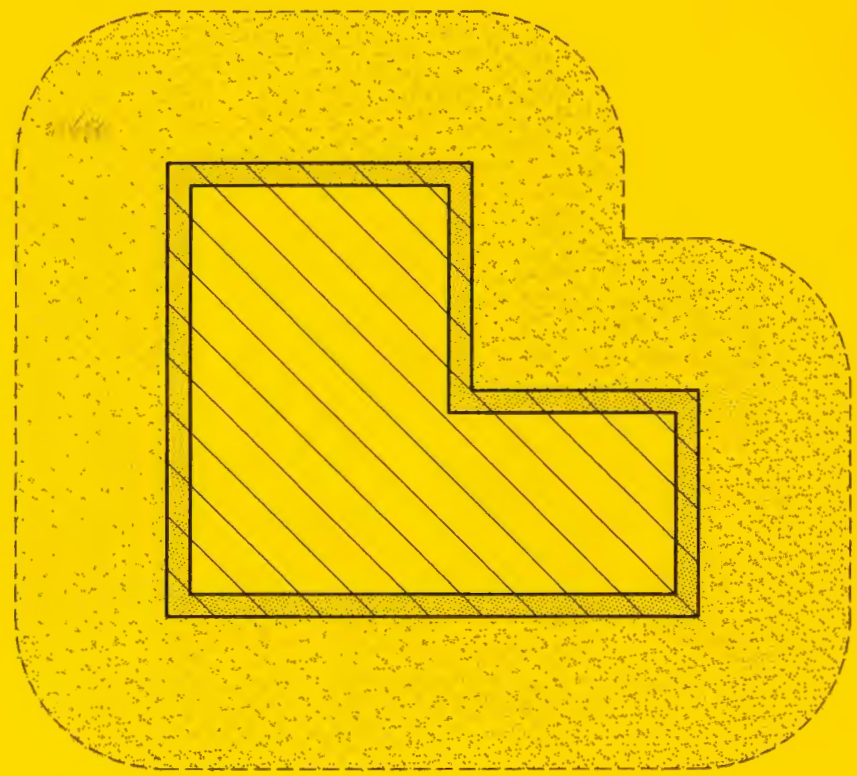
SHELTER REGULATIONS

SR - ENGLISH EDITION



RÄDDNINGS VERKET

SHELTER REGULATIONS

has been prepared by

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PREFACE

BACKGROUND

Shelters for civil application shall be constructed where, in accordance with the civil defence plan of the local council, there is a need for a shelter. This usually takes place in connection with new building, rebuilding, or extension, whereby a shelter comprises a prerequisite for building permission. A shelter can also be built into an already existing building or facility.

The building of shelters is regulated by the Swedish Civil Defence Act and the Civil Defence Proclamation. On the basis of the Proclamation the Swedish Rescue Services Board has issued regulations as to the design and equipment of shelters (SRVFS 1992:1). These regulations are presented in this publication, which is designated Shelter Regulations.

APPLICATION

Shelter Regulations is applicable as of the 1st of July 1992. This publication includes the regulations and approved solutions which are required for the building of a shelter. Previous regulations may be applied if building permission was applied for prior to the 31st of December 1992.

The regulations in chapter 1 are applicable for all production of shelters. They are, as far as possible, expressed as functional requirements, that is, it is the objective and not the means which is prescribed. This implies that the requirements are applicable irrespective of which production method is employed.

Examples of approved designs are reported in chapters 2 - 6. These refer to the production of shelters which are built as isolated units or as part of a building which is built at the same time as the shelter. For each approved design there is a reference to the applicable regulations in chapter 1. If these examples are implemented in their entirety a shelter will be achieved which complies with the regulations.

During the application of Shelter Regulations familiarity with New Building Regulations, Regulations for Concrete Constructions (BBK), Regulations for Steel Constructions (BSK), the Concrete Handbook, and several other Swedish Standards, is assumed.

OTHER SOLUTIONS

The solutions reported in Technical Regulations for Shelters provide an example of how the Swedish Rescue Services Board consider that the regulations can be implemented. The application of other solutions is permissible on the assumption that these also comply with the regulations described in chapter 1.

It is incumbent on the building contractor to confirm that alternative solutions comply with the regulations, and in their entirety comply with the regulations. The consideration of individual cases rests on the authority of the Local District Council or the County Council. A general approval is issued by the Swedish Rescue Services Board.

TYPE DRAWINGS

The Swedish Rescue Services Board has established approved solutions as to individual components in the shelter. The manufacturing drawings for these components are compiled in the the publication Shelter Regulations, list of drawings. This list is continuously revised.

SPECIFIC APPROVAL

Installations and equipment which by virtue of their positioning are of importance for the protective capacity of the shelter against chemical warfare must have a specific approval in order to be used. This approval shall be indicated by means of product marking.

This publication is applicable as of the 1st of July 1992. Previous regulations (TB 78, edition 2) cease to be applicable unless building permission was applied for prior to the 31st of December 1992.

Swedish Rescue Services Board

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Björn Ekengren

1 REGULATIONS

1 REGULATIONS

1:1 DESIGN AND EQUIPMENT

1:11 General requirements

1 § These technical regulations refer to the new building of shelters.

2 § The design and equipment of the shelter shall enable the number of persons for whom the shelter is built for to stay there without interruption for at least three days.

3 § The shelter shall be designed and equipped for a service-life of at least 50 years.

1:12 Protective capacity of the shelter

4 § The shelter shall, with negligible risk to the occupants in need of shelter of being killed or injured, be able to withstand:

1. The effect of a pressure wave corresponding to that produced by a 250 kilograms GP-bomb with 50 weight per cent TNT which bursts freely outside at a distance of 5.0 metres from the outside of the shelter during free pressure release.

2. A long-term overpressure of 50 kilopascal and a long-term underpressure of 8 kilopascal.

5 § The shelter shall, with negligible risk to the occupants of the shelter of being killed or seriously injured, also be able to withstand the effect of splinter from a burst bomb as per 4 § item 1.

6 § The shelter shall be so designed that ionizing radiation from radioactive fallout in the shelter is on average no more than 2.5 per cent of the radiation outside the shelter.

7 § The shelter shall be sufficiently tight to provide protection from chemical and biological warfare, and explosive gas.

8 § An overpressure of at least 60 pascal shall be able to be continuously maintained and recorded in the shelter.

9 § The carcase of the shelter shall be of non combustible aterial which only permits the air temperature in the shelter to rise by 15° C after a fire of two hours outside the shelter.

1:13 Size of the shelter

10 § The gross area of the shelter may, if there is a floor over the entire shelter at least 5.0 metres above the shelter roof, not be larger than, together with the area outside the shelter which lies closer to the shelter than 5.0 metres, 550 square metres. The floor shall have a bearing capacity and mass which at least corresponds to the requirement for floors in apartment blocks.

If there is no floor as per the first paragraph the gross area of the shelter may not be larger than, together with the area outside the shelter which lies closer to the shelter than 5.0 metres, 440 square metres.

The shelter may be made larger than what is stated in the first paragraph if it is structured so that the risk in the event of the impact of weapons does not increase for the number of persons which the shelter is to be built for as a result of the greater area.

11 § The room height in the shelter shall be at least 2.1 metres and max. 3.8 metres.

1:14 Entrances and exits to the shelter

12 § The shelter door shall have a frame width of at least 0.9 metres and a headroom of at least 1.9 metres. The entrance opening shall have a frame width of at least 0.8 metres and a headroom of at least 0.8 metres.

13 § At least one door shall open to the outside or an area which is not part of the shelter.

14 § The shelter shall in a satisfactory manner be able to be evacuated to the outside by at least two separate points.

1:15 Air, water and lighting

15 § In the shelter there shall be an installation for tap water and drain, including equipment so that water, hygiene and toilet requirements can be provided.

16 § In the shelter there shall be an electrical installation for lighting which provides at least 50 lux.

17 § The air intake to the shelter shall be placed so that air can be supplied to the shelter in the best possible manner under the circumstances, and with predictable air pollution.

18 § The equipment for the air supply shall be able to be operated with electricity. The equipment shall also be able to be operated manually or by means of an auxiliary unit.

19 § Air which is supplied to the shelter shall be able to be purified from dust and coarser particles, including chemical and biological weapons.

20 § The shelter shall be equipped with an air lock which accommodates at least three persons, and with an opening size corresponding to the shelter doors as per 12 §.

The air lock as per the first paragraph shall open to the outside or an area which is not part of the shelter, and shall be so designed that the air in the air lock can be replaced at least 50 times an hour.

21 § Exhaust air shall be able to be removed from the shelter via the toilet areas and the air lock.

22 § The shelter shall be designed and equipped so that:

1. The air temperature in the shelter becomes max. 29°C when the air outside the shelter maintains a temperature of 17°C and a relative humidity of 70%.

2. The oxygen content is at least 17 volume per cent and the carbon dioxide content max. 2 volume per cent in the shelter when the air pressure outside the shelter is 100 kilopascal.

23 § The shelter shall be equipped so that the air temperature in the shelter can be at least 5°C when it is unoccupied.

24 § Only piping for water with a maximum temperature of 100°C and air with a maximum pressure of 900 kilopascal shall be used in the shelter.

1:16 Miscellaneous on design and equipment

25 § In the shelter's carcase there shall be inlets for aerial and telephone wires.

26 § The shelter shall be provided with equipment which enables the arrangement of the shelter for its purpose, the extinguishing of fires in the shelter, and evacuation.

27 § Installations in the shelter shall be attached so that they will not be dragged loose or break apart as a result of the effects of a shock wave as per 4 §.

28 § The shelter shall be equipped with electrical outlets for the requirements of long-term abode.

29 § Electrical installations shall via a group distribution box in the shelter be connected directly to the main distribution box in the building.

30 § Installations and equipment in the shelter shall be easily accessible.

31 § Loose equipment which belongs to the shelter shall in peacetime be stored in a separate area which is locked, dry, ventilated and heated to at least 5°C.

This area as per the first paragraph shall only be used for shelter equipment.

32 § The shelter shall be provided with a layout drawing over the shelter with information on the shelter's loose equipment and how the shelter is to be arranged for its purpose.

33 § The shelter shall be provided with marking plates, established by the Swedish Rescue Services Board, so that it is apparent from outside that it is a shelter.

The shelter shall also be provided with marking plates which indicate where installations and equipment are, and how the shelter is to be used.

1:17 Exemption from regulations

34 § The County Administration may, on consultation with the Swedish Rescue Services Board, in single cases and if special reasons exist, provide exemption from the application of the above regulations.

1:2 PLANNING

35 § The location and design of a shelter shall be determined with respect to the possibilities of the public to reach the shelter during an alarm, and to assume long-term abode there. (28 § Civil Defence Act.)

36 § During the determination of the size of the shelter, consideration shall be taken to a net floor space 0.75 square metres for each person to be provided with a place in the shelter. (13 § Civil Defence Proclamation.)

37 § Peacetime utilization or intervention in the shelter must not diminish its protective capacity against the effects of weapons, or otherwise adversely influence its function in civil alert or war. (CFS 1985:12, 1 § first paragraph.)

38 § Shelters shall, irrespective of type or age, be able to be put in order for operation as shelters within 48 hours. (CFS 1985:12, 2 § second paragraph.)

1:3 PRODUCTION

39 § In the event of liability to apply for building permission for facility or building within a shelter locality it is incumbent on the local building authority during the examination of such application, to ensure that the construction works correspond with the regulations (33 § first paragraph, Civil Defence Act.)

40 § The shelter shall be inspected in all parts with a view to its protective capacity before approval. Checking of the shelter's tightness is included in the final inspection. During such inspection the equipment in the shelter shall be installed to the requisite extent. (CFS 1981:1, item 4.6 first paragraph.)

2 PLANNING

2 PLANNING

2:1 LOCATION

2:11 Position

The number of persons which the shelter shall be dimensioned for is indicated in the Notice issued by the local authority. The positioning of the shelter is optional on the assumption that the shelter regulations are complied with.

As per 35 § in chapter 1, the location and design of a shelter shall be determined with respect to the possibilities of the public to reach the shelter during civil warning and to assume long-term abode there. In order that this is possible it is necessary that the shelter will be separated from dangerous activities and goods, and that access to the shelter is high. Designs as per 2:12 and 2:4 are approved.

2:12 Surroundings

2:121 Dangerous activities and goods

During the selection of location for the shelter consideration must be taken, to comply with 35 § in chapter 1, to the existence of dangerous activities or goods. The following design is approved.

Only areas which are adjacent to the shelter and its evacuation routes require to be taken into consideration. To separate the shelter and its evacuation routes from dangerous activities or goods which exist in these areas a protective construction (wall or floor) shall be arranged between the shelter and the activities or goods. The protective construction shall be well anchored and designed as per *3:34 b-c*.

Dangerous activities or goods which during the arrangement of the shelter shall be removed, and which can be carried out by the persons searching shelter and with the equipment belonging to the shelter, do not need to be taken into consideration. Information on this shall be indicated in the shelter drawing as per 5:62.

Activities, goods, or the like, which can imply danger to the shelter occupants may, for example, consist of vessels under pressure, inflammable goods, oil stores, chemicals, and gas-holders.

2:122 Flooding

The shelter shall, in order to comply with 35 § in chapter 1, be placed so that flooding in the shelter is limited. The following design is approved.

During the positioning of the shelter consideration shall be taken to the close vicinity of water-courses, larger water and sewer pipes, the average water-table, and the water transmission capacity of surrounding earth materials adjacent to the shelter.

The shelter shall be placed so that the floor level lies no more than 2.0 m below the average water-table, and also so that the surrounding earth material, calculated from the outside of the building and 10 m beyond, has a water transmission which is less than 10^{-5} m/s. If this cannot be ensured the floor level shall lie no more than 1.0 m below the average water-table.

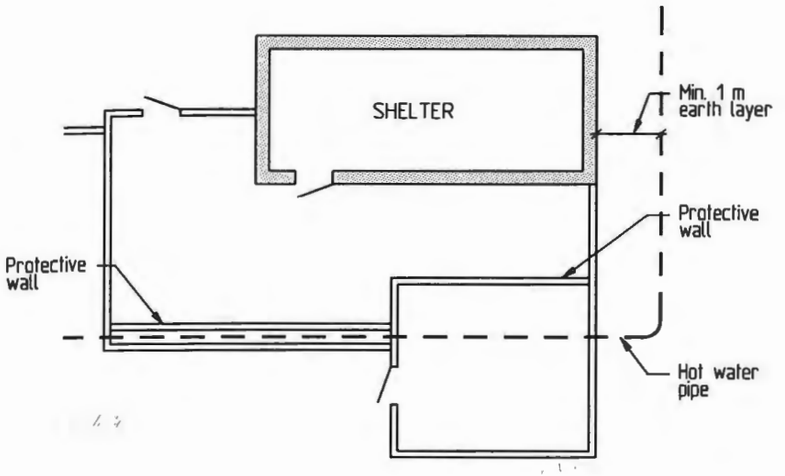
Naturally sedimented moraines, silt and clay normally have a water transmission less than 10^{-5} m/s. It is not necessary to take ground drainage into consideration. Drainage systems with natural fall are assumed to function even after damage has occurred. Pumping for the actual building is assumed not function.

2:123 Hot water

In order to comply with 35 § in chapter 1 it is required that the shelter and its entrance and evacuation routes be separated from piping which contains hot water. Hot water refers here to water with a temperature greater than 100°C. The following design is approved.

A separate hot water pipe shall be separated from the shelter and its entrance and evacuation routes with a reinforced concrete construction at least 150 mm thick. If the piping is layed in the ground the surrounding earth shall have a thickness of at least 1 metre.

Example of protection from hot water is shown in *2:123a.*



2:123a. Principle for protection from hot water in the vicinity of the shelter.

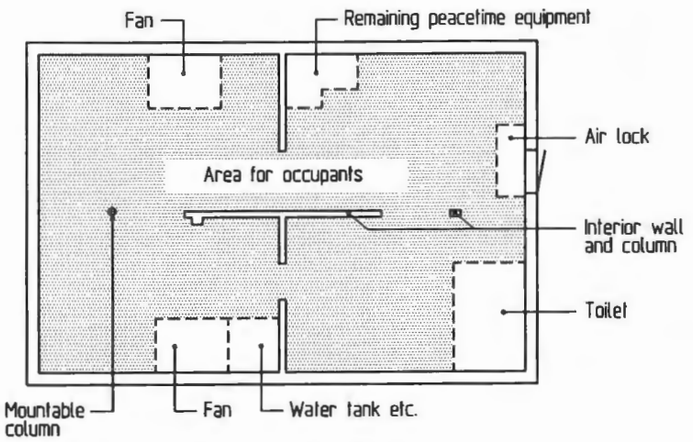
2:2 AREA REQUIREMENT

2:21 General

The shelter shall, in order to comply with 35 § and 36 § in chapter 1, have sufficient area for the intended number of persons searching shelter, including the arrangements for habitual abode during utilization of the shelter. Designs as per 2:22 - 2:26 are approved.

In addition to the area for the occupants there can be area which cannot be used by the occupants, such as area which is occupied by remaining peacetime equipment, columns and interior walls. Area in or under stairways in a two-storey shelter is not included in the area for shelter places. Area for storage as per 5:5 refers to storage in peacetime and shall not be included separately in the shelter area. The total area is limited as per 2:3.

Example of area requirement is shown in *2:21a.*



2:21a. Example of area requirement.

2:22 Number of shelter places

The shelter Notice from the local authority indicates the number of persons which the shelter shall be arranged for. Each shelter place shall as per 36 § in chapter 1 be given a net area of 0.75 m^2.

2:23 Air lock

The shelter shall, as per 20 § in chapter 1, be provided with an air lock. The following design is approved.

For a mountable air lock a floor area of at least 1.2 m^2 shall be allocated.

Air locks designed as per 4:123 are approved.

2:24 Ventilation unit

As per 18 § in chapter 1 there shall be equipment for the air supply. The following design is approved.

A ventilation unit shall be arranged for every 60 shelter places, or part thereof. The floor area for the fan and the service area shall together be at least 3 m^2.

The ventilation unit designed as per 4:124 is approved.

2:25 Earth closet

Toilets are required as per 15 § in chapter 1. The following design is approved.

An earth closet shall be arranged for every 30 shelter places, or part thereof. The floor area for the earth closets, and the area for entrance and exit, shall together be at least 1.5 m^2.

Earth closets are approved as per 5:1.

2:26 Water tanks and other equipment

Water tanks and tools are required as per 15 § and 26 § in chapter 1. The following design is approved.

A floor area of at least 0.5 m^2 shall be allocated for shelter equipment for every 30 shelter places.

Water tank and equipment are approved as per chapter 5.

2:3 SIZE

2:31 General

The size of the shelter depends partly on the number of shelter places which are required as per the shelter Notice, and partly by the peacetime utilization which is planned for the room. The area may be made larger than what is motivated with respect to the number of shelter places, on the assumption that the area restriction as per 10 § in chapter 1 is observed.

Several shelters can be placed adjacent to each other or above each other, on the assumption that the accessibility requirement as per 35 § can be complied with.

A shelter can also be arranged as a two-storey shelter, with intermediate floor and stairway within the boundary walls of the shelter.

2:32 Room height

As per 11 § in chapter 1 the room height in the shelter shall be at least 2.1 m and no higher than 3.8 m. The following design is approved.

The free headroom under limited sections shall be no less than 1.9 m. Lower headroom than 1.9 m is permissible on the assumption that the floor area under these sections is not included in the area which is required for the operation of the shelter. The use of the shelter must not be impaired as a result of the lower headroom.

2:33 Size calculation

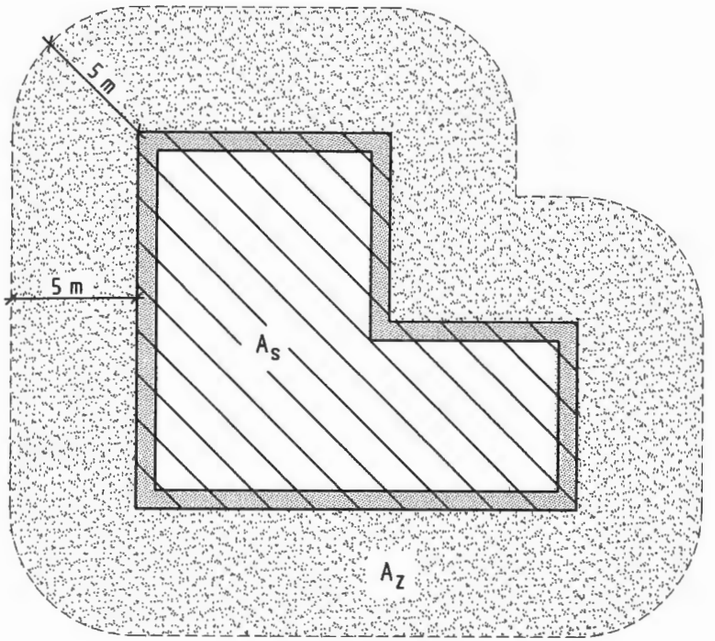
As per 10 § in chapter 1 the size of the shelter shall be limited. The largest area which the shelter may have depends on the layout selected.

The calculation of size shall be made separately for each shelter. This also refers to two shelter rooms which have a party wall inbetween. The total area shall be calculated as:

$$A = A_s + A_z \leq A_{max}$$

Symbols:

A	The total area incl. a 5.0 m zone round the shelter.
A_{max}	The maximum value of A. This may be no more than 550 m^2 if there is a concrete floor at least 5.0 m above the entire shelter roof; otherwise max. 440 m^2.
A_s	Gross area of the shelter, see *2:3a*.
A_z	The area obtained by a 5.0 m wide zone round the shelter. This zone is fictitious and shall be put round the outside of the shelter irrespective of what is there.



2:3a. Principle for size calculation.

2:4 ENTRANCE

2:41 General

In order to comply with 35 § in chapter 1 the accessibility to the shelter must be checked in connection with the determination of its position. Designs as per 2:42 - 2:43 are approved.

The persons seeking shelter are assumed to use the shortest route to the shelter. To avoid excessive widths of the entrance routes the number of routes can be increased instead, or the shelter can be given another location in the building, or in consultation with the local authority the shelter can be divided up into several shelters at different positions.

2:42 Length of entrance route

As per 35 § in chapter 1 a shelter shall be located where it is possible for the intended occupants to intended to reach it when the alarm goes. The distance to the shelter shall therefore be limited. The following design is approved.

In the building where the shelter is located the entrance route to the shelter only needs to be calculated from the most unfavourable position on the ground floor. For adjacent buildings which generate a requirement for places in the shelter the entrance route shall be calculated from the entrance to the respective building. The length of the entrance route shall be calculated as per:

$$L = l_1 + 0.5\, l_2 + 4\, l_3 \leq 70$$

Symbols:

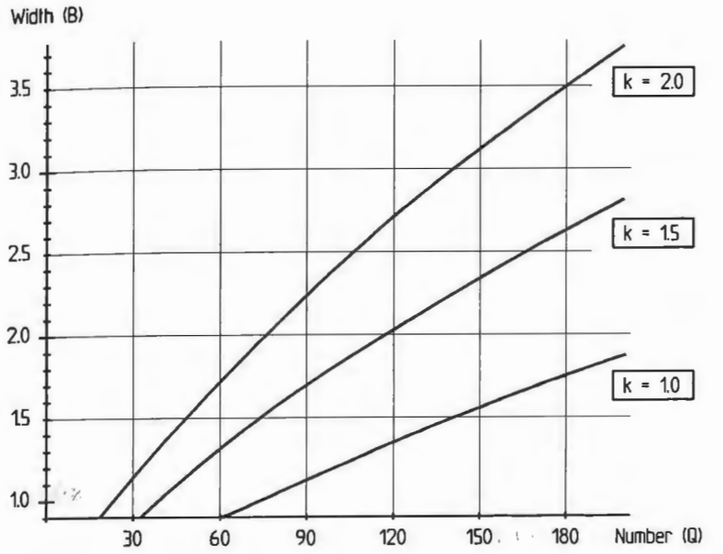
L	Entrance route. The max. permissible value of L is 70.
l_1	Horizontal route in metres outdoors or in areas where the roof is not reinforced against weapons loads (50 kN/m^2).
l_2	Horizontal route in metres indoors in areas where the roof is reinforced against weapons loads.
l_3	Height difference in metres at stairway (the horizontal length of the stairway is not included).

2:43 Accessibility

In order to comply with the requirement of accessibility as per 35 § in chapter 1 the occupants must be able to reach the shelter without the delay of crowding or queuing in narrow passageways. The following design is approved.

The minimum width for different sections of the entrance route are taken from *2:43a*. The difference in width from one width to another, e.g. at a stairway, shall be smoothly evened out for a distance of at least 2 m.

It is the actual number of persons passing each section which shall be included when determining the width, even if the plans allocate persons to different shelters. As an alternative to a wide door, two or more narrower doors can be selected.



2:43a. Minimum width in entrance route.

Symbols in *2:43a:*

B	width of section in metres B_{min} = 0.9 m ($B = 0.07k \cdot Q^{0.62}$)
Q	number of persons passing the section
k	1.0 at door and horizontal route 1.5 at straight stairway 2.0 at swung stairway

2:5 EVACUATION

2:51 General

As per 14 § in chapter 1 a safe evacuation outdoors from the shelter shall be arranged at a minimum of two separate points. An opening for evacuation from a shelter shall as per 12 § be at least 0.8 m x 0.8 m.

The blocking of the shelter's evacuation routes by the collapse of overhead or adjacent buildings can be prevented by several different measures, such as special opening arrangements, reinforced floors over evacuation routes and the arrangement of tunnels, etc.

Designs as per 2:52 are approved.

2:52 Calculation of evacuation routes

Evacuation routes via the shelter's boundary wall shall be designed as a reserve exit or a shelter door. Reserve exit refers to an evacuation route which can be opened inwards to the shelter both from inside and outside the shelter. A shelter door opens outwards, seen from the shelter. Examples of reserve exits and shelter doors are given in *3:42a*.

At least two of the shelter openings shall be allocated as reserve exits. If the evacuation alternative A or B as shown below is selected it is sufficient that only one opening in the shelter consists of a reserve exit.

The calculation of the shelter's evacuation facilities shall take place as per:

$$U = 4n_A + 4n_B + 2n_D + n_E \geq 6$$

Symbols:

U	Total evacuation facilities of the shelter; must not be less than 6.
n_A	Number of evacuation routes as per evacuation alternative A.
n_B	Number of evacuation routes as per evacuation alternative B.
n_C	Number of evacuation routes as per evacuation alternative C.
n_D	Number of evacuation routes as per evacuation alternative D.
n_E	Number of evacuation routes as per evacuation alternative E.

Evacuation alternatives:

A The opening in the shelter wall opens outdoors. There are no overhead or adjacent buildings.

B The evacuation route opens at a distance which corresponds to at least half the building height from overhead or adjacent building. Protection along the evacuation route consists of a tunnel or culvert which is dimensioned for collapse load.

C The opening in the shelter wall opens outdoors. There are no overhead or adjacent buildings.

D The opening in the shelter wall opens indoors. There is a floor dimensioned for collapse load up to an opening in the wall of the building. The overlying floor extends from the centre line of the evacuation route at least 1 m on each side or to a bearing wall within 1 m.

E The opening in the shelter wall opens indoors. There is an overlying floor which is dimensioned for collapse load.

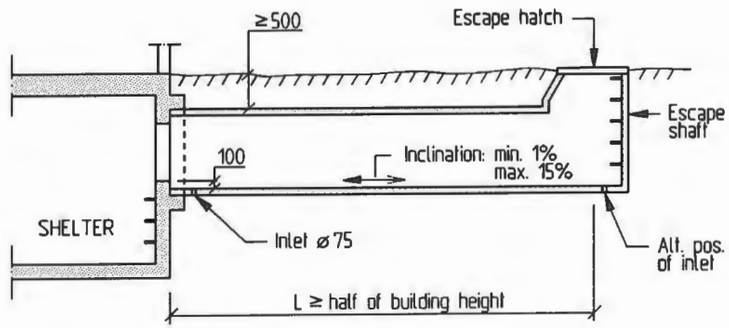
The evacuation routes shall be separated from each other. This normally implies that they shall open onto different walls of the building. If this is difficult to achieve, two evacuation routes may open onto the same wall in the building if the distance between them is at least 10 m.

Outdoors refers to a place outdoors which is not enclosed by walls, closed building walls or the like. An open basement stairway is considered to be outdoors.

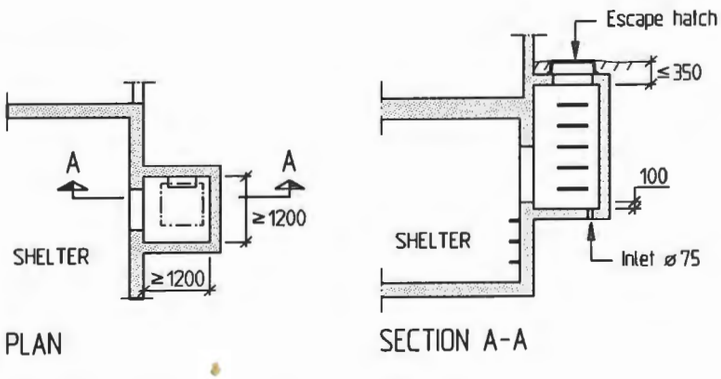
A building shall be considered as adjacent if the distance to the opening or a evacuation route opening is less than half the height of the building.

The lower edge to an evacuation opening may be max. 1.2 m over the shelter floor without requiring a step up to the lower edge of the opening to be arranged inside the shelter. On the outside of the shelter this distance shall be calculated from the ground or a stable plane, from which a stairway or step is arranged to the ground. Steps may be arranged fixed or removable.

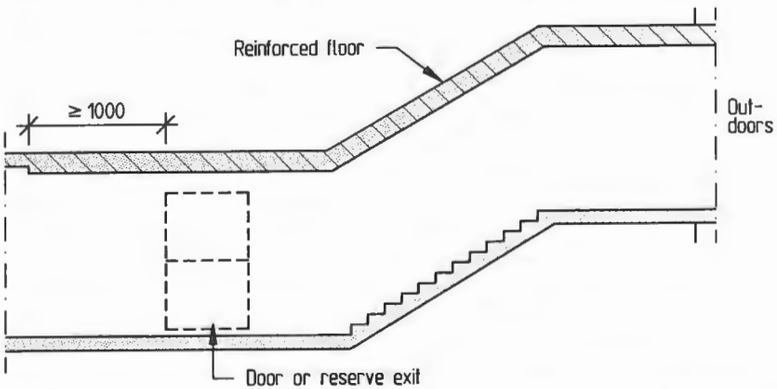
Examples of approved design are shown in *2:52a-c*. Reserve exits must not be backfilled.



2:52a. Reserve exit with tunnel. Evacuation alternative B.



2:52b. Reserve exit with escape shaft. Evacuation alternative C.



2:52c. Reinforced floor up to opening in building wall. Evacuation alternative D.

3 CONSTRUCTIONS

3 CONSTRUCTIONS

3:1 GENERAL

The regulations in chapter 1 set requirements as to the protective capacity of the shelter to weapons. This chapter considers constructions for a shelter which is designed as a reinforced, solid concrete construction. If the chapter is applied in its entirely a design will be achieved which also complies with the requirements in chapter 1.

A shelter shall, with respect to the impact of weapons, be referred to safety class 3 as per New Building Regulations.

This chapter only considers the construction in its function as a shelter. Other building regulations are applicable for the peacetime utilization of the room.

3:2 LOAD CONDITIONS

3:21 General

A shelter shall withstand a pressure wave as per 4 § in chapter 1. The following design is approved.

Load combinations as per 3:22 - 3:24 are to be applied and all loads shall be given with their characteristic values. Partial coefficients shall be selected for accidental loads, that is, 1.0.

Collapse loads and weapons loads do not need to be combined. The effect of weapons load or collapse load as an overload on the ground during the calculation of earth pressure do not need to be considered either.

3:22 Load combination during shelter operation

Floors in shelters shall be dimensioned in ultimate stress condition for a vertical distributed fixed load of 3 kN/m^2 directed to the floor. Free loads and requirements in ultimate stress conditions do not need to be considered for this load combination.

3:23 Weapons load combination

3:231 General

The weapons load combination shall consist of:

- A uniformly distributed weapons load as per *3:231a*.
- Load as per 3:22.
- Load as per New Building Regulations with standard load values. Wind load shall not be included.

Weapons loads directed against and from the shelter are separate load combinations, and are assumed to separately influence the entire outside of the shelter and perpendicular to the plane of the construction part. Weapons loads are to be considered as fixed loads.

Weapons loads on construction parts which connect to the shelter are assumed not to be transferred to the shelter. For a party wall or a party floor between two shelters the weapons load on the connecting shelter shall, however, be considered. The most unfavourable load combination shall be selected, that is, loads as per 3:22 which are counter directed weapons loads shall not be included.

Construction part	Weapons load in kN/m^2 directed	
	to shelter	from shelter
Shelter roof, boundary wall	50	8
Floor or party wall between two shelters	100	100
Floor as per 3:22:		
foundation case 1	-	-
foundation case 2	10	-
foundation case 3	50	-
Reinforced evacuation route, tunnel, escape shaft*)	50	-

*) The connection of the escape shaft to the boundary wall shall be dimensioned for a force of 200 kN which acts in an arbitrary direction in the wall plane.

3:231a. Weapons load.

3:232 Weapons load to floor

The floor construction shall be dimensioned for an upward directed distributed weapons load. During the determination of this the characteristics of the ground, the foundation method and the risk for air cavities during the construction, shall be considered as per the foundation cases reported below. Weapons loads for the different foundation cases are indicated in *3:231a*.

If the sub-foundation within a depth of 5 m below the floor slab consists of material which can be referred to the different foundation cases as per this section, the most unfavourable case shall be applied. Varying foundation conditions under the same shelter must be considered so that the floor is made of different thicknesses depending on the type of ground. Heat insulation or drainage layers under the floor slab do not affect the choice of weapons load to the floor. This is also applicable during the replacement of heavy material with lighter material.

The weapons load acts upwards to the underside of the construction. The inherent weight must therefore be calculated in the weapons load case, while where appropriate the water pressure must be added.

Foundation case 1. The following floor constructions are included here:

a) Direct on the rock, blasted base, on blast stone filling.

Or

b) On gravel, solid sedimented course and intermediate sand or filling of this. The foundation depth shall be greater than 1.0 m below the ground level which surrounds the building.

Foundation case 2. The following floor constructions are included here:

a) On gravel, solid sedimented coarse and intermediate sand or filling of this. The foundation depth is less or equal to 1.0 m below the ground level which surrounds the building.

Or

b) On loose sedimented coarse and intermediate sand, fine sand or silt, where air cavities below the floor slab as a result of settling cannot be expected.

Foundation case 3. The following floor constructions are included here:

a) On clay, either direct or via piles.

Or

b) With air cavity below the floor or below the floor level within 5 m to the sides with the exception of:

1. Culverts which are dimensioned for an outward directed distributed weapons load of 50 kN/m^2 and which has a min. diameter and min. reinforcement as an evacuation tunnel.

2. Piping below the shelter floor with max. 150 mm internal diameter and a centre distance of at least 1.0 m.

3. Piping below the shelter floor in the minimum pressure class PN 6.

3:24 Collapse load combination

3:241 General

As a result of weapons impact as per 4 § in chapter 1 the shelter can be exposed to collapse loads. The shelter must therefore be dimensioned for this load. The following design is approved.

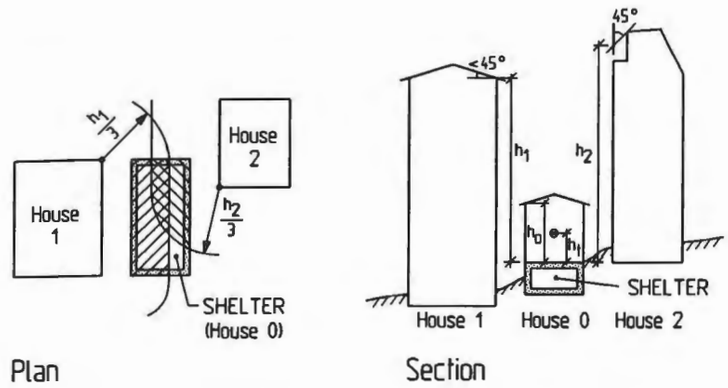
The collapse load does not need to be considered if the height of overhead or adjacent buildings does not exceed 6 m calculated from the upper edge of the shelter. Evacuation tunnels with at least 0.5 m of earth cover and a width of max. 1.5 m do not need special dimensioning for collapse loads either.

The impact of a collapse from adjacent buildings (incl. planned but not built) shall be considered within a distance of h/3 from the building. The height h is calculated as per *3:241a*. Information on planned buildings can be obtained from the detailed plans of the local authority.

The collapse load shall be considered as a static load as per 3:242 with vertical alignment to the shelter roof. The collapse load combination shall therefore consist of:

- Collapse load.
- Load as per 3:22.
- Load as per New Building Regulations with standard load values, excl. wind load.

The collapse load shall be calculated as the greatest load value within the respective area as per *3:241a* for impact from overhead and adjacent buildings.



Area	Dimensioned collapse load q_d
▭	q_0 ($q_{0\ red}$)
▨	the greater of q_0 and q_1 ($q_{0\ red}$ and $q_{1\ red}$)
▧	the greater of q_0 and q_2 ($q_{0\ red}$ and $q_{2\ red}$)
⊠	the greater of q_0, q_1 and q_2 ($q_{0\ red}$, $q_{1\ red}$ and $q_{2\ red}$)

3:241a. The height of building above the shelter and dimensioning collapse loads.

3:242 Collapse load from building

The collapse load from overhead or adjacent buildings shall be calculated as:

$$q = k \cdot \frac{Q}{A} \cdot \sqrt{h_t} \qquad (1)$$

Symbols:

q collapse load (kN/m^2)

k collapse load coefficient as per *3:242a*

A external roof area of shelter (m^2)

Q inherent weight (kN) together with effective load of the part of the building which lies over the area A. For adjacent buildings the quotient Q/A is calculated as the average value for the part of the building which lies closer to the shelter than $h_i/3$ and above a horizontal plane on a level with the upper edge of the shelter.

h_i the greatest building height in metres of existing or planned adjacent building. The height is calculated from the upper edge of the shelter.

h_t vertical distance in metres between the building's centre of gravity (point of application for Q) and the upper edge of the shelter. The centre of gravity is calculated for the part of the building which lies over the shelter.

For houses with a uniform mass distribution, such as standard apartment blocks and office buildings, h_t can be set to half the building height of that part of the building which is used to calculate Q.

Effective load can be reduced in accordance with the New Building Regulations with respect to load combination during the load calculation.

If information is not available on an adjacent building the collapse load for this shall be calculated as:

$$q = 3.0 \sqrt{h_i^3} \qquad (2)$$

Number of floors above shelter	Collapse load coefficient k	
	Group A	Group B
≤ 3	1.4	1.4
4	1.3	1.4
5	1.3	1.4
6	1.2	1.4
7	1.1	1.4
8	1.0	1.4
9	1.0	1.4
≥ 10	0.9	1.4

3.242a. Collapse load coefficients.

Symbols in *3:242a*:

Group A: Collapse damping building. Buildings with a carcase which complies with the following criteria are included here.

1. The unity within floors and bearing walls, and between these, corresponds to a tensile strength of F in two perpendicular alignments in the horizontal plane. Friction is not considered to transfer force in this connection.

$$F = 1.25 \cdot b \cdot q_r \qquad (3)$$

$$F_{min} = 40 \text{ kN/m}$$

Symbols:

b: min. span in metres.

q_r: total of inherent weight and fixed effective load per surface unit in m^2.

2. For a column beam structure the criteria for a collapse damping building are fulfilled in the following manner:

   The unity as per item 1 refers to within the floor and between floors and beams. The unity within beams and between beams and columns is calculated in a corresponding way, whereby q_r is the total of the inherent weight and the fixed effective load per length unit in metres of the beam.

   For columns at the edge of a construction and with beams only from one side the force may be limited to the horizontal force which gives ultimate flexural stress in the column.

3. The construction shall be sufficiently flexural that it permits the floor and the beam to deflect downwards 15% of the span in the mid field.

4. A separate attachment shall, without the previously mentioned transmission of force ceasing, be able to withstand an angular change of 90° of a floor segment or beam. For concreted reinforcement in the bottom edge of the floors of steel types Ks400 or Ks600 the requirement is considered to be fulfilled if the anchorage is sufficient in both directions and the rods are not welded in critical sections.

5. Flat-slab floors and bearing arrangements are to be designed so that after penetration or local fracture they are capable of bearing the floor inclusive of the effective load. For a flat-slab floor this implies a shear

reinforcement which consists of down-bent top rods, which are dimensioned for the entire column force.

Group B: Remaining building. This includes buildings with a carcase which does not fulfil the criteria for unity and flexural capacity as per group A. Carcases of prefabricated elements are normally referred to this group.

3:243 Dimensioning collapse load

For floors and interior beams and columns the collapse load may be reduced to q_{red} as per the following. Otherwise no reduction may be made.

$q_{red} = qb/n$ where $b<n$ (1)

$q_{red} = q$ where $b>n$ (2)

Symbols:

q collapse load as per 3:242.

b the min. distance in metres between the bearing lines of the floor section under consideration. Sections of the bearing line which are not supported may have a max. length equal to the greater of b/3 and 1.5 m. For interior beams or columns b is set equal to the width of shelter.

n The number of floors included above the shelter roof in the building from which q derives. For adjacent buildings n is selected as equal to $h_i/3$.

3:3 MATERIALS AND DIMENSIONING

3:31 Construction materials

In order to comply with the requirement for protective capacity as per chapter 1 the following materials are approved.

Concrete shall be of at least strength class K30 and execution class II.

Reinforcement shall be of hot galvanized steel in the highest quality class Ks600. Welding of reinforcement may not be carried out. Floor constructions which do not absorb ground pressure from weapons loads or

collapse loads, including upper layers in two-layer floors, may have optional reinforcement.

3:32 Dimensioning values for strength

3:321 General

In order to comply with the requirement for protective capacity as per 4 § in chapter 1 the following dimensioning values are approved.

Partial coefficients and strength values for ultimate flexural stress in general shall be used for load combinations during shelter operation as per New Building Regulations.

The partial coefficients and strength values which are applicable for accidental load as per New Building Regulations shall be used for weapons load combination and collapse load combination. However, the following formulas shall be used for the tensile strength of reinforcement.

$f_{st} = 1.1f_{yk}$ $f_{yk} \leq 390$ MPa (1)

$f_{st} = 0.9f_{yk}$ $f_{yk} = 590$ MPa (2)

For non sheer-reinforced concrete slabs the following formula for the concrete's sheering strength shall be used.

$$f_v = \xi\,(1 + 50\rho) \cdot 0.50\, f_{ct} \quad (3)$$

Symbols:

ξ as per BBK

f_{st} dimensioning tensile strength of reinforcement in MPa

f_{yk} characteristic yield stress limit of reinforcement in MPa

f_v conventional sheering strength of the concrete in MPa

f_{ct} dimensioning tensile strength of the concrete in MPa

3:322 Foundation stresses and pile loads

The values for foundation stresses and pile loads used during normal building shall be doubled for dimensioning for weapons load cases and collapse load cases.

3:33 Bearing system

3:331 General

The requirement for protective capacity in chapter 1 implies that the shelter's bearing system and other structural parts shall be designed with respect to bearing capacity, flexural capacity, unity, stability and energy absorbing capacity. The following design is approved.

In order to achieve a flexural construction the moment distribution in slabs shall be selected so that the bearing moment is not greater than the field moment.

The reinforcement volume, which on the basis of calculation shall exist where there is an opening, shall be placed as reinforcement round the opening.

A plate structure or other similar bearing structure which is fully or partially outside the shelter may not bear the shelter construction. Area below the shelter is approved, however, if its bearing structure is dimensioned as if the area were a shelter.

The requirement for flexural capacity and unity of the structure shall be satisfied by means of the following solutions for dimensioning against penetration, minimum and maximum reinforcement volume, and jointing and anchorage of the reinforcement.

3:332 Penetration

Dimensioning against penetration is approved when implemented as per New Building Regulations or the Concrete Handbook. Sheer reinforcement shall be implemented with down-bent rods or the like. In those cases where the roof slab is supported by columns the sheer reinforcement shall be applied for the full column force.

3:34 Concrete thickness and reinforcement content

The regulations in chapter 1 set requirements for the protective capacity of the shelter. The following thicknesses and reinforcement content are approved.

A concrete structure shall be solid and have a minimum thickness as per *3:34a-c*. Reinforcement shall be placed in two perpendicular alignments as per *3:34a-c*. The reinforcement content shall lie within the following limits.

$$\rho_{min} = 0.01\,(f_{cck} + 40)/\,(f_{yk} + 100) \qquad (1)$$

$$\rho_{max} = 0.15 f_{cck}/f_{yk} \qquad (2)$$

Symbols:

f_{cck} the characteristic compression strength of the concrete in MPa.

f_{yk} the characteristic yield stress limit of the reinforcement in MPa; max. 390 MPa.

The maximization of the reinforcement content does not refer to columns which are primarily exposed to compression force.

For constructions which are reinforced with closed stirrups ρ_{max} shall be multiplied by $(1 + 250\rho_v)$, where

$$\rho_v = 2(h_v + b_v)A_v/(b \cdot d \cdot s) \qquad (3)$$

with symbols as per *3:34d*.

Shortening or spacing of field reinforcement is not permitted. The maximum permissible distance between parallel reinforcement rods is 400 mm. Covering concrete to the inside of the shelter may be max. 50 mm thick.

The limits for minimum and maximum reinforcement content shall guarantee the strength and flexural capacity of the construction. Minimum thicknesses refer to a shelter with the size limited as per 2:3.

Shelter roof

Min. thickness:	300 mm
Min. reinforcement:	Placed in both edges. Calculated on effective height.

Reinforced floor over evacuation route

Min. thickness:	200 mm
Min. reinforcement:	Placed in bottom edge. Calculated on effective height.

Party floor between two shelters

Min. thickness:	400 mm
Min. reinforcement:	Placed in both edges. Calculated on effective height.

Intermediate floor in two-storey shelter

Min. thickness:	150 mm
Min. reinforcement:	Placed in bottom edge. Calculated on effective height.

Protective floor

Min. thickness:	150 mm
Min. reinforcement:	Placed in bottom edge. Calculated on effective height.

Floor for foundation case 1

Min. thickness:	100 mm (200 mm for parts which absorb ground pressure from weapons load or collapse load).
Min. reinforcement:	Placed in top edge. Calculated on effective height; min. 100 m.

Floor for foundation cases 2 and 3

Min. thickness:	200 mm
Min. reinforcement:	Placed in top edge. Calculated on effective height.

3:24a. Minimum concrete thickness and reinforcement volume.

Top layer in two-layer floor

Min. thickness:	-
Min. reinforcement:	Placed centrically. Calculated on layer thickness.

Boundary wall without backfill

Min. thickness:	350 mm (see *3:34e*).
Min. reinforcement:	Placed in both edges. Calculated on effective height.

Boundary wall with backfill or protective wall

Min. thickness:	250 mm (see *3:34e*).
Min. reinforcement:	Placed in both edges. Calculated on effective height.

Party wall between two shelters

Min.thickness:	400 mm
Min. reinforcement:	Placed in both edges. Calculated on effective height.

Inner wall in shelter, bearing wall in reinforced evacuation route

Min. thickness:	150 mm
Min. reinforcement:	Placed centrically. Calculated on wall thickness.

Protective wall

Min. thickness:	150 mm
Min. reinforcement:	Placed centrically. Calculated on wall thickness.

Shaft and tunnel with rectangular cross-section

Min. thickness:	150 mm
Min. reinforcement:	Placed in both edges. Calculated on 200 mm.

3:34b. Minimum concrete thickness and reinforcement volume.

Shaft and tunnel with circular cross-section

Min. thickness:	110 mm
Min. reinforcement:	Placed centrically. Calculated on 200 mm.

Beam, column

Min. thickness:	-
Min. reinforcement:	Placed in both edges. Calculated on effective height; sheer reinforcement calculate on 150 mm.

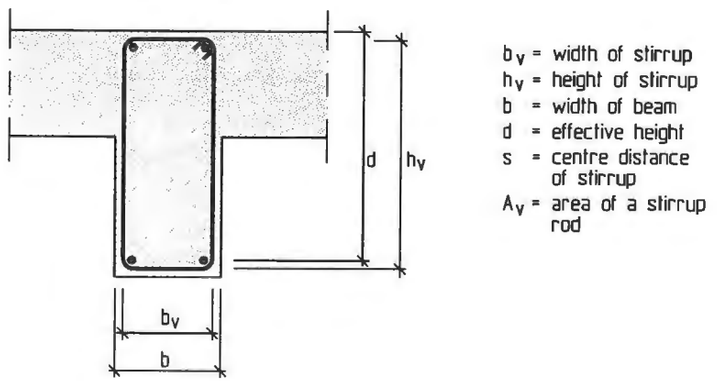
Capital, reinforcing plate, counterthrust

Min. thickness:	-
Min. reinforcement:	Placed as per *3:51f.* Calculated on thickness; min 100 mm.

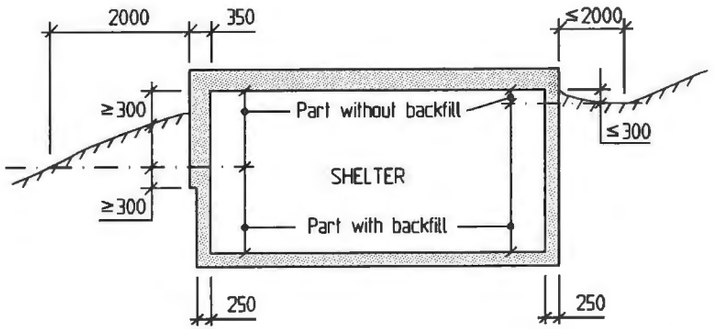
Concreting round piping

Min. thickness:	100 mm
Min. reinforcement:	Placed in as per *3:54a-b.* Calculated on 200 mm.

3:34c. Minimum concrete thickness and reinforcement volume.



3:34d. Symbols for calculation of ρ_v.



3:34e. Minimum wall thickness for partially backfilled wall and sloping ground. The height of the backfill is calculated to the lowest point within 2 m from the shelter wall.

3:35 Attachment

3:351 General

As per 27 § in chapter 1 installations in the shelter shall be secured so that they will not be pulled out or break during weapons load. The following design is approved.

The bearing capacity of an attachment and the unity of a secured object can be shown by means of calculation. For this calculation it shall be assumed that the construction part is retarded by 1000 m/s^2 from a speed of 15 m/s to idle. Return movement of the construction part does not require to be considered. Plastic deformation and sliding shall be considered.

If the inherent unity of the object is not sufficient an appropriate trap arrangement for the object shall be made.

Dimensioning can also be made as per 3:352 and 3:353.

3:352 Dimensioning of attachment

An attachment shall be dimensioned for the force:

$F = k \cdot m$

Symbols:

F static tensile force (kN)

k coefficient as per *3:352a*

m the attached mass (kg)

The force F is assumed to act on the centre of gravity of the object and be aligned perpendicular to the plane of the construction part. The force from an object may be distributed on several attachment points. The following attachment types can be distinguished during dimensioning.

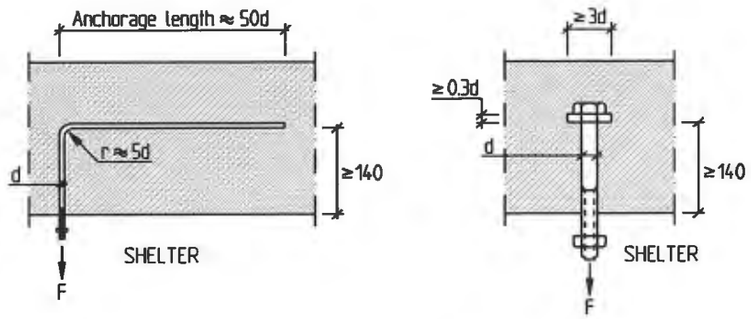
Embedded attachment. This refers to plain round bars, bolts with head and washer, and anchor bars with anchorage. These shall be designed with an embedded length of at least 140 mm, see *3:352b-c*. Plain round bars shall be designed of standard structural steel which is bent 90°. Ribbed bars are not approved.

Drilled attachment. This refers to expander bolts, expander sleeves and chemical anchors. These shall be dimensioned as per existing type approvals and mounting instructions, but with a minimum mounting depth of 50 mm. If the total mass of the attached object is greater than 5 kg the attachment force shall be distributed to at least three attachment points. These shall be placed irregularly to reduce the risk of cracking through several attachments.

Other attachment. This refers to attachment with screws in plastic plugs and moisture resistant adhesive. Gun nails are not approved for the attachment of equipment and installations which shall be dismantled when setting the shelter in order.

Attachment type	k	m_{max}
Embedded attachment:		
plain round bar	0.4	40
bolt with head and washer	0.8	25
anchor bar with anchorage	1.0	15
Drilled attachment:		
expander bolt, expander sleeve	1.0	10
chemical anchor	1.0	5
Other attachment:		
screw in plastic plug	1.0	0.1

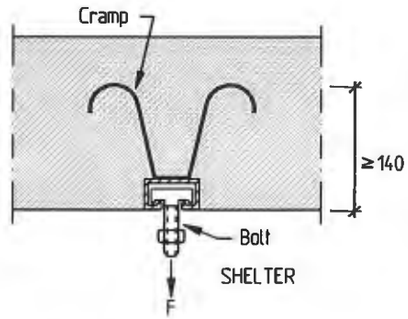
3:352a. Coefficients for dimensioning of attachments.



Plain round bar

Bolt with head and washer

3:352b. Embedded attachment.



Anchor rod with anchorage

3:352c. Embedded attachment.

3:353 Covering of floor construction

Reinforced top concrete may be cast without special attachment direct on the floor construction.

An unreinforced covering may be cast direct on the floor construction if the characteristic value of the adhesive strength in kN is at least 1.5 times the mass of the covering in kg. The thickness of the covering may together with the cover layer of the construction concrete be max. 50 mm.

3:36 Surface layer and heat insulation

As per 27 § in chapter 1 material attached in the shelter shall have an inherent strength such that they do not break up during weapons impact. As per 22 § the air temperature in the shelter shall be limited. The following design is approved.

Surface layers shall be designed as per the requirement for evacuation routes as per New Building Regulations. Ceramic material and the like set in concrete or adhesive is not approved.

In order to limit the temperature increase during operation of the shelter the heat insulation of the shelter carcase shall be placed on the outside of the shelter.

3:37 Corrosion protection

As per 3 § in chapter 1 the shelter shall be designed and equipped for a service-life of at least 50 years. In order to ensure the function of the steel parts in the shelter during this time these must be protected from corrosion. The following design is approved.

Columns, eyebolts for concrete elements in gobbings and cross-beams for gobbing with concrete elements are also to be considered in addition to steel for embedded components.

The division into environmental classes as per BSK is to be applied. Internal steel parts shall normally be referred to environmental class M1, and external steel parts to environmental class M3. Steel parts in the ground are not permissible without surrounding casts. The inside of outdoor air ducts shall be referred to environmental class M3 in their full length. Doors in outer walls are referred to environmental class M3 even if they have a protective climate lining.

Bolts, nuts, washers and protective plates as per 3:42 shall be hot galvanized. Outside air ducts shall be hot galvanized both internally and externally.

All corrosion protection shall be completed at workshop in at least environmental class M1. Casting goods, such as frames and inlets shall either be hot galvanized or painted for correct environmental class at workshop. Otherwise adjustment to correct environmental class and touching up of damage to the corrosion protection may be carried out after mounting. Corrosion protection implies pre-treatment, primer application, and top coat.

Hot galvanized, externally threaded attachment elements shall comply with the requirements for class 3 or 4 in SS 3192. Hot galvanized parts shall otherwise comply with requirements in SS 3583.

Slide surfaces, threads and the like shall be oiled. Embedded goods only require to be painted on the surfaces which are not embedded, and 50 mm in on the surfaces to be embedded.

Examples of treatment are reported in BSK.

3:4 BUILDING PARTS

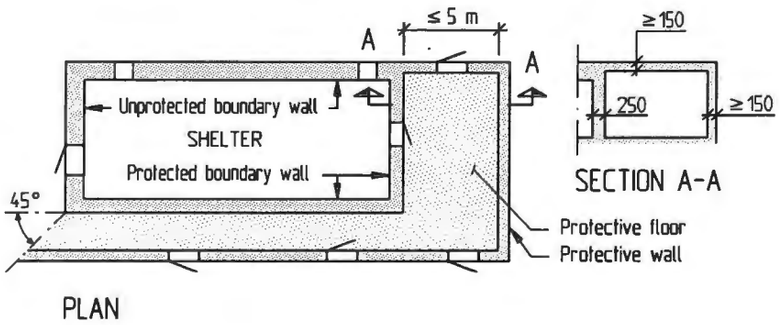
3:41 Protective walls and floors

The requirements for construction thicknesses are indicated in 3:34. The following design for the utilization of adjacent constructions is approved.

A shelter wall which is not backfilled may be reduced in thickness to 250 mm if it is protected by a concrete construction as per *3:34b-c* which is located no more than 5 m from the part which is to be protected.

Openings in protective walls and floors are permitted if these consist of no more than ten per cent of the area. This restriction refers to each wall section and floor section separately. Openings with splinter protection gobbing are not required to be included in the opening area.

The principle for a protective construction is indicated in *3:41a*.



3:41a. Protective construction.

3:42 Openings

The gobbing of an opening in the shelter's carcase shall comply with the requirements for protective capacity in chapter 1. As per 30 § in chapter 1 the gobbings shall be easily accessible. The following design is approved.

The gobbing of openings with a maximum area of 0.04 m^2 is permitted in roofs.

Gobbings which do not provide sufficient protection from radiation shall be combined with a special radiation protection.

The distance between two openings shall be at least the same as the free width for the smaller opening. The distance between wall corners and openings shall be at least equal to the free width of the openings.

A door may be built-in in peacetime only on the assumption that the covering is made sufficiently easy to dismantle that the door can at any time and without damaging action or special tools be accessible for checking and periodic maintenance.

Examples of gobbings are indicated in *3:42a*.

Gobbing type	Frame width mm	Overhead mm	Comment
Door:			
SRD 9x21	910	2110	single door
SRD 9x21G	910	2110	for party wall
SRD 11x19	1110	1970	single door
SRD 11x19G	1110	1970	for party wall
SRD 11x21	1110	2110	single door
SRD 11x21G	1110	2110	for party wall
SRD 23x19	2380	1970	double sliding door
SRD 23x19G	2380	1970	for party wall
SRD 24x24	2480	2410	double sliding door
SRD 24x24G	2480	2410	for party wall
Hatch:			
GSL 2x2	200	200	
GSL 4x4	400	400	
GSL 6x6	600	600	
GSL 8x8	800	800	
GSL 8x8Ö	800	800	reserve exit
Protection plate:			
SP 2	ϕ200		
SP 4	ϕ400		not in roof
Concrete element:			
BE 8x8	800	800	reserve exit
BE 8x8G	800	800	for party wall

3:42a. Examples of gobbings.

3:43 Mountable columns

A column which is included in the shelter's bearing system may be made mountable. The following design is approved.

Steel columns shall be dimensioned as per BSK. Dimensioning against penetration shall be made as per 3:332 for connection at roof and floor. Foot plates and load distribution plates may be considered as columns if they are dimensioned to transmit the column load to the concrete by means of a uniformly distributed contact pressure.

The column shall be designed so that it can hang in the roof during mounting. The design shall be such that mounting can be carried out by no more than two persons and with the tools which belong to the shelter; see 5:4. The column may weigh no more than 60 kg.

3:5 STRUCTURAL DESIGN

3:51 Reinforcement and connections

Reinforcement and connections shall comply with the requirements for protective capacity as per chapter 1. The following design is approved.

Splicing of a reinforcement rod is permissible on the assumption that the ultimate yield limit of the rod is reached before fracture in the splice. Splicing of reinforcement shall take place as per New Building Regulations, but with minimum splice length l_j as per:

$$l_j = 0.18 f_{st}\,\phi/(f_{ct}\cdot\eta_1) \qquad \text{Ks400} \qquad (1)$$

$$l_j = 0.22 f_{st}\,\phi/(f_{ct}\cdot\eta_1) \qquad \text{Ks600} \qquad (2)$$

$$l_j = 0.28\,(f_{st}/f_{ct} - 45)/\eta_1 \qquad \text{Ss260} \qquad (3)$$

Symbols:

f_{ct} dimensioning tensile strength of the concrete in MPa

f_{st} dimensioning tensile strength of the reinforcement in MPa

ϕ rod diameter in m

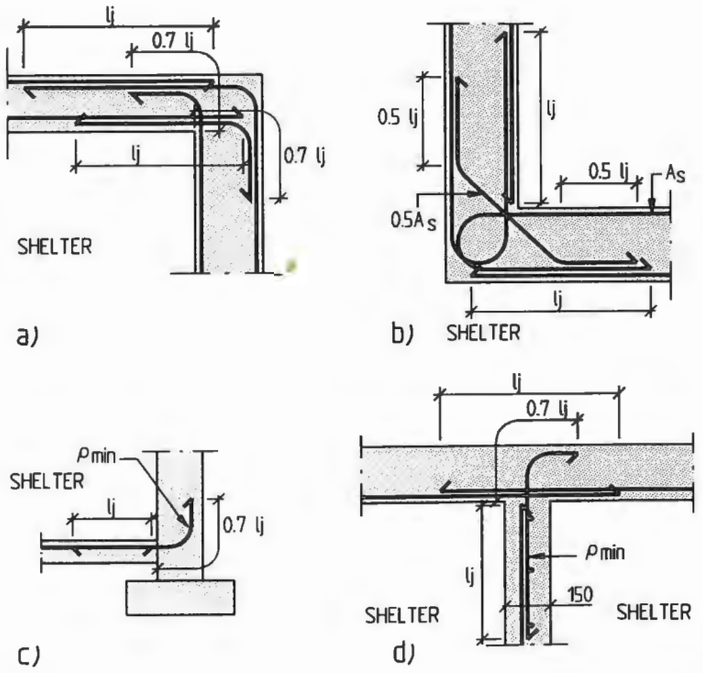
η_1 1.0 for ribbed rods in bottom edge of floor and vertical ribbed rods

0.7 for ribbed rods in top edge of floor and horizontal ribbed rods in walls

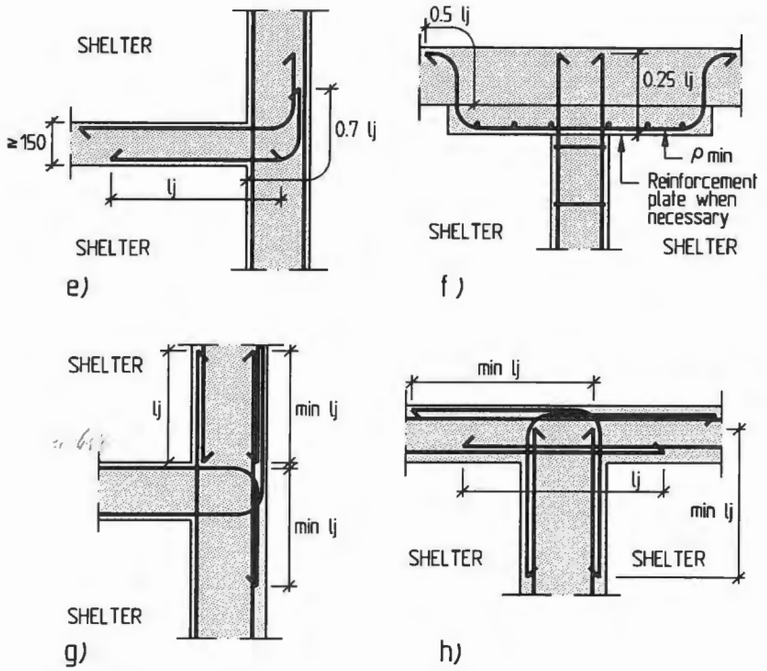
0.5 for plain rods in top edge of floor and horizontal plain rods in walls

Reinforcement which on the basis of calculation absorbs tensile force may be spliced with no more than every other rod in the same section. Field reinforcement shall, even at intermediate bearing, have splice length l_j. Reinforcement may be plain if provided with end hooks.

Examples of connections between structural parts with minimum acceptable splice length and anchorage are shown in *3:51a-h.* The anchorage length is at least $0.7l_j$, but the calculated force in a rod can in certain cases require a larger anchorage length. A_s designates the reinforcement area.



3:51a-d. Reinforcement in connections between structural parts in the shelter carcase. All reinforcement is not reported.



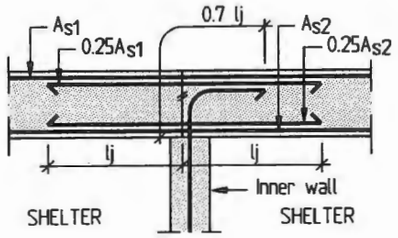
3:51e-h. Reinforcement in connections between structural parts in the shelter's carcase. All reinforcement is not reported.

3:52 Joints

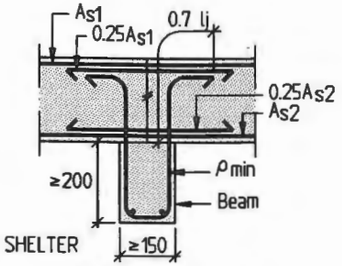
A joint in the shelter carcase shall be designed so that the requirements for protective capacity in chapter 1 are satisfied. The following design is approved.

The reinforcement area through the joint shall be at least $1.25A_s$ within the splice length on each side of the joint, where A_s is the reinforcement area of the construction part. Joints without back bearing shall have a longitudinal recess at least 40 mm in depth, where the recess shall consist of approx. half the thickness of the construction part. Vertical joints may not be placed closer to inward corners than 1 m. Flexible joints are not permitted.

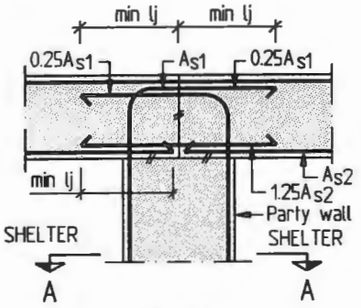
Joints may be designed as per *3:52a-d.*



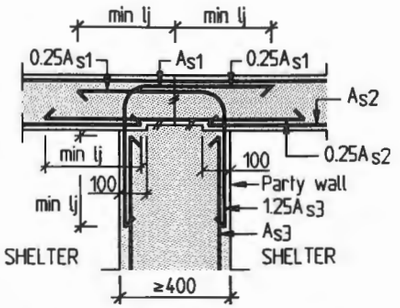
VERTICAL SECTION
a)



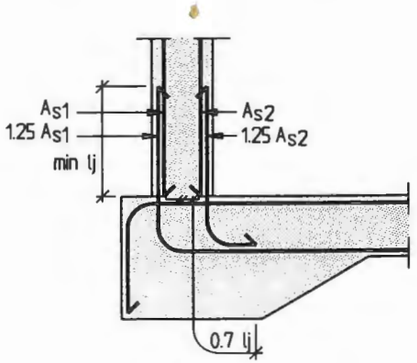
VERTICAL SECTION
b)



VERTICAL SECTION
c)



HORIZONTAL SECTION A-A



VERTICAL SECTION
d)

3:52a-d. Examples of joints. All reinforcement is not reported.

3:53 Measures against shrinkage cracks

In order to comply with the requirements for protective capacity in chapter 1 measures must be taken to prevent damaging cracking as a result of the shrinkage of the concrete. The following design is approved.

The layout and foundation of the shelter shall be designed so that concentrations of cracks are not produced as a result of cross-sectional variations, spot anchorage in the foundations or the like. In certain cases, for example, a boundary wall may require to be provided with a horizontal crack-distributing reinforcement in addition to the minimum reinforcement as per 3:34. Where concentrations of cracks may still be expected, extra reinforcement shall be inserted to limit the crack width, for example at concreted piping or other weak points. If possible, shrinkage joints shall be arranged in construction parts which connect to the shelter to minimize the risk for damaging shrinkage.

3:54 Embedment goods and piping

During the embedment of components in the shelter carcase the requirements for protective capacity in chapter 1 shall be observed. The following design is approved.

Embedment goods shall be cast at the same time as the carcase is cast. Through form tie sleeves are not permitted. Piping and cabling in the shelter shall have the following design.

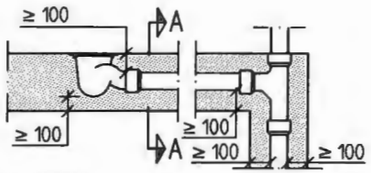
a. Casting in the carcase. The free distance between parallel pipes shall be greater than ten times the largest internal pipe diameter. If the internal diameter is greater than 50 mm a cover layer and shear reinforcement shall be arranged as per *3:54a*. Branching with an angle of at least 45° is permitted.

b. Laying in additional concrete in the carcase. Additional concreting shall be carried out with a minimum 100 mm concrete cover around the pipe and be reinforced as per *3:54a*.

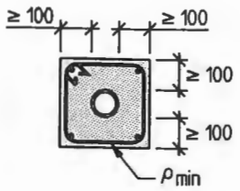
c. Drainpipe placed separately in the shelter. The pipe shall comply with requirements as per 4:232.

d. Water pipe and compressed air pipe placed freely in the shelter. The pipe shall comply with requirements as per 4:231.

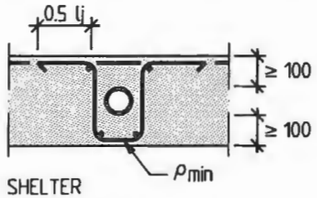
See also 4:232 for casting round drainpipe.



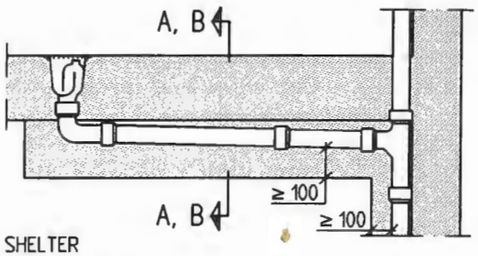
SHELTER
VERTICAL SECTION



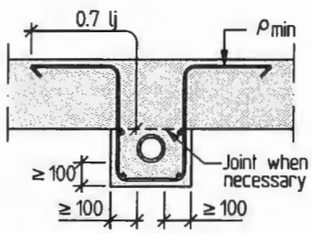
HORIZONTAL SECTION
Design at column



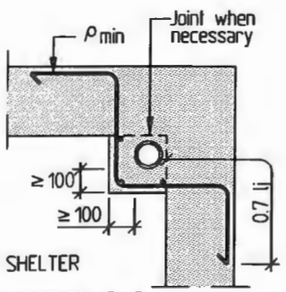
SHELTER
VERTICAL SECTION A-A



SHELTER
VERTICAL SECTION



SHELTER
SECTION A-A



SHELTER
SECTION B-B

3:54a. Casting of pipes. All reinforcement is not shown.

4 INSTALLATIONS

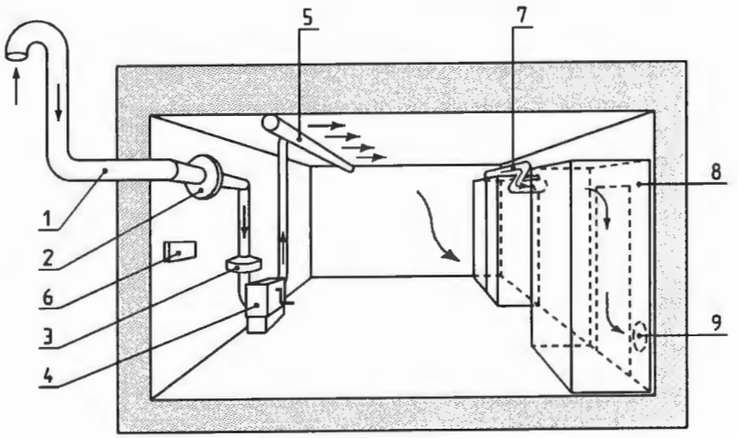
4 INSTALLATIONS

4:1 AIR PROCESSING

4:11 General

As per 2 § in chapter 1 the persons in need of protection shall be able to stay in the shelter without interruption for at least three days. In order that this shall be possible installations are required which supply oxygen and remove carbon dioxide, heat and moisture. The air processing system described in this chapter is approved if it is applied in its entirety.

An air processing system for shelters is shown in principle in *4:11a.*



1	Outdoor air duct	4:121	6	Overpressure gauge	4:126
2	Shock wave protection	4:122	7	Exhaust air duct	4:131
3	Protection filter	4:123	8	Air lock	4:132
4	Ventilation unit	4:124	9	Overpressure valve	4:133
5	Intake duct	4:125			

4:11a. General design of a ventilation system for shelters.

4:12 Supply air

4:121 Outdoor air duct

As per 17 § in chapter 1 the air intake to the shelter shall be placed so that air can be supplied to the shelter in the safest possible manner under the circumstances and without predictable air pollution. As per 19 § the air shall be able to be purified from coarse particles. Tightness requirement as per 7 § and materials requirement as per 3 § shall be fulfilled for the air intake. The following design is approved.

The outdoor air duct shall be designed in steel piping as per SMS 1886 or SS 14 23 43. Where it passes through the shelter carcase it shall be provided with a welded sealing flange in the middle of the embedment. The height of the flange shall be at least 20 mm and shall have a thickness of at least 3 mm.

The outdoor air duct shall be designed with a dimension of at least DN 100 if the length is max. 10 m and there are no more than five pipe bends of 90°. Longer ducts shall be dimensioned in each separate case with respect to the pressure drop in the duct.

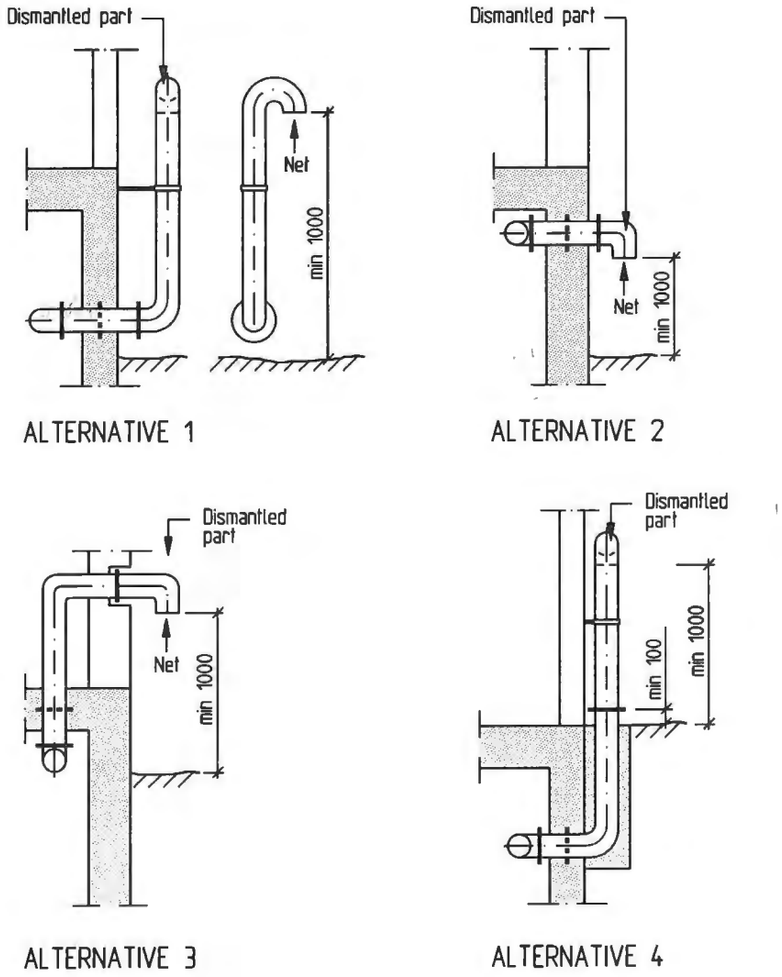
There shall be one outdoor duct for each ventilation unit in the shelter. The duct shall open in or in front of the building wall or on the building roof. Several plants may not be connected to the same outdoor air duct. Where there are several outdoor air ducts the intakes for these shall be placed as far from each other as possible. This normally implies that the intakes are placed on different walls. If an outdoor air duct thus becomes longer than 10 m the intake for this can be placed on the same wall as the intake for another outdoor air duct. The prerequisite for this is that the distance between the ducts which are on the same wall is at least 10 m. The air intake may not be placed so that exhaust air from the shelter, or other predictable air pollution, can be sucked into the outdoor air duct.

The outdoor air duct may be designed as fixed, or possible to dismantle. Parts which can be dismantled may not weigh more than 60 kg. The connection flanges which are necessary during dismantling shall be designed in at least pressure class PN6.

Approved positionings of the external part of an outdoor air duct are shown in *4:121a*. The duct's external opening shall be provided with a well anchored hot galvanized protective net with a mesh width of 15 - 17 mm and a wire thickness of 1.5 - 2.5 mm.

It shall be possible to clean the duct. The low-point of the duct shall be provided with an easily accessible and closeable drain device for condensation water with a dimension of at least DN 15.

Attachment designed as per 3:35 is approved, and embedment as per 3:54. Attachment shall be executed along the full length of the outdoor air duct, that is, including rooms outside the shelter and along building walls.



4:121a. Alternative positionings of the external part of an outdoor air duct.

4:122 Shock wave protection

In order to comply with the requirement for protective capacity as per 4 § in chapter 1 each outdoor air duct must be provided with a shock wave protection device. The following design is approved.

A shock wave valve shall be placed between the outdoor air duct and the ventilation unit as per 4:124. The valve shall prevent a pressure wave from weapons impact coming into the shelter. It shall not otherwise obstruct the air supply to the shelter. The valve connections shall be tight against chemical weapons. Connection to the protective filter and ventilation unit shall be made with a flexible hose which is as short as possible.

4:123 Protective filter

As per 19 § in chapter 1 air which is supplied to the shelter shall be able to be purified. The following design is approved.

Each ventilation unit as per 4:124 shall be provided with a protective filter. This shall be able to purify the incoming air from dust and chemical weapons. The filter shall when necessary be able to be connected in on the suction side of the ventilation unit.

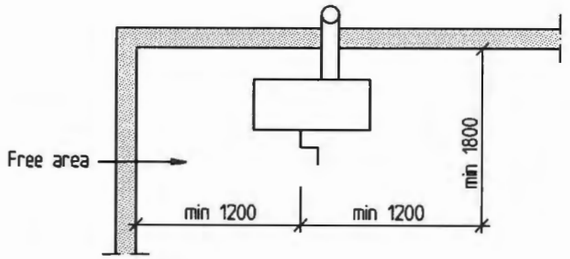
4:124 Ventilation unit

As per 18 § in chapter 1 there shall be equipment for the air supply and this shall be electrically powered and also be able to be operated manually. The quality of the air inside the shelter shall comply with the requirement as per 22 §. The following design is approved.

A ventilation unit shall be installed for every 60 shelter places, or part thereof, which ensures the required air quality inside the shelter. The unit shall have an air capacity for 60 persons. The air capacity per person shall with connected filter be 2.5 m^3/h.

The unit shall be provided with a handle for manual operation. This shall be placed so that the centre of the crankshaft comes approx. 1.1 m over the floor. The unit shall be placed in the plan as per *4:124a*.

Approved attachment to be designed as 3:35.



4:124a. Positioning of the ventilation unit.

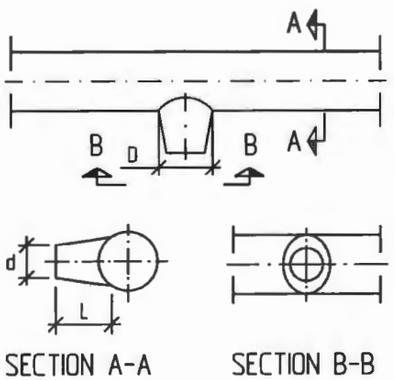
4:125 Supply air duct

The shelter shall have equipment which ensures an air quality as per the requirement in 22 § in chapter 1. The following design is approved.

Each ventilation unit shall be provided with a supply air duct with supply air terminal device. The air distribution in the shelter shall normally be sufficient if the air is blown in at roof height along the full length of the shelter.

The supply air duct shall have an inner cross-sectional area which at least corresponds to a pipe with a diameter of 100 mm. The connection between the ventilation unit and the supply air duct shall be designed with a flexible hose which is as short as possible. The supply air terminal device shall be dimensioned for an air volume of 2.5 m^3/h per person. An example of approved sleeve couplings is shown in *4:125a*.

Approved attachment designed as per 3:35.



Number of pers/ supply terminal	Size in mm		
	D	d	L
10	55	35	55
20	80	50	80
30	90	60	90

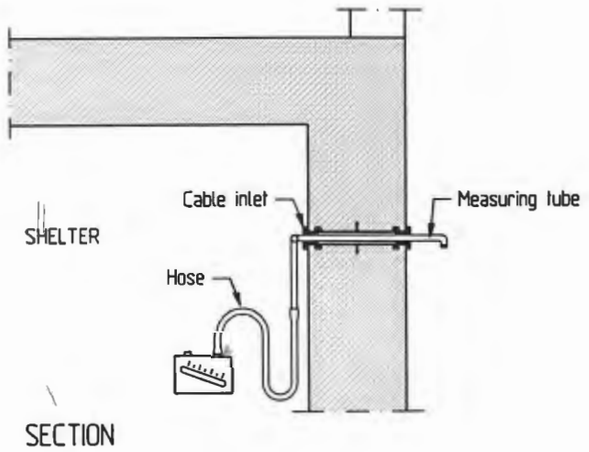
4:125a. Examples of supply air terminal device.

4:126 Overpressure gauge

As per 8 § in chapter 1 it shall be possible to read the overpressure inside the shelter in relation to atmospheric pressure. The following design is approved.

An overpressure gauge shall be connected with a hose no more than 0.5 m long to a measuring tube, which by means of a cable inlet is connected with the air outside of the shelter. The measuring tube shall be made of copper with dimension Dy6. It shall be possible to drain the tube and hose. The positioning of the overpressure gauge in the shelter is optional, on the assumption that it is easy to read. It shall not be placed in the air lock or toilet areas.

The principle for installation of an overpressure gauge is shown in *4:126a*.



4:126a. Principle for installation of an overpressure gauge.

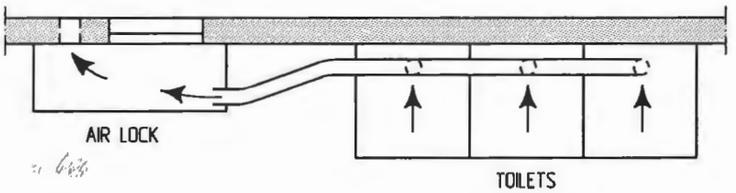
4:13 Exhaust air

4:131 Exhaust air duct

As per 21 § in chapter 1 the exhaust air shall be removed from the shelter via the toilet areas and air lock. The air turnover in the air lock shall, as per 20 §, be at least 50 per hour. The following design is approved.

An exhaust air duct shall be arranged between the toilet areas and the air lock. This shall be connected so that there is an exhaust air opening to each toilet area; see *4:131a*. The opening may be placed in the roof of the toilet area, and is connected with a flexible hose. The size of the exhaust air duct shall be at least 150 mm for an overpressure valve as per 4:133, at least 200 mm for two overpressure valves, and at least 250 mm for three overpressure valves.

Approved attachment is designed as per 3:35. Marking of ducts which can be dismantled is approved as per 5:63.



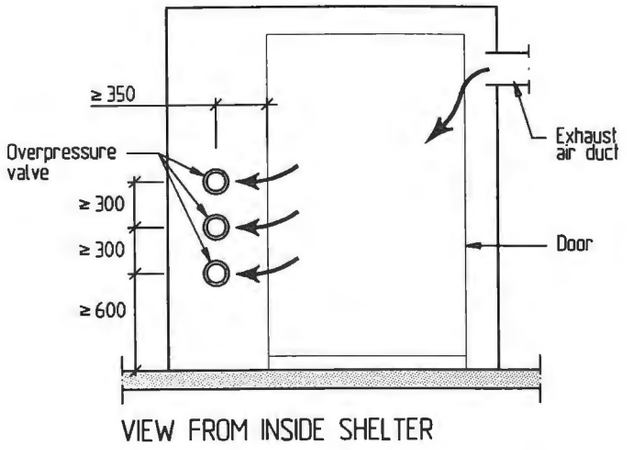
4:131a. Exhaust air duct.

4:132 Air lock

As per 20 § in chapter 1 the shelter shall be provided with an air lock for at least three persons. It shall be able to be vented with at least 50 air exchanges per hour. The following design is approved.

The air lock shall be able to be assembled, and have an internal area of at least 1.2 m^2. It shall be designed so that normal passage is not obstructed when interlocking is not required. The exhaust air duct shall be entered into the air lock at one of the top corners which do not connect to the shelter wall. It may not be placed on the same side of the shelter door and the overpressure valves. The principle for an air lock is indicated in *4:132a*.

When positioning the air lock the distance from the corner shall be sufficient to enable assembly. The contact surfaces between the air lock and wall shall be smooth and free from electric cables, piping and the like.



4:132a. Arrangements for air lock.

4:133 Overpressure valve

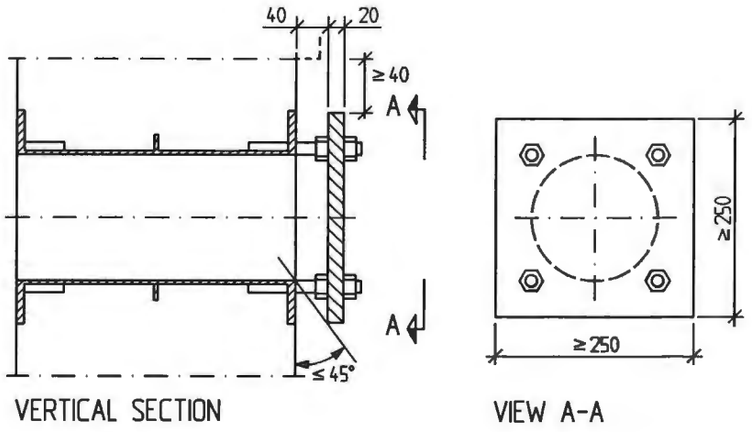
As per 21 § in chapter 1 it shall be possible to remove exhaust air from the shelter. The inlets in the shelter carcase which are required for this must comply with the requirement for the shelter's protective capacity in chapter 1. The following design is approved.

Overpressure valves shall be used as inlets in the outer wall of the air lock. An overpressure valve shall open at an overpressure in the shelter in relation to an atmospheric pressure of approx. 60 Pa. It shall close if the overpressure diffuses, or if the valve is activated by an external pressure wave.

There shall be one overpressure valve for every 60 persons and ventilation unit. The nominal air flow of the valve shall be 300 m^3/h at a maximum pressure drop of 200 Pa.

The valves shall be placed with a minimum relative centre distance of 300 mm and with the centre at least 350 mm from adjoining structural parts, but at least 600 mm above the floor. Overpressure valves and exhaust air ducts may not be placed on the same side of the shelter door.

The overpressure valves shall be provided with a splinter protection on the outside of the shelter. This can be designed as per *4:133a* or consist of protective wall and floor as per 3:41.



4:133a. Splinter protection for overpressure valve.

4:14 Heating

As per 23 § in chapter 1 the shelter shall be provided with heating arrangements which ensure a temperature of at least 5°C when the shelter is empty.

As per 22 § the temperature in the shelter is to be limited when it is fully occupied. In order to meet this requirement the heating arrangements must be manually regulated so that the heat can be switched off inside the shelter.

Plumbing is approved when arranged as per 4:231. Electric heating is approved when arranged as per 4:311. The attachment of heating arrangements is approved when designed as per 3:53.

4:15 Arrangements for peacetime ventilation

Opening for peacetime ventilation may be arranged in the shelter carcase if they are provided with special arrangements for gobbing during the operation of the shelter; see 3:42.

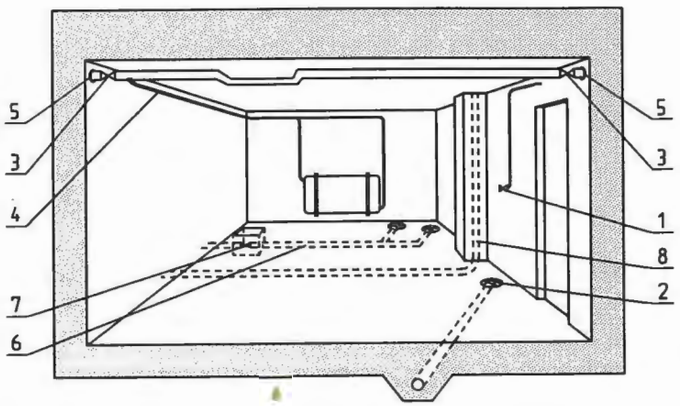
The part of a ventilation duct which goes through the shelter carcase for peacetime operation must be dismantled when the shelter is set in order. The attachment of peacetime ventilation is approved as per 3:35.

4:2 PLUMBING

4:21 General

As per 15 § in chapter 1 the shelter shall be provided with installations for tap water and sewer. Both this and other piping must be arranged so that the requirement for protective capacity for the shelter is fulfilled. Requirements for materials and dimensions are indicated in 4:22.

The general design of plumbing in a shelter is shown in *4:21a*.



1	Tap point	4:221	5	Pipe inlet	4:231
2	Floor well	4:222	6	Peacetime sewer	4:232
3	Stop valve	4:231	7	Valve pit	4:232
4	Piping	4:231	8	Through sewer	4:232

4:21a. General design of plumbing in a shelter.

4:22 Plumbing for shelter operation

4:221 Tap points

As per 15 § in chapter 1 the shelter shall have at least one tap point for water. The following design is approved.

The positioning of the tap point in the shelter is optional, but it shall be placed together with the floor well. It may not be placed in the air lock or in the vicinity of the main distribution box.

Plumbing shall be executed as per 4:232. The tap point shall be provided with equipment as per 5:3.

4:222 Floor well

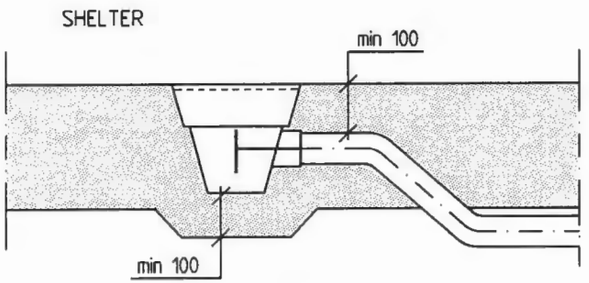
As per 15 § in chapter 1 the shelter shall be provided with a sewer. This shall comply with the requirement for protective capacity in chapter 1. The following design is approved.

The drain shall be connected to the nearby sewer network. If this is not possible the drain may be drawn to a drainage well outside the shelter. This drainage well shall have a volume of at least 0.5 m^3 for each tap point which it serves.

The drain shall be provided with a floor well. It shall be possible to close this manually. The closing device shall sit in the floor well and be of non corrosive material. Resistance to external pressure shall be not less than 100 kPa. Floor wells without inherent shut-off devices or with automatic shut-off devices are not permissible.

The drain from the floor well shall in foundation case 3 as per 3:232 be embedded with at least 100 mm of concrete. Embedment is not required for foundation cases 1 and 2.

Floor wells are approved when executed as per *4:222a*.



4:222a. Floor well for shelter.

4:23 Plumbing for peacetime utilization

4:231 Piping for water and compressed air

As per 24 § in chapter 1 only piping for water and compressed air may be used in the shelter. The temperature of the water may be max. 100°C and the air pressure max. 900 kPa. Where pipes go through the shelter carcase the requirement for protective capacity in chapter 1 shall be fulfilled. The following design is approved.

Piping, valves, connected installations and sealing flanges shall be designed in at least pressure class PN 6.

The following pipes and maximum pipe dimensions comply with the requirement for protective capacity:

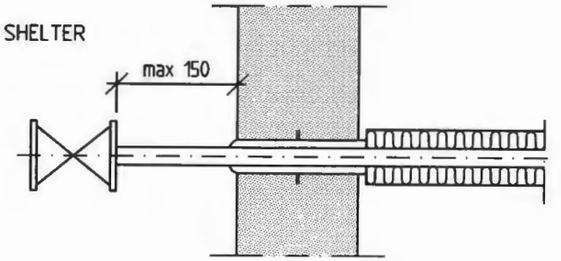
- Copper piping as per SMS 1890 series 2 with dimension 70/2 and series 3 with dimension 70/2.5.
- Steel piping as per SMS 1886 with DN 65.
- Steel piping as per SMS 326 or SMS 327 with DN 65.

Piping with max. DN 65 which passes straight through the shelter carcase may be embedded with a minimum centre-centre distance of 150 mm. Other embedded piping shall be placed as per 3:54.

Piping which can give rise to condensation or the release of heat into the shelter shall be provided with insulation, the surface layer of which is approved in evacuation routes; see 3:36. In order that a pipe inlet shall be accessible for checking the insulation shall be terminated approx. 50 mm from the pipe inlet.

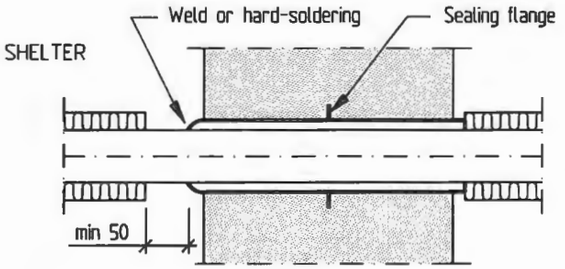
The attachment and hanging of piping and fittings is approved as per 3:335. The positioning of piping in the contact surface between air lock and wall is approved as per 4:132. Tap water installation is to be designed as per New Building Regulations.

Pipes which go through the shelter carcase shall be provided with a stop valve max. 150 mm from the inlet on the inside. Piping which goes through a party wall between two shelters shall be provided with a stop valve by the party wall in each shelter. Positioning is indicated in *4:231a*.



4:231a. Installation of stop valve.

Inlets through the shelter carcase shall be sealed; see *4:231b*. The sealing flange shall be hard-soldered or welded, and designed with a height of at least 20 mm and thickness of at least 3 mm. The distance between adjacent pipe inlets flanges shall be at least 30 mm. Cable inlets may also be used as inlets for pipes.



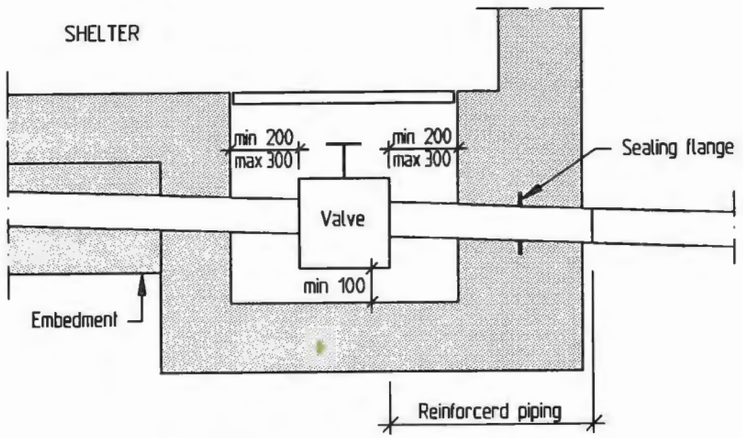
4:231b. Example of tight pipe inlet.

4:232 Drain installations

In order to comply with the requirement for protective capacity in chapter 1 the drain units only intended for peacetime use shall be able to be closed with a special stop valve. The following design is approved.

A stop valve may serve several drain units and shall be placed in a separate valve pit as per *4:232a.* This shall be covered with a tramp-proof hatch of corrosion resistant material. The hatch shall be screwed into a frame of the same material. The stop valve and the reinforced piping shall be designed in at least pressure class PN 6. The reinforced piping shall be provided with a sealing flange as per 4:231. Pipes under the shelter floor shall be embedded with at least 100 mm of reinforced concrete. Between the drain units and stop valve there may not be any connection to drains for shelter operation or a through drain.

Floor wells shall always be designed with inherent shut-off in the floor well, see 4:222.



VERTICAL SECTION

4:232a. Valve pit for peacetime utilization.

Through drains inside the shelter without connected drain units within the shelter shall be designed in piping which complies with at least requirement SS 14 23 42 and pressure class PN 10. The pipe shall be made without joints in the shelter, and the inlets in the shelter carcase shall be made tight with sealing flanges as per 4:231. The pipe may be made of other material if it is embedded with at least 100 mm of reinforced concrete as per 3:54 or has a dimension and stop valves as per 4:231.

Where cleaning facilities are required for embedded drains the pipe shall be made of cast iron or stainless steel. Transfer to other material may take place 0.5 m in an embedment as per the above.

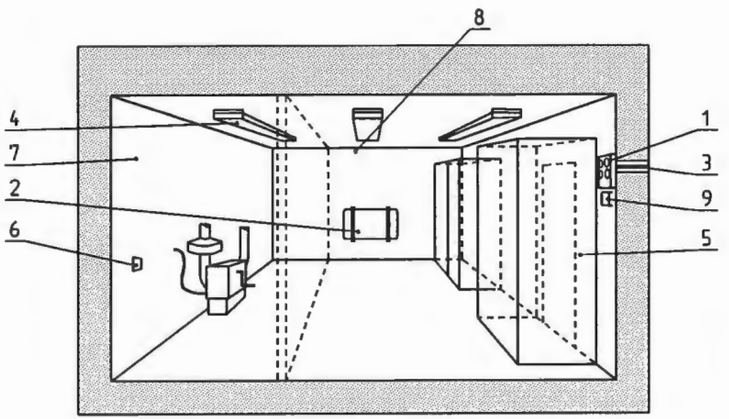
A floor well embedded in the shelter's roof slab is indicated in 3:54.

4:3 ELECTRICAL INSTALLATIONS

4:31 Electrical installations for shelter operation

4:311 General

A shelter shall contain several functions which are supplied with electricity. The general design of electrical installations in a shelter is shown in *4:311a.*



1	Distribution box	4:311	6	Plug	4:314
2	Electric radiator	4:311	7	Aerial inlet	4:315
3	Main cable	4:312	8	Telecommunications inlet	4:315
4	Lighting	4:313	9	Safety switch for peacetime installation	4:32
5	Switch	4:313			

4:311a. General design of electrical installations in a shelter.

As per 29 § in chapter 1 the electrical installations in the shelter shall be connected directly to the main distribution box in the building via a group distribution in the shelter. The following design is approved.

The distribution box shall only serve functions which belong to the shelter and may not be placed in the air lock or in the vicinity of a tap point. Electrical installations shall be allocated to separate fuses so that a fault in one function will not fuse other functions. Each ventilation unit shall be connected to its own group in the distribution box. The lighting shall be allocated to at least two group fuses. Automatic fuses may be used in the distribution box.

Electric radiators shall have a minimum water-tightness of IP 34 (as per SS IEC 529) and be placed at least 1.0 m above floor level. A lower positioning is permissible if the radiator is provided with an earth-fault switch.

Electrical installations may be designed as both external and recessed. External wiring is not permissible, however, on contact surfaces between air lock and shelter walls.

The attachment of fittings and other electrical installations is approved as per 3:35. The embedment of cable conduits is approved as per 3:54.

4:312 Wiring and distribution boxes

As per 29 § in chapter 1 the shelter's electrical installations shall be connected to the main distribution box in the building. Inlets in the shelter carcase shall comply with the requirement for protective capacity in chapter 1. The following design is approved.

The power supply mains to the shelter shall be connected to separate fuses in the main distribution box in the building. Tight cable inlets and cables which can be enclosed in such inlets shall be used for though passage in the shelter carcase.

Conduits for electric cables may be embedded in the shelter carcase if they are drawn between external and internal reinforcement. They shall also have a relative distance of at least ten times the internal diameter. On connection to the group distribution box this size may be reduced.

Embedment is approved as per 3:54. Markings are approved as per 4:316.

4:313 Lighting

As per 16 § in chapter 1 all areas in the shelter shall be provided with lighting of at least 50 lux. As per 27 § the installations in the shelter shall have first-rate mechanical strength. The following design is approved.

The air lock and toilet areas do not require to be fitted with their own light points if they can be arranged so that the light conditions are satisfactory.

The switches shall be manually operated. Impulse switches and push buttons are permissible. The impulse switch shall be able to be by-passed with a switch. Switches for the shelter may be placed in the air lock.

If the lighting for peacetime use is controlled by automatic stairway units or timers a switch shall be installed so the automatic switches can be by-passed to a manual switch. The switches shall be provided with markings which indicate their function.

The output for lighting in the shelter may be max. 15 W/m^2 during operation of the shelter. If a higher output is required during peacetime use of the shelter it shall be clearly indicated on the shelter drawing as per 5:62 how the output is to be reduced to the required level.

Attachment is approved as per 3:53. If the inherent unity of a light fitting is not sufficient it shall be supplemented with an appropriately adjusted trap device for the fitting.

4:314 Power points

As per 28 § in chapter 1 the shelter shall be equipped with power points for the electrical requirements of occupants. The following design is approved.

In addition to plugs for the ventilation units there shall be at least two two-way and earthed plugs arranged for every 60 shelter places, and part thereof. These power points shall be placed at least 1.0 m above floor level. Lower positioning is permissible if the plug is provided with earth-fault switch.

As per New Building Regulations power points which are not tamperproof shall be placed at least 1.7 m above floor level.

4:315 Aerial and telecommunications inlets

As per 25 § in chapter 1 there shall be inlets for aerial and tele-communications wires in the shelter carcase. These shall comply with the

requirement for protective capacity in chapter 1. The following design is approved.

A cable inlet with a minimum dimension of 20 mm shall be used. The inlet shall be sealed with a cover at both ends and appropriate screw unions shall be stored with marked function in the shelter storeroom.

The inlet for the aerial shall open outdoors at least 2 m above ground level or in a shaft which belongs to the shelter. The telecommunications inlet shall open at an appropriate location with respect to other telephone wires within the building.

Marking plates are approved as per 5:64.

4:316 Marking

As per 33 § in chapter 1 the shelter shall be provided with marking plates in such a way that distinct information is available to enable the arrangement and operation of the shelter. The following design is approved.

At the main distribution box it shall be indicated on a group wiring diagram or plate which shelter power supply mains is referred to and which designation and area the power supply has. At the group distribution box in the shelter shall have a group wiring diagram where it is stated in writing where the main fuse for the group distribution box is placed.

At safety switches for installations which must be able to be dismantled as per 4:32 there shall be a marking plate which indicates that the switch shall be locked in the Off position during the arrangement of shelter, and that the dismantling of the installation shall be carried out after the switch. An example of a marking plate is given in *5:64a.*

4:32 Electrical installations for peacetime use

As per 26 § in chapter 1 the shelter shall be provided with the necessary equipment to enable the shelter to be arranged for its purpose. Fixed electrical installations which shall be dismantled during the arrangement of the shelter must therefore be provided with special equipment. The following design is approved.

The electrical installation shall be connected to a separate sub-distribution box connected to the group distribution box in the shelter. Between these two distribution boxes there shall be a safety switch as per SS 428 06 05 (SEN 28 06 05) which is placed so that the sub-distribution box can be disconnected. The safety switch shall be fitted with a lock. The distribution

boxes shall be marked with marking plates which indicate the function of the respective distribution boxes, and how dismantling is carried out.

Marking is approved as per 4:316.

5 EQUIPMENT

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5:1 EARTH CLOSET

As per 15 § in chapter 1 the shelter shall contain toilets. 2:25 approves the arrangement of an earth closet for every 30 shelter places, and part thereof. The following design is approved.

The areas for earth closets shall be arranged with partitions inbetween and between the other shelter areas. The intake for supply air shall be arranged at the floor and exhaust air shall be removed from the upper part of the area to the air lock.

Each area shall be provided with a toilet container, an appropriate seat ring with cover, and 20 sacks which fit in the container. The container shall have a standard seat height, and be designed in an age-resistant material which is resistant to flushing with water. The sacks shall be designed in age-resistant plastic with a thickness of at least 0.2 mm, with double-welded seams. They shall be able to be knotted and removed from the container when full to the volume of the container.

The attachment of the partition shall be designed as per 3:35. Lighting is to be arranged as per 4:313.

5:2 WATER TANKS

As per 15 § in chapter 1 the shelter shall contain equipment for the storage of water. The following design is approved.

The shelter shall be provided with storage tanks for water which can be sealed, with a total volume of at least 10 litres per shelter place. The tanks shall be designed in an age-resistant material which resists flushing with water, and have a volume of at least 60 litres and max. 130 litres.

5:3 EQUIPMENT FOR TAP POINTS

As per 15 § in chapter 1 there shall be an installation for tap water and equipment for the water requirements in the shelter. The following design is approved.
The shelter's tap points as per 4:221 shall be provided with a hose with an adjustable steel pipe and appropriate screw union, including a hose shelf adjacent to the tap point. The hose shall be sufficiently long so that the entire shelter can be reached and flushed with water; minimum length 10 m.

5:4 OTHER EQUIPMENT

5:41 General

As per 26 § in chapter 1 the shelter shall have the necessary equipment to ensure its arrangement for the intended purpose. The following design is approved.

The shelter shall be provided with basic equipment as per 5:42. If the shelter has peacetime utilization which is so complicated that it cannot be dismantled with the basic equipment the shelter shall be provided with extra equipment needed.

5:42 Basic equipment

The shelter shall be provided with at least the equipment indicated in *5:42a-b*. The scope of certain equipment is related to how the shelter has been arranged; see 5:41.

Qty	Equipment
5	Litres joint sealing compound in 0.3 ltr cartridges for each gobbing with concrete element. Group 54 as per HUS AMA 83 with resistance to at least 10 years storage and aging.
5	Litres extra joint sealing compound with the same quality and packing as above.

5:42a. Basic equipment.

Qty	Equipment
2	Sealing compound guns adjusted to the above cartridges (quality corresponding to Luna 2955).
1	Pointed spade (as per SMS 1526, 210x350).
1	Iron bar 7 kg (as per SMS 1591).
1	Crow bar approx. 750 mm (quality corresponding to Luna 2281).
1	Hack saw for 300 mm blades (quality corresponding to Luna 9607).
6	Hack saw blades 300 mm of quick-steel, 24 teeth per inch (as per SMS 1332).
1	Flat chisel approx. 150 mm (quality corresponding to Luna 1633).
1	Pointed chisel, approx. 300 mm (quality corresponding to Luna 1647).
1	Polygrip pliers 250 mm (as per SS-ISO 8976).
1	Chisel hammer 1.5 kg with handle (as per SMS 1597, SMS 1611).
1	Workshop sledge hammer 4 kg with handle (as per SMS 1606, SMS 1611).
1	Rope 10 m, min. ϕ6 mm, breaking load min. 5 kN.
1	Adjustable wrench, 375 mm (as per SS 3469).
5	Buckets of 12 litres.
2	Box wrenches fitting mountable column foot bolts (only where mountable column used).
1	Box wrench with jaw width 36 mm fitting SRD door.
1	Wrench for each floor well.

5:42b. Basic equipment.

5:5 STORAGE OF EQUIPMENT

As per 31 § in chapter 1 all the loose equipment belonging to the shelter shall be able to be stored during peacetime in a separate area which is locked, dry, ventilated and heated to at least 5°C. This area shall only be used for shelter equipment. The following design is approved.

This storeroom shall be sufficiently large so that periodic inspection and maintenance of the equipment is possible with emptying the area. The storeroom may be placed in, or adjoining to, the shelter. It may not be intended for several shelters.

A minimum area as per *5:5a* shall be allocated for the shelter storeroom. Each case shall be evaluated on its merits in the event that additional area is required for extra equipment. Concrete elements for gobbing of reserve exits are considered as loose equipment and may not be mounted in peacetime. These shall be stored in the storeroom.

Number of places	30	60	120	180
Min. area, m^2	3.0	4.0	5.0	6.0

5:5a. Requirement for storage area.

5:6 INFORMATION

5:61 General

As per 32 § in chapter 1 the shelter shall be provided with a layout drawing over the shelter, and on this there shall be information as to all loose equipment belonging to the shelter and how the shelter shall be set in order. This drawing shall as per 31 § be stored in the shelter storeroom.

As per 33 § the shelter shall be provided with marking plates so that is clear where the installations and equipment are, and how the shelter shall be used. It shall also be clear from outside that it is a shelter. The durability requirement as per 3 § shall be fulfilled.

Design as per 5:62 - 5:64 approved.

5:62 Shelter drawing

Such interior fittings and equipment which are to be mounted or dismantled when the shelter is put in order shall be reported on a drawing. In addition all interior fittings or equipment which may remain in the shelter when the shelter is being used shall be reported. A report shall also be made of such dangerous activities or goods outside the shelter, which as per 2:121 shall be removed from the vicinity of the shelter. The parts for which measures shall

be taken are given on the drawing with a character, and the measures which relate to respective characters are to be compiled in a list on the drawing.

The drawing, which shall contain all requisite information, shall be unambiguous and as far as possible free from abbreviations. It shall be designed in a drawing material which is classes as archive resistant. The scale shall be 1:50. In most cases the drawing will require to be supplements with separate written information; see 5:63.

5:63 Instructions

Instructions for assembly and where appropriate maintenance shall by means of distinct and durable labels, plates or other markings be placed direct on the respective parts. Supply and exhaust air ducts which are intended to be dismantled during peacetime shall be marked in such a way that they can easily be mounted when the shelter is put in order. Columns which are to be mounted shall be provided with information as their positioning in the shelter, and concrete elements for gobbing shall be provided with information as which openings they refer to.

5:64 Marking plates

The shelter shall be provided with marking plates which simplify the arrangement of the shelter and its use. These shall be unambiguous and made of durable material, and shall be placed where they are clearly visible. Durable also implies that the attachment is also durable.

The markings shall indicate where the equipment is and where there are installations, concealed or otherwise difficult to find, which shall be put in order when the shelter is taken into operation. Outside every door it shall be indicated if there is an air lock or not inside the door.

The shelter shall be provided with at least two separate marking plates so that it is clear from outside that it is a shelter. One marking plate shall be placed adjacent to a door to the shelter. The other is intended to be placed outside the entrance to the building. In the event that the shelter only has one door and that this leads directly outdoors it is sufficient that the shelter be provide with one marking plate. The plates shall be designed as per the type drawing of the Swedish Rescue Services Board.

Plates as per *5:64a-b* shall be selected it an appropriate extent. Plates for the electrical installations are indicated in 4:316. Additional plates may be required for individual cases. The plates shall also be mounted in peacetime.

1.	Text:	**Shelter**
	Design:	As per Rescue Services Board drawing 2Ö-1502.
	Positioning:	Outside of shelter door and at entrance to building.
2.	Text:	**Shelter. Entrance with air lock.**
	Size of char:	25 mm.
	Colour:	White text on green background.
	Positioning:	Outside shelter door to air lock.
3.	Text:	**Shelter. Entrance without air lock.**
	Size of char:	25 mm.
	Colour:	White text on green background.
	Positioning:	Outside shelter door without air lock.
4.	Text:	**Shelter equipment.**
	Size of char:	15 mm.
	Colour:	White text on green background.
	Positioning:	Outside shelter storeroom.
5.	Text:	**Shelter equipment. Equipment for this shelter is in ..**
	Size of char:	15 mm and 8 mm.
	Colour:	White text on green background.
	Positioning:	Inside a shelter door where the equipment is not in the shelter. The plate is combined with a layout which shows the location of the equipment in relation to the shelter.
6.	Text:	**Equipment for shelter..**
	Size of char:	15 mm.
	Colour:	White text on green background.
	Positioning:	In the shelter storeroom if this is not in the shelter.
7.	Text:	**Floor well. To be held closed during shelter operation.**
	Size of char:	15 mm and 8 mm.
	Colour:	Black text on yellow background.
	Positioning:	On wall at floor well.
8.	Text:	**Stop valve for peacetime drain. Held closed during shelter operation.**
	Size of char:	15 mm and 8 mm.
	Colour:	Black text on yellow background.
	Positioning:	On wall at stop valve for peacetime drain if such valve exists in shelter.

5:64a. Examples of marking plates.

9.	Text:	**Switch for peacetime installation. Locked in Off position before dismantling of peacetime installation.**
	Size of char:	15 mm and 8 mm.
	Colour:	White text on green background.
	Positioning:	At switch for electrical installation which shall be dismantled.
10.	Text:	**Shelter aerial.**
	Size of char:	8 mm.
	Colour:	White text on green background.
	Positioning:	On both sides of wall at inlet for aerial cable.
11.	Text:	**Shelter telephone.**
	Size of char:	8 mm.
	Colour:	White text on green background.
	Positioning:	On both sides of wall at inlet for telephone cable.

5:64b. Examples of marking plates.

6 IMPLEMENTATION

6 IMPLEMENTATION

6:1 GENERAL

Correctly applied the approved solutions in chapters 2 - 5 will ensure that a shelter provides the intended protection. Since the function of the shelter is not tested during peacetime it is important that meticulous checking is carried out during the entire planning and production phases.

Before building permission is granted a check must be made as per 39 § in chapter 1 that the planned shelter corresponds to the regulations in force. As per 40 § the shelter shall subsequently be inspected in all parts with respect to protective capacity before approval. The following provides an approved method as to how these requirements shall be implemented.

6:2 BUILDING PERMISSION DOCUMENTS

On application for building permission, in order that 39 § in chapter 1 shall be observed, drawings and descriptions must be issued to the required extent to confirm that the shelter corresponds to the shelter Notice and the requirements applicable for size, location, layout, and entrance and evacuation routes. The following information is normally required:

1. The number of places, the utilization area of the shelter with a report of how the area was calculated.

2. The positioning and layout of the shelter, including room height, a report of adjacent buildings, a cross-section through the actual building indicating ground levels, the positioning of earth closets, tap points and floor wells, cable inlets for electricity, overpressure gauges, telecommunications and aerials, and the positioning of heating arrangements.

3. The close vicinity of dangerous activities or goods, and the risk for flooding. Foundation survey.

4. Thicknesses of structural concrete parts.

5. Planned peacetime operation and where appropriate extra area for peacetime equipment left in place.

6. Entrance and evacuation routes indicating width and reinforced floors and protective walls.

7. Type, size and direction of opening for doors, embedment of doors and positioning of air lock.

8. Type and positioning of evacuation openings, positioning of extra openings and type of gobbing for these.

9. Positioning and design of ventilation units, air intakes, overpressure gauges, overpressure valves, etc.

10. Positioning of shelter storeroom.

11. Other documents which are required for the shelter.

6:3 SUPPLEMENTARY BUILDING DOCUMENTS

Before work is begun it is required that, in order to comply with 39 § in chapter 1, supplementary building documents be issued. This is necessary in order to check that the shelter in its entirely corresponds with the regulations in force. The following information is normally required:

1. The size, structure and openings (drawings and calculations) of the shelter with load assumptions, material classes, design classes and dimensioning.

2. The construction of walls and roofs in reinforced evacuation routes, including the construction of protective walls and roofs.

3. The positioning of thermal insulation around the shelter.

4. Piping inlets and stop valves.

5. Mountable columns.

6. Attachments which are dimensioned for weapons impact.

7. All other embedment goods in the shelter carcase shown on the layout drawing.

8. Electrical installations (also for peacetime utilization).

9. Heating arrangements.

6:4 INSPECTION DURING BUILDING PERIOD

In order that the requirements in 40 § in chapter 1 shall be fulfilled the building contractor shall give the authority responsible for inspection the opportunity to inspect the construction, carcase and equipment of the shelter, including the constructions which lie outside the shelter and which belong to the shelter. The following applications for inspection are normally required:

1. After completion of the excavation.

2. Prior to concreting of the floor.

3. Prior to doubling of wall formwork.

4. Prior to concreting of the roof.

5. Prior to such peacetime installation as obstructs a complete final inspection.

6. Prior to final inspection.

6:5 FINAL INSPECTION

During the final inspection of the shelter, in order that 40 § in chapter 1 shall be fulfilled, the shelter shall be put in order so that its design, equipment and function can be checked. This implies that all equipment which shall be mounted and that all parts shall be accessible for inspection. The shelter drawing shall be inspected. Inspection also includes ensuring that all equipment, as per 31 §, is placed in the shelter storeroom after final inspection.

As per 40 § the tightness of the shelter shall be inspected. The tightness requirement is indicated by 7 §. As per 8§ an overpressure of at least 60 Pa shall be achieved during the continuous use of the shelter. The following implementation of these inspections are approved.

a. **Tightness.** The shelter's ventilation system shall be used during tightness testing, whereby the overpressure shall be approx. 1000 Pa during the inspection for air leakage. Filters shall not be connected and all overpressure valves shall be closed.

b. **Continuous overpressure.** One overpressure valve per ventilation unit in use shall be open when reading the overpressure. The overpressure shall be able to be constant at a

minimum of 60 Pa. Inspection shall take place during an air flow for each unit of 125 m^3/h and without connected filters.

The tightness checks may be carried out prior to the final inspection of the shelter. The final inspection may be carried out prior to the external and internal completion of the shelter for peacetime use. A prerequisite for this is that the building contractor applies for a post-inspection when the shelter is put in order for peacetime use.

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