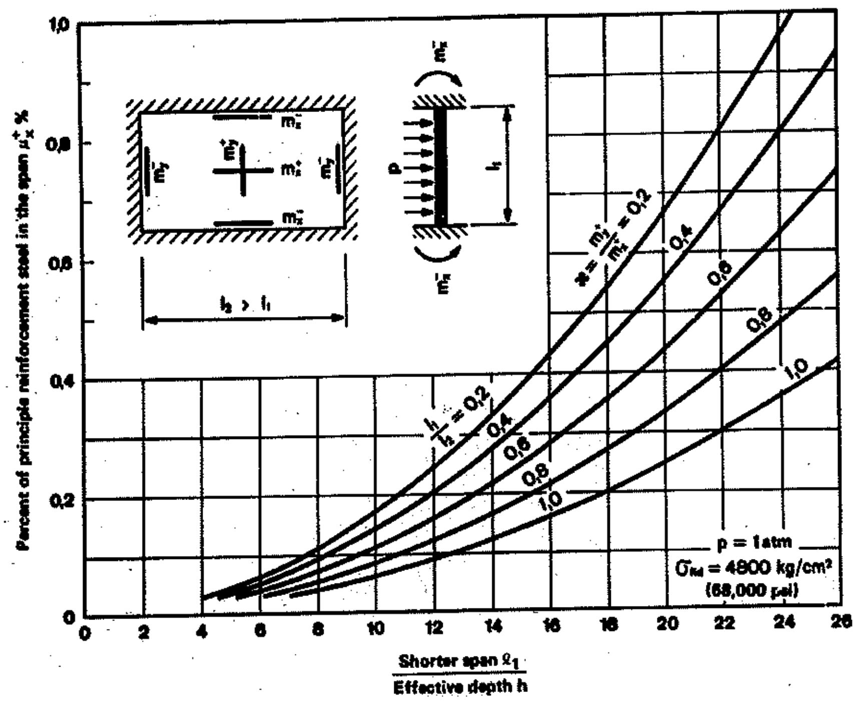


Fig. 3-12. Ultimate load design for a reinforced concrete slab with a plastic edge fixity of 0.5 on four sides.

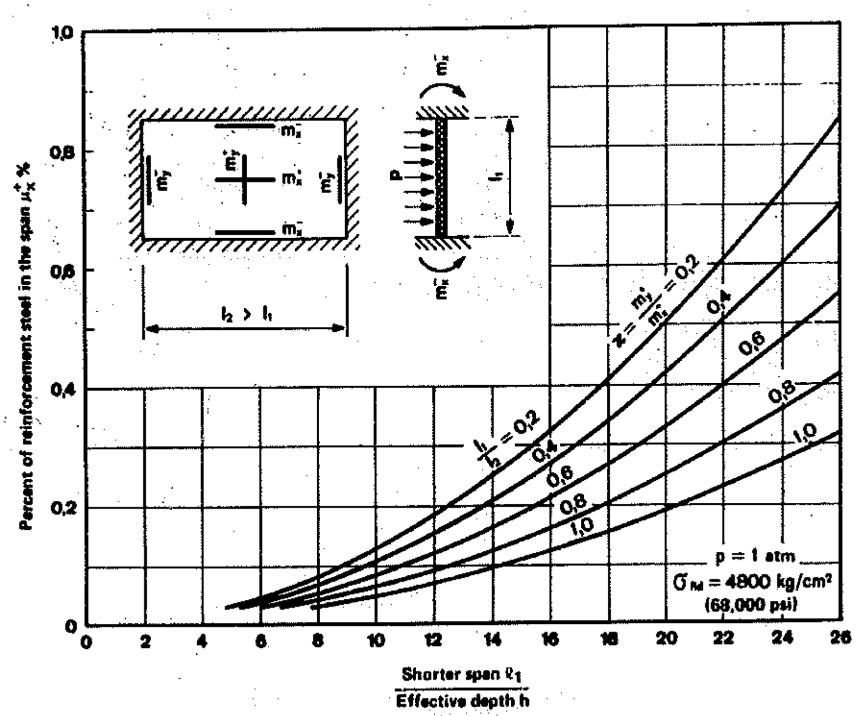


Fig. 3-13. Ultimate load design for a reinforced concrete slab with a plastic edge fixity of 1.0 on four sides.

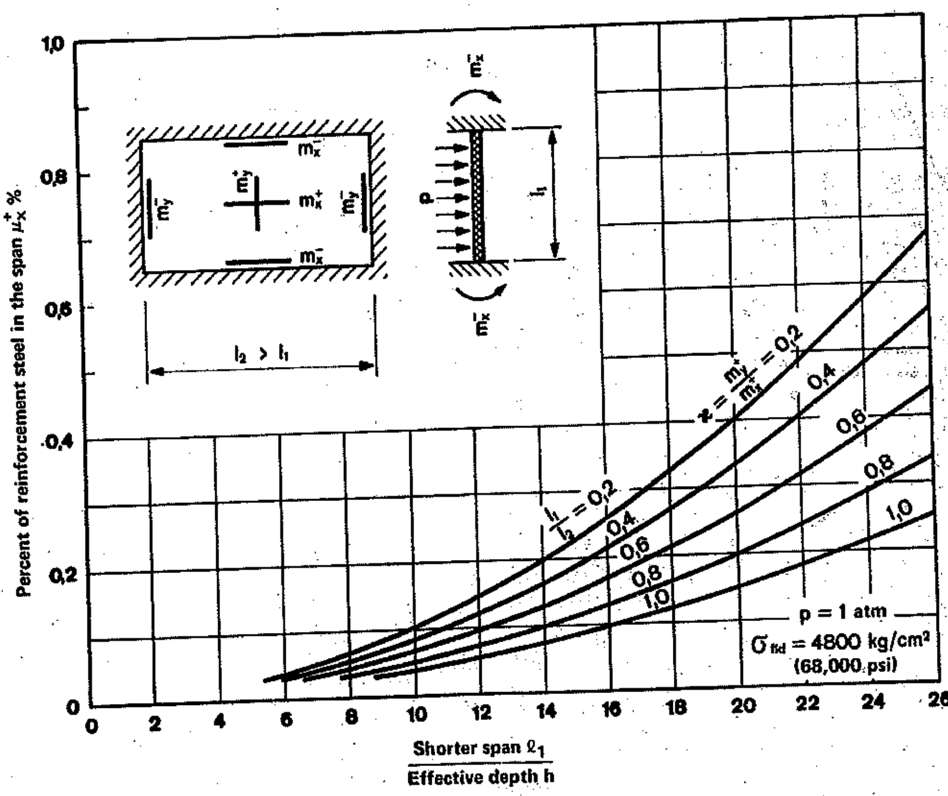
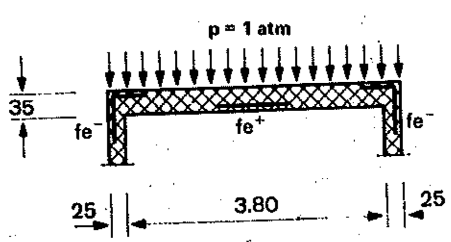


Fig. 3-14. Ultimate load design for a reinforced concrete slab with a plastic edge fixity of 1.5 on four sides.

Example No. 1: Roof of a 1 atmosphere shelter

Given:

Span	l = 400 cm (13 ft 2 in.)
Slab thickness	d = 35 cm (14 in.)
Wall thickness	d_W = 25 cm (10 in.)
Static depth:	
mid-span	h = 32 cm (12½ in.)
edge	h^- = 22 cm (8½ in.)
Degree of plastic fixity (assumed)	$\frac{m^-}{m^+} = 0.25$



To be found:

Effective cross-sectional area of steel reinforcement A_s^+ in the span and A_s^- over the supports:

$$\left(\frac{1}{h} = \frac{158}{12} = 12.6\right) \quad \frac{1}{h} = \frac{400}{32} = 12.5$$

$\lambda^- = 0.25$

from Fig. 3-10:

$\mu^+ = 0.35\%$ $fe^+ = 11.2\ cm^2/m$ (0.52 in.²/ft)

The thinner section of the wall will be determining for the moment over the supports. The quantity of reinforcement is proportional to the static depth h, therefore:

At the supports

$$\mu^- = \mu^+ \cdot \lambda^- \cdot \left(\frac{h}{h^-}\right)^2 = 0.19\%$$

$fe^- = 4.2\ cm^2/m$ (0.245 sq in./ft)

The dead weight of the roof [$g_e = 1\ t/m^2$ (200 lb/sq ft) in this case] is to be included when calculating the ultimate load. The steel content must therefore be increased by a factor of 1.1 [1 atmos. plus 1 t/m^2 (200 lb/sq ft) = 1.1 atmos.]. Therefore:

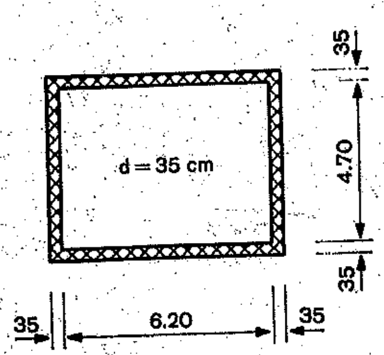
$fe^+ = 12.3\ cm^2/m$ (0.570 sq in./ft)

$fe^- = 4.6\ cm^2/m$ (0.270 sq in./ft)

Example no. 2: Roof of a 1 atmos. shelter

Given:

span length	$l_1 = 500$ cm (16 ft)
span width	$l_2 = 650$ cm (21 ft)
slab thickness	d = 35 cm (14 in.)
wall thickness	$d_w = 35$ cm (14 in.)
effective depth: mid-span	h = 32 cm (12 in.)
edge	$h^- = 32$ cm (12 in.)
plastic fixity (assumed)	$\frac{m^-}{m^+} = 1.0$



To be found:

Cross-sections of steel reinforcement fe_x^+, fe_x^-, fe_y^+, fe_y^-

with:

$$\frac{l_1}{h} = \frac{16 \times 12}{12} = 16.0 \qquad \frac{l_1}{h} = \frac{500}{32} = 15.6$$

$$\frac{l_1}{l_2} = \frac{500}{650} = 0.77 \cong 0.8$$

$$\frac{l_1}{l_2} = \frac{16}{21} = 0.76 \cong 0.8$$

From Fig. 3-13:

$$\chi = 0.8 = \frac{m_y^+}{m_x^-}$$

$\mu_x^+ = 0.16\%$ $\qquad fe_x^+ = 5.1\ cm^2/m = 0.24\ in.^2/ft$

$\mu_y^+ = 0.8 \cdot \mu_x^+ = 0.13\%$ $\qquad fe_y^+ = 4.1\ cm^2/m = 0.19\ in.^2/ft$

Since the degree of plastic fixity λ^- is 1.0 the plastic moments over the supports are the same as in the span. For equal effective depths h^- and h^+ the reinforcement is the same in the span as over the supports. In addition the values taken from the charts for 1 atmosphere pressure must be converted to the ultimate total load including dead weight:

Therefore it follows that : [dead weight $g_e = 1\ t/m^2$ (200 lb/sq ft)]

$$fe_x^+ = fe_x^- = 1.1 \cdot 5.1 = 5.6\ cm^2/m$$
$$= 1.1 \times 0.24 = 0.26 \text{ sq in./ft}$$

$$fe_y^+ = fe_y^- = 1.1 \cdot 4.1 = 4.5\ cm^2/m$$
$$= 1.1 \times 0.19 = 0.21 \text{ sq in./ft}$$

In both examples the required reinforcement is more than the minimum value of 0.1% which therefore does not apply.

Appendix A. Summary of the Most Important Information

This abbreviated summary contains only the most important information from the chapters 1 through 3 and is not meant to be a complete summary of the compulsory regulations. It is intended only as an aid for reference to be used in conjunction with the main text.

1. Applicability of the TWP — Section 1.1

Private shelters in new buildings
Degree of protection:
required 1 atmos.
permitted 1 or 3 atmos.

2. Application of the TWP

Shelter planning (architect)	Chapter 2
Final structural design of the shelter (engineer)	
General	Chapter 3
Exceptions (only 1 atmos. shelters with up to 25 places)	Appendix C
Design procedure	Section 3.1
Dimensions for preliminary design and building permit	Article 2.1.3
Calculation of concrete thickness:	
Fire load	Section 3.2
Radioactive radiation	Section 3.3
Calculation of the concrete reinforcement	
Mechanical effects of weapons (or peacetime loads)	Section 3.4
Fulfilling requirements for the effects of other weapons (Section 1.4)	
Minimum concrete thickness	Sections 3.2 and 3.3
Minimum concrete reinforcement	Section 3.4

3. The number of places to be provided in the shelter — Article 2.1.1.2

Type of building	Number of places
Homes and vacation houses	1 per room
Hospitals and asylums	1 per bed
Hotels	⅔ of the number of beds
Restaurants, places of amusement (movies, theatres, etc.), schools	⅔ the number of seats
Churches and temples	½ the number of seats
Offices and administration buildings, industrial and commercial businesses (factories and shops)	⅔ the number of work places
Stores and warehouses	1 per 20 m^2 (200 sq ft) of floor space
Storehouses, permanent exhibits, and exposition halls	1 per 150 m^2 (1500 sq ft) of floor space

4. Space requirements — Article 2.1.1.3

Per place in the shelter	1 m^2 (10 sq ft) of floor space 2.5 m^2 (88 cu ft) of volume
For each ventilator	1 m^2 (10 sq ft) of floor space
For each air lock	0.05 m^2 (0.5 sq ft)/shelter place min 2.5 m^2 (25 sq ft) max 5.0 m^2 (50 sq ft)
For each decontamination room	0.07 m^2 (0.7 sq ft)/shelter place min 3.5 m^2 (35 sq ft)
For each combined air lock-decontamination	0.1 m^2 (10 sq ft)/shelter place min 5 m^2 (50 sq ft)
Shelter floor space	min 6 m^2 (60 sq ft)
Head room for a shelter	min 2 m (6 ft 6 in.)

5. Structural dimensions for preliminary design Article 2.1.3

Structural element	Location	Concrete thickness 1 atmos. cm	in.	3 atmos. cm	in.
Roofs	Under buildings	35	14	55	22
	Not under buildings with earth cover of				
	0 in.	55	22	85	34
	12 in.	35	14	65	26
	More than 20 in.	30	12	50	20
	Normal intermediate floors	20	8	20	8
	Intermediate floors over or under an air lock	25	10	30	12
Walls	Entirely underground (ceiling below ground)	25	10	25	10
	Partially underground (underside of ceiling not more than 2 ft above ground)	50	20	70	28
	Exterior wall standing free (underside of ceiling more than 2 ft above ground)	80	32	120	48
	Walls facing the basement not against the ground (also partition walls between two shelter groups)	35	14	55	22
	Partition walls	20	8	20	8
	Air lock walls	25	10	30	10
Floors	Foundation slabs	20	8	25	10

6. Requirements for air locks, decontamination rooms, toilets, and showers Article 2.2.2.3

Number of shelter places	Inclusion	Construction of S and RE in one room or separate	Minimum number of showers	Minimum number of toilets[a]
up to 50	optional	S and RE in 1 room		
51–100	required	S and RE in 1 room or separate	1 per 100 places	1 per 30 places
101–200	required	S separate from RE		

[a]Half may be chemical toilets and the rest latrines.

7. Arrangement of emergency exits Article 2.2.3

Number of shelter places	Minimum requirements for unaided emergency exit for stage I	II	IV	Figure
up to 13		1		2-7
14–50	1	1		2-8a
or			1	2-8b
51–100		1	1	2-9a
or	1	2		2-9b
101–200	1	1	1	2-10a
or		2	1	2-10b

Construction of emergency exits

Stage I — Article 2.2.3.3
Air blast-proof escape passage (with cantilever slab or entrance gallery)
Width min 1.3 m (4'3")
Length min 2.0 m (6'6")

Stage II — Article 2.2.3.4
Emergency escape shaft 60 × 80 cm (24 by 32 in.)
With shaft 60 × 80 cm (24 × 32) in. inside
Without shaft: clean sand or gravel fill

Stage III — Articles 2.2.3.6 and 2.2.3.5
Escape chimney and escape tunnel ending in debris area: only allowed exceptionally as partial substitute for stage IV

Stage IV — Article 2.2.3.5
Escape tunnels that terminate outside the debris area (distance = ½ height under eaves) and/or connect to other escape tunnels system
Min cross-section: Concrete pipe 100 cm (40 in.) diam
Oval pipe 80/120 cm (32/48 in.)
Rectangular 80/100 cm (32/40 in.)

8. Shelter doors and shutters Article 2.2.4

Type	Opening	Inside dimensions cm	inches
PT	Outward	80 × 185	32 × 72
		100 × 185	40 × 72
		140 × 220	55 × 87
		60 × 120	24 × 48
PD	Inward	60 × 80	24 × 32
DT	Either way	80 × 185	32 × 72
		100 × 185	40 × 72
		140 × 220	55 × 87

2

9. Ventilation — Section 2.3

Capacity: Fresh air: 6 m^3/hr (212 cu ft/hr) per shelter place	Article 2.3.2.2
Filtered air: 3 m^3/hr (106 cm ft/hr) per shelter place	Article 2.3.2.3
Air intake: Outside the debris area (distance = ½ height under eaves) in escape tunnel for instance	Article 2.3.5.1

Ventilators — Article 2.3.3

Number of places in shelter[a]	Ventilator type number	Minimum ventilation capacity fresh air operation m^3/hr	Minimum ventilation capacity fresh air operation ft^3/min	Filter operation m^3/hr	Filter operation ft^3/min	Type of power	Power requirement (watts)
7	VA 20[b]	40	24	20	12	Manual	40
13	VA 40	80	48	40	24	Manual and electric	50
25	VA 75	150	90	75	40	Manual and electric	60
50	VA 150	300	180	150	90	Manual and electric	120

[a]In exceptional cases the number of places in the shelter may be increased by 10%.
[b]Only for one family houses.

10. Conduits — Section 2.4

Conduits in the shelter shell	Article 2.4.3.1
Only in the outer half of the shelter walls.	
The maximum cross-sectional area is ¼ d^2 without reinforcing the wall	
Conduits through the shelter wall	Article 2.4.3.1
Total cross-sectional area in any one wall maximum 600 cm^2 (93 sq in.)	
Conduits without double bend max 250 cm^2 (39 sq in.)	
Smooth finished openings max 150 cm^2 (24 sq in.)	Article 2.4.3.1
Water pipes up to 2 inch without special permission	Article 2.4.3.3
Sewer pipes	Article 2.4.3.2
Gas and fuel lines not allowed in shelters	Article 2.4.3.2
Communication A 20 cm (¾ inch) diam pipe must be provided in the exterior wall of each shelter	Article 2.4.3.2

11. Fuel tanks — Article 2.4.4

Underground

The minimum distance from the shelter wall is 1.5 m (5 ft) or the wall must be 50 cm (20 in.) thick

In the basement

Oil tanks of 10,000 to 20,000 l (2500 and 5000 gallons) must be 3 and 5 m (10 and 16 ft) respectively from the shelter or the shelter wall must be 75 cm (30 in.) thick (without opening)

Oil tanks of more than 20,000 l (5000 gallons) capacity require special authorization

In case of a leak the fuel must not be able to reach the shelter (i.e., place the tank in a basin)

Gasoline tanks require special authorization

Appendix B. List of Terms with Definitions

1. TERMS CONCERNING THE EFFECT OF WEAPONS

Fusion bomb

A nuclear bomb which releases its energy through melting of atomic nuclei.

Fission bomb

A nuclear bomb which releases energy through splitting of atomic nuclei.

Ground level, low, and high explosions

Indication of the relative height of a nuclear explosion above ground. Ground level means an explosion near the ground (forming a crater). Low and high designate an explosion of 1 KT equivalent energy at 100 to 200 m (300 or 600 ft) altitude respectively or an explosion of 1 MT equivalent energy at 1000 to 2000 m (3000 or 6000 ft) altitude respectively.

Conventional weapons

Explosive weapons which release energy through molecular reactions (explosive and incendiary bombs, grenades, fragmentation bombs, and shells).

Roentgen

Physical unit for measuring radiation intensity.

Rem

Unit for measuring the biological effect of radioactive radiation.

Fire load

Measure of the existing flammable material in the neighborhood of the shelter, such as kg of wood equivalent per sq meter of floor space (or pounds/sq ft of floor space).

Shock

Collective term for the maximum values of acceleration, velocity, and displacement to which the shelter, as a rigid body, is subjected by the pressure wave propagated through the ground.

Mechanical effects

Comprehensive term for loads due to air pressure, soil pressure, shocks, fragments, debris, etc.

Reflected pressure

That pressure which is created on the surface of a solid object when an expanding air blast strikes it. The reflected pressure is more than twice as great as the impinging pressure due to the compressibility of the air.

2. TERMS CONCERNING THE SHELTER AS A UNIT

Shelter unit

A shelter consisting of one single room for occupancy (the shelter cell) by not more than 50 persons.

Shelter group

A shelter, consisting of two to four shelter cells surrounded by one single shelter shell and provided with only one entrance.

Protective capacity

The sum of the protective effect offered by the shelter. For a comprehensive description one should include the maximum values of the effects of each type of weapon against which the shelter may offer some protection. In general only the maximum value for one single critical effect will be given, such as the peak value of the air blast resulting from a nuclear explosion in open terrain measured in atmospheres (i.e., atmospheres of excess pressure).

Shelter shell

The external elements (roof, walls, and floor) of the shelter which separate it from the unprotected surroundings.

Phases of operation

Specially defined conditions for which the shelter must fulfil a certain purpose or function (see section 1.3).

Unaided exit

The action of the surviving occupants of a shelter by which they free themselves from debris without outside help after an attack.

5% rule

An abbreviation for the rule, based on the Federal Law concerning the Structural Measures for Civil Defense of a 4 October 1963, which limits the additional costs for construction of a shelter to normally not more than 5% of the building costs.

3. TERMS CONCERNING SHELTER COMPONENTS

Exterior walls

Walls of the shelter shell.

Underground wall

A wall is against soil up to at least ceiling level.

Partially underground wall

A wall which is covered with soil to within at least 60 cm (two feet) of the ceiling height.

Free-standing wall

A shelter exterior wall which is not in a covered basement or covered with soil to within at least 60 cm (two feet) of the ceiling height.

Uncovered wall

A shelter wall which is in a covered basement.

Intermediate floor or wall

Floor or wall within the shelter shell.

Shelter in ground water

A shelter where the maximum yearly ground water level rises more than 50 cm (20 inches) above the shelter floor level.

Emergency exit

A comprehensive term for all sorts of exits which may be used when the surroundings are destroyed.

Air blast-proof escape passage

An emergency exit which leads out under the building with walls and roofs resistant to air blast. The exit from the shelter is by means of openings in the wall or an armoured door.

Emergency shaft

An emergency exit leading directly through the shelter shell to the building limits.

Escape tunnel

An underground emergency exit leading away from the building.

Escape chimney

An emergency exit consisting of an air blast proof vertical escape tube leading from the shelter above the expected level of debris.

Wall opening

An opening (protected with an armoured cover) in the shelter shell leading to an emergency exit.

Wall break-out panel

An opening in the partition wall between row houses which is closed off in peacetime, but which may be easily broken through in case of war for use as an emergency exit.

Debris area

The ground surface within which piles of debris may be expected to form when the building is destroyed. It extends a distance of ½H in all directions from the face of the building (H being the height under the eaves of that face of the building).

Armoured door PT

A door used to close the entrance through which the occupants pass into the shelter shell or the air lock (the protective capacity in accordance with specifications).

Armoured cover PD

A cover used to close openings in the shelter shell for emergency shafts, escape tunnels, escape chimneys and wall openings.

Pressure door DT

A shelter door which is built into partition walls within the shelter.

Standard door NT

Standard (not brittle) door with no protective effect used in non-structural partition walls.

Air lock

A room placed at the entrance of the shelter with two pressure- and gas-proof doors (PT) in sequence. One of the doors must always be closed. This makes traffic possible with the outside world without opening the shelter.

Decontamination room

A room placed at the entrance to the shelter which serves as a place to clean or change clothes contaminated with poison gas or radioactive dust carried by persons entering the shelter. It may also be used as a toilet or lavatory.

Blast protection valve

A check valve in the ventilation air intake which remains open during normal operation but will be closed automatically in a few milliseconds by an air blast and protect the ventilation system (filter) and the shelter from too great over pressure.

Pressure valve

A quick-closing valve in the air outlet which is opened sufficiently by an excess internal pressure of a few mm of water to permit the exhaust air to escape and closes automatically in case of excess pressue outside (or if the excess internal pressure drops).

Primary filter

A filter placed before the gas filter and the ventilator to eliminate the coarsest dirt from the intake air.

Fresh air operation

A mode of operation for the ventilating system in which the intake air is not drawn through the gas filter. In this mode the ventilating capacity is 6 m^3 (3.5 cu ft)/min per person.

Filter operation

A mode of operation for the ventilating system in which the intake air is passed through the gas filter. In this mode the ventilating capacity is 3 m^3 (1.75 cu ft)/min per person.

Non-civil-defense

All that which does not add to the protection of the shelter.

4. TERMS USED IN THE DESIGN OF THE SHELTER

Ultimate load method

A method of static calculation used to determine the rupture load for a supporting structure.

Failure, failure load

The limiting condition and limiting load, respectively, of a structure. No further loading is possible without inhibiting the function of the structure. The ultimate load is obtained by superposing the equivalent static load from the mechanical effects of weapons and loads acting simultaneously (i.e., dead weight).

Degree of plastic fixity

The ratio of the plastic bending moment over the supports to the bending moment in mid-span for beams or slabs.

Under-reinforced concrete cross-section

A cross-section for which an increase in the bending moment will stress the reinforcing beyond the elastic limit before the concrete fails in compression. (This definition, used in connection with the plastic design method, is different than that for an elastic under-reinforced section.)

Appendix C. A Typical Small Shelter

In order to simplify the final design and detailing for structures of secondary importance after the preliminary planning (data given in Chap. 2) the following almost complete designs for small shelters are presented. Since such typical plans are necessarily based on gross simplifications no special conditions for particular cases are considered. This saving of extra effort in the design at the cost of the quality of the solution is worthwhile only for small shelters. The design included here is therefore only applicable directly to 1 atmosphere shelters with no more than 25 places.

In addition the following conditions must be fulfilled in order to use the typical design:

1. The floor elevation must be above the ground water level.
2. The shelter ceiling must not extend more than 60 cm (2 ft) above ground level.
3. The ceiling height of the shelter must not exceed 2.4 m (7 ft 10 in.).
4. The shelter must be under a building.
5. The concrete cylinder compressive strength at 28 days must be at least 300 kg/cm^2 (3200 psi.).
6. The reinforcement steel must be type III (SIA code 162-1966).

If not all of these conditions are fulfilled the design must be prepared in accordance with chapter 3. The structural dimensions for the typical shelter are given in Table C-1. The reinforcement and the construction details are shown on the plan.

Table C-1. Concrete dimensions for a typical small shelter

Roof	35 cm	14 inches
Floor	20 cm	8 inches
Exterior walls:		
Toward the cellar (free-standing)	35 cm	14 inches
Underground wall (ceiling below ground level)	25 cm	10 inches
Partially underground wall (ceiling not more than 2 ft above ground)	50 cm	20 inches

Two-family House H. Müller, Bern

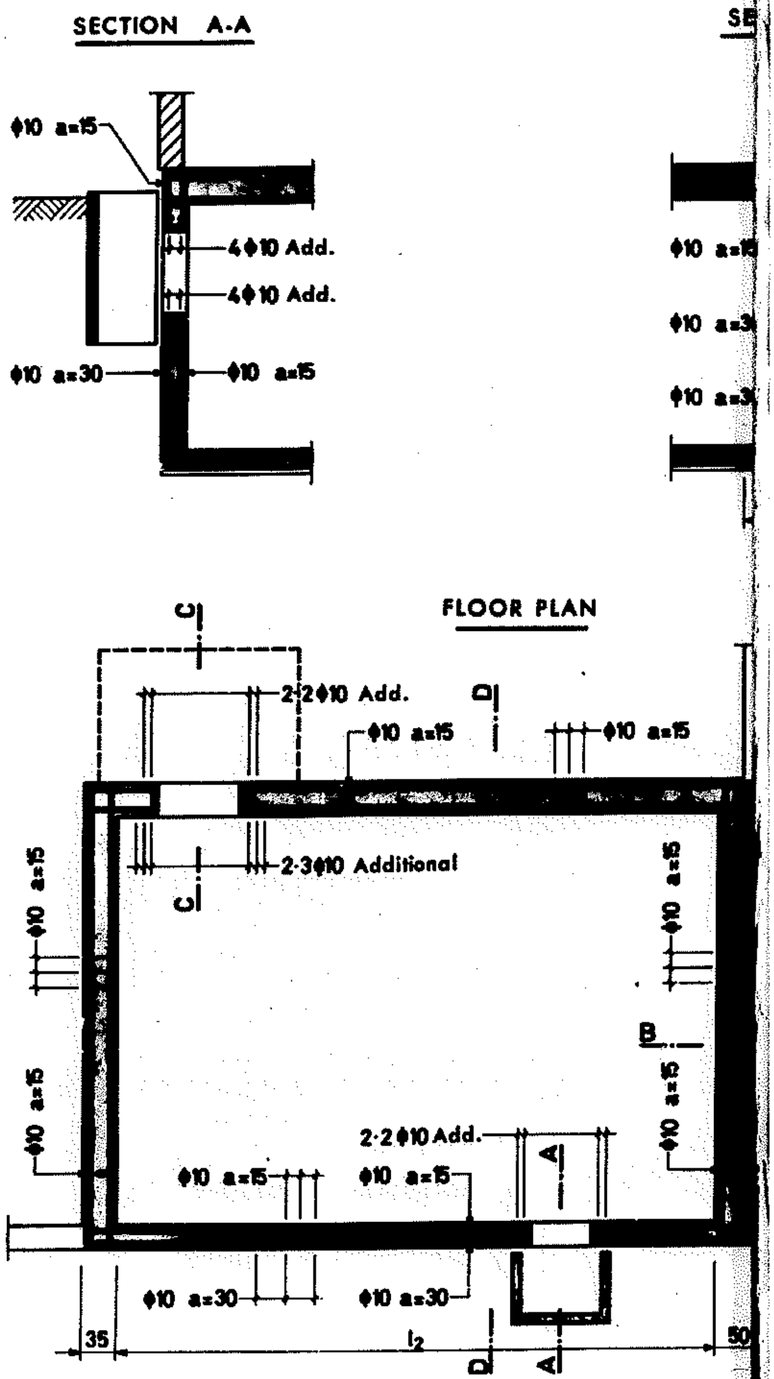
SMALL SHELTER

max. 25m²

REINFORCEMENT SCHEDULE

Bern, 1.April 1967

Consulting Engineering Office
P. Meier
Bern



Reinforcing Steel III
(z.B: Box-Ultra, Caron, Tor)

Concrete min. BH PC 250, β_{w28} = 300 kg/cm²

Steel Overlap
on Earth Side 2,5cm
in Building Interior 1.5cm

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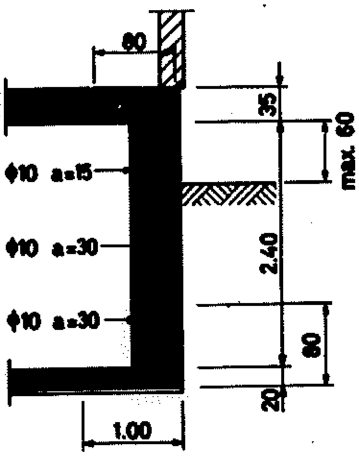
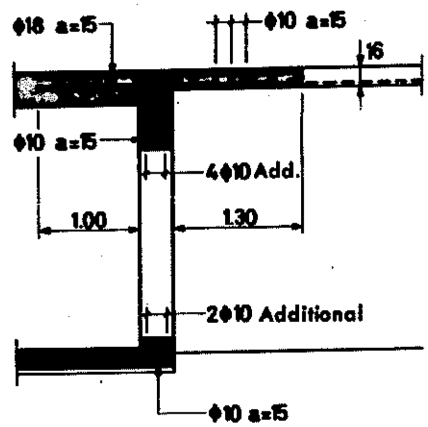
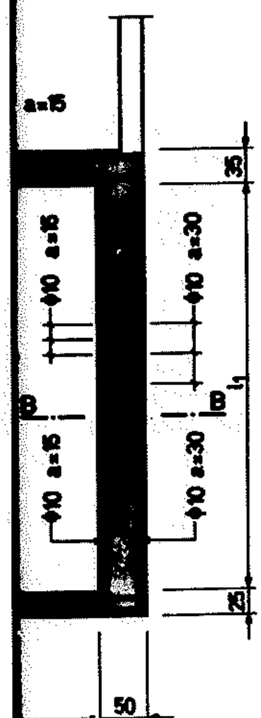
SECTION B-B

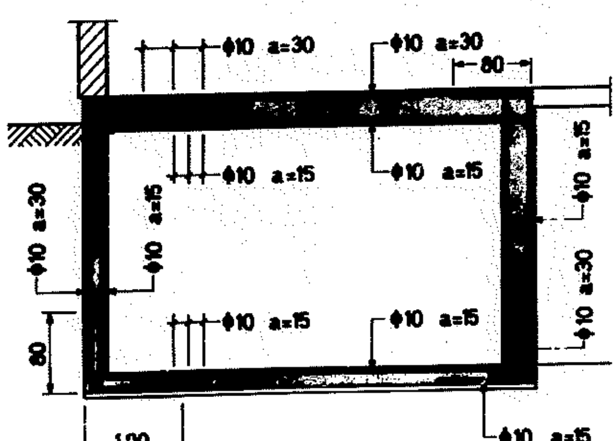


SECTION C-C





SECTION D-D



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Part II. The 1971 Conception of the Swiss Civil Defence

Report of the Federal Council to Parliament on the 1971 Conception of Civil Defence (of August 11, 1971)

Mr. President,
Gentlemen,

We have the honour to submit to you the 1971 conception of Swiss civil defence. We thus conform to the postulates of the Members of Parliament, Mr. Eisenring of March 18, 1965, concerning the studies made in view of an examination of the whole of the civil defence conception, Mr. Tschäppät of December 1, 1965, concerning the multipurpose constructions in connexion with civil defence, and Mr. Schürmann of March 17, 1970, concerning the transmission of the report of the Study Group.

SUMMARY

We ask you to take note of the present report and of the 1971 conception of civil defence. It is the result of studies carried out by the Committee for Civil Defence convened in 1966 by the Department of Justice and Police, in agreement with the Federal Council. The terms of reference of this Committee included, notably, a directive to obtain reliable data for the appreciation of the menace to the civil population and the possibilities of protection, as well as to work out a report thereon and proposals for a technically and financially practicable defence conception.

This report was submitted at the end of 1970. Its contents have met with our approval. It lays down the measures to be carried out for the protection of our civil population during the next two decades. The main emphasis of the measures, hitherto principally confined to rescue and relief, is now laid on precaution and prevention.

The realization of the 1971 civil defence conception is expected to require in the next 20 years, an aggregate expenditure of about 6.75 billions of francs. By virtue of the legislation now in force, the annual share to be borne by the Confederation will amount to about 180 million francs. In the order of its importance, this share corresponds to the expenditures foreseen within the framework of the longterm financial plan.

The two Federal laws governing civil defence and the measures of construction relative thereto, which date from the years 1962 and 1963, must be adapted to present conceptions. The revised proposals will be submitted to you in a separate communication.

I. THE 1962/63 CIVIL DEFENCE CONCEPTION

The hitherto existing conception of civil defence was based on the Federal law of March, 23, 1962, on the same subject and the Federal law of October 4, 1963, concerning the construction measures in civil defence. These were presented to you in the communication of October 6, 1961, and of September 21, 1962. They were based on the knowledge then at hand of the menaces to the population in case of armed conflicts, but for lack of scientific data, the effects of massive destruction by modern weapons could not be given the necessary consideration. This induced the Federal Department of Justice and Police on December 31, 1965, to set up a committee for the study of civil defence, with instructions to work out certain propositions, on the basis of reliable scientific documents, to establish a conception of civil defence which would be technically feasible and financially bearable. On December 30, 1970, the aforementioned committee submitted its report. The General Defence Staff approved it on February 4, 1971, and the General Defence Board did likewise on February 17, 1971. In the joint consultations with the various departments, some questions were raised and observations made. The supervisory board of the Study Group expressed its opinions at its meeting of July 19, 1971, and most of the suggestions made were taken into consideration when the text of the conception was finally drawn up.

By the resolution of August 11, 1971, we gave our approval to the report reproduced in the appendix as well as to the conception contained therein.

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II. THE WORK OF THE STUDY GROUP

The work of the Study Group has shown that the conception defined to date by the two laws, can be substantially maintained as it stands, but with certain modifications and additions. The examinations extended principally to the following spheres:

1. Menace

The 1962/63 conception was still based on the assumption that the menace to the civil population consisted predominantly of massive air attacks as carried out in the second world war. Inasmuch as these attacks were only aimed at localities of strategic importance, populated areas of less than 1,000 inhabitants were not obliged to organize civil defence and to erect shelters.

2. Warning

Our communication of October 6, 1961, while it drew attention to the shortening of the warning time due to increased flying speeds, still counted on the practicability of a timely warning to our civil population in case of air attacks.

3. Evacuations

The 1962/63 conception ruled out the possibility of mass evacuations, but envisaged the power to move, in an orderly fashion, the population resident in particularly menaced regions to a safe area or to an area sufficiently provided with shelters.

4. Rescue and medical assistance, self-preservation

Civil defence measures have hitherto been largely centered on rescue and medical assistance. It was incumbent on the local assistance organizations of the civil defence to repair the damage caused by air attacks. Only particularly menaced large communities were allotted air defence troops. Neighbouring or regional help have been, in principle, equally envisaged, but the planned creation of directive bodies from outside was never completed.

5. Shelters

It is true that the 1962/63 conception did not require the complete technical fitting out of shelters. Nevertheless, a great number of ventilated shelters were built, notably by virtue of article 2, paragraph 1, of the Federal law of October 4, 1963, concerning civil defence constructions. These shelters can also be used, without reservation in future, for the protection of the population. They form, therefore, a genuine basis for the further development of modern civil defence.

An improvement of the shelters erected from 1950 to 1960 by virtue of the Federal decree of December 21, 1950, was only envisaged in case of war. No provision was made for the modernization of non-ventilated shelters. This modernization, which must be carried out in peace time, can still be realized. Nevertheless, the expense incurred must be in reasonable proportion to the improvements envisaged.

III. TABLES OF FORESEEABLE MENACES DURING THE 1970'S AND THEIR INFLUENCES ON THE NEW CONCEPTION

In our report of June 6, 1966, concerning the conception of the country's military defence, as well as in our communication of October 30, 1968, regarding the Federal law on the organization of the directive bodies and the general defence council, we have presented the aspects and the forms of the menaces to be expected in the future. At the same time we have drawn the attention to the importance of civil defence as part of the Swiss national defence.

The table of anticipated menaces in the 1970's is largely characterised by modern arms of massive destruction (nuclear, bacteriological and chemical weapons). The effects of these weapons can extend over such large surfaces, that it is no longer possible to distinguish between "safe" and menaced regions in our country. Moreover, the use of these arms, especially modern rockets and airplanes, can cause surprise attacks. Our system of provisioning and the tendency of our population to concentrate in certain areas of our country, increase its vulnerability to attacks from arms of massive destruction. But since we have also to reckon with the use of conventional arms, the conception of our national defence must take into consideration their effects as well as those of arms of massive destruction.

The report of the Study Group outlines the essential principles to be followed in the setting up of the civil defence. Inasmuch as it is based on all forms of armed intervention which can be used in the foreseeable future, reckons with reasonable mounting expenditure and realises equally the peculiarities of the environment, one can believe that the new conception will be valid for rather a long time. Nevertheless, some adaptations will be inevitable due to the progress made in the development of arms. The 1971 conception outlines once more, the following essential directives:

1. Completion of the civil defence

Due to the fact that the menace is general and cannot be limited to certain areas, there must be a shelter place for every inhabitant. It is necessary to activate the construction of shelters and to order the erection of the latter in localities of less than 1,000 inhabitants where there still exists no obligation to provide them under the 1963 law.

2. Gradual and precautionary occupation of shelters

Inasmuch as there will not be time to give the civil population any warning of a surprise attack by new arms, the precautionary occupation of shelters must be ordered by the authorities, according to the political and military situation. This exigence necessitates, not only a sufficient appraisement of the situation, but also a clear ruling defining the responsibilities of the authorities charged with giving the order to occupy the shelters in good time and to coordinate this occupation in an orderly manner.

3. Renunciation to evacuations and movements of population

In view of the modern image of danger, it is evident that no region of our country is safe from attack. Owing to the unforeseeable duration and intensity of the effects of new arms, it is no longer possible to guarantee the provisioning of the evacuated population. The possibility of surprise attacks by such arms prevents large scale population movements. The only efficacious procedure in future wars consists of providing protection for the population in their own domiciles or in the immediate vicinity thereof. This can be achieved by the utilization of shelters and taking special measures in the domaine of organization and provisioning.

IV. NECESSARY FINANCE

As far as one can judge the present situation, in order to realise the 1971 conception of civil defence, the financial outlay will rise to some 6.75 billions of francs, which must be raised in about 20 years by the Confederation, the Cantons, the Municipalities, commercial firms and private individuals. This sum is composed of the following items:

	Millions of Francs
Shelters for persons (completion) Sanitary installations, command posts Assembly rooms for the civil defence organisations Reinforcements of the provisional shelters, pending their completion	5.570
Equipment, instruction, maintenance and administration	1.150
Scientific research and development	30
	6.750

Counting with an unchanged cost distributor, the Confederation's share of approximately 180 million francs corresponds to the expenditures for civil defence as foreseen within the framework of the long term Federal Government's financial plan.

V. CONCLUSIONS

The examination of the 1962/63 civil defence conception undertaken by the Study Group has shown that the planning in force up to the present is generally sound. Nevertheless, certain variations and supplementary measures, due to changes and increases of the dangers and menaces foreseeable in 1970, are advisable. This necessitates the adaptation of the two laws of 1962 and 1963 on civil defence to the conception of 1971.

We shall submit to you a special communication setting out the proposals for certain revisions and modifications which have become necessary as a result of experiences gained in the execution of the laws in question and by justified demands of the Cantons and the Municipalities. The distribution of costs between the Confederation, the Cantons and the Municipalities as envisaged by the two laws, must be particularly revised as requested by the Initiative of the Canton of Geneva, dated May 7, 1968, remitted to us by the Chamber of Deputies on June 4, 1968, and by the "Ständerat" (a legislative body with similar functions as the U.S. Senate) on June 6, 1968, by the interpellation of Mr. Diethelm, Member of Parliament, of December 3, 1968, and the postulates brought forward by Messrs. Rubi and Riesen, Members of Parliament, on June 4, 1969, and September 24, 1970, respectively.

The efforts for the realization of an efficient and effective civil defence are being pursued. In view of the clearly established aims and concrete conceptions for their realization, it should be possible to achieve gradually the stages of development we are striving for.

With reference to the foregoing, we have the honour to propose that action be taken on the present report according to the 1971 civil defence conception, and to shelve the postulates presented by the Members of Parliament, Messrs. Eisenring (No. 9210), Tschäppät (No. 9374) and Schürmann (No. 10538) of March 18, 1965, December 1, 1965 and March 17, 1970, respectively.

Berne, August 11, 1971

In the name of the
Swiss Federal Council,

Gnägi, President
Huber, Chancellor

The 1971 Conception of the Swiss Civil Defence

PREFACE

The solutior. of problems of national importance, particularly those which, in times of danger, influence the fate of the country and each inhabitant, requires a well-defined conception. This will include a general plan in which the wishes of the community can be carried out in an orderly and methodical manner. It must take into account the inalterable conditions of the country and of the world around in order to define the principles which are essential for solving the problems. The respect of the liberties of individuals on the one hand, and the necessity to find an efficacious and economical solution on the other hand, must largely determine the choice of principals serving as a basis for the conception.

The guarantee of an efficient all-embracing protection of the whole population within the sphere of our armed and protected neutrality, is the original conception of Swiss civil defence. The dangers of modern warfare, in particular those resulting from the use of a great number of arms of massive destruction, compel us to organize direct protection of the civil population.

This understanding induced the Federal Council in 1966 to recommend to the Federal Justice and Police Department to set up a study group for the civil defence with a view to examine the civil defence conception within the framework of Swiss natioial defence and to adapt it to the latest knowledge acquired in Switzerland and abroad. The following is the result of this work. It will serve as a basis to the organization and further development of our civil defence, and, at the same time, will form the departure point for the necessary adaptation of existing legislation.

The possibilities and methods of conducting a war, generally fall in line with scientific and technical development. In future years, our national defence will be periodically confronted with new situations. The conception of civil defence must keep pace with this irreversible evolution, on the one hand in the choice of fundamental principles, and on the other, in the periodical adaptation to the changing images of war. The legislation of 1962/63, compared to that of 1934 and 1950, give an example of this adaptation.

All branches of the national defence, especially the army, the civil defence and the war economy have to fulfil a common mission and are dependent on each other. They must synchronize their efforts and support each other even in peace time. The soldier must know that his family at home will be protected and cared for, otherwise he will lack one of the most important moral reasons to fight.

Civil defence measures encroach on the rights of the Confederation, the Cantons, the Municipalities and, above all, each citizen. For that reason, the basic principles of the conception are addressed to each and everyone. From these principles spring concrete measures in the fields of construction and organization. It is for the responsible branches of the Confederation, the Cantons and the Municipalities to carry out these measures. Hence the conception leads to a compulsory mandate for the authorities entrusted with the execution of the civil defence.

The present civil defence conception implies that the direction of the national defence organization operates coordinately at a high level. Moreover, it takes as an established fact that the army puts at the disposal of the civil defence, at least as many anti-aircraft troops as hitherto and that a particularly close collaboration with the territorial organization continues to exist.

The conception has to start from an assumed total war, which does not spare the civil population. Nevertheless, in expressing this assumption, it goes without saying, that Switzerland does not consider the different forms of total war normal or legal. On the contrary, everything possible should be done to preserve peace and – should this fail – the population must be protected as much as possible from the effects of modern arms, in compliance with international conventions.

Even if these efforts should fail and if the population were then exposed to the effects of modern weapons of massive destruction, the survival of the major part of the civil population would be assured – leave out the fact of total annihilation – thanks to the measures of protection foreseen in this conception. For that reason, the realization of these measures in the sphere of construction and of organization would permit our country to resist, faced with the possibility of nuclear blackmail.

December 30, 1970

CHAPTER I. FUNDAMENTAL PRINCIPLES

1.1 Tasks of the Civil Defence

The civil defence is part of our national defence. Proceeding from this principle, the Federal constitution and the Federal laws have created the basis for the implementation of civil defence. As well as being a balanced component within the framework of national defence, its tasks are as follows:

1. The civil defence must strengthen our country's capacity to resist attacks and attempts of blackmail by foreign powers and contribute, by its degree of credibility, to the safeguarding of our independence and to the integrality of our territory, even without total war.
2. In the state of armed neutrality and above all in case of war, the civil defence must, in collaboration with the army and the war economy, ensure that the greater part of the population survives and create favourable conditions for the future life and reconstruction of the country.
3. The civil defence, in collaboration with the existing civil administration and the army, particularly anti-aircraft troops, should be in a position to provide help in peace time catastrophes.

1.2 Image of War

1.2.1 Basis of the image of war. History and the daily events the world over eloquently show that future wars are still possible. Our people's determination to maintain an efficient national defence is based on this assumption.

The planning of protection against the effects of modern arms is founded on the fact that our country, at any given time, can be dragged into a war or even become the nerve center. It is difficult to predict what form this war will take.

The more completely we may succeed in drawing an accurate picture of a possible future war, the more precisely and effectively can the protective measures be planned and put into operation. There are two main obstacles against all efforts to determine the most efficient protective measures:

1. The uncertainty about the course which a future war as such will take.
2. The continuous perfectioning of arms and their mode of employment.

In spite of these facts, it is necessary to make the basis for the protection measures as solid as possible. This basis must be founded on the most reliable data, with particular reference to the probable aspects of war, viz:

1. From our knowledge of the presently existing means of attack and the perceptible tendencies of their future development.
2. From the study of the possibilities and the supposed intentions, as well as the methods of warfare of a potential aggressor of our country.

The inherent incertitudes, in spite of all, of the present assumption of the image of war, must be eliminated as far as possible when determining the measures of protection. Moreover, the rapid development in the technique of arms renders the periodic controls of all assumptions indispensible, as well as the eventual adaptation of the conception and of all the decisions which follow.

1.2.2 Menace. The various forms of aggression and destruction are naturally significantly different for the army and the civil population. Yet both elements are basically subject to the same menace. The conception of menace embraces all possibilities of the employment of military power against our country. This menace is explained in minute detail by the federal council's report to Parliament dated June 6, 1966, on the conception of our country's military defence. The findings contained in this report are valid even today. We can summarize them as follows:

1. In the European sphere there are two groups of opposing powers, each possessing huge stocks of weapons of massive destruction, the employment of which occupies an important place in their military planning and preparation. If in the near future Switzerland were to be involved in a war, in all

probability it would be a general war with the use of arms of massive destruction or under the constant threat of such an engagement.

2. Today there are certain indications of the relaxing of tension between the different groups of powers. Nevertheless, the probability of limited conflicts conducted with conventional arms increases, and so long as powers retain their stocks of arms of massive destruction, these conflicts can always contain a germ of nuclear war.

3. An important characteristic of modern armies is their equipment of nuclear arms destined for strategic, operational and tactical use. In the field of nuclear arms, the general tendency leads to an increase in number, to a greater shooting precision and an extension in their possible use. In consequence, it must be admitted that military and civil objectives which today are not nuclear targets may well be in the future.

4. Apart from being lavishly equipped with nuclear, chemical, and even bacteriological weapons, modern armies characterize themselves by their greater capacity to employ them more swiftly, more accurately, and over longer distances, from the ground, the air, and space. Moreover, they now have at their disposal conventional arms which are more powerful and of wider range.

1.2.3 Probable war images. A war image is largely influenced by the following factors:

1. An aggressor's intentions against our country.
2. His advantages over the means and times of attack as well as his strategic and operational conception.
3. Our own defence measures.

One of the principal characteristics of particular significance of modern war is the suddenness of attack by weapons of massive destruction, or, in other words, the briefest possible warning, which can vary from several minutes to none at all. The large number of rapid vectors in existence – rockets and satellites for example – limit the possibility of providing sufficient warning of such attacks.

The present conception, therefore, must forget the old idea of being able to give sufficient warning of attack. It depends, nevertheless, on the important fact that before a first engagement of arms of massive destruction, one sees a renewed outbreak of foreign political and military activity, which triggers off a pre-alert of several days or weeks. When establishing the most significant images of war, one realizes that an adversary will employ, according to his objectives and at an opportune moment, the means of combat which will offer him the best chances of obtaining his objective rapidly, while suffering himself the least possible losses.

The great number of possible images of war with which our country must count upon in case of conflict, taking into account the intentions of the aggressor, can be summarized, from the civil defence point of view, into the following four groups:

Blackmail. A powerful aggressor can try to compel our country to accept certain conditions by menace of the use of arms of massive destruction, or by taking economic sanctions against her. These threats could, for example, concern:

1. the supply or the transit of military material or other commodities;
2. the use of our air space or our territory for free passage;
3. the political capitulation.

The oppressor could probably provoke such situations by the help of well prepared actions of psychologic and subversive warfare. Should he fail to achieve his purpose, he may, for instance – by way of his first act of war – drop nuclear bombs on our country from great or very great heights. The effects of such actions would be extremely widespread, resulting in fires, annihilation of cultivations, and the total disruption of our telephone and radio communications. In this case, it is not yet a question, so to speak, of fighting on our territory. It is also conceivable that an aggressor could use conventional or nuclear weapons in order to destroy certain dams or dikes or to devastate vast regions, without specifically using arms of massive destruction against the population.

Limited use of arms of massive destruction. In the choice of his means of attack, an aggressor wanting to invade our country, will take into account the following factors:

1. the danger to his own troops by the use of his own armament;
2. the risk of undesired destruction of objects which he wished to make use of himself.

For that reason, for example, he will avoid the use of nuclear arms on the ground on account of the danger to his own troops from radio-active fall-out. Similar considerations apply to the unlimited use of bacteriologic and inert chemical means of combat.

It is possible that an aggressor will use arms of massive destruction even if he has the intention of taking advantage of our industry and man-power.

Our territory can also be violated by a power in the course of its operations directed against other powers. The attempt of a march through our country may require an efficient protection of the flanks by the use of armament. This would present the danger of a third power fighting the aggressor on our own territory with the use of arms of massive destruction.

The use of conventional arms. It is conceivable that an aggressor only intends to use conventional arms when attacking us, but even then the danger of an escalation leading to the use of arms of massive destruction is very great. Military operations using conventional weapons, would, in principle, have the same effect as during the second world war, but with considerable intensification due to increased firing power, greater mobility, amphibian operations, and air transport.

It is improbable that heavy bombardments such as those experienced during the second world war will be undertaken to destroy our cities. In order to attain such destruction, the aggressor has at his disposal today far more efficient, safer, and less costly means – nuclear weapons for example.

Wars started with conventional weapons always bring about the danger of an escalation into the use of weapons of massive destruction.

Strategic destruction. Any aggressor who has at his disposal a sufficient quantity of heavy caliber weapons of massive destruction, would, in principle, be in a position to destroy our country wholly or partly. He has now the choice between many effective ways of destruction; radioactive contamination, the annihilation of all surface construction by fire and pressure, and the destruction of infrastructures and shelters. There is little probability, but still a possibility, that the intention of an eventual aggressor would be to totally destroy our country.

1.2.4 Other dangers. Apart from the proper images of war which can be derived from the possible intentions of an aggressor, two other sorts of danger to the civil population must be considered:

War operations in neighbouring countries (possibility of violation of neutrality). In the case of military operations between other countries, Switzerland may suffer destruction and contamination without being directly involved in the war. It can be a question of, amongst other things, explosions of nuclear weapons in neighbouring countries with the corresponding radio-active fall-out. There exists also the possibility of explosions of nuclear weapons in our own country, for instance as a result of errors in the system of guided missiles or airplane crashes.

Catastrophes. These catastrophes have nothing in common with war operations, but they can, nevertheless, endanger the civil population as in the case of war. The principal dangers are as a result of accidents, always possible in factories and depots of nuclear arms situated abroad, crashes of atomic weapon carriers above or near our frontier with radio-active fall-out, accidents during transport of highly effective radio-active chemical and bacteriological substances, as well as accidents by explosions of important quantities of conventional explosives.

In the same category, it is necessary to mention the bursting of dams and dikes, as well as natural disasters such as storms, earthquakes, avalanches, inundations and landslides. Such catastrophes distinguish themselves from those which are engendered by wars by the fact that, outside the zone directly affected, all the means of rescue work are readily available (personnel, materials, means of transport, sanitary services). One can resort to far greater means of life-saving than in war time.

In war not only the extent of the damage is far greater, but also the rescue squads are hampered by obstacles which are non-existent in peace time. The organization of the rescue services is subject to altogether different rules from those in force when dealing with catastrophes in time of peace. In such situations, the personnel and equipment of the civil defence will be available as a means of supplementary assistance.

1.2.5 Relative importance to the effects of destruction by modern arms. The measures to be taken depend to a large degree on the relative importance of the different effects of destruction or contamination by modern arms. The different images of war clearly show that the principal emphasis must be placed on nuclear arms in view of their manifold and widespread effectiveness, their diversity of use and their ever growing stockpiling. Nuclear explosions produce pressure, heat, primary radio-active fall-out, shock, and electromagnetic impulse as direct effects. The indirect consequences are: conflagrations, build up of debris and rubble throwout, earth-scorching, interruptions of lines of communications, disorganization of supply and communications.

It is also necessary to take into consideration the use of conventional arms, chemical, and bacteriological weapons. Conventional arms can, firstly, cause incendiaries, explosions, and project splinters; chemical arms can cause poisoning of long duration and over a large surface and bacteriological arms produce widespread contamination.

Faced with the effects of these arms, above all with those of nuclear arms, but also conventional, chemical, and bacteriological arms, and studying detailed comparisons of the different possibilities of protection, one can conclude that only construction measures will achieve the aim mentioned at the beginning of this document. However, an absolute protection is hardly possible, because all known materials of construction, even concrete and steel, dissolve in the proximity of a nuclear explosion. In this connexion, if one could undertake effective construction, it would be necessary to envisage an expenditure so high that one would jeopardize the protection of the whole population. At a distance of 2.6 kilometers from the point of explosion of a bomb of one megatone, the population can expect to be reasonably protected from all effects of nuclear arms. Without any construction measures, an effective protection in this area would not be possible.

CHAPTER 2. MEASURES OF PROTECTION

2.1 General Principles

The planning of defence measures in favour of the civil population must of needs take into account the comprehensible fundamental ideas, which in turn are independent of civil defence.

The mental picture of War constitutes one of the groups of these data. Another group embodies the whole of particularities and contingencies peculiar to our people and our State. Among them, there are above all the financial means which the people are ready to assign to civil defence. To this group must be added the geographical division of our population, the knowledge acquired in the civil occupation and in the army, also the economical structure and topography of the country. The type of massive building comprising habitations and industrial complexes, especially the construction of cellars, represent one of the present particularities within the scope of the measures of protection with regard to constructions.

The principles of the conception and the measures following therefrom must be integrated in the framework of these data. They can be summed up in the following manner:

1. All defence measures must be planned in such a way as to render them independent of the War image.
2. All defence measures must tend to ensure maximum protection having regard to the foreseen expenditure.
3. All defence measures must bear in mind the physiological and psychological particularities of the human being.

2.1.1 Independence of defence measures in relation to the War image. As a principle, it would be wrong to model the defence measures on some exceptional contingencies brought about by War. Any enemy could, in fact, modify this strategy and aggression tactics in such a way as to render such measures ineffectual. The consequences would be the same following the creation of new arms and their possibility of employment.

Consequently, these defence measures must be independent of the ideas one has of certain known War aspects and they must be as efficacious as possible whatever these aspects. The following principles comply with these demands.

1. A place in a shelter for every inhabitant of Switzerland. The impossibility to foresee which regions of our country would be affected by the destruction and contamination prompts us to envisage the provision of a place of shelter for every Swiss inhabitant.

2. Preventive and gradual occupation of shelters as soon as political or military tension reaches a critical level. Attacks by carriers of modern weapons, such as rockets or satellites, are largely impossible to detect with sufficient speed. In most cases it is now impossible to foresee such actions some time ahead, in contrast to what was still possible during the second World War during raids by enemy air forces. Shelters are useless if they are empty at the time of the attack. The uncertainty as to the time of attack must be counteracted as follows: As soon as an increase in political or military tension can be ascertained or certain acts of War take place abroad, the population will be alerted and will occupy the shelters. Similar steps will be taken in the event of partial occupation of our country.

3. Ensure an autonomous sojourn in the shelter for several days or weeks. Certain weapons can have rather lasting effects, so that following such an attack man may be compelled to live for some time in the shelter without help from outside and cut off from peacetime facilities. In order to obviate as far as possible the inconveniences connected with the length of this sojourn, it is necessary to build, arrange, and equip the shelters so as to permit the stay of several days or weeks, interrupted by short pauses.

4. Building of simple and resistant shelters closed on all sides. In the shelters which are closed all round, the occupants need not concern themselves from where the effects of the weapons come. The conception and the construction of the shelters must be as simple as possible, with maximum resistance; this applies as much to the caisson (envelope) as to the interior arrangements and technical installations. The installations of the shelters are then less vulnerable and more efficient than in the case of too specialised and advanced dispositions.

5. No evacuation of the population. Modern methods of massive destruction, especially their employment with the element of surprise, practically forbid in our country the possibility of evacuating the population into "safe" areas. The deployment of arms of massive destruction from the air or from a neighbouring country can endanger all regions of our country, even the thinly populated areas. It would not be possible to guarantee the transfer of the population and their victualling at the reception centers, during War operations. Furthermore, such evacuation might hinder important actions undertaken within the scope of national defence. The uncertainty regarding the time and the duration of such evacuation would render such operation particularly difficult. Under modern War condition, evacuations on a large scale are ineffectual and even dangerous for Switzerland. One can and must avoid them, on condition that a place in a shelter be allocated to each inhabitant, at his domicile or at proximity thereof.

6. Diversification. The construction plans must show a certain diversity. This can quite easily be obtained by using the different existing possibilities. The shelters differ either by their position in a complex of buildings or in the ground, either by the mass of earth covering them or by their dimensions, the installations which they contain, etc. One has to exploit this diversity in order to avoid the general effect of protection measures losing simultaneously its efficacity, even in the case of the effects of unforeseeable destruction. One could thereby oppose the enemy with a varied series of means of protection of the population. Consequently, the population could hardly be gravely affected by a single attack.

2.1.2 Economic aspects. The extent of the protection measures is limited by the availability of funds of the confederation, the cantons, and the urban districts. To achieve maximum efficacity, one has to be guided by the following principles.

1. Absolute protection is impossible. The effects of nuclear weapons near the point of explosion are of such intensity that complete protection is technically unrealisable in the neighbouring zone. Against direct hits scored by bombs dropped from airplanes or by classical heavy artillery, protection by means of constructions is theoretically possible but unrealisable economically. There is therefore no absolute protection, whether it be against nuclear, classical, or B- and C-weapons. However, extensive research has proved that at a relatively short distance from the point of impact protection is technically possible. The achievement of a degree of protection of 1 atm, carried in certain cases to 3 atm, guarantees a high probability of survival and happens to be financially tolerable for the civil protection of our country.

2. Harmonizing protection measures. The various protection measures are interdependent. Thus the measure "construction of shelters" only makes sense if the measure "occupation of shelters" is carried out prior to an attack. Like a chain, the solidity of which depends on its weakest link, protection measures are only efficient as a whole if the efficiency of each of them is guaranteed during the whole duration of the war. The principle of harmonizing efforts pertains to all sections of civil defence, not only in regard to its conception, but also in the carrying out in detail of protection measures concerning constructions and organisation.

3. Best exploitation of all possibilities of protection. The peacetime structures of our country – fundamental element of civil defence – offer numerous possibilities in the domain of multiple utilisation of constructions and material. Cellars, garages, and underground storing places, adequate road tunnels etc., can be combined in the long term planning, with civil defence constructions. Certain existing constructions offer the possibility of fitting up makeshift shelters. Most suitable planning from an economic and organization point of view can be obtained by combining airraid shelters with constructions required by the civil defence organisms. The combining of elements of operation centers protected by installations of the same nature, of hospitals, should only be undertaken if this can be done without interfering with the principles of simplification and harmonization and if it is more economical than separate installations.

4. Previous planning of civil defence preparedness in regard to periods of increased danger. In the event of increased danger, Switzerland will be compelled to devote a larger part of its economy to national defence than in normal times. This planning covers above all the construction of makeshift shelters of all sorts, but also preventive measures against fire, radioactive fall-out, and other causes of destruction.

5. Prevention is better than cure. It is not only human, but also economically more advantageous to concentrate the efforts of civil defence primarily on preventive measures in favour of inhabitants, leaving the planning of lifesaving and medical help as a secondary urgency. By applying this principle to the preventive protection of persons, the importance and the cost of these measures can be reduced whilst rendering them more efficient.

6. Flexibility of protection measures. The dangers to be faced by the different sectors of civil defence cannot be precisely foreseen. To guard against this uncertainty, it is necessary to apply the organisation and construction plans with some flexibility. Estimated in view of maximum efficacity under average conditions, they must remain operative in the case of an increase of one of these duties, for example in the case of a larger number of casualties, even if it is to the detriment of comfort.

2.1.3 Considerations on account of physiological and psychological peculiarity of the individual. Civil defence is entirely geared on the protection of the individual, even if you include therein the protection of property of vital importance and of cultural value. In planning protection measures one must take into account the probable behaviour of the individual in wartime. The following four principles must be observed.

1. Maintaining natural communities, especially family circles. When allocating places in shelters and during the brief vacating of shelters in rotation, one must consider natural communities and especially family groups. Existing communities are better able to withstand danger periods than those gathered at random.

2. Man's capacity of adjustment. Experience has proved that, generally speaking, man can adapt himself to difficult situations. The more precarious the situation, the less comfort one expects to have. This establishment of fact is evident during all stages of occupation of shelters, from the period of peace to "pre-attack," during the transition from the period of "pre-attack" to the periods of attack and "post-attack" (see chapter 2.2.1).

3. Equal chances of survival for all. On principle, the same chance of survival during wartime must be offered to all inhabitants of our country. Man overcomes tests all the better if he shares them with his fellow creatures. The principle of equal chances for all does not preclude special safety precautions for certain sections of the civil defence organization. This measure is above all indicated where, thanks to this measure, the situation of the population as a whole can be improved. Besides, the realization of civil defence measures will bring about certain unavoidable differences from one shelter or community to another.

4. Guidance and assistance. People living in shelters need guidance and assistance. Preparing and carrying out these tasks are among the main duties of civil defence organisms. Only persons in charge and trained formations are capable of curbing disorder or panic in shelters. One of the principal conditions of keeping people in shelters calm and reflective is to keep them permanently informed. Therefore, it is indispensable to provide a well conceived system of liaison between the shelters and the central organization capable of functioning even after the attack.

2.2 Scope of Organization

2.2.1 Phases of action in civil defence. Modern civil defence must get rid of the old ideas of Air raid warnings; it can no longer count on the possibility of warning the population in good time. Nowadays, warning times are too short, and the length of the effects of certain weapons may prevent the occupants leaving the shelter for several days.

The planning of civil defence measures must take this reality judiciously into account. The staggering of operations will facilitate the solution of this problem. It will lead to the following phases:

1. Phase of peace. During this phase, no immediate danger is evident. Therefore, it should be used primarily for planning, preparation, and as far as possible for carrying out civil defence measures. During this period it is necessary that the means of civil defence (for instance shelters for persons) be made widely available for purposes other than for those intended, i.e., for peacetime use. Not only economic considerations apply, since the peacetime utilisation of the premises will facilitate their maintenance and that of technical installations. There is only one restriction to this rule, it is essential that all means of civil defence be ready to function at very short notice in case of emergency.

2. Pre-attack period. During this transition period, the organisms of civil defence are gradually put into operation. The shelters and the material used in peacetime will be prepared for functioning in case of anything grave happening. Makeshift shelters will be fitted out and installations and equipment of shelters will be completed. Then follows the order of gradual occupation of the shelters, according to the degree of danger.

The duration of the period preceding the attack is uncertain. It may extend over days and weeks. Since one has always to be ready to meet grave happenings, it is necessary that, on principle, the largest possible number of people should permanently occupy the shelters (some short interruptions in rotation are admissible). During this period, it is imperative to maintain the activity of certain vital branches of the economy, especially those connected with victualling. It is absolutely indispensable that these businesses be able to operate as long as possible, even in the difficult atmosphere of a permanent menace. One cannot do without the planning of essential services, taken in common accord, already prepared in peacetime, by the civil defence and the War economy. In this manner, one will be able to decide as to who will be permitted to leave the shelter to go to work and look after the activity of the vital branches of the economy. The material needs of the population locked up in shelters being fewer than in peacetime, only a small fraction of our economy, well organised, will suffice to ensure the provisioning. During a prolonged period of pre-attack, the danger of aggression will not be constant for days and weeks. According to the degree of momentaneous danger and the requirements of the war economy, the occupation of the shelters will vary between practically total and only partial occupation.

3. Period of attack. During this period, the shelter is exposed to the effects of weapons, pressure, splinters, debris, shock, primary radioactivity, electromagnetic effects, heat, intoxication, and contamination of the surroundings or effects resulting from certain catastrophes.

4. Post-attack period. The instantaneous effects of an attack having ceased to make themselves felt, it is probable that, even for a long time afterwards and according to its position in relation to the attacked objective, the shelter will be utilised as a protection against more lasting effects, such as fire, debris, radioactive fall-out, or chemical and bacteriological effects. This period is called "post-attack" phase.

In spite of these lasting effects, the occupants of the shelters must be able to continue to live in an autonomous manner, i.e., independent from the outer world. According to the nature of the durable effects, it can be a question of an autonomy permitting no contact with the outside world, or of an autonomy only as far as the provisioning (air, water, food, electricity) are concerned.

The degree of autonomy depends on the intensity of lasting effects. At the apparition of radioactive fall-out for instance, its intensity reaches its highest point shortly after the attack. then decreases progressively. It is therefore necessary that the occupants should remain in the closed shelter, especially after the attack.

After that, sojourns outside the shelter, first for short, later for longer periods, are possible. These sojourns will be employed above all to carry out the most urgent life-saving operations, applying always the principle of rotation. If no lasting effects, such as radioactive fall-out, effects of poisonous gas warfare, or bacteriological weapons are discerned, it will be possible to leave the shelter earlier, for instance even after a few minutes or a few hours after the attack. It will be up to the civil defence organisms to explain to the occupants the behaviour to adopt according to the situation and to act accordingly.

Outside help to the occupants of the shelters depends on the extent of the damage and the progressive disappearance of durable effects. If, contrary to what happened during the second world war, the shelter cannot generally be abandoned immediately after an attack, it must be able to fully cope with the situation, which means that the survival of the occupants should not be endangered, for instance by fire or debris. If large surfaces are affected, especially by radioactive fallout, a much longer period will pass until outside help can reach the shelter, if such help is still useful, inasmuch as the occupants have perhaps the possibility of getting themselves out of difficulty.

5. Reconstruction period. The transition from the post-attack period to the period of reconstruction takes place in stages, according to the appreciation by those in charge. During this period civil defense can only carry out the following tasks:

1. As soon as possible after the attacks, it will proceed methodically with the work of fire extinguishing, decontamination, and salvage. It can be efficiently assisted in these tasks by the anti-aircraft troops.
2. As the possibilities of staying outside the shelters progressively increase, civil defence personnel will take part in jobs of provisioning from external depots and the reconditioning of the substructure.

If, in the course of the post-attack and reconstruction period, new risks make themselves felt in certain regions, it will be necessary to take the measures which are foreseen for a new phase of pre-attack.

In case of vast destruction, the shelter, even if modest, will provide sufficient protection during this phase. Certain installations in the collective shelters and the shelters provided by local defence units will form the nucleus of a new system of supplying the population with water, food, and electric current from emergency generation plants. With the aid of these installations, it will also be possible to restore communications which have broken down as a result of these damages.

2.2.2 Principal duties of the Civil Defence Organisation. Since the first post war civil defence legislation, in 1950, but especially since the entry in force of the C.D. laws of 1962/63, important sums of money have been invested in defence measures, especially in the sector of constructions. The present aim is to be able to provide each inhabitant of Switzerland with a perfectly fitted up place in a shelter. This necessity causes important additional expense and these sacrifices will only be fully justified if the well instructed and well organised civil defence bodies are in a position to guarantee prompt occupation and utilisation of these shelters. These main tasks of the civil defence bodies logically follow the strict application of the principles governing each phase of action. This is a principle which, once again, deserves being specially underlined, because it will be in the future the most important leit-motif of the civil defence organisation; it is an undeniable fact that preventive measures for the protection of persons are the most efficacious ones and that they must have priority over measures of life saving and medical help.

1. Precautionary measures in favour of occupants of shelters. The organisms plan, arrange, and supervise the occupation and the utilisation of shelters as well as the feeding of its occupants. They assist the war economy in the provisioning of the population during the period preceding and following the attack and during the period of reconstruction.

2. Guidance, assistance, and information. The organisms direct and assist the occupants of shelters during the phases of pre-attack, attack, and post-attack. They continually keep the population acquainted with the development of the situation in the domain of civil defence. They give guidance as to the occupation and the abandoning of shelters. Safe systems of transmission must allow the organisms to maintain the necessary liaison between all echelons and especially to keep in contact with the population sojourning in the shelters.

3. Life saving and medical care. After an attack, the C.D. bodies commence as soon as possible the systematic tasks of fire extinguishing, ground clearance, decontamination, life saving, and assistance to injured people. Mobility in the engagement and flexibility of methods must enable them to cope with these tasks, within the framework of regional aid, at least in the bordering zones of destruction.

4. Supra-local instrument of direction. In order to overcome a disastrous situation, every time the occasion arises, it is necessary, in good time, to have a regional civil management. Once the event has taken place, it is too late to improvise. It must be set up in peacetime and based on the territorial service organisation; close cooperation with the army headquarters and the War economy is indispensable.

5. Steps to take during the transition period. Some considerable time will elapse before each inhabitant will have at his disposal a place in a fully equipped shelter. During this period, the insufficiency of protected places, albeit in constant regression, is none the less evident. The risks ascribed to this situation can and must be reduced to a minimum. It is the duty of the civil defence organisation to see that the whole of the existing protection possibilities can be exploited at any moment of this transition period. The precaution consists in recognising the possibility of fitting up makeshift shelters to ensure the quick availability of the material necessary for their equipment, as well as constantly preparing and adapting the general plans of civil defence (see general planning of civil defence, item 2.4).

2.3 Measures Regarding the Construction of Shelters

2.3.1 Extent and degree of protection. The effects of modern arms are numerous and various according to the nature of each weapon. Nevertheless, the shelters must be built and equipped in such a way as to withstand these effects in a well defined measure. The whole of effects from which the shelter offers protection is called the "extent of protection." The effectiveness of protection against the particular effect of a weapon is called "degree of protection." This degree of protection – according to the principle of "harmonising measure of protection" – must be selected in such a manner as to enable a shelter to resist uniformly all effects of weapons, which a certain "War image" can produce.

The shelters must provide protection against a certain number of effects from nuclear, classic, chemical, and bacteriological weapons. The effectiveness of this protection (degree of protection) is laid down as follows for each type of weapon:

Nuclear weapons. The explosion of medium and large calibre nuclear arms provokes an over-pressure in the atmosphere affecting large surfaces. It is therefore essential to build the shelters in such a manner as to ensure the survival of the occupants at a reasonably short distance from the point of explosion for the atmospheric overpressure to be reduced to 1 atm. At the same time, one has to take into account all the other effects discernible at this distance, such as primary radiation, heat, radio-active fall-out, collapse of buildings, and fires. Shelters which fulfil all these conditions have the degree of 1 atm overpressure protection.

The long duration of the effects of certain weapons makes it essential that all shelters be equipped with drinking water, foodstuffs, and adequate material for an autonomous period of maximum 2 to 4 weeks.

The 1 atm degree of over-pressure protection is based on very extensive theoretical research on the probability of losses in case of nuclear explosions. Furthermore, practical experiences acquired until now prove that the 1 atm degree of overpressure protection suits perfectly our widespread practice of erecting shelters in the cellars of buildings. Since, in certain forms of warfare, one has to expect vast destruction of surface construction, it is advisable to provide shelters of sufficient resistance so as to be still intact when the buildings are destroyed. The 1 atm degree of overpressure protection perfectly meets this requirement.

Classic weapons. Shelters offering a 1 atm degree of overpressure protection against nuclear weapons guarantee also good protection against nearby explosion of classic weapons.

Chemical and bacteriological weapons. It is necessary to prevent substances of chemical and bacteriological warfare penetrating into the shelters. Only few openings in the outer cover of the shelter and which can be closed hermetically, as well as a device of artificial ventilation with filters and creating an interior overpressure, will ensure this protection.

Increased degree of protection. In certain cases, the increase of the degree of overpressure protection from 1 to 3 atm is justified, especially when it is a question of large collective shelters. The shelters of civil defence bodies and medical services have an important mission to accomplish; for instance, command stations, sanitary emergency posts, and protected operation centers of hospitals must also enjoy a higher degree of protection.

Generally speaking, wherever there are possibilities of increased protection due to normal factors, they must be exploited to the full. For installations erected in rocks, an improvement of the degree of protection up to 9 atm of overpressure is fully justified.

2.3.2 Elaboration of protection measures in the matter of constructions. Preventive protection of the population by preparing shelters in sufficient numbers is the most efficient and most urgent task of civil defence in the matter of constructions. Thus, the loss in human lives and the number of casualties to be cared for can be reduced to a minimal part of the estimation concerning a population which is not or only insufficiently protected. The main effort must conduce to providing every inhabitant with a sufficiently protected place. The "war images" and the action phases betoken moreover that this protected place must be at the domicile of each inhabitant or at proximity thereof.

For a certain part of the active population, it is necessary to fit up additional protected places at their place of work. This concerns above all the personnel of enterprises which are vital to our economy, as well as part of public services which are required to function in spite of an increased danger of attack. The requirements and choice of the site of all protection constructions must be determined within the framework of local and regional general planning of shelters. By applying the principle of diversification, one must conceive a protection system which would be hard for the enemy to locate. First class planning can considerably improve the efficiency of the whole system of protection constructions.

Wherever this is possible, it will be necessary to join the collective shelters and those of the civil defence bodies into veritable islands of survival. The result will be greater flexibility of the organisation, better assistance to the population as well as an appreciable economy in the construction of shelters. When planning collective shelters, it is advisable to pay particular attention to the growing problems of construction and organisation as far as the occupation, the management, the assistance, and the provisioning are concerned.

Constructions destined for the medical services must be adapted to the diversity of the care which they are to provide. That is why flexibility is of primordial importance when fitting out the interior of these constructions. They must be conceived to allow the passing over from peacetime treatment of a restricted number of injured people to giving first aid to a large number of casualties.

Stocks of goods of vital importance, such as foodstuffs, fuel, medical supplies, etc., must be protected as much as possible so as to remain intact for reconstruction after the attack. The protection of these commodities can often be assured by makeshift means.

2.4 Planning

The application of protection measures in the matter of constructions and organisation requires constant adaptation during the preparatory stage reached at a certain moment. Close collaboration with other public and private planning sectors is indispensable in order to ensure that the invested means will offer the population as complete as possible protection. The realisation of construction and organisation measures must result from planning and systematic and long term co-ordination.

The requirements, the additional problems, and the means of civil defence must be studied and planned within the regional plans and in close coordination with the requirements of other regional planning such as housing, lines of communication, etc. According to local conditions, one region may comprise all or part of or even several urban districts. The results of this study lead to the general planning of civil defence, representing an addition to the present civil defence apparatus. It covers the principles of specific planning of all protection measures in the area. The aim of civil defence planning is to attain a definite setting up of a protected place for each inhabitant and to providing the equipment necessary for that purpose. It also takes into consideration the transition period up to the final arrangement and includes the following essential points:

1. Assessment of the vulnerability of an area from a point of view of civil defence: zones of debris, fire, floods, submersion, landslides, particular danger on account of the proximity of objectives liable to be attacked, such as military and industrial installations and lines of communications.
2. Assessment of the present distribution of inhabitants, the type, the number, and position of existing shelters and the number of places lacking protection.
3. Assessment of possibilities of supplying goods of vital importance for the sojourn in the shelter, work connected with life saving, removal of debris, and reconstruction work inasmuch as these duties are not incumbent on the War economy.
4. Appreciation of the present state of civil defence constructions. Recording of the possibilities of fitting up makeshift shelters and measures to be taken in case of surprise attacks by classic weapons. Planning of the distribution of the population in the different shelters and makeshift shelters.
5. Assessment of the possibilities of definitely remedying the lack of shelters in the district. Determination of the situation, the lodging capacity, and the reception perimeter of public shelters. Elaboration of the principles for a prospective planning of protection constructions linked with the long term financial planning of the district authorities.
6. Appreciation of the permanent situation of the district with regard to constructions taking into account any foreseen extension, i.e., until exhaustion of all construction possibilities of the district. Establishing the legal basis applicable to specified cases and aiming at releasing the obligation to construct and the financial participation in the construction of existing collective shelters and those still to be erected.
7. Planning of the general structure of civil defence organisation taking always into account the situation of shelters for persons.

CHAPTER 3. EXECUTION

3.1 Financial Planning in the Course of Time

The basic principles applicable to the whole of construction and organisation measures, presented in this conception, roughly determine the necessary expense and its sharing in the course of time.

To accomplish this task, long term general planning of expenses and the required time is necessary, apart from the special technical planning. For this purpose, a general investigation has been made as to the present position (1969) and the anticipated future state at the time of its definite setting up of civil defence. On this basis, it was possible to estimate the future evolution of annual investments, the total expenditure foreseen as well as the time required for achieving the final objective. They are approximate estimations based above all on experience acquired, and which cannot, consequently, be considered as a hard and fast rule. As far as possible, and within the scope of these researches, one has taken into account the restrictions imposed by the general financial plan of the authorities, and the anticipated capacity of the administration, the industry, and the economy.

These indications are only general guiding rules for the next few years and represent in no case a rigid financial plan. They must, therefore, be periodically reviewed.

In the course of these revisions, one will take into account new experiences acquired in the meantime and knowledge resulting from constant development of technique.

3.2 Present Position

Civil defence construction and organisation measures which have been realised up to this date (1969) belong to two distinct periods. Prior to 1960, the planning of shelters was based as a rule on the experiences gained from the second World War. Some of these shelters are not yet equipped with artificial ventilation and according to the limited knowledge acquired in those days, they offer insufficient protection against the effects of nuclear weapons. In the future, and until completion of the program of construction, such constructions can, in many cases, only serve as makeshift shelters. In principle, shelters built since 1960 have artificial ventilation. It is only since 1964 that the planning of the extent and degree of protection offered by them is based on sure knowledge of the effects of nuclear arms.

For the whole of our country, we have now (end of 1969) shelters offering protected places for about 3.1 million persons. We estimate that approximately 1.9 million of these places reach the extent and the degree of 1 atm overpressure, representing for the present population of about 6 million people about 30% of the volume to be constructed. Apart from that, we have at our disposal 1.2 million makeshift shelters.

Even now, in the domain of general organisation, we attach more importance to life-saving than to preventive measures. This situation finds its counterpart in the apportionment of the local civil defence personnel and to the importance now assigned to the total strength and the engagement of men in charge of buildings.

In most urban districts, whose duty it is to organise civil defence, the plans correspond to the prescriptions, which have been in force until now. In the urban districts, which have not been subjected to this duty, no preparation or construction is in progress.

Since 1964, the instruction takes its inspiration from the principle of training the personnel from "bottom to top," putting the accent on fire extinguishing and life-saving detachments. This fact causes considerable difficulties to the Cantons and municipalities. The setting up of well prepared formations is delayed by the lack of trained personnel of all ranks. The materials supplied to the communities obliged to organise Civil Defence mainly consist of fire extinguishing and life saving equipment.

3.3 Objective of Planning

In the matter of construction, this objective comprises on the one hand the preparation of shelters for the whole of the population and on the other hand the construction of special installations for the civil defence leaders. The latter comprises shelters for the directing bodies, the medical service, life-saving services, and the establishments of vital importance, their setting up, and their equipment.

From an organization point of view, the first task is the choice and the training of the ranks of the civil defence personnel, as well as the information of the authorities and the population. Bearing in mind the cost evaluation of these measures, financially bearable, and the desirable speed with which the objective is to be achieved, the delay has been fixed at 15 to 20 years. Thus, the final equipment for a population estimated at 7.5 million inhabitants would be realized in the years 1986 to 1990.

Departing from the present state of realizations in the domain of civil defence construction and organization, one has to reckon with a total expenditure for these 15 to 20 years of about 6.75 billions of francs at their present value. The share of this expenditure to be met by the Confederation is roughly equal to the provisions of its long-term financial plan.

On the basis of the present conception, it is not possible to accurately fix neither the availability of these means during this period of 15 to 20 years nor their appropriation to the various categories of measures. The main efforts and the dominant tendencies can be summarised as follows:

1. The most urgent measure is the organisation of general and complete planning of civil defence in all urban districts and all regions, in order to ensure that the bulk of investments earmarked for the construction be used well and judiciously co-ordinated.

2. Unquestionably and true to the precept that "prevention is better than cure," the principal effort in the matter of constructions must be the providing of shelters for persons. On the average, 300,000 new protected places must be built every year. The proportion of the investments foreseen for the construction of shelters and those destined for the medical services and other installations of the organisation is now of about 2:1. In the future, this proportion must be seriously improved in favour of the population.

3. The census and the planned preparation of protection in improvised shelters are of primary necessity, because they will be especially needed during the coming years. Even today, about half the population has no protected place.

4. Marked prioiority must be given to the preventive occupation of the shelters by establishing legal basis and adequate measures of organisation.

5. Research is an important and permanent mission since it requires only relatively insignificant financial outlay. It must attentively follow the evolution of new weapons, their effects, and the changed aspects of War resulting therefrom. It must also analyse the importance of these changes, their incidence upon special measures, and the very conception of civil defence. Thus, research is indispensable in order to guarantee that the measures now taken will not one day be overtaken without noticing it.

6. Local defence bodies and guardians of buildings must adapt themselves to the principle of priority for the preventive protection of the population. At the same time, one must above all consider the conditions of lengthy occupation of shelters. As far as the districts are concerned which are not yet subjected to compulsory civil defence, one must

prepare the necessary basis – particularly the legal basis – for the application of the principles of the conception regarding constructions and organisation.

7. The higher ranks of civil defence, especially cantonal chiefs, local chiefs, service chiefs, heads of enterprises which are vital in wartime, and leaders of shelters must be urgently instructed in the general lines of this conception. This instruction will be completed and continually adapted to the evolution of the general aspects of war. The choice of higher ranks and their instruction already in time of peace must be undertaken – with regard to national defence – keeping in close contact with the army, the War economy, and the civil authorities.

8. The choice and the supply of civil defence material, the informing of the authorities, and the instruction of the population must be adapted, in collaboration with the army, to the new conception and accelerated in the near future.

9. Existing gaps in the preparation and instruction of the staff of civil regional bodies must be made good.

10. Training for the collaboration between the ranks, the formation of civil protection, and the antiaircraft protection must also be adapted to the new conception and intensified.

11. One must continue the instruction in the domain of national defence with a view to collaborating with the territorial organisation, the army headquarters, and army units, always taking into consideration the new conception. The first step to take in this direction is the systematic information of the Command headquarters.

12. Civil defence must also maintain close collaboration with those in charge of National Defence, especially when organising the general medical services and the services of A/C-defence. This collaboration must be particularly close in the domain of research.

CHAPTER 4. SUMMARY

The conception of civil defence originates from the idea that the eventuality of being touched directly or indirectly by war cannot be excluded.

Civil defence is part and parcel of National Defence. Jointly with the army in particular, its mission, thanks to good preparation, is to contribute to render the possibility of an attack or an attempt at blackmail against our country less and less probable. If, in spite of all this, our country were involved in a war, civil defence must assure the safety of the majority of the population and guarantee its survival.

The duties imposed on civil defence derive from the idea of a possible future war bearing in mind the particularities of our country and of our people.

The greatest danger menacing our civil population comes from nuclear weapons, on account of their large surface action, their numerous and surprising engagement possibilities, and the persistence of their effects. The devastation created by nuclear weapons and other arms of massive destruction is such that in case of a possible conflict, it must exclude any distinction between military combat zones and zones of habitation in our densely populated country. As to the classical arms, they have considerably progressed in fire power, frequency of engagement, and firing precision as compared with those of the second World War. They must therefore be taken into consideration. Bacteriological and chemical weapons represent, by reason of the intensity of their effects and the large possibilities of engagement, the third important group in the image of war. Already in peacetime, catastrophes can occur as a result of accidents in factories and atomic arms depots situated abroad, atomic explosions triggered off by mistake, of accidents due to radio-active, chemical, or bacteriological material. Furthermore, there is always the possibility of natural catastrophes.

The second group of duties justifying the existence of civil defence are "internal" duties. One assumes that the people are ready to contribute to the cost of a larger extension of modern civil defence. This expenditure is made within the framework of long term financial planning of the Confederation. Existing conditions, especially the custom of building cellars in new buildings, also topographical and geological conditions facilitate civil defence constructions, whilst the training of civil and military persons belonging to civil defence creates conditions which are favourable for the development of the protection bodies.

From the objective of civil defence on the one hand and its servitudes on the other emerge some general principles forming the nucleus of the new conception and which can be divided into three groups:

I. Independence in regard to the image of war. It is possible to diminish the uncertainty regarding the image of a future war by adopting the following six principles:

1. A shelter for each inhabitant of Switzerland. Thus, the problem of the uncertainty as to the locality of the effects of arms is lessened.

2. Preventive and staggered occupation of the shelters. Warning times becoming ever shorter, it must be possible to occupy shelters progressively, when political and military tension reaches a critical stage.

3. The guarantee of a place in a shelter which is independent of the exterior. The uncertainty regarding the duration of the effects of arms and the consequences of the annihilation of peacetime structure must be compensated by the possibility of a place in a shelter for days and weeks. Short interruptions before and, according to the situation, after the attack will render this sojourn more bearable (principle of rotation).

4. The construction of simple and resisting shelters, protected from all sides. Thanks to this principle it is not important to know from which direction the effects of weapons make themselves felt. Shelters too specialised and complicated soon become obsolete; they are more vulnerable and they complicate their use.

5. No evacuation of the population. By reasons of the great efficacity and the uncertainty of the duration of the engagement of modern weapons of massive destruction, there will be no more safe areas in the event of a future war. "Vertical evacuation" i.e., in shelters, is the most efficacious means of survival.

6. Diversification. The exploitation of a diversity of organisation and construction measures will permit the avoidance of an aggressor knocking our population hard and the whole of our protection measures breaking down.

2. Economy. The aim of civil defence is the survival of the largest part of our population in the event of war. All preparations aiming at the realisation of this objective must be undertaken bearing in mind their economic aspects. The following six principles derive therefrom:

1. There is no absolute protection. Technically, absolute protection, i.e., survival at immediate proximity of the impact of modern weapons, is impossible. Within reasonable limits, it is however possible to afford efficient protection for each inhabitant of Switzerland and if such protection is well conceived, it will guarantee high probability of survival.

2. Harmonizing protection measures. A whole chain of construction and organisation measures are necessary to guarantee survival, and the strength of the chain depends on its weakest link.

3. Best use of all protection possibilities. Most shelters can certainly be constructed in Switzerland in a more economical manner if they can be combined with cellars and other peacetime basement constructions.

4. More urgent planning to be prepared in periods of danger. The transformation of cellars into makeshift shelters must be planned in peacetime, so as to make them ready if war should break out at a time when the final setting up of defence protection is not yet completed.

5. Prevention is better than cure. Precautionary protection of persons is the most efficient measure, i.e., the most economical and the most human one. Measures of life-saving and medical care are subordinate to this principal task of civil defence.

6. Capacity of adaptation. Measures of construction and organisation, tributaries of the diversity of needs arising during war time, must be characterised by a certain flexibility, and they must not be conceived to meet the worst only.

3. Considerations on physiological and psychological factors of the human being. It is the human being that is the center point of civil defence. One must take into account his behaviour in wartime and in times of stress, bearing in mind the following principles:

1. Holding family circles together. Preventive occupation of shelters must be prepared in such a manner as to guarantee the maintenance of family units in case of grave events.

2. Adaptation capacity of man. In case of grave events, peacetime comfort can be seriously curtailed, especially in shelters.

3. Equal chances of survival for all. A human being will bear ordeals much better if he can share them with his fellow creature.

4. Guidance and assistance. Trained persons in charge of shelters are able to teach the population how to withstand even difficult situations in shelters and to organise assistance.

The tasks and concrete organisation and construction measures issue from these general principles. These two groups of measures are constantly reviewed, taking into account the following five action phases:

1. The peacetime period, during which civil defence preparations must be taken in hand and the population informed of possible grave events.

2. The pre-attack period, in which the shelters are occupied in stages according to the growing degree of political and military tension, and the protection preparations completed as rapidly as possible in accordance with the projected planning.
3. Period of attack, characterised by the actual deployment of arms and by the sojourn of the population in closed shelters.
4. The post-attack period, during which, according to the nature of the aggression, shelters must remain occupied for shorter or longer periods and function in an autonomous manner.
5. The reconstruction period, which prepares the post-war period, and during which Civil Defence helps to gradually resume the peacetime economy.

The tasks of the civil defence mainly consist of:

1. Forethought in favour of the occupants of shelters, especially during their occupation and use of shelters.
2. Guidance, assistance, and information of the population during the different periods.
3. Life-saving and care, with the precise and limited means in time and space, according to the situation and possibilities of mutual relief.
4. Regional direction, in collaboration with military headquarters.
5. Measures to be taken during the transition period, in the event of war breaking out before the final setting up of civil defence installations.

As far as the measures in the matter of construction is concerned, it is fitting, first of all, to fix the extent and the degree of protection. Against nuclear explosions, a degree of protection of at least 1 atm overpressure is required. At the same time, one must take into account all the other effects of this weapon arising simultaneously. In case of warfare by classic weapons, one takes into account close action, and against chemical and bacteriological weapons, one will provide protection by the appliance of artificial ventilation equipped with gas filters.

The planning of organisation and construction measures must take place within the framework of "General Civil Defence Planning".

1. It takes into account the conditions which interest the civil defence in a district, such as danger of debris, fire, landslide, flood, submersion, and others.
2. It inquires into the present distribution of inhabitants, the type, the number, and the site of existing shelters.
3. It indicates the possibilities of getting supplies of vital importance and means of life-saving and reconstruction.
4. It reveals the figures relating to the present state of makeshift shelters and the distribution of population in the shelters.
5. It assists in the drawing up of detailed plans designed to remedy the lack of protected places.
6. It objectively determines the situation and the size of civil defence organisation constructions, taking into consideration the whole of the protection structure of the district.

The efforts made until today for civil defence already show interesting realisations. Out of the 3.1 millions of protected places existing at the end of 1969, 1.9 million offer the required degree of protection, whereas the others represent good makeshift shelters until such time as the construction program is completed. In the domain of the organisation, the civil defence constructions supply important data for the acquisition of material and for the instruction.

The aim of the planning consists in ensuring that from now until 1985/1990 there will be a protected place for each of the 7.5 million inhabitants which our country will have by then. The main accent of the efforts must bear on:

1. the general planning of civil defence with an eye to an efficient and coordinated engagement of investments,
2. the setting up of about 300,000 protected places every year, especially in the zones of old constructions of districts now committed to creating civil defence bodies and all those which are not yet bound to do so.
3. the planning of the construction of makeshift shelters and their utilisation pending the completion of their setting up.
4. the preparation of the preventive occupation of shelters on the necessary legal basis,
5. the pursuit of research to maintain a level of constructions and organization in line with the development of armaments,
6. the training of local defence bodies, with priority for preventive protection,
7. the training of all ranks and especially of those in charge of the civil defence in the Cantons and Municipalities, the supply of material, the information to the authorities and the population,

8. the appointment of regional directors,
9. the collaboration with headquarters of army command and the war economy,
10. the collaboration in the domain of national defence.

APPENDIX: ALPHABETICAL INDEX OF USUAL TERMS

Catastrophe

Damaging event of great extent, unforeseen, not imputable to war action, but which brings about dangers for the civil population of the same magnitude as those presented by the various war aspects.

Collective Shelter

A shelter which can receive at the most some thousand persons and meeting the requirements of protected places in a densely populated area not provided with private shelters. The size of this area is fixed by the capacity of reception and the time required to reach the shelters.

Conventional Arms

Weapons of all kinds, to the exclusion of nuclear, chemical, and bacteriological arms.

Danger

Totality of possible noxious effects on persons and property, on which one has to count in specified areas.

Degree of Protection

Efficacity of protection against the effects of a weapon, sufficient to allow the shelter to remain in service. Example: shelter with a degree of 1 atm protection = shelter which can resist an atmospheric over-pressure of 1 atm (atmospheric pressure of 10 tons per m2).

Degree of Realisations

Percentage of the program of construction of shelters realised at a given moment. For the construction of shelters for persons, it is a question of the percentage of the population having at its disposal a protected place, in proportion to the total population of a given region.

Delay of Forewarning

Period comprised between the first signs of danger and the effective engagement of the weapons.

Dissuasion

Ability to influence the will of an eventual aggressor to induce him to give up hostile acts by persuading him that he would have more to lose than to gain in a conflict and that he would in no case obtain the anticipated advantages.

Diversification

Basic principle of planning according to which the construction and organisation measures must be varied:

1. so that the risks of total losses in certain regions are as widely as possible spread over these regions,
2. that it is not necessarily all sections of civil defence that suffer a weakening of their efficiency if the effects of unknown weapons make themselves felt,
3. that the aggressor discovers an objective, the possibilities of protection thereof are multiple and difficult to locate.

Economy

Basic principle of planning, according to which the maximum of protection can be attained in wartime with a minimum of expenditure in peace time.

Extent of Protection

Synthesis of all effects of destruction and contamination against which a shelter must resist.

Final Arrangements

State permitting each person to benefit by a protected place in a shelter able to resist 1 atm over-pressure, placing at the disposal of civil defence organisations the constructions and the necessary material means, and guaranteeing the logical unfolding of the various action periods.

Forewarning

Situation during which political and military signs forecast imminent danger, by possible use of arms of massive destruction, and leading to the order of applying a certain degree of preparedness, for instance partial occupation of shelters.

General Planning of Civil Defence

Instrument of vast regional and district planning of construction measures and civil defence organisation.

Harmonisation

Principle according to which, on the one hand, the particular efficacity of each protection measure to be applied during the unfolding of the war is guaranteed, and on the other hand, the degree of protection of each measure taken against the effects of clearly defined weapons is harmonised with the degree of protection of other weapons.

Image of War

The idea one has of a conflict based on precise assumptions regarding the means and possibilities of the parties concerned and the sphere of the hostilities.

Immediate Protection

Simple measures of protection in the open air and in buildings – for instance in places of heavy human concentration in enterprises of vital importance, etc., offering protection against surprise attacks. They are above all foreseen in cases where the preventive occupation of shelters is only partially indicated or not indicated at all, or in case of partial occupation by rotation.

Makeshift Shelters

Shelters which reach neither the extent nor the "1 atm degree of overpressure protection" and which will undergo various improvements during the pre-attack period.

Menace

Combined possibilities of force being used against our country.

Occupation

Occupation of shelters in stages, for periodical or lengthy sojourn therein.

Occupation of Long Duration

Period of autonomous occupation of shelters, during which the shelters must be fully or largely independent of supplies from outside and can only be left for short periods.

Organisation

Entirely of personnel and material means of civil defence.

Phase of Action

Various phases of utilizing shelters, or in other words, of the preparation and the activity of the civil defence bodies and the population.

Phase of Attack

Period characterized by the effective engagement of weapons and by their effects of short duration, such as pressure, splinters, commotion, heat, fire, primary radio-active radiation etc.

Phase of Peace

Period during which there is no immediate danger.

Phase of Pre-attack

Period during which the civil defence bodies are put into operation according to the various degrees of preparation, as a result of the political/military tension, and during which the population gradually occupies the shelters.

Phase of Recovery

Period during which civil defence organisation is engaged in applying measures of life-saving and assistance and in utilizing, as far as possible, all its means to put into application the most urgent measures of restoration.

Post-attack Period

Period during which it may be very difficult or dangerous to stay outside the shelters because of the persistence of fires, debris, radio-active fall-out, poisonous gas, or bacteriological weapons.

Principle of Rotation

Principle according to which it is convenient, in accordance with the degree of danger, to organise alternating periodical stays for shorter or longer periods outside the shelters. This principle also applies to pre-attack and post-attack periods.

Regional Aid

Help given to a region which has suffered a disaster, by the personnel and material of civil defence, anti-aircraft protection and other relief organisations from regions which have not been touched by the catastrophe.

Warning – Time of Warning

The warning takes place, whenever possible, from the time of discovery of the approach of weapon carrying machines. The time of warning is that between the identification and the effect of these machines.

Weapons of Massive Destruction

Arms, the effects of which make themselves felt over a very large radius, or arms engaged over very vast surfaces, especially A, B, and C weapons.

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