ABOVEGROUND HOME SHELTER

H-I 2-2
JUNE 1980
(Supersedes H-12-2
dated Feb. 1973
which may be used.)

Protection is provided in an outside aboveground shelter. The shelter can be used as a tool shed or workshop.

federal emergency management agency

GENERAL INFORMATION

This family shelter is intended for persons who prefer an aboveground shelter or, for some reason such as a high water table, cannot have a belowground shelter. In general, belowground shelter is superior and more economical than an aboveground shelter.

The shelter is designed to meet the standard of protection against fallout radiation that has been established by the Federal Emergency Management Agency for public fallout shelters. It can also be constructed to provide significant protection from the effects of hurricanes, tornadoes, and earthquakes, and limited protection from the blast and fire effects of a nuclear explosion. 1/ It has sufficient space to shelter six adults.

The shelter can be built of two rows of concrete blocks, one 12" and one 8", filled with sand or grout, or of poured reinforced concrete. Windows have been omitted; therefore, electric lights are recommended for day to day use.

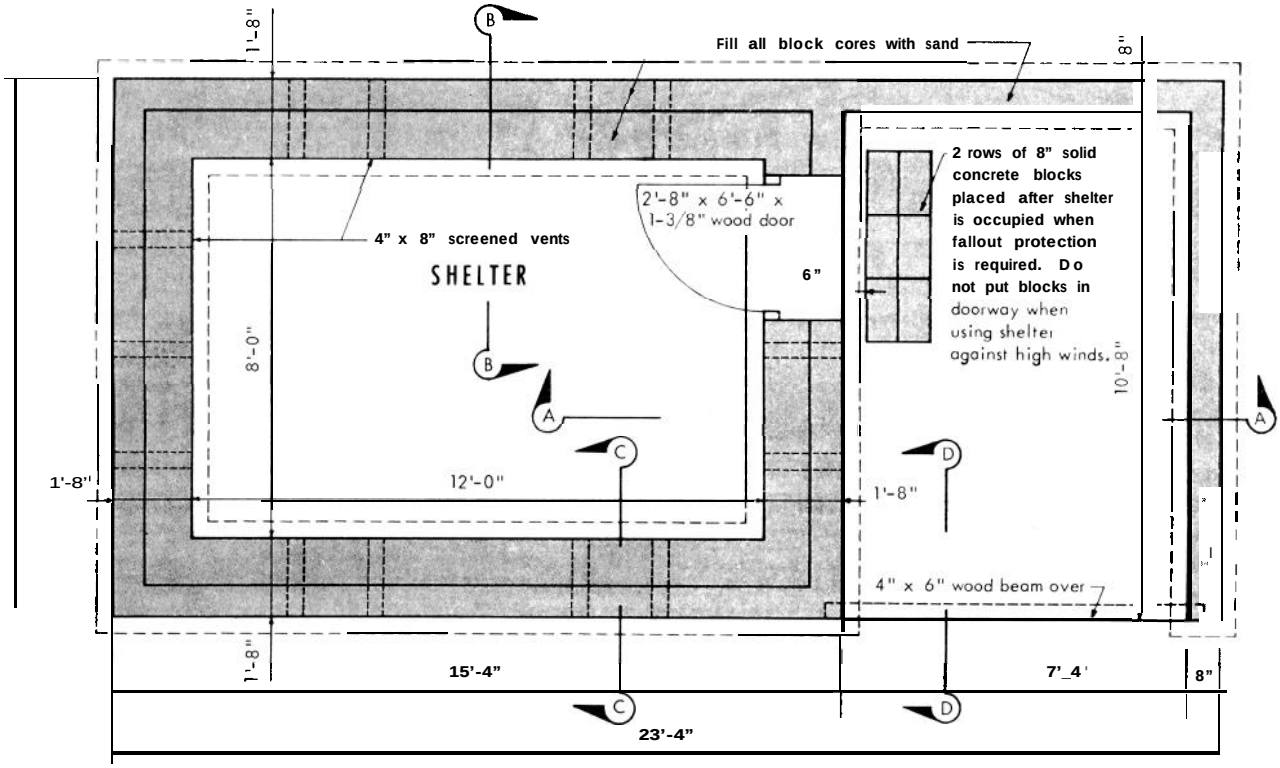
The details and construction methods are considered typical. If materials other than shown are selected -- for example, concrete block faced with brick -- care should be taken to provide at least the same weight of materials per square foot: 200 lb. per sq. ft. in the walls and 100 lb. per sq. ft. in the roof. The wood frame roof over the reinforced concrete ceiling probably would be blown off by extremely high winds such as caused by a blast wave or tornado. However, the wood frame roof is intended primarily for appearance; the concrete ceiling provides the protection. When using the shelter for protection against high winds, DO NOT place the concrete blocks in the doorway or windows.

This structure has been designed for areas where frost does not penetrate the ground more than 20 inches. If 20 inches is not a sufficient depth for footings, one or two additional courses of concrete blocks may be used to lower the footings. Average soil bearing pressure is 1,500 lb. per sq. ft. Most soils can be assumed to support this pressure without special testing or investigation.

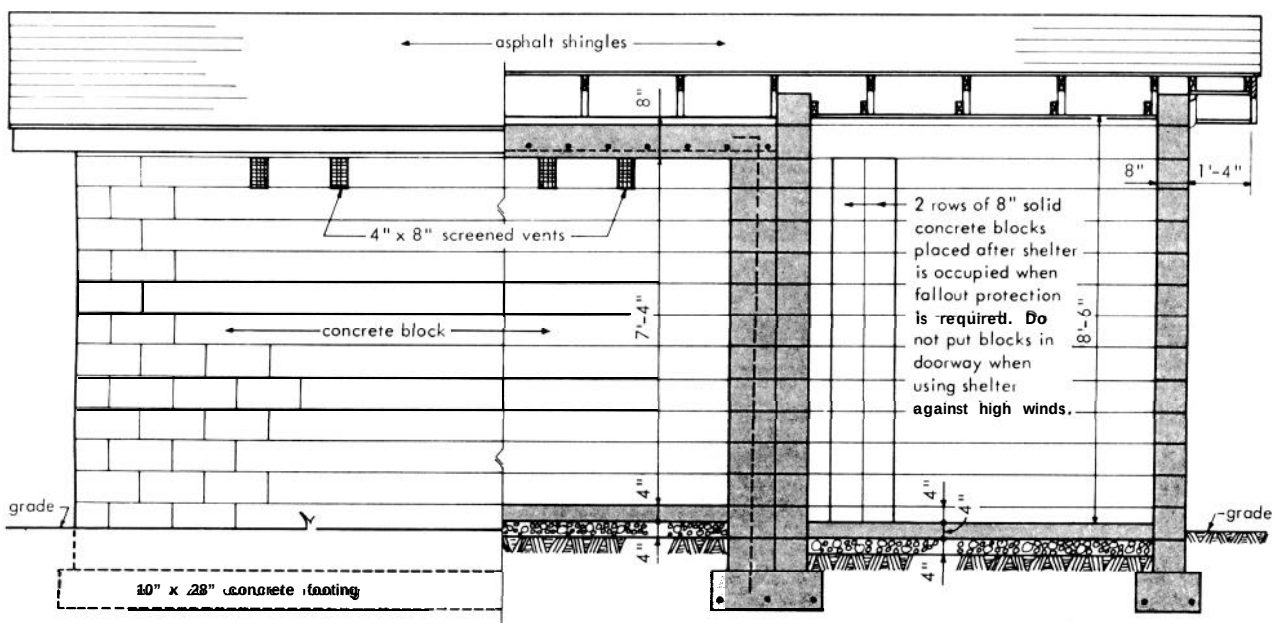
The baffle wall outside the entrance to the shelter is extended out 7'-4" to allow storage of lawn equipment such as wheelbarrows and lawn mowers. If additional space is desired, extend this dimension.

Before starting to build the shelter, make certain that the plan conforms to the local building code. Obtain a building permit if required. If the shelter is to be built by a contractor, engage a reliable firm that offers protection from any liability or other claims arising from its construction.

1/ This shelter will withstand over-pressures of up to 5 p.s.i.

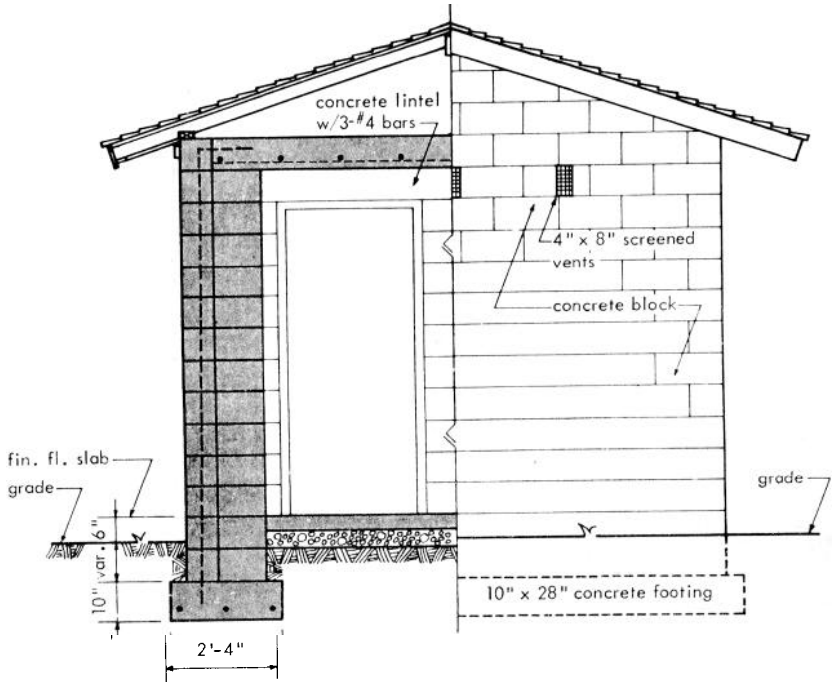


PLAN



ELEVATION

SECTION A-A



SECTION B-B ELEVATION

NOTES

Provide horizontal joint reinforcement for 1'-8" walls in every third course and metal cross ties at 2'-0" o.c. in every alternate course.

If concrete is used in place of block, the walls of the shelter shall be 1'-2" thick with #4 bars at 14" o.c., each way, each side.

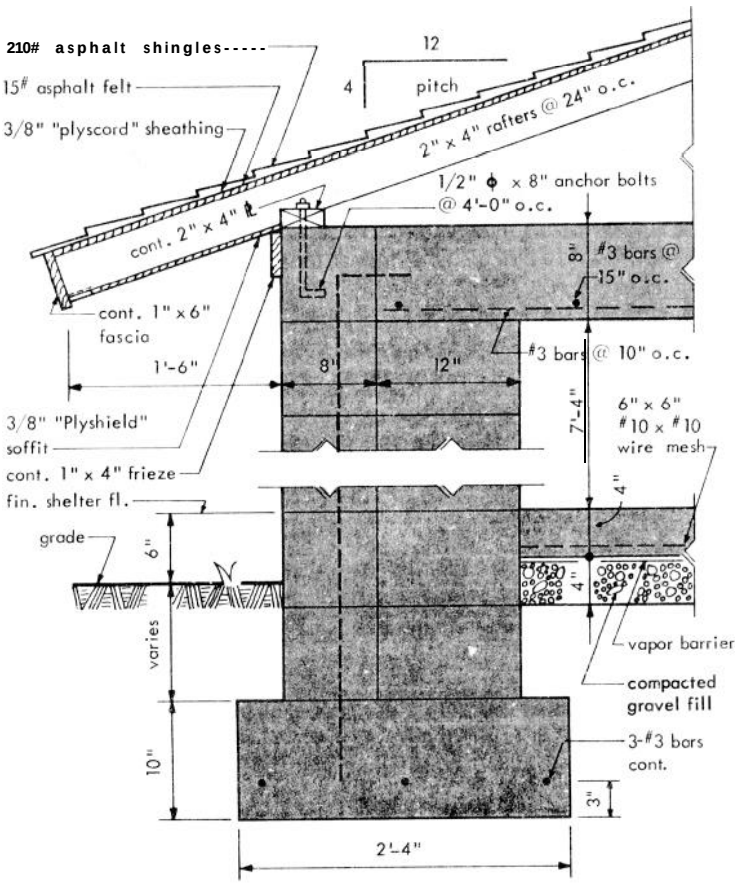
The dimension from finish grade to bottom of footings is dependent upon the depth of frost and varies with geographic location. Consult your local building code.

In areas subject to hurricanes, tornadoes, or earthquakes, walls shall be reinforced with #4 bars at 16" o.c. vertically. Place bars in block cells and then fill with grout. Lop bars between wall and footing dowels, and between wall and roof slab.

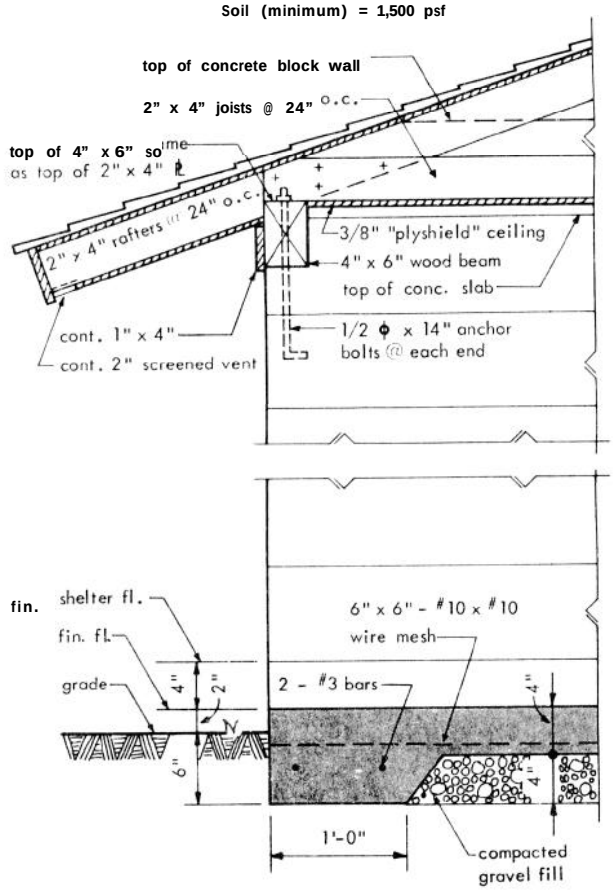
The wood frame roof over the reinforced concrete ceiling probably would be blown off by extremely high winds such as caused by a blast wove or tornado. However, this roof is primarily intended for appearance; The concrete ceiling provides the protection.

Structural design data:

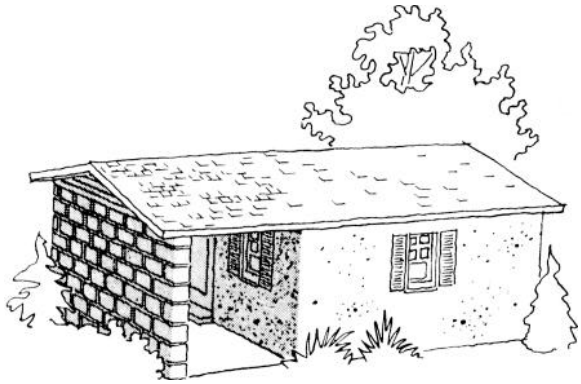
Steel = 20,000 psi
Concrete = 2,500 psi
Soil (minimum) = 1,500 psf



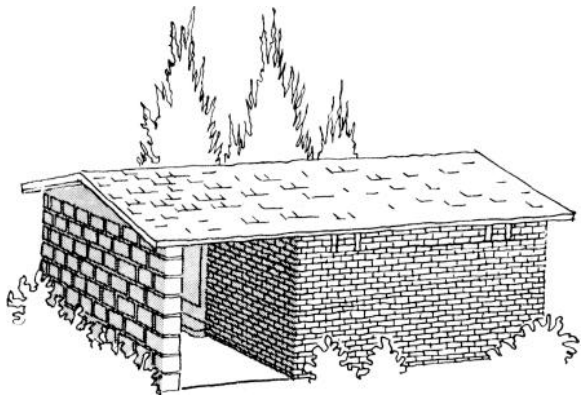
SECTION C-C



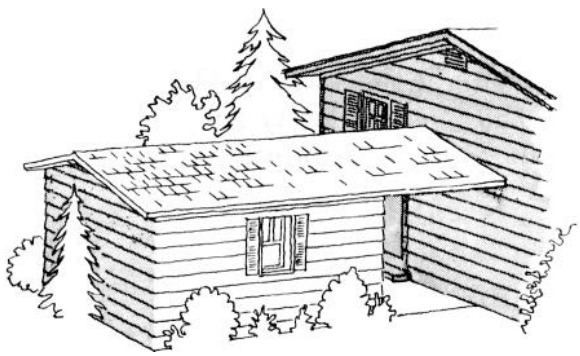
SECTION D-D



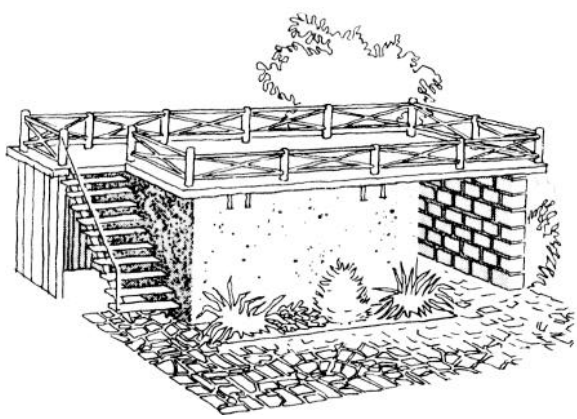
FIRST ALTERNATE indicates windows in the workshop area. Solid blocks, equal to a thickness of 12 inches, should be available to fill these openings to provide adequate fallout protection. Window sizes should be kept small. When using the shelter for protection against high winds, do not place the concrete blocks in the doorway or windows.



SECOND ALTERNATE shows the cement block faced with bricks. Use one course 4-inch brick and two courses of 8-inch cement block to obtain the required weight per unit area.



THIRD ALTERNATE is to attach the tool shed or workshop to the house, with a covered area between. In this case, the facing materials should match the house.



FOURTH ALTERNATE is to install built-up roofing of asphalt or tar, or other wearing surface, on top of the concrete deck.

GUIDE TO CONTRACTS AND SPECIFICATIONS

It is generally advisable to have a written contract with your contractor as well as specifications to supplement the drawing. A widely used and convenient contract form for construction of this size is AIA Document A 107, "Short Form For Small Construction Contract Stipulated Sum," which is available from the American Institute of Architects, 1785 Mass. Ave., Washington, D.C. 20036. It would be impractical to write a specification to suit every local condition; however, the following summary of generally accepted construction materials and practices is a useful guide:

CONCRETE

For details of concrete construction, follow "Building Code Requirements for Reinforced Concrete (AC I-3 18-71)." This publication can be obtained from the American Concrete Institute, Detroit, Michigan 48219.

DAMPPROOFING

Dampprcofing the bottom slab is necessary to make the room more comfortable in most areas. Any contractor will be accustomed to compacting gravel and applying a polyethylene vapor barrier course. In areas that regularly experience high humidity, the outside walls of the block or concrete should be treated with a colorless type of protective coating material which is readily available at building supply stores. In areas of very low humidity, dampproofing might be omitted.

VENTILATION

Ventilation is obtained by natural convection. Air will enter the doorway and be exhausted through the holes at the ceiling. If a roof exhaust ventilation system is desired, the following manufacturer makes units that will meet the requirements:

Penn Ventilator Co.*/
Red Lion and Gantry Rd.
Philadelphia, Pennsylvania 19115

*/The listing of a specific manufacturer of equipment does not denote a preference for his products.

OPTIONS

To accommodate additional persons, increase the shelter length 2' -6" for each two shelter spaces. Do not increase the 8' -0" width.

Lighting and receptacles may be installed with electric service obtained from a separate residence circuit. A branch circuit breaker should be installed inside the shelter.

MATERIALS LIST

Item		Quantity
Concrete:		
footings		4.5 cu. yd.
floor		2.3 cu. yd.
ceiling		3.4 cu. yd.
	Total:	10.2 cu. yd.
Steel Reinforcing:		
footings (3# deformed bars)		198 lin. ft.
ceiling (3# deformed bars)		257 lin. ft.
walls (4# deformed bars for hurricane, tornado, or earthquake resistance)		
	approx.	300 lin. ft.
	Total:	755 lin. ft.
tie wire		100 lin. ft.
Masonry:		
8" X 8" X 16" hollow concrete blocks		800
12" X 8" X 16" hollow concrete blocks		430
8" X 8" X 16" solid concrete blocks		75
sand (to fill cores)		12-1/2 yd.
Mortar:		
sand		1-1/2 yd.
portland cement		9 bags
lime		2 bags
Lumber: ("construction"grade)		
2" X 4" X 8'-0" roof rafters		32 pcs.
1" X 6" ridge		26 lin. ft.
2" X 4" X 12'-0" ceiling joists		5 pcs.
4" X 6" X 8'-0" beam		1 pc.
2" X 4" bearing plate		36 lin. ft.
4'-0" X 8'-0" X 3/8" "plyscord" sheathing		13 sheets
4'-0" X 8'-0" X 3/8" "plyshield" soffit & ceiling		6 sheets
1" x 4" x 3/4"		48 lin. ft.
1" X 6" X 3/4"		84 lin. ft.
3/4" - 1/4 ϕ		24 lin. ft.
2'-8" X 6'-6" X 1 3/8" solid core wood door		1
2'-8" X 6'-6" X 5 1/2" wood iamb		1

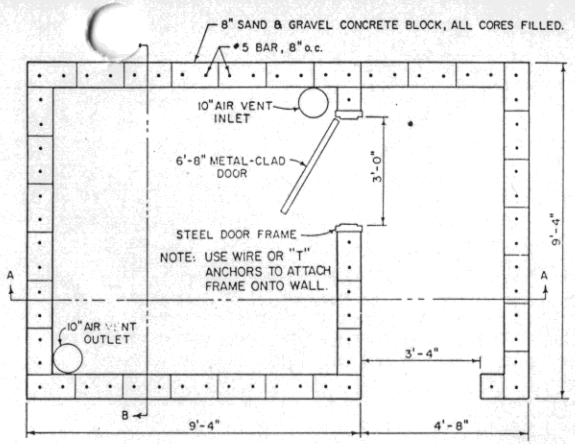
Miscellaneous:

15# roofing felt	4 1/2 squares
210# asphalt shingles	4 1/2 squares
1/2" ϕ X 8" anchor bolts	12
1/2" ϕ X 14" anchor bolts	2
copper screen	20 sq. ft.
6" X 6" - #10 X #10 wire mesh	200 sq. ft.
polyethylene vapor barrier (4 mil)	200 sq. ft.
gravel fill	2 1/2 yds.
4" butts w/screws	3
lockset	1
16d common nails	25 lb.
8d common nails	20 lb.
6d common nails	10 lb.
8d casing nails	5 lb.
exterior paint, primer	5 gal.
exterior paint, 2 coats	6 gal.
interior paint, primer	4 gal.
interior paint, 2 coats	5 gal.

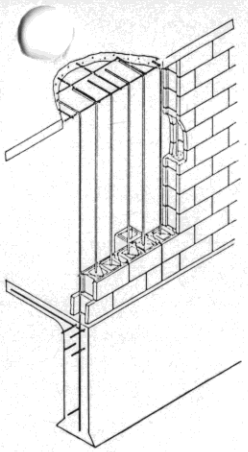
Distribution:

FEMA Regions and Staff College
State & Local Civil Preparedness Directors

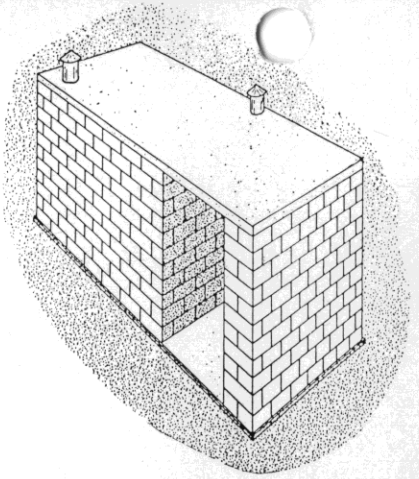
U.S. GOVERNMENT PRINTING OFFICE : 1980 0 - 329-360



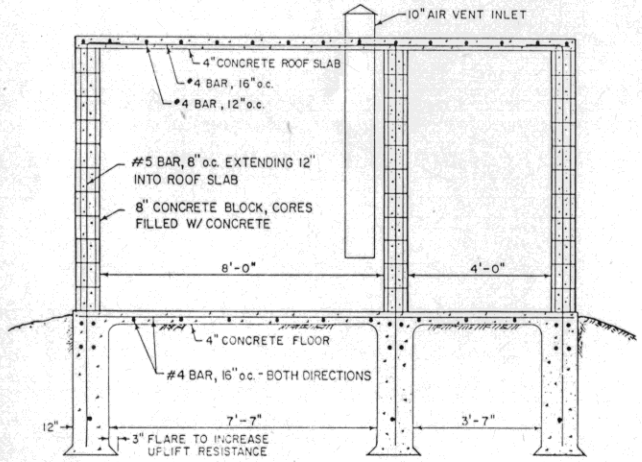
FLOOR PLAN 12" 6" 0 1' 2' 3'



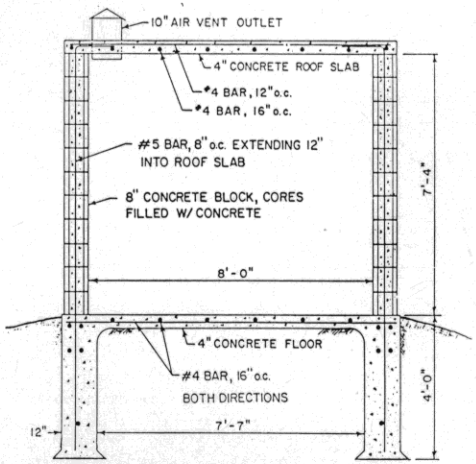
CUT-AWAY ISOMETRIC OF SIDEWALL AND ROOF
(NOT TO SCALE)



PERSPECTIVE (NOT TO SCALE)



SECTION A-A 12" 6" 0 1' 2' 3'



SECTION B-B 12" 6" 0 1' 2' 3'

NOTES:

THIS SHELTER IS DESIGNED TO WITHSTAND THE PRESSURES INDUCED BY A 260 MPH WIND AS RECOMMENDED BY "INTERIM GUIDELINES FOR BUILDING OCCUPANT PROTECTION FROM TORNADOES AND EXTREME WINDS", TR-83A, DEFENSE CIVIL PREPAREDNESS AGENCY, SEPTEMBER, 1975.

SHELTER OPENING SHOULD FACE AWAY FROM PROBABLE STORM DIRECTION. EASTERN EXPOSURES FIT THE NEED FOR MOST OF U.S..

CONSULT LOCAL BUILDING AUTHORITIES BEFORE STARTING CONSTRUTION.

BILL OF MATERIALS

DESCRIPTION	QUANTITY
CONCRETE	
FOUNDATION AND FLOOR	10.5 CU. YD.
ROOF	2 CU. YD.
GROUT (ALL CORES FILLED)	6 CU. YD.
MORTAR	9 CU. YD.
CONCRETE BLOCK	
STRETCHER	296
CORNER	56
DOUBLE CORNER	11
HALF CORNER	22
REINFORCED CONCRETE LINTEL, 4'-8" LENGTH	2
REINFORCING STEEL	
NO. 5 (5/8-INCH DIA.)	820 FT.
NO. 4 (1/2-INCH DIA.)	700 FT.
JOINT REINFORCEMENT	500 FT.
AIR VENT (10-INCH DIA.)	8 FT.
STEEL DOOR AND FRAME, 3'-0" X 6'-8"	1

GENERAL SPECIFICATIONS

CONCRETE: 3,500 PSI MINIMUM COMPRESSIVE STRENGTH

STEEL: 40,000 PSI MINIMUM YIELD STRENGTH REINFORCEMENT BARS. OVERLAP SPLICES A MINIMUM OF 12 INCHES AND USE WIRE TIES TO SECURE. DO NOT WELD.

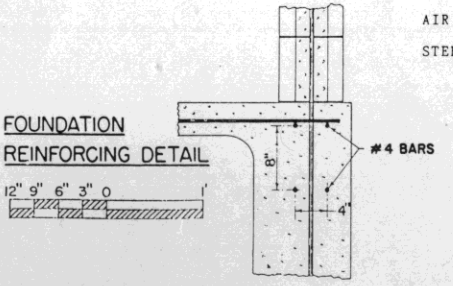
CONCRETE MASONRY: 8-INCH SAND AND GRAVEL BLOCKS

MORTAR: TYPE M OR S

JOINT REINFORCEMENT: PLACE HORIZONTAL, TRUSS-DESIGN, REINFORCEMENT AT EVERY HORIZONTAL MORTAR JOINT. OVERLAP SLICES A MINIMUM OF 6 INCHES AND USE WIRE TIES TO SECURE.

GROUT: USE NOT LESS THAN 6 BAGS PORTLAND CEMENT PER CUBIC YARD OF GROUT AND AGGREGATE NO LARGER THAN 1/2-INCH DIAMETER.

OTHER USE: ALTHOUGH STRUCTURE MAY BE SUITABLE FOR VEGETABLE OR OTHER STORAGE IT SHOULD NOT BE USED FOR THAT PURPOSE AS IT WILL REDUCE CAPACITY AND MAY BLOCK ENTRY.



FOUNDATION REINFORCING DETAIL
12" 9" 6" 3" 0 1'

COOPERATIVE EXTENSION SERVICE
AGRICULTURE AND HOME ECONOMICS

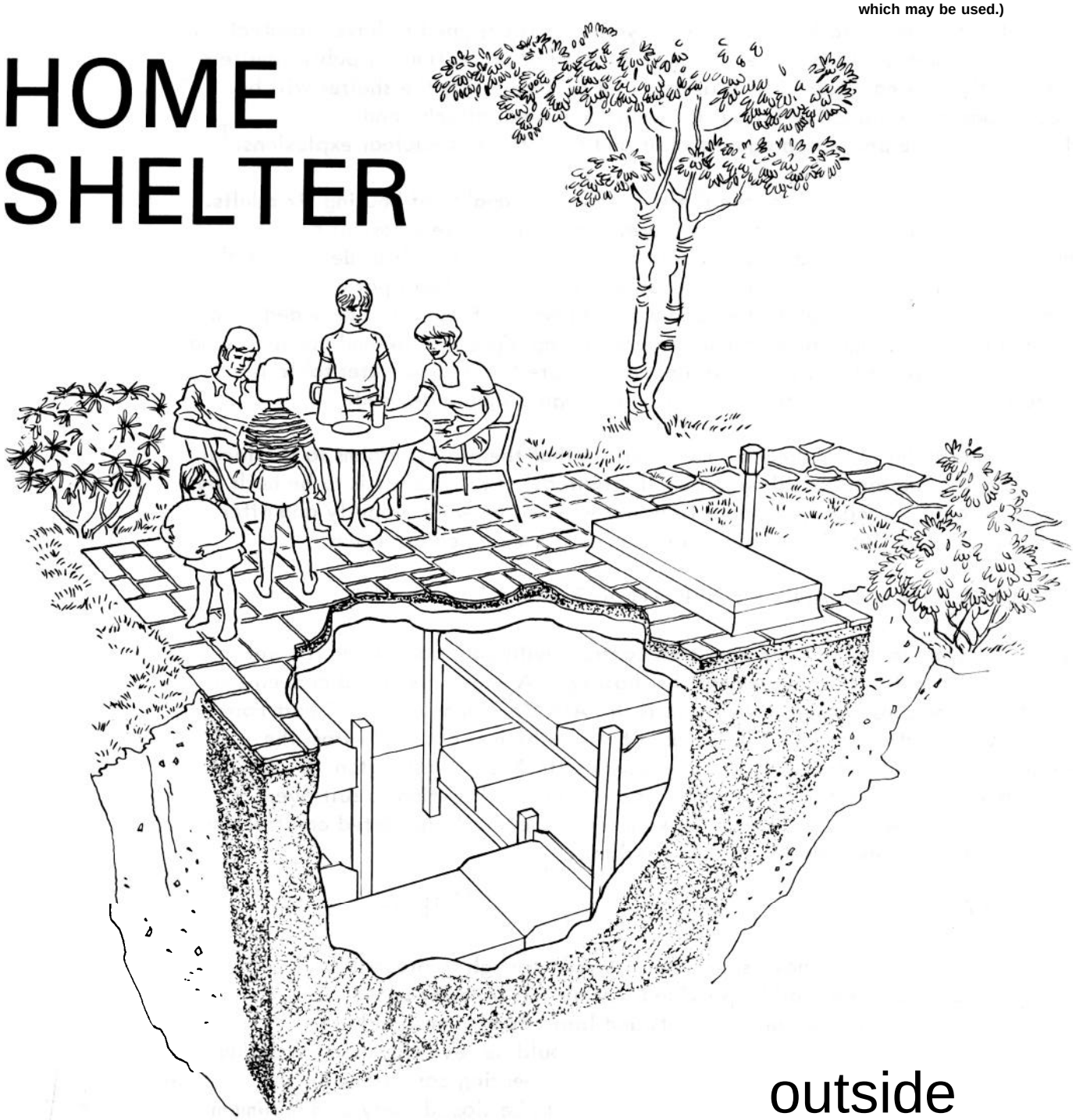
AND
UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

ABOVE-GROUND STORM SHELTER

OK 1985	6376	SHEET 1 OF 1

H-l 2-1
JUNE 1980
(Supersedes H-12-1
dated April 1975
which may be used.)

HOME SHELTER



outside concrete shelter

Protection is provided in an outside concrete shelter. The roof of the shelter can be used as an attractive patio.

federal emergency management agency

GENERAL INFORMATION

This family fallout shelter, designed primarily for homes without basements, is a permanent home shelter to be placed in the yard. It is designed to have a protection factor of at least 40, which is the minimum standard of protection for public shelters throughout the United States. This assures that persons inside the shelter will be protected against radioactive fallout following a nuclear attack, and will also have some protection against blast and fire effect of nuclear explosions.[1]

Following are detail drawings of the shelter, which is capable of housing six adults. It can be built of poured reinforced concrete, precast concrete slabs, or a combination of concrete blocks and poured concrete. If it is built as detailed with the top near ground level, the roof slab can be used as an outdoor patio. The shelter is accessible by a hatch-door and wood stairway. Fresh air is provided by a hand-operated centrifugal blower and two ventilating pipes that extend above ground level. In areas where there is poor drainage or where the ground water table is close to the surface, the fourth modification on page 5 should be used.

Before starting to build the shelter, make certain that the plan conforms to the local building code. Obtain a building permit if required. If the shelter is to be built by a local contractor, engage a reliable firm that will do the work properly and offer protection from any liability or other claims arising from its construction.

GUIDE TO CONTRACTS AND SPECIFICATIONS

It is generally advisable to have a written contract with your contractor, as well as technical specifications to supplement the drawing. A widely used and convenient contract form for construction of this size is the AIA Document A 107, “Short Form For Small Construction Contract -Stipulated Sum, " which is available from the American Institute of Architects, 1785 Massachusetts Ave., Washington, D. C. 20036. It would be impractical to write a technical specification to suit every local condition; however, the following summary of generally accepted construction materials and practices should be a useful guide.

EXCAVATION

The excavation should have side slopes gradual enough to prevent caving, or appropriate shoring should be provided. Materials used for backfill and embankment should have debris, roots and large stones removed before placement. The subgrade for the floor slab should be level for ease in placing waterproofing membrane and to provide uniform bearing conditions for the structure. The area surrounding the patio should be sloped away at a minimum grade of 1 inch per 10 feet to provide good drainage.

[1] This shelter will withstand overpressures of up to 5psi, and provides excellent protection from tornadoes.

CONCRETE

For details of concrete construction, the "Building Code Requirements for Reinforced Concrete/ (ACI 318 – 71)" should be followed. This publication can be obtained from the American Concrete Institute, Detroit, Michigan 48219.

WATERPROOFING

Waterproofing specifications may be obtained from the nearest FHA (Federal Housing Administration) office, or those of a reputable manufacturer of waterproofing materials may be used.

VENTILATION

The ventilation piping for the shelter should be installed in accordance with the practices outlined in the "National Plumbing Code (ASA A40.8 – Latest Edition). " This publication may be secured from the American Society of Mechanical Engineers, New York, N.Y. 10018. All pipe and fittings shall be galvanized. Suitable ventilating blowers and roof ventilators are available from many sources of supply. Fabrication details and consequently the installation requirements will differ for equipment furnished by the various manufacturers. Positive-displacement blowers having both electric motor and geared hand-crank drives have been manufactured by:

Centaur Forge, Ltd.
P. 0. Box 239
117 N. Spring St.
Burlington, Wisconsin 53105

B&B Sales
P. 0. Box 86
So. Decatur Street
Marietta, Pa 17547

TEMET USA, Inc.
9417 Brian Jac Lane
Great Falls, VA 22066

Roof exhaust and supply ventilators are manufactured by:

Penn Ventilator Co.
Red Lion and Gantry Rd.
Philadelphia, PA 19115

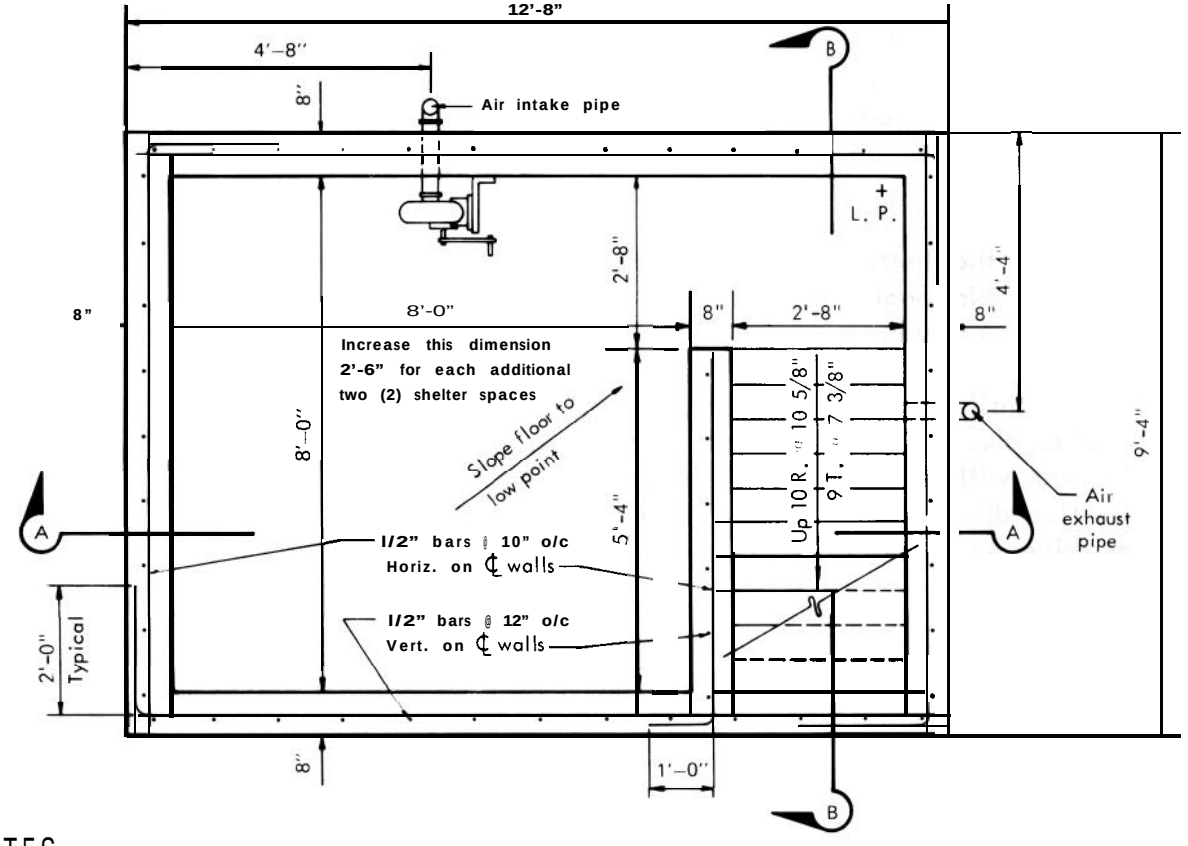
The names of specific manufacturers of equipment are given only as examples, and do not denote a preference for their products.

OPTIONS

To accommodate additional persons, increase the shelter length 2'-6" for each two (2) shelter spaces. Do not increase the 9'-4" width.

Electrical serv ice for lighting and outlets may be installed in the shelter from a separate residence circuit. A branch circuit breaker should be installed inside the shelter. Additional lighting and outlets may be provided from this circuit'for the patio above.

An electric motor and pully may be installed to operate the centrifugal hand-crank blower by virtue of the electrical service option.



NOTES

Exterior walls, roof slab and under floor slab shall be waterproofed with a 3-ply membrane waterproofing system. This provides a continuous blanket which seals the entire area of surface to be protected. The membrane shall be protected from backfill damage and when completing other stages of construction.

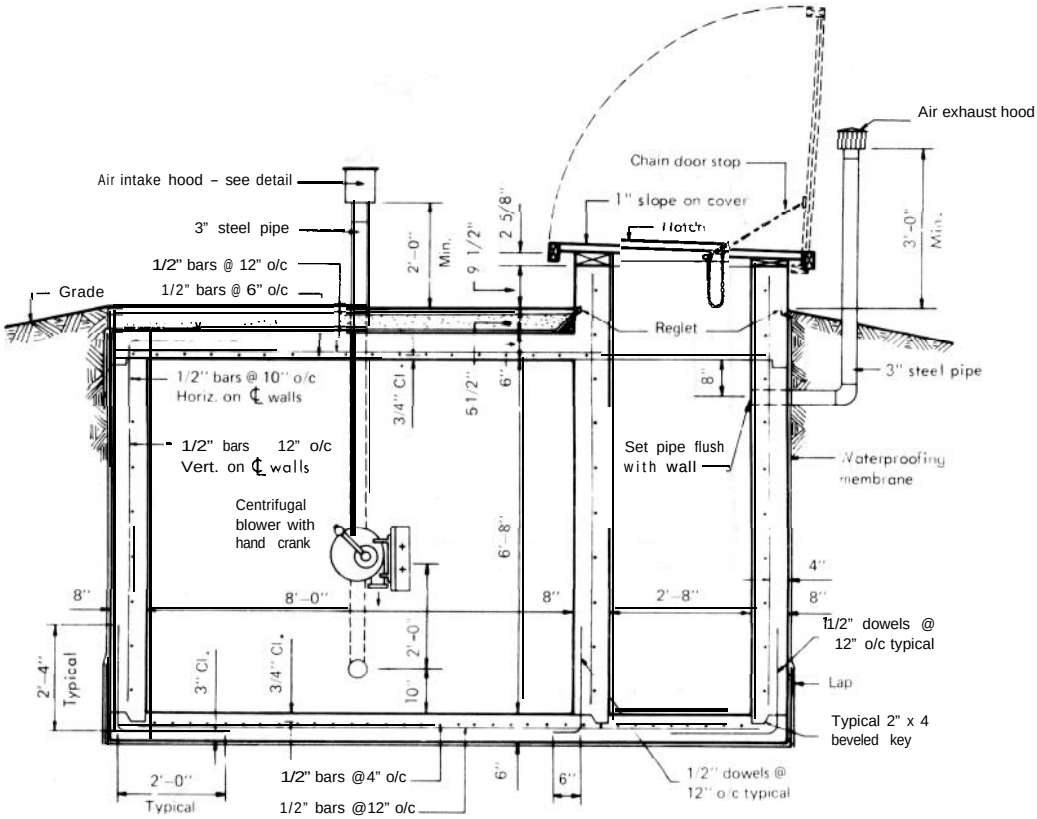
Place flagstone or bricks on a sand bed when using the roof slab as a patio.

There are a number of commercially produced metal roof hatches that will adequately serve as a shelter door. However, as long as the door is weatherproof and durable, a job-made, galvanized sheet metal covered wood door is suitable.

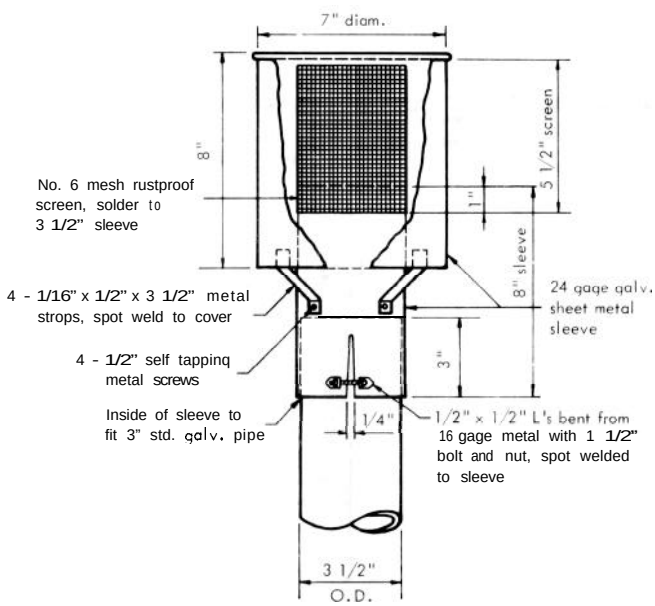
Bevel all exposed corners of concrete 3/4" at 45^{o}.

Structural design data:

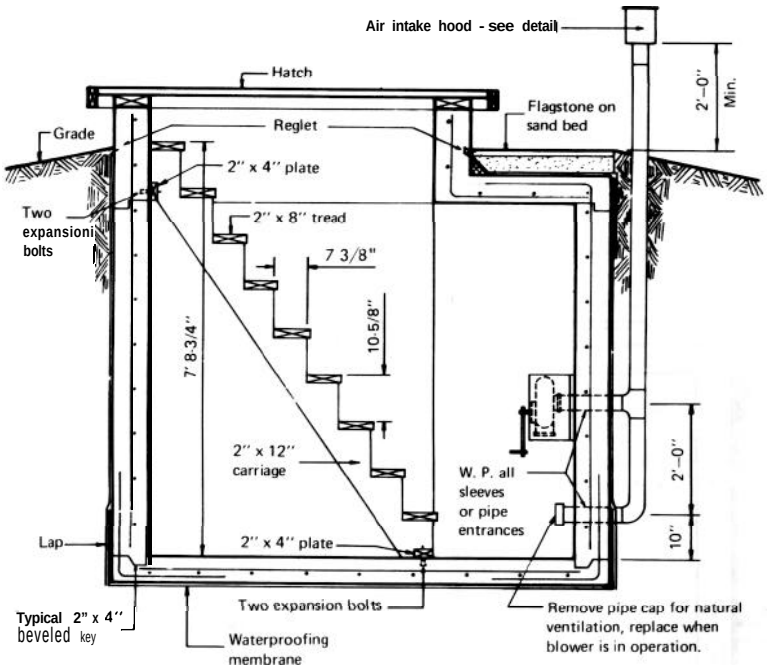
Steel = 20,000 psi
Concrete = 2,500 psi
Soil (minimum) = 600 psf, to withstand downward pressure



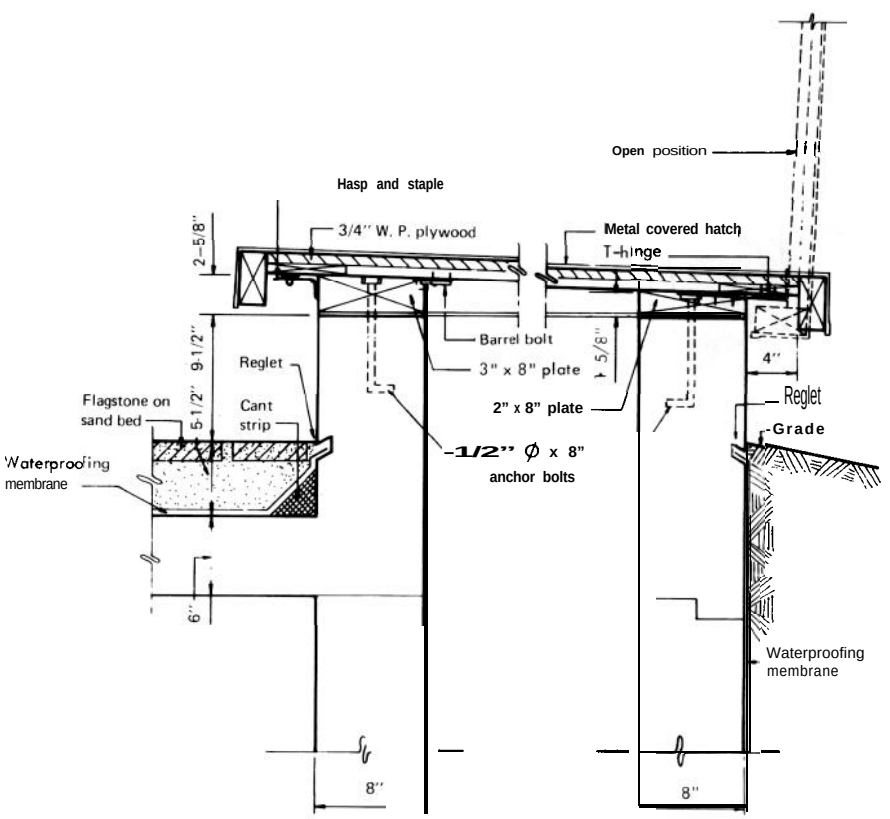
SECTION A- A



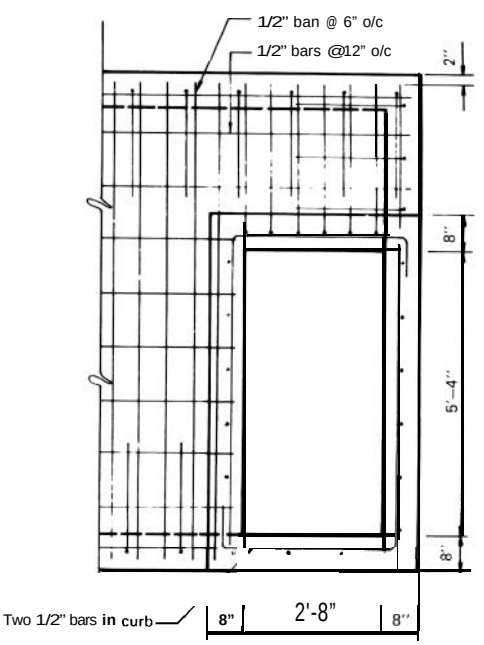
AIR INTAKE HOOD DETAIL



SECTION B-B

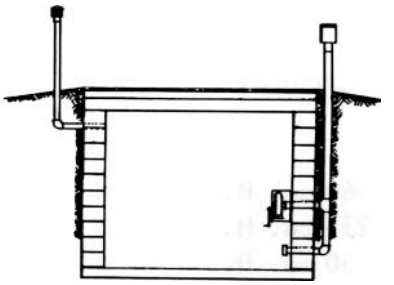


HATCH DETAIL



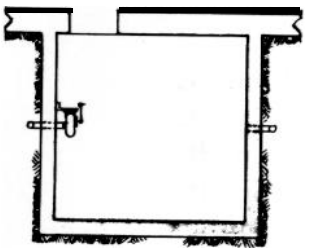
HATCH FRAMING

MODIFICATIONS



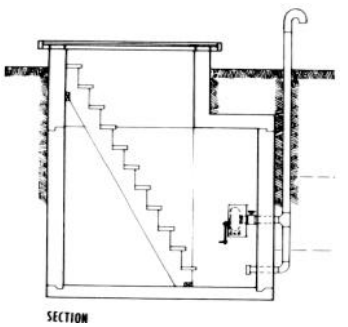
SECTION

This first modification utilizes 12-inch concrete masonry units for walls instead of reinforced concrete. The floor, roof and entranceway are the same as in the basic shelter, and the amount of protection provided is essentially the same.



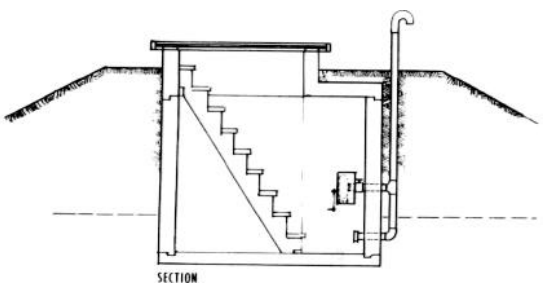
PLAN

If a basement is available, the shelter may either be separate from it, or attached. In this modification, an attached shelter is entered through the basement of the house, thereby permitting dual use of the shelter space. Other advantages of this modification include flexibility of shape and design to conform to the house design and the use of the same kind of building materials as used in the construction of the house.



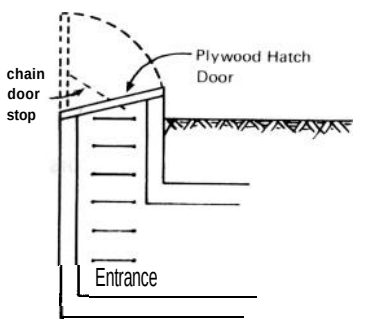
SECTION

If the topography permits, the shelter can be built into a hillside or embankment. This modification increases the protection factor by the addition of an earth mound over the shelter. A maximum of 3 feet of earth cover is recommended.



SECTION

The principal advantage of this shelter modification is that it can be erected with a minimum of excavation in locations where there is poor drainage or where the ground water table is close to the surface. However, the exposure of the shelter above ground requires the addition of earth mounding around all sides.



This shelter modification permits the design and construction of a shelter with a fairly small hatch entry. The iron rungs placed in the concrete wall will also maximize the useable shelter area.

MATERIAL LIST

Item	Quantity
Concrete:*	
floor	60 cu. ft.
walls	235 cu. ft.
roof	50 cu. ft.
	345 cu. ft.
Total	13 cu. yds.
Steel Reinforcing:	
floor	580 lin. ft.
walls	945 lin. ft.
roof	260 lin. ft.
Total	1,785 lin. ft.
Miscellaneous:	
tie wire - 6" coils	2
hand blower w/mounting bracket	1
3" galv. steel pipe	16 lin. ft.
3" galv. ells	2
3" galv. tee	1
3" galv. cap	1
intake hood, w/screen	1
exhaust hood, w/screen	1
wood carriages, 2" x 12" x 10'	2
wood treads, 2" x 8" x 2'-8"	9
wood plates, 2" x 4" x 2'-8"	2
hatch door, metal covered	1
wood plate, 2" x 8" x 7'	1
wood plate, 3" x 8" x 14'	1
T-hinges, 8" x E. H., galv.	3
hasp and staple, galv.	1
chain door stop, galv.	1
anchor bolts, 1/2" ϕ x 8"	8
expansion shields and bolts, 3/8" ϕ x 4"	4
waterproofing membrane	715 sq. ft.
flagstone	100 sq. ft.
sand	1.5 cu. yds.
cant strip	12 lin. ft.

*Form work not included.

Distribution:
FEMA Regions and Staff College
State & Local Civil Preparedness Directors

U.S. GOVERNMENT PRINTING OFFICE : 1980 0 329-359

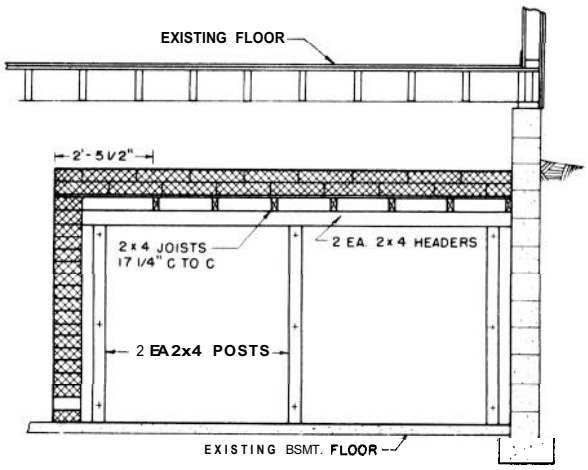
C

H-I 2-C
May 1980

A compact shelter
is provided
in a basement corner
by the use of
common lumber
and concrete blocks
with mortar joints
for permanent construction.

HOME FALLOUT SHELTER
concrete block shelter-
basement location plan C

FEDERAL EMERGENCY
MANAGEMENT AGENCY



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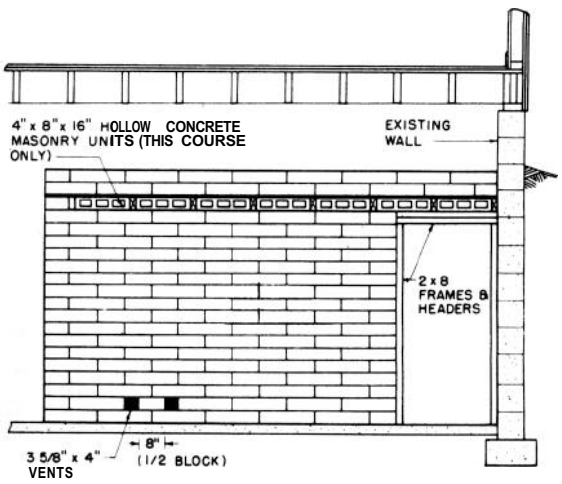

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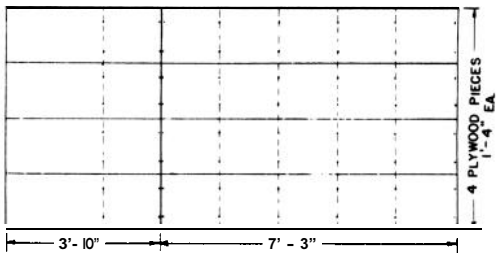
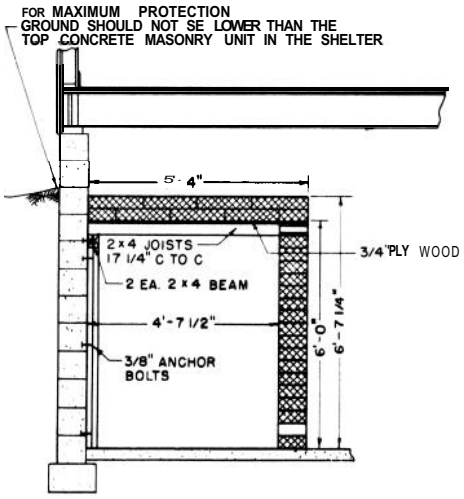
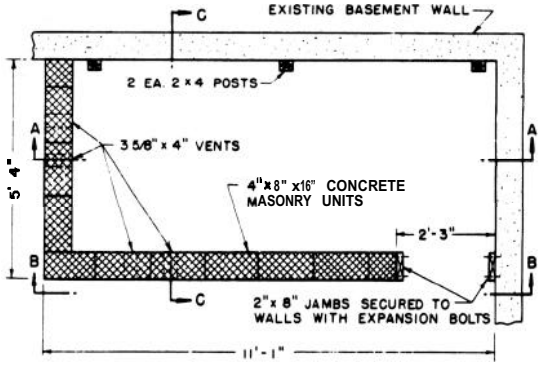


PLAN OF PLYWOOD CEILING



SECTION C



PLAN

GENERAL INFORMATION

This compact basement shelter will provide low-cost protection from the effects of radioactive fallout. Its purpose is to provide adequate protection for the minimum cost in an existing basement. In addition to the low cost, materials should be readily available, and the labor time will be short.

TECHNICAL SUMMARY

This shelter has about 50 square feet of area, 300 cubic feet of space and will provide shelter for five persons.

The materials required to build this shelter are obtainable at local concrete block plants and/or lumber yards.

Natural ventilation is provided by the entranceway and the air vents in the shelter wall.

Estimated construction time for the basic shelter is less than 44 man-hours.

MATERIALS LIST

Item	Actual Number Required
Masonry:	
4” x 8” x 16” solid concrete masonry units or	296 blocks
2-l/4 x 4” x 8” solid bricks	1776 bricks
4” x 8” x 16” hollow concrete masonry units	7 blocks
Lumber: (“Construction” or “No. 1” grade or better)	
posts 2 x 4 x 5’-4”	6
joists 2 x 4 x 5’-4”	7
beams 2 x 4 x 10’-5-l/2”	2
frame 2 x 8 x 5’-4-3/8"	2
header 2 x 8 x 2’-3”	2
plywood l'-4” x 6’-9-l/4” x 3/4” (utility B-C grade)	4 pieces
plywood 1’4” x 4’-3-3/4” x 3/4” (utility B-C grade)	4 pieces
Hardware :	
8d nails	2 pounds
10d nails	2 pounds
3/8” bolt size multiple-expanding machine bolt anchors	18
3/8” x 3-l/2” square-head unfinished anchor bolts	18
Mortar (prepared dry-mix bags	9 bags

Special tools :

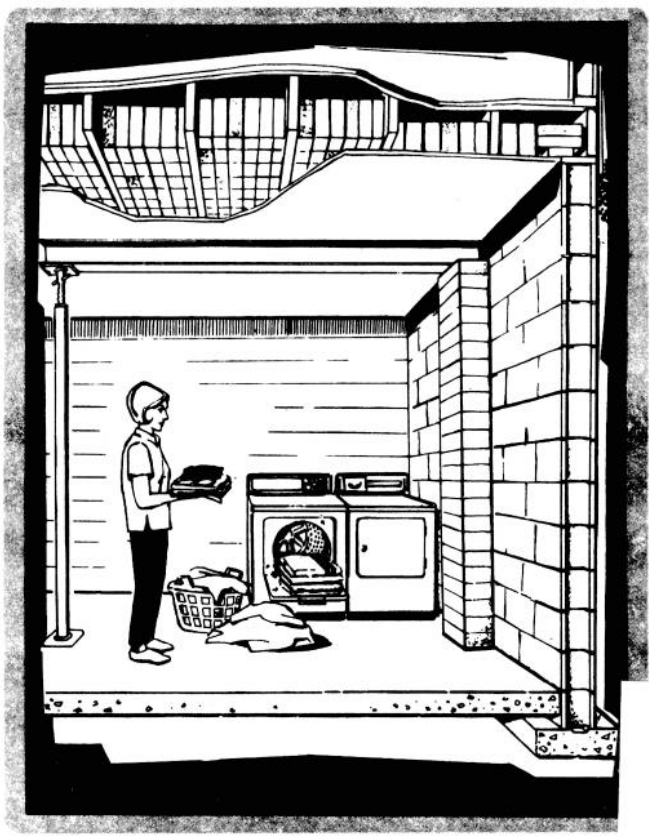
3/4" star drill for 3/4" x 2-7/8" anchor bolts

CONSTRUCTION SEQUENCE

1. Lay out guidelines with chalk on basement floor for shelter walls.
2. Lay first course of 4" x 8" x 16" solid blocks in a full bed of mortar to make the walls 8" thick. Vary the thickness of mortar bed if basement floor is not level.
3. Set door frame in place and continue to lay wall blocks. Be sure to leave the 4 " spaces for air vents as shown on the drawing.
4. Continue this procedure until the walls have been laid up to a height of 5'-8" (17 courses). This height can be increased, if the basement headroom permits and provided the shelter roof remains below the outside ground level.
5. Fasten posts and door frame to the basement wall using two expansion anchors and bolts for each. Be certain the posts rest on the floor.
6. Nail two 2 x 4 boards together to make the wall beam. Nail the beam on top of the posts and secure with expansion anchors and bolts to the wall.
7. Place wood joists in position and secure with nails.
8. Place the 4" x 8" x 16" hollow blocks between joists as shown on the drawing. The holes in the blocks will afford ventilation.
9. Put several 3/4" pieces of plywood on the joists as shown and nail them to the joists with 8d nails.
10. Lay two layers of solid 4" x 8" x blocks flat on top of the plywood; stagger the joints. Mortar is not required in the ceiling.
11. Continue procedures 9 and 10 until the roof is completed.
12. Additional blocks stored in the shelter are for stacking in the entryway after occupancy.

H-12-A
April, 1980

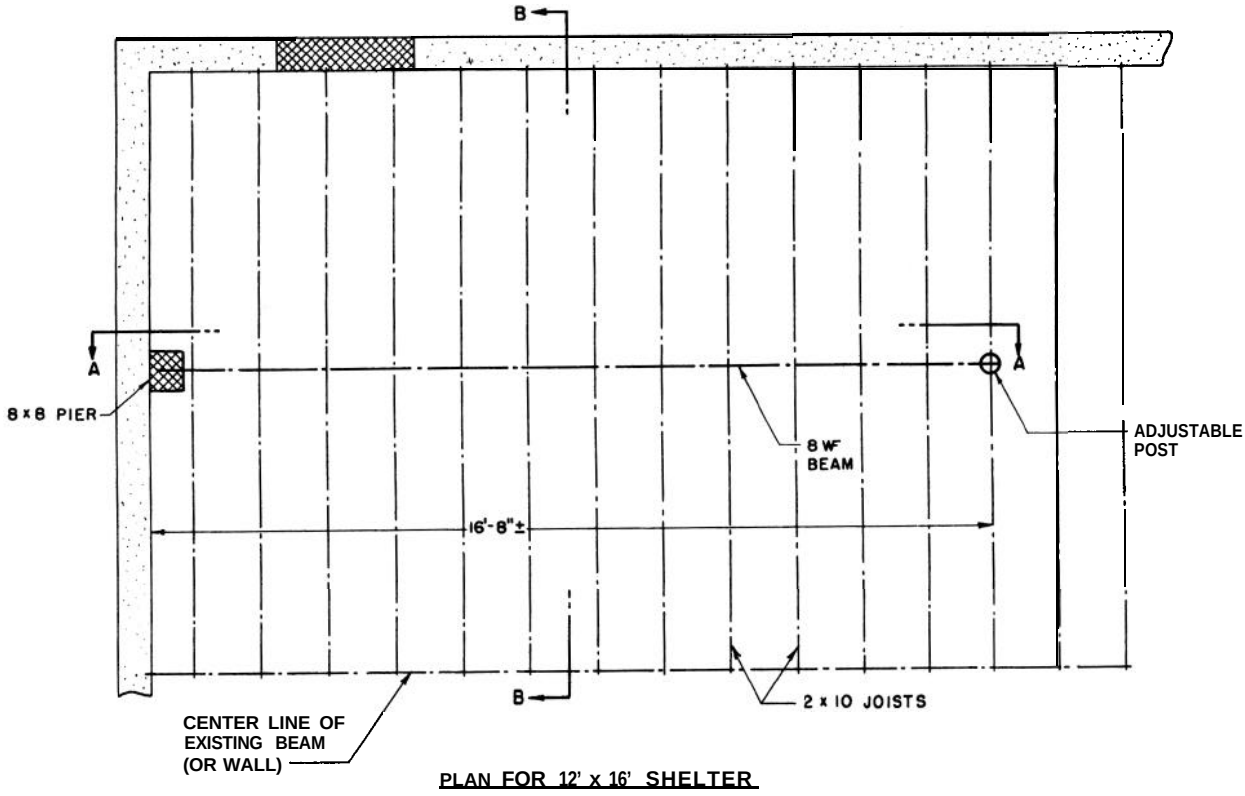
A



Protection is provided
in a basement corner
by bricks
or concrete blocks
between the overhead joists.
A beam
and jack column
support the extra weight.

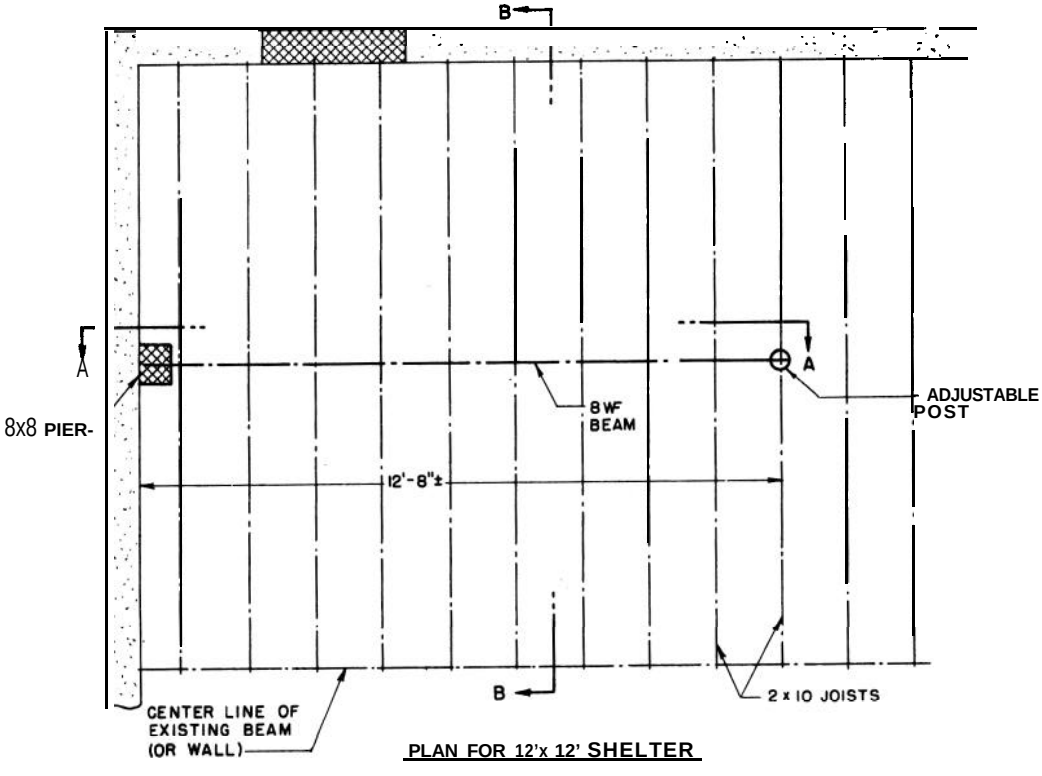
HOME FALLOUT SHELTER
modified ceiling shelter-basement location plan a

FEDERAL EMERGENCY
MANAGEMENT AGENCY

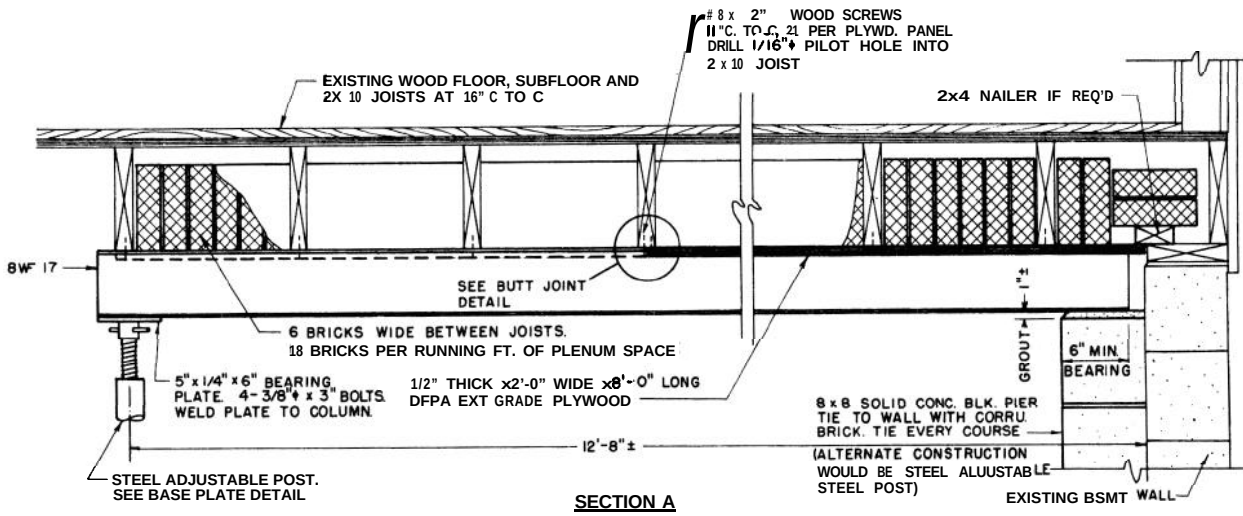


PLAN FOR 12' x 16' SHELTER

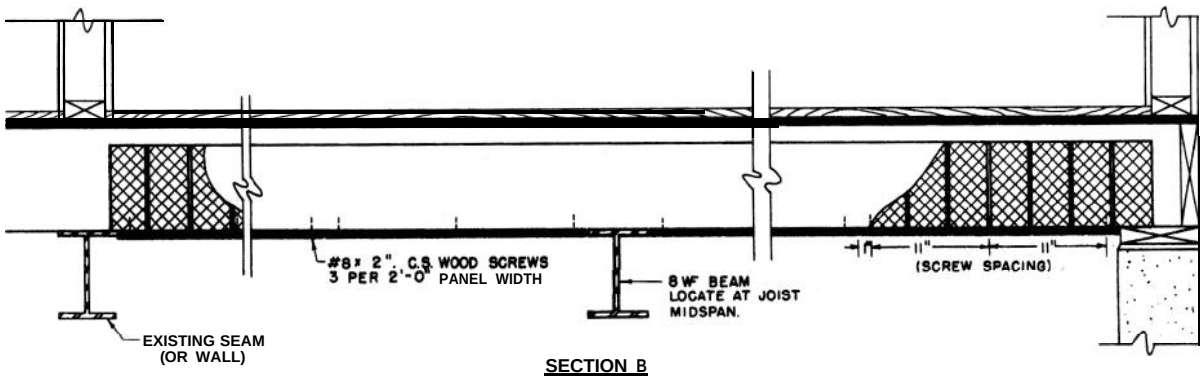
BLOCK UP ANY WINDOWS IN SHELTER AREA



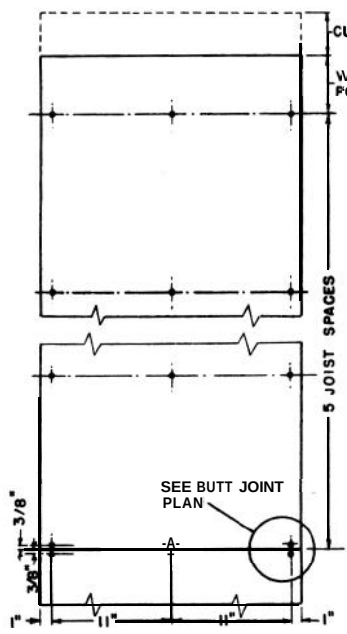
PLAN FOR 12'x 12' SHELTER



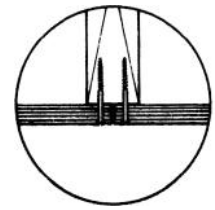
SECTION A



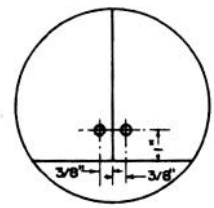
SECTION B



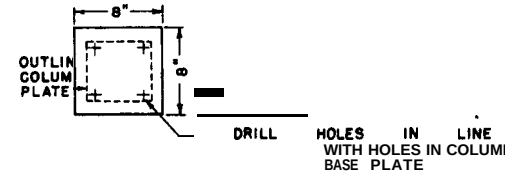
PLAN OF TYPICAL PLYWOOD CEILING PANEL



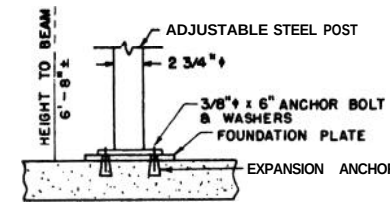
BUTT JOINT DETAIL



BUTT JOINT PLAN.



FOUNDATION PLATE PLAN



BASE PLATE DETAIL

CAUTION

This home fallout shelter design should only be constructed in low risk areas. A low risk area is one which is not expected to be subjected to the blast effects of a nuclear weapon. It is suggested you contact your State or local civil preparedness director for information concerning the type of area you live in, i.e., low risk or high risk area.

GENERAL INFORMATION

This shelter can be permanently installed in the basement of your home and will not interfere with its utility in any way.

In basements whose walls are mostly below grade on all four sides, adequate shelter from fallout radiation is provided by modifying the overhead floor joist and ceiling construction as shown in the drawings. The plywood, which is screwed to the bottoms of the joists, supports the masonry shielding material and provides a solid base for a more decorative ceiling treatment. A beam and jack post are used to support the extra weight. Approximately 2 man days are required to construct the ceiling.

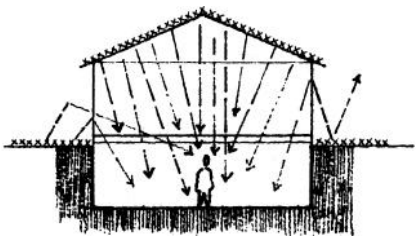
SHELTER SIZE

The plans on the preceding pages show two sizes of shelters of this type - **a 12' x 16'** size, which may be suitable for use in many one story homes, and a **12' x 12'** size, which is suitable for use in many two story homes.

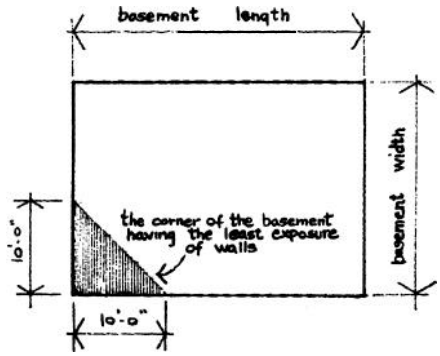
On the following pages, under LIMITATIONS OF THE CEILING MODIFICATION SHELTER IN BASEMENTS, you will find illustrations of the conditions which make this type of construction an effective shelter, and some additional things that must be done if these conditions are not met by your particular basement situation.

Note that if some joist spaces contain heating ducts, or are closed in with sheet metal to serve as return air ducts, the protection in this area of the shelter is reduced since bricks or blocks cannot be placed as shown in the drawings.

LIMITATIONS OF THE CEILING MODIFICATION SHELTER IN BASEMENTS

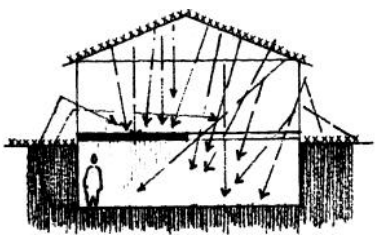


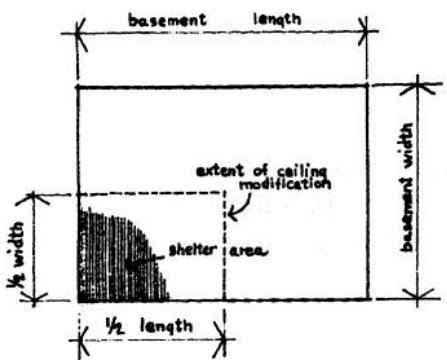
This cross-section of a one story house shows radiation coming into the basement from fallout particles on the roof and the ground, Most of the radiation comes from the roof because of the shielding effect of the ground outside the basement walls.



The shaded area in the basement floor plan shows the location of the best potential shelter area (approximately 50 square feet). The drawings on the preceding pages are for the adding of bricks or blocks in the ceiling over this best corner.

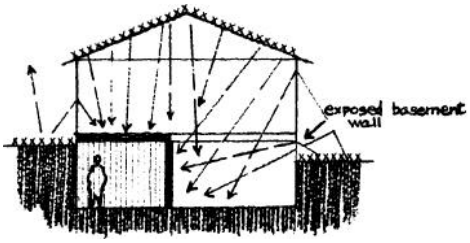
This placement of added weight in the proper portion of the basement ceiling will considerably improve the protection in the best corner. Note that is not necessary to add this weight to the entire ceiling area.

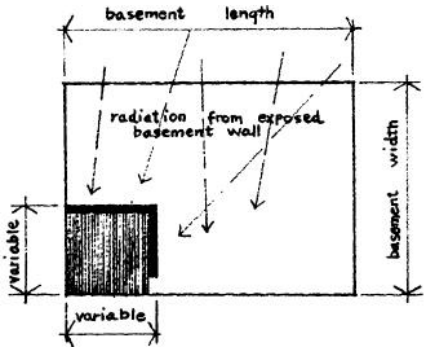




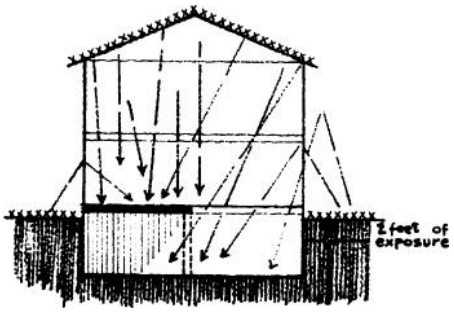
The extent of the ceiling modification area depends on the type of house (i. e., one or two story), the dimensions of the basement, and the amount of basement wall exposure. In a one story house, approximately one - quarter of the area of the basement ceiling should be filled with the concrete blocks or bricks in order to obtain the most protection out of this improvement.

This arrangement will effectively shield all of the radiation coming from the roof - the largest contributing source.





If it is found to be impractical to shield one quarter of the basement ceiling area, the extent of ceiling modification may be reduced to any desired size by constructing vertical masonry walls on the two open sides of the shielded area, thus providing a room suitable for use as a hobby or laundry room. These masonry walls will also provide protection from excessive amounts of radiation coming through exposed portions of the basement wall.



In homes with 2 or more stories above ground, the extent of the basement ceiling modification can usually be reduced to 12' x 12'. Note, however, that vertical side walls may be required if the basement wall exposure exceeds two feet.

Adding bricks or blocks to the basement ceiling can also create shelter in certain portions of the basements of split-level houses. It is recommended that expert advice be sought for basement situations which do not fit the plan sizes or illustrations in this pamphlet.

The MATERIALS LIST shows quantities for the two plan sizes shown. If additional materials are required for the building of shielding walls in an emergency, they must be added to the list.

MATERIALS LIST Item	Actual Number Required For 12' x 16' Size	Actual Number Required For 12' x 12' Size
Masonry :		
4" x 8" x 16" solid concrete blocks or 2-l/4" x 4" x 8" bricks	432 blocks or 2492 bricks	330 blocks or 1978 bricks
8" x 8" x 8" solid concrete blocks (standard stone aggregate no-sand forming)	10	10
Mortar:		
prepared dry-mix bags	l bag	
Plywood sheets: (cut to fit exact basement dimensions)		
l/2" 5-ply Utility B-C grade, good one side.		
2'-0" x 8'-0" sections	12	6
2'-0" x 4'-0" sections		6
Steel:		
8WF17 Beam (Determine length from basement dimensions). Maximum span 16'-0" *	1	
Adjustable steel posts with tubes 13 ga., top tube 2-l/2", bottom tube 2-3/4" with 5" x 6" x l/4" plate welded to each end.	1	
8" x 8" x 3/8" extra base plate, 4-7/16" holes in each plate.	1	
Hardware :		
3/8" x 3" sq. head unfinished bolts each with 2 washers and nuts	4	4
3/8" x 6" sq. head unfinished bolts each with 1 washer and nuts	4	4
3/8" size multiple-expanding machine bolt anchors hole size is 3/4" x 2-7/8"		
Corrugated brick ties, galvanized steel 23 ga., 7/8" x 7"	16	16
#5 screw gage size lead insert shields, hole size l/4" x l-1/2"	16	16
#5 x l-1/2" unfinished wood screws	16	16
#8 x 2" cad. plated wood screws, c. s.	260	195

Special tools :

l/4" and 3/4" star drills to install anchoring devices

*Greater depth required for longer spans

CONSTRUCTION SEQUENCE

1. Drill holes in block wall for lead insert shields and attach corrugated ties with screws, two per mortar joint.
2. Lay up 8” x 8” masonry pier against wall, tying pier to wall with corrugated ties.
3. Locate and drill for machine bolt anchors in basement floor using base plate of jack post for template.
4. Thoroughly coat under side of foundation plate with rust-inhibiting paint.
5. Place foundation plate and base plate of jack post over anchors and drive anchor bolts tight.
6. Lower jack and bolt one end of steel beam to top plate, resting other end temporarily on top of pier.
7. Raise jack to level position of beam, shimming under pier end to a snug fit under the joists.

   PRECAUTIONARY NOTE: Excessive tightening of the jack post at this point may cause undue stress in the joists and slab, as the ceiling spaces are filled. Make several adjustments in the post as the material is added.

8. Grout mortar under beam at pier.
9. Cut plywood into 2 ' × 8' sheets.
10. Starting at wall, attach plywood to joist bottoms, using 2” #8 screws.
11. Remove cross bridging, if any, from existing joist spaces.
12. Fill the joist spaces with blocks or bricks.
13. Repeat steps 10, 11 and 12 for each of the other sheets.

Before constructing the shelter described here, you should check to see that the construction conforms to your local building codes, and whether a building permit is required.

If work is to be done by a builder or contractor, it is recommended that firms be retained that carry necessary insumnce and guarantees to properly protect the owner against subsequent liability and claims on the work and to ensure satisfactory results. Members of the National Association of Home Builders and the Associated General Contractors meet these and other requirements of protection for the home owner.

U.S. GOVERNMENT PRINTING OFFICE : 1982 0 - 376-178

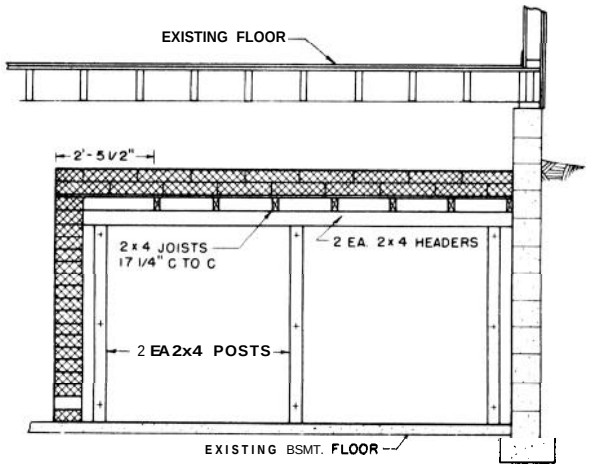
C

H-I 2-C
May 1980

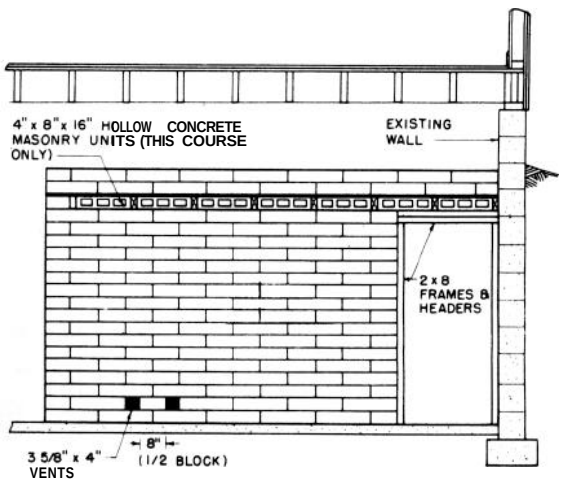
A compact shelter is provided in a basement corner by the use of common lumber and concrete blocks **with mortar joints for permanent construction.**

HOME FALLOUT SHELTER
concrete block **shelter**–
basement location plan C

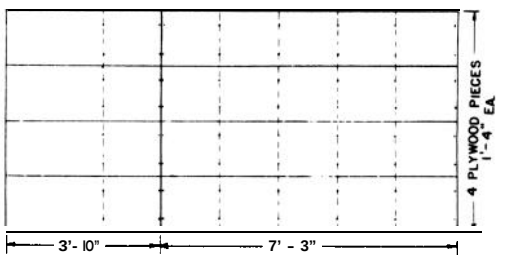
FEDERAL EMERGENCY
MANAGEMENT AGENCY



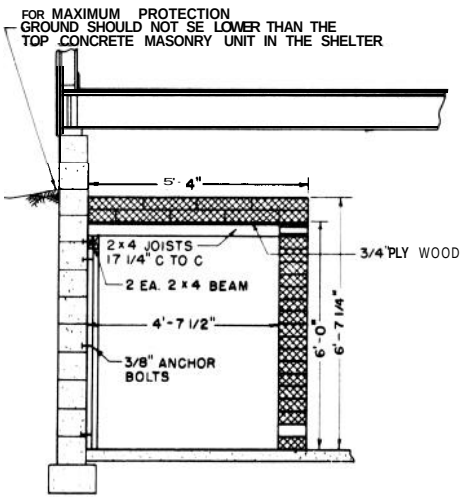
SECTION A



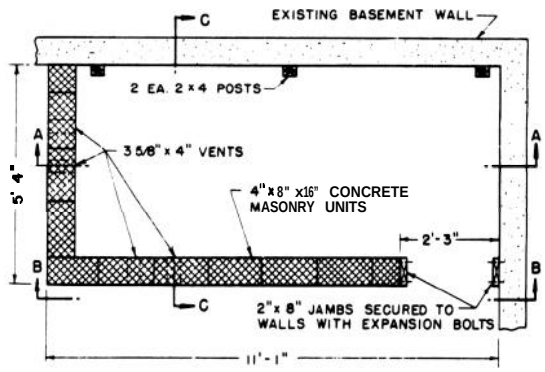
SECTION B



PLAN OF PLYWOOD CEILING



SECTION C



PLAN

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joists 2 x 4 x 5’-4”	7
beams 2 x 4 x 10’-5-l/2”	2
frame 2 x 8 x 5’-4-3/8"	2
header 2 x 8 x 2’-3”	2
plywood l'-4” x 6’-9-l/4” x 3/4” (utility B-C grade)	4 pieces
plywood 1’4” x 4’-3-3/4” x 3/4” (utility B-C grade)	4 pieces
Hardware :	
8d nails	2 pounds
10d nails	2 pounds
3/8” bolt size multiple-expanding machine bolt anchors	18
3/8” x 3-l/2” square-head unfinished anchor bolts	18
Mortar (prepared dry-mix bags	9 bags

Special tools :

3/4" star drill for 3/4" x 2-7/8" anchor bolts

CONSTRUCTION SEQUENCE

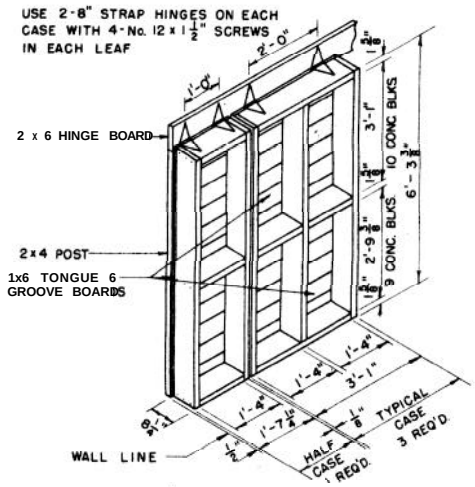
1. Lay out guidelines with chalk on basement floor for shelter walls.
2. Lay first course of 4" x 8" x 16" solid blocks in a full bed of mortar to make the walls 8" thick. Vary the thickness of mortar bed if basement floor is not level.
3. Set door frame in place and continue to lay wall blocks. Be sure to leave the 4 " spaces for air vents as shown on the drawing.
4. Continue this procedure until the walls have been laid up to a height of 5'-8" (17 courses). This height can be increased, if the basement headroom permits and provided the shelter roof remains below the outside ground level.
5. Fasten posts and door frame to the basement wall using two expansion anchors and bolts for each. Be certain the posts rest on the floor.
6. Nail two 2 x 4 boards together to make the wall beam. Nail the beam on top of the posts and secure with expansion anchors and bolts to the wall.
7. Place wood joists in position and secure with nails.
8. Place the 4" x 8" x 16" hollow blocks between joists as shown on the drawing. The holes in the blocks will afford ventilation.
9. Put several 3/4" pieces of plywood on the joists as shown and nail them to the joists with 8d nails.
10. Lay two layers of solid 4" x 8" x blocks flat on top of the plywood; stagger the joints. Mortar is not required in the ceiling.
11. Continue procedures 9 and 10 until the roof is completed.
12. Additional blocks stored in the shelter are for stacking in the entryway after occupancy.

H-12-E
April 1980

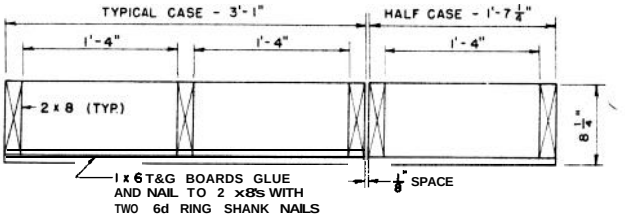
A storage unit is hinged to the wall in a basement corner. It is tilted-up to rest on stacked brick or concrete block and filled for overhead protection.

HOME FALLOUT SHELTER
tilt-up storage unit shelter-basement **location**

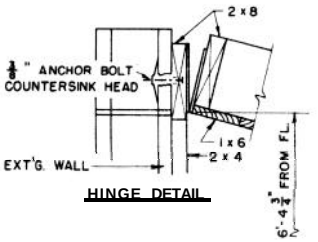
FEDERAL EMERGENCY
MANAGEMENT AGENCY



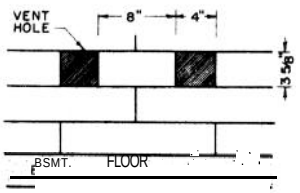
ISOMETRIC OF CASES



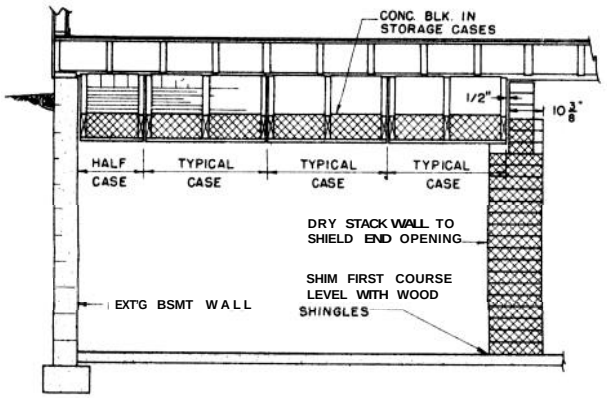
DETAIL SECTIONS



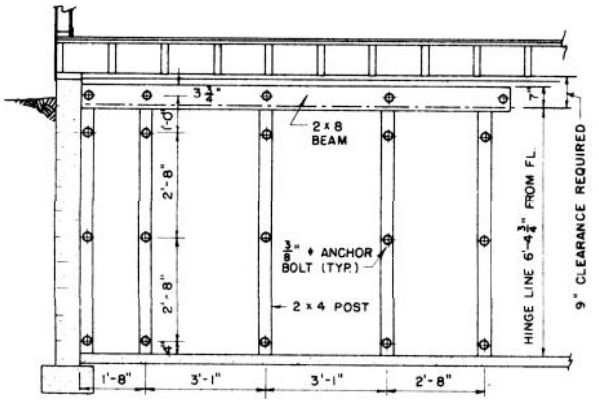
HINGE DETAIL



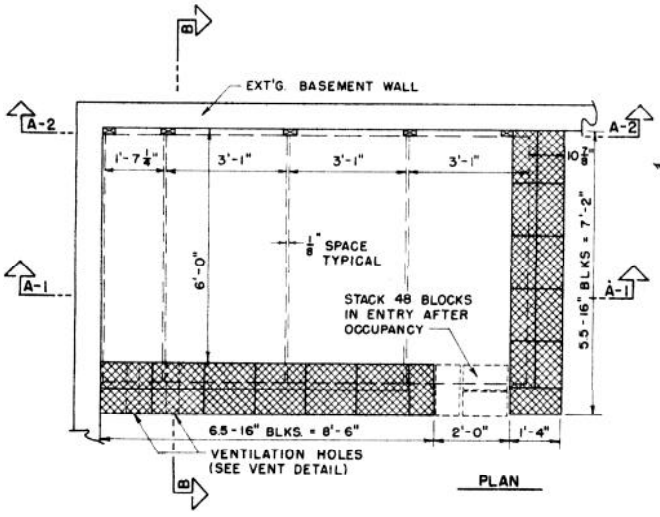
AIR VENT DETAIL



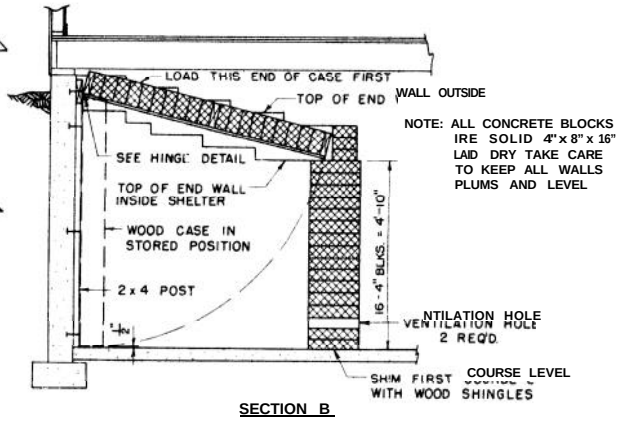
SECTION A-1



SECTION A-2



PLAN



NOTE: ALL CONCRETE BLOCKS IRE SOLID 4" x 8" x 16" LAID DRY TAKE CARE TO KEEP ALL WALLS PLUMS AND LEVEL

SECTION B

GENERAL INFORMATION

The principal feature of this shelter is a roof composed of tilt-up storage units, the top of which is hinged to the wall. The units can be used as book cases, pantry shelves, or for miscellaneous storage. In an emergency, the storage units can be tilted up so that they rest on a stacked masonry wall built from materials stored nearby the units.

In basements where the outside ground level is above the top of the tilted-up units, adequate shelter from fallout radiation is provided by filling the units with brick or solid concrete block 8" thick. The shelter will house 6 people.

Approximately 2 man days are required to construct the storage units. The materials are readily available, from retail lumber yards.

MATERIALS LIST

Item	Actual Number Required
Masonry:	
4" x 8" x 16" solid concrete masonry units or	575 blocks or
2-1/4" x 4" x 8" solid bricks	3450 bricks
Lumber: ("Construction" or "No. 1" grades or better)	
posts 2 x 4 x 6'-4-1/4"	5 pieces
beam 2 x 8 x 10'-11-5/8"	1 piece
3 cases plus half case	
2 x 8 x 6'-3-3/8"	8 pieces
2 x 8 x 6'-0-1/8"	3 pieces
2 x 8 x 1'-4"	9 pieces
2 x 8 x 2'-9-5/8"	6 pieces
1 x 6 x 1'-7-1/4" T & G*	13 pieces
1 x 6 x 3'-1" T & G *	39 pieces
Hardware :	
3" x 8" x 1/8" unfinished steel strap hinges	8
#12 x 1-1/2" wood screws, c. s.	64
3/8" diam. x 6" square head unfinished anchor bolts	20
3/8" bolt size multiple-expanding machine bolt anchor	20
6d ring shanked nails	3 pounds
glue, protein emulsion (must develop 450 lbs. /sq. in.)	1-1/2 pints
16d common nails	3 pounds

*Square edge boards may be used.

Special tools :

bubble level to insure wall is level as it is stacked

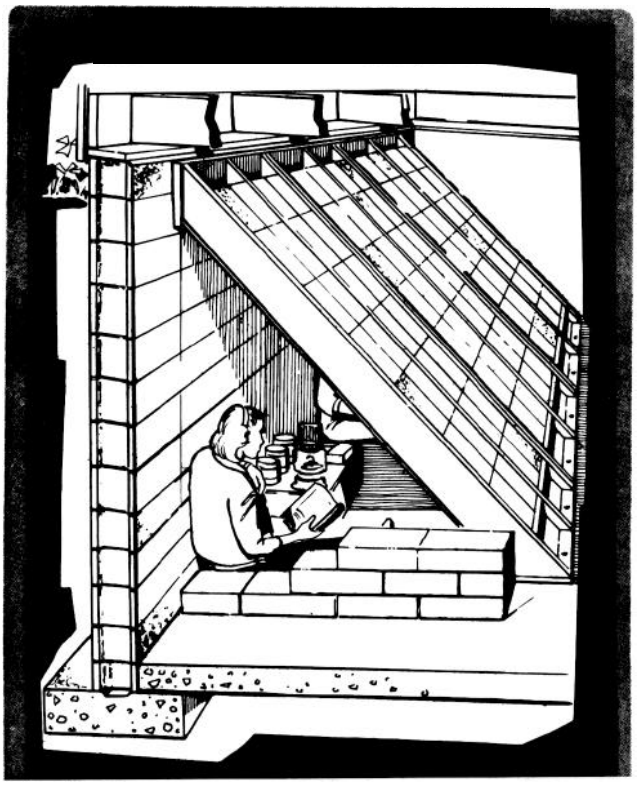
3/4" star drill for making anchor holes in existing basement wall

CONSTRUCTION SEQUENCE

1. Prepare wood case units.
   a. Assemble wood units in accordance with drawings on sheet 2.
   b. Fasten hinges to hinge board with 1-1/2" #12 * wood screws.
   c. Locate and drill holes in basement walls to receive machine bolt anchors.
   d. Bolt hinge board and 2 x 4 posts to wall with 3/8" anchor bolts.
   e. Fasten wood case units to hinges with 1-1/2" #12* wood screws.
2. Provide suitable storage location for required concrete block.
3. Assembly of shelter.
   a. Remove items stored from wood case units.
   b. Mark location of shelter walls on floor with chalk.
   c. Move concrete blocks lo shelter location.
   d. Lay first course of blocks for shelter walls, shimming block as required with wood shingles until course is level. It is important that the wall be stacked as nearly level and plumb as possible for stability.
   e. Tilt up case units in corner of basement and support temporarily with 2 x 4 prop or household step ladder. Build-up 16" concrete block wall to support case units.
   f. Remove prop, lower case units to block wall and fill case units with concrete blocks.
   g. Build end wall up above the side of the end storage unit.
   h. Move 48 concrete blocks into shelter.
   i. Occupy shelter and fill entry with 48 blocks.

* Drill lead holes 5/32" in diameter, 1-3/8" deep and shank lead holes 3/16" in diameter, 3/8" deep.

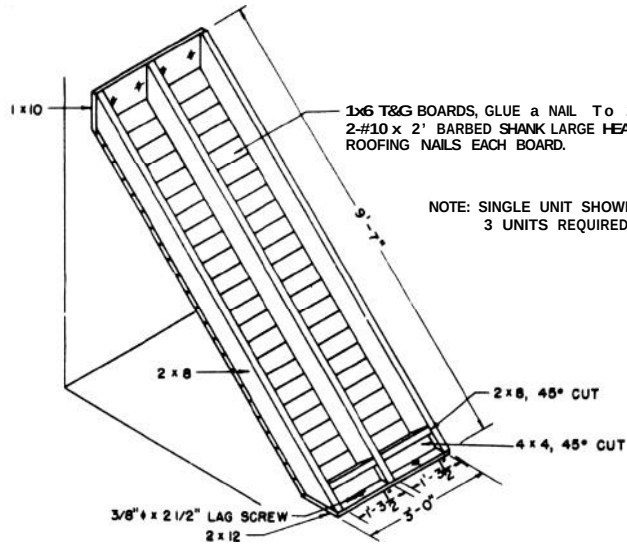
H-I 2-F
April 1980



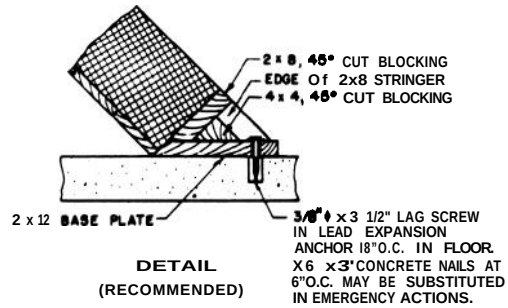
Pre-built wood components stored in the basement may be assembled and filled with bricks or concrete blocks for emergency protection.

HOME FALLOUT SHELTER
lean-to shelter-basement location plan f

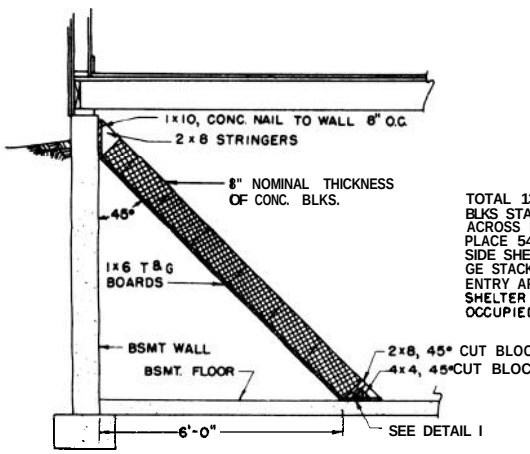
FEDERAL EMERGENCY
MANAGEMENT AGENCY



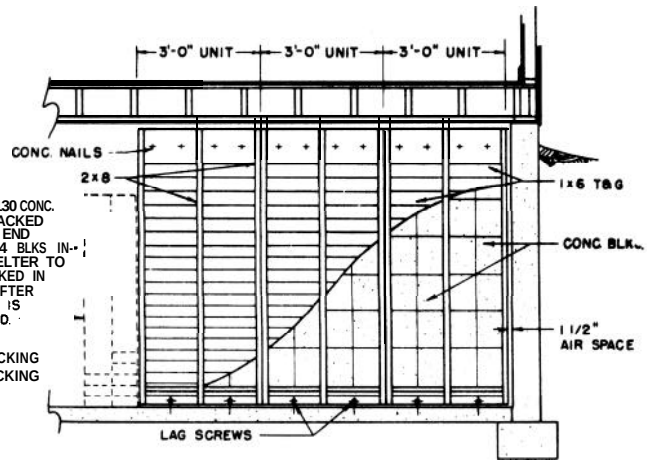
ISOMETRIC OF LEAN-TO UNIT



DETAIL
(RECOMMENDED)

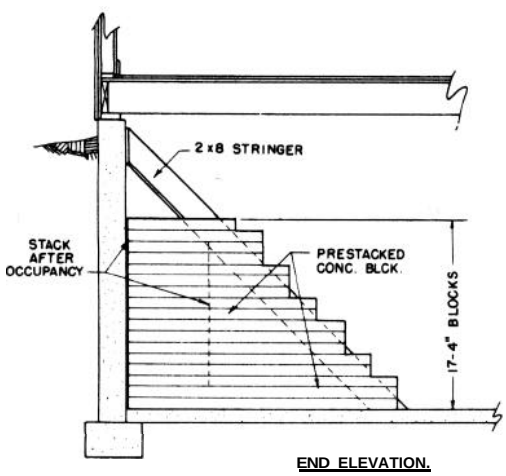


SECTION A

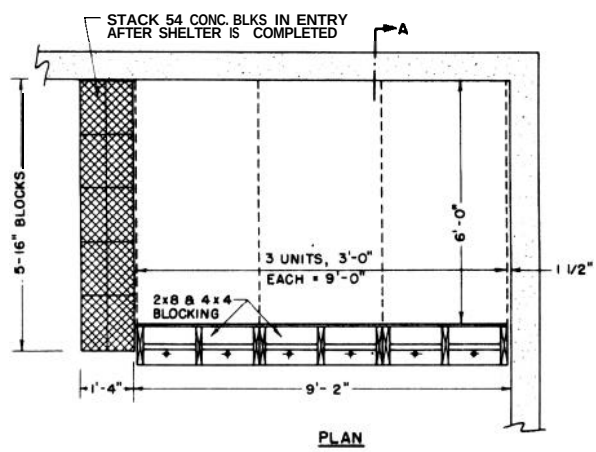


TOTAL 130 CONC. BLKS STACKED ACROSS END PLACE 54 BLKS IN-SIDE SHELTER TO GE STACKED IN ENTRY AFTER SHELTER IS OCCUPIED.

FRONT ELEVATION



END ELEVATION.



PLAN

GENERAL INFORMATION

This shelter is designed to provide protection from the effects of radioactive fallout in the below grade basement of an existing house. Its advantages are low cost, simplicity of construction, general availability of materials, and the fact that it may be easily disassembled.

TECHNICAL SUMMARY

This shelter design will provide 54 square feet of area and approximately 216 cubic feet of space. It will house three persons. The shelter length can be increased by increments of 3 foot panels. The height may be increased by the use of more materials. This increase will be limited by basement height and handling of the panels.

The materials necessary to construct this shelter should be available from retail lumber yards.

Natural ventilation is obtained by omitting 3 blocks from the top of the entranceway closure and by leaving a l-1/2 in. gap between the end of the shelter and the basement wall.

Construction time should not exceed 20 man-hours when all the materials are on hand at the shelter location. It is desirable to preassemble the lean-to units and store them in a corner. They can then be installed in the best corner of the basement and stacked with blocks in 1 hour.

MATERIALS LIST

Item	Actual Number Required
Masonry :	
4" x 8" x 16" solid concrete masonry units or	290 blocks or
2-l/4" x 4" x 8" solid bricks	1740 bricks
Lumber: ("construction" or "No. 1" grades or better)	
stringers 2 x 8 x 9'-7" (45" diag. cut at both ends)	9 pieces
boards 1 x 6 x 3'-0" T & G (square edge may be used)	69 pieces
1 x 10 x 3'-0"	1 piece
2 x 10 x 3'-0"	1 piece
blocking 2 x 8 x l'-3-l/2 stress-grade lumber	6 pieces
4 x 4 x 1'-3-l/2"	3 pieces*

*Rip lengthwise at 45" to provide the 6 pieces required

Hardware:

3/8" diam. x 2-l/4" lag screws and washers	12
3/8" bolt size lead expansion shield, 9/16" x 2" hole	12
#lO ga. x 2" barbed shank, large head roofing nails	3 pounds
16D common nails	1 pound
glue, protein emulsion (must develop 450 lbs. /sq. in.)	l-1/2 pints
#5 x 3" concrete nails	36

Special tools :

9/16" star drill to install anchor bolts into concrete basement floor and walls

CONSTRUCTION SEQUENCE

1. Prepare shelter units.
   a. Cut 45° bevels on 2 x 8 stringers. Arrange in 3 foot panels. Using 16d common nails, attach bottom boards and blocking on the beveled ends first,
   b. Fit in, glue and nail remaining bottom boards with large head roofing nails.
   c. Units can be stored assembled, if desired, to save time. It is desirable to locate lag screw holes and install lead shields in floor and basement wall.

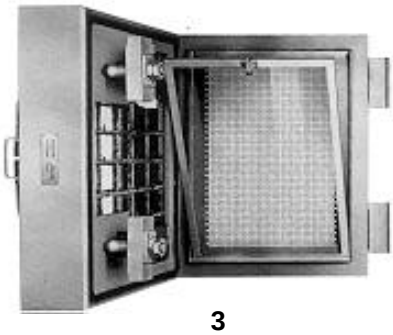
2. Assemble shelter (emergency actions)
   a. Turn this panel right side up and place it in its permanent position. Fasten the panel to the floor with lag screws in lead shields leaving a l-1/2" gap between the end of the shelter and the basement wall. If lead shields have not been installed ahead of time, use concrete nails as shown in the detail.
   b. Fasten in sequence as many panels as are to be used. Nail to wall with concrete nails.
   c. Fill panels with 2 layers of solid concrete block or brick starting at bottom.
   d. Build end wall of 76 stacked blocks 456 bricks.
   e. Place 50 blocks or 300 bricks in the shelter for emergency closure of entranceway.

Shelter closures

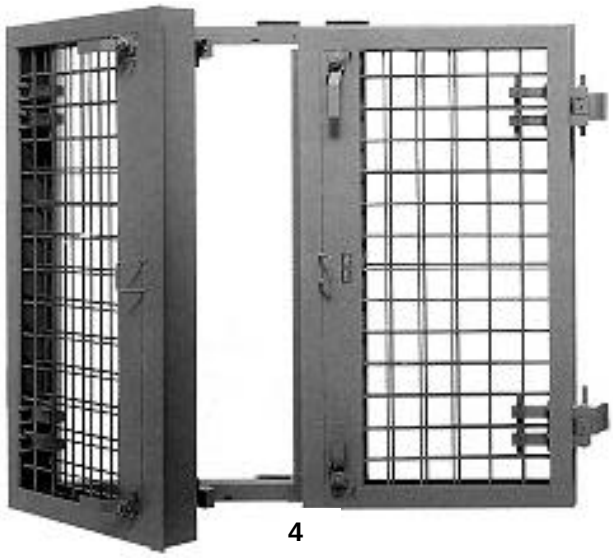
According to the technical regulations
of the Swiss Federal Office of Civil Defence (BZS)

1

2



3



4

1 Pressure door DT-1
2 Blast door PT-1
3 Blast cover PD
4 Blast double door PTO

Why armoured concrete doors and covers ?

Concrete shelter walls are providing optimal protection against *Pressure, Radiation, Heat, Gases and Physical Impact*.
Lunor armoured doors provide these excellent characteristics and assure that shelter entrances are „no weak spots“.
Lunor armoured doors are set in place and poured with concrete simultaneously with the walls, thus forming a fully integral part of the shelter shell.

Protection against weapon effects:

- Airblast from conventional or nuclear weapons
- Impact from fragments and debris
- Ground shock, i.e. vibration of shelter which is subjected to pressure wave propagating through the ground
- Heat from fires and thermal radiation from atomic weapons.
- Nuclear radiation
- Chemical and biological warfare agents

Protection against effects from accidents in industrial plants.

- Airblast from bursting pressure vessels, vapor, dust, toxic releases, heat from fires

LUNOR doors are provided with durable rubber seals fitted into specially designed grooves. The protection against toxic gas or nuclear fallout is achieved by creating an overpressure of filtered air within the shelter.

The leakage through the PT-doors and PD-Covers by an inside overpressure of e.g. 250 N/m2 is less than 20 m3/h. (PTO-doors 40m3/h)

Lunor
Quality as Tradition
LUNOR, G. Kull AG - Allmendstrasse 127—CH-8041 Zürich
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

Armoured door

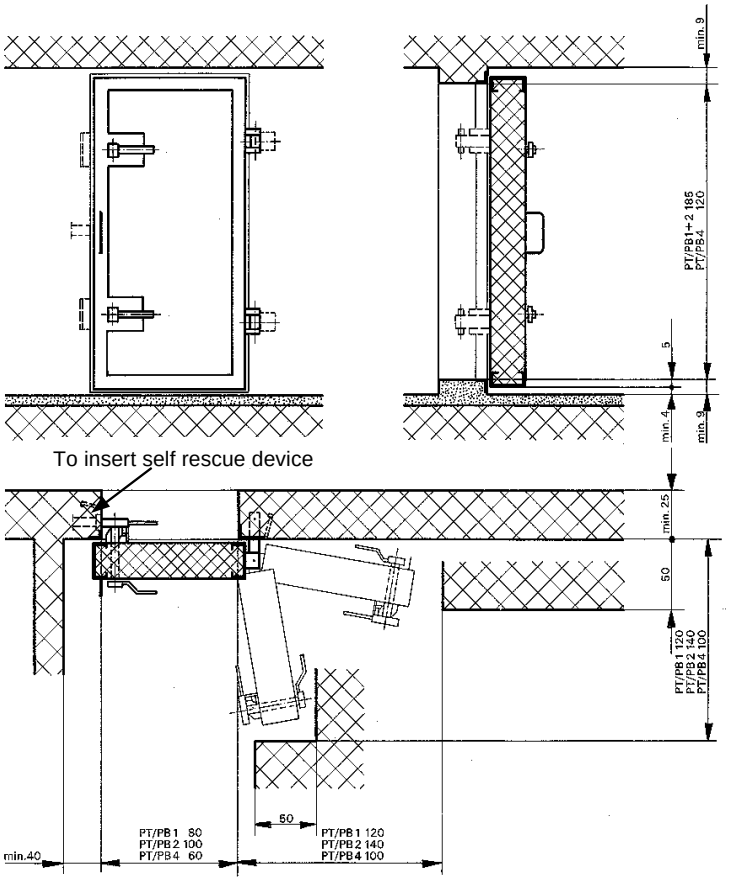
PT-1, PT-2
PT-4

Outside closure with 1 and 3 bar protection

Specification:

Supplier: **LUNOR, G.Kull AG**
CH-8041 Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration.
Door frame in angular profile with massive anchors and double hinges.
Steel parts not to be covered with concrete, coated with primer.



Armoured door, type PT-1
BZS-Nr. 74 PT-1
Frame dimensions:

Inner width:	80 cm
Inner height:	185 cm
Door thickness:	20 cm
Protection level:	3 bar
Weight without concrete:	205 kg

Armoured door, type PT-2
BZS-Nr. 74 PT-2
Frame dimensions:

Inner width:	100 cm
Inner height:	185 cm
Door thickness:	20 cm
Protection level:	3 bar
Weight without concrete:	250 kg

Armoured door, type PT-4
BZS-Nr. 74 PT-4
Frame dimensions:

Inner width:	60 cm
Inner height:	120 cm
Door thickness:	20 cm
Protection level:	3 bar
Weight without concrete:	170 kg

Installation requirements:
PT and PTO-doors always open towards the outside (against air blast)
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Modifications reserved

Further details are given in the technical directives for installation, which are included with each delivery.

Lunor
Quality as Tradition
LUNOR, G. Kull AG - Allmendstrasse 127—CH-8041 Zürich
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

Armoured door

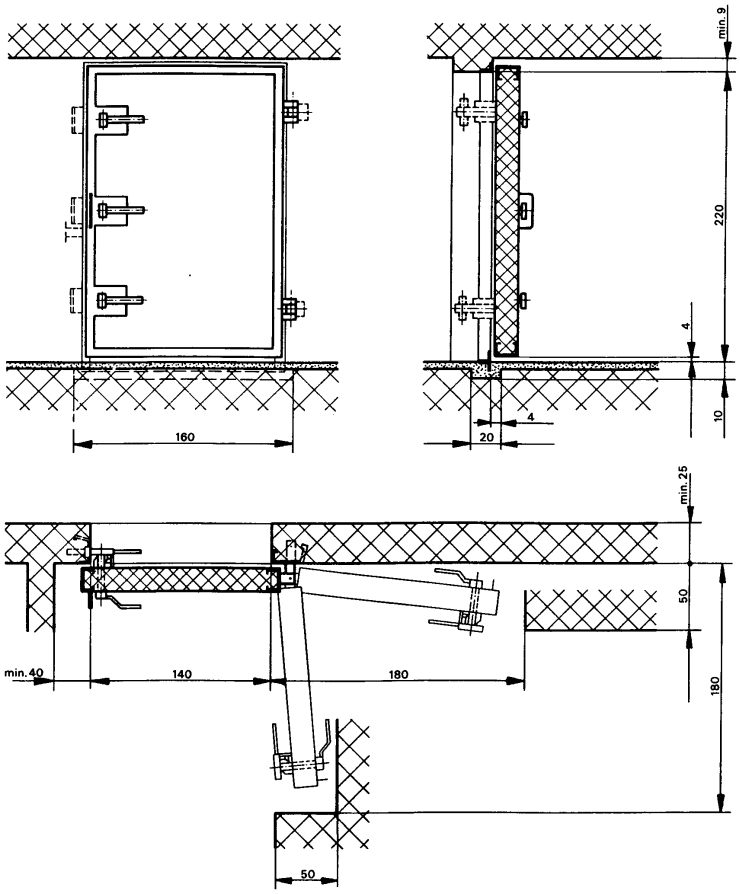
PT-3

Outside closure with 1 and 3 bar protection

Specification:

Supplier: LUNOR, G.Kull AG
CH-8041Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence..
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration.
Door frame in angular profile with massive anchors and double hinges. Steel parts not to be covered with concrete, coated with primer.



Armoured door, type PT-3
BZS-Nr. 74 PT-3
With removable door sill.
Frame dimensions:

Inner width:	140 cm
Inner height: [1)]	220 cm
Door thickness:	20 cm
Protection level:	3 bar
Weight without concrete:	480 kg

[1)] Dimension if door sill is removed

Important !

When ordering please state hinged side (left or right when viewed from outside)

Modifications reserved

Installation requirements:
PT and PTO-doors always open towards the outside (against air blast)
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Further details are given in the technical directives for installation, which are included with each delivery.

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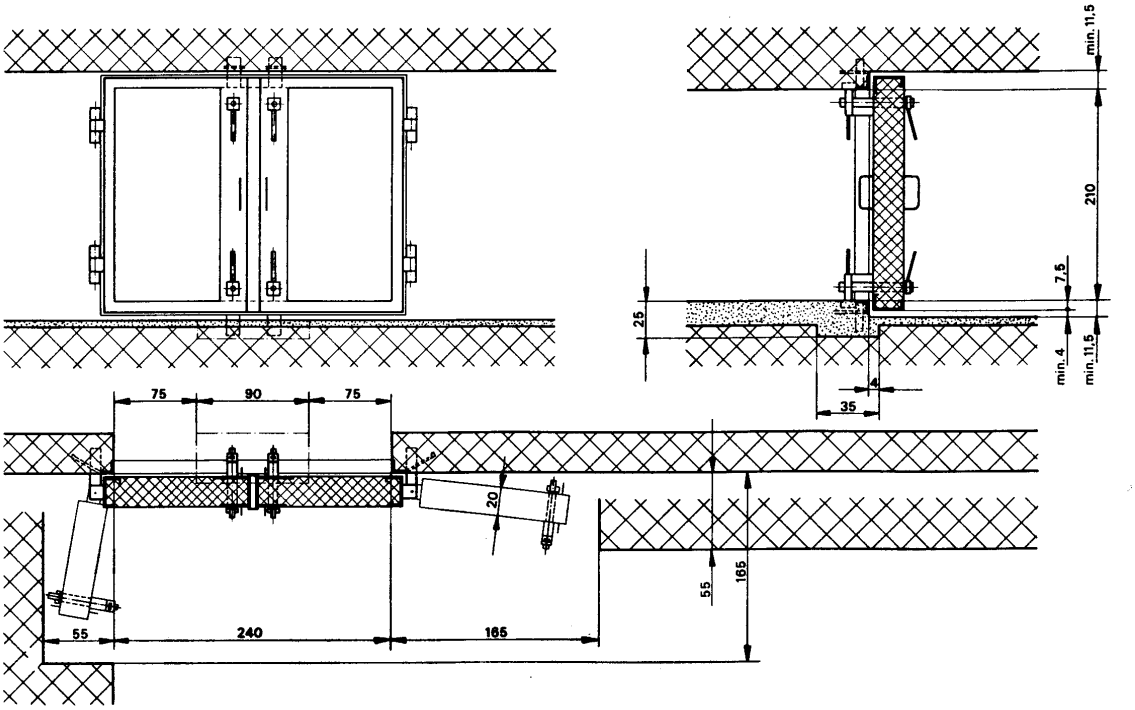
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

Armoured double-door PTO

Outside closure with 1 bar protection



Specification:

Supplier: LUNOR, G.Kull AG
CH-8003 Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence..
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration.
Door frame in angular profile with massive anchors and double hinges. Steel parts not to be covered with concrete, coated with primer.

Armoured door, type PTO
BZS-Nr. 74 PTO

Frame dimensions:

Inner width:	240 cm
Inner height:	210 cm
Door thickness:	20 cm
Protection level:	1 bar

Weight without concrete: 800 kg

Installation requirements:
PT and PTO-doors always open towards the outside (against air blast)
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Further details are given in the technical directives for installation, which are included with each delivery.

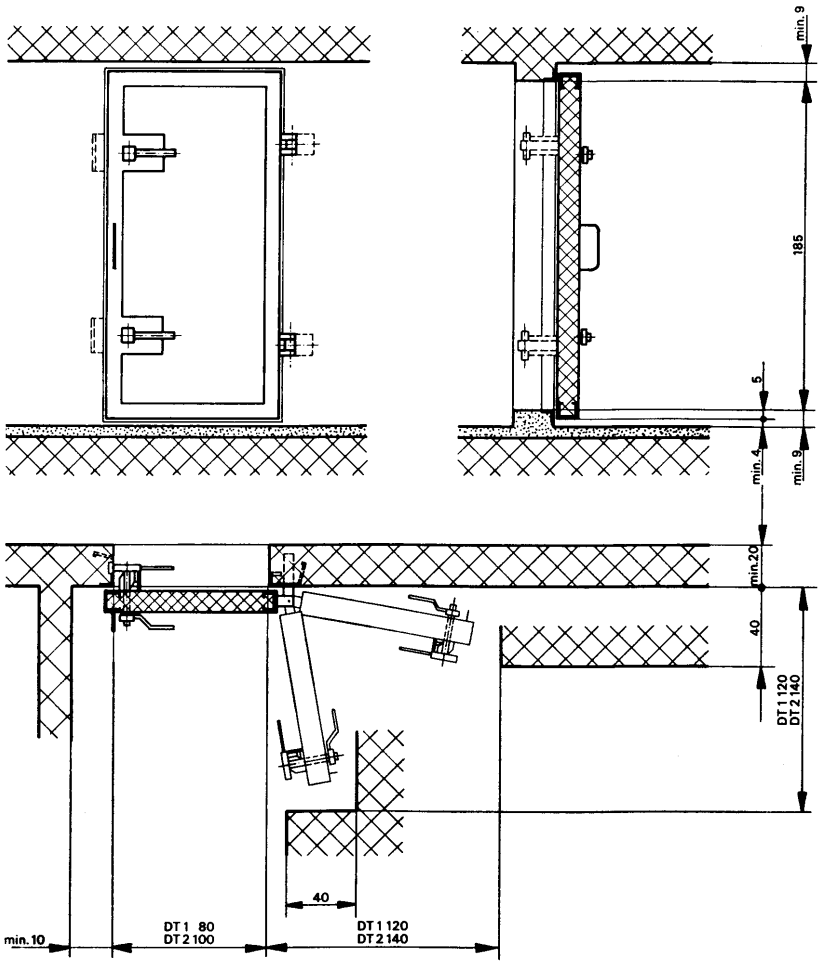
Lunor Quality as Tradition
LUNOR, G. Kull AG - Allmendstrasse 127—CH-8041 Zürich
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

Pressure door DT-1, DT-2

Specification:

Supplier: LUNOR, G.Kull AG
CH-8041 Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence..
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration. Door frame in angular profile with massive anchors and double hinges. Steel parts not to be covered with concrete, coated with primer.



Armoured door, type DT-1
BZS-Nr. 74 DT-1
Frame dimensions:

Inner width:	80 cm
Inner height:	185 cm
Door thickness:	10 cm

Intermediate closure (inside shelter) for shelters with 1 and 3 bar protection
Weight without concrete: 115 kg

Armoured door, type DT-2
BZS-Nr. 74 DT-2
Frame dimensions:

Inner width:	100 cm
Inner height:	185 cm
Door thickness:	20 cm

Intermediate closure (inside shelter) for shelters with 1 and 3 bar protection
Weight without concrete: 125 kg

Installation requirements:
DT-doors open in either direction
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Modifications reserved

Further details are given in the technical directives for installation, which are included with each delivery.

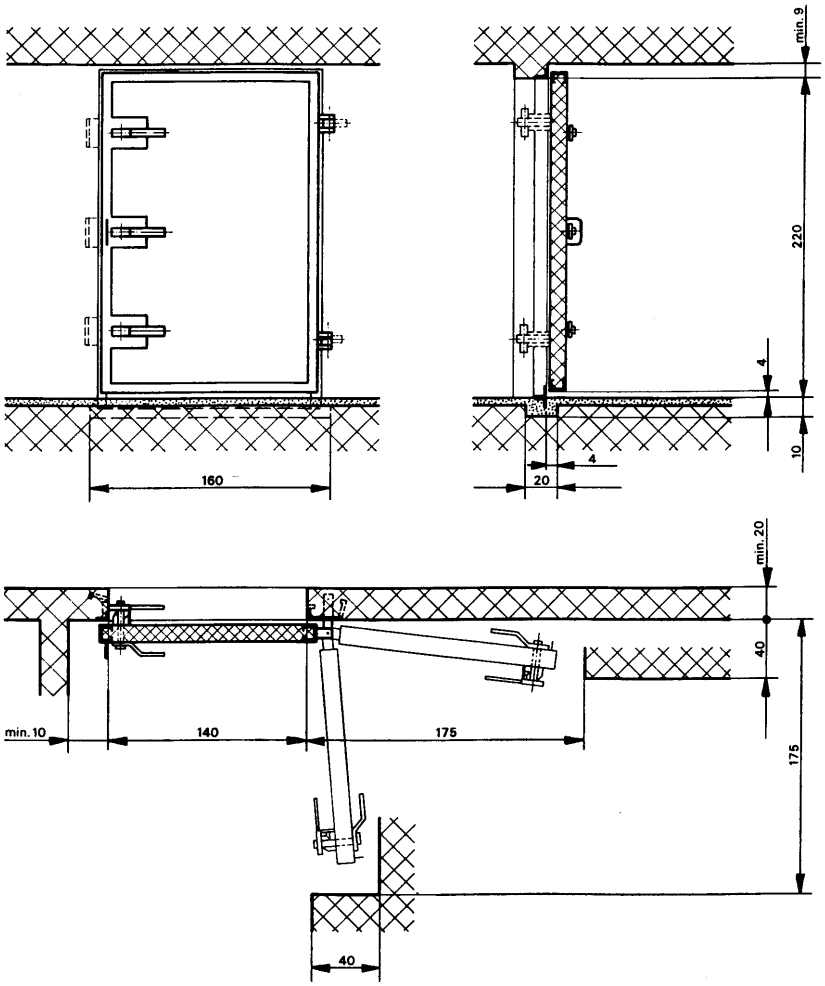
Lunor Quality as Tradition
LUNOR, G. Kull AG - Allmendstrasse 127—CH-8041 Zürich
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

Pressure door DT-3

Specification:

Supplier: LUNOR, G.Kull AG
CH-8041 Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence.
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration. Door frame in angular profile with massive anchors and double hinges. Steel parts not to be covered with concrete, coated with primer.



Armoured door, type DT-3
BZS-Nr. 74 DT-3
Frame dimensions:

Inner width:	140 cm
Inner height: [1)]	220 cm
Door thickness:	10 cm

Intermediate closure (inside shelter) for shelters with 1 and 3 bar protection, in peacetime used as warehouse etc. (passing of fork-lifts etc. possible).
Weight without concrete: 170 kg

[1)] Dimension if door sill is removed

Installation requirements:
DT-doors open in either direction
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Further details are given in the technical directives for installation, which are included with each delivery.

Important !

When ordering please state hinged side (left or right when viewed from outside)

Modifications reserved

Lunor Quality as Tradition
LUNOR, G. Kull AG - Allmendstrasse 127—CH-8041 Zürich
Tel. 0041 1 488 66 00 Fax 0041 1 488 66 00
email: info@lunor.ch

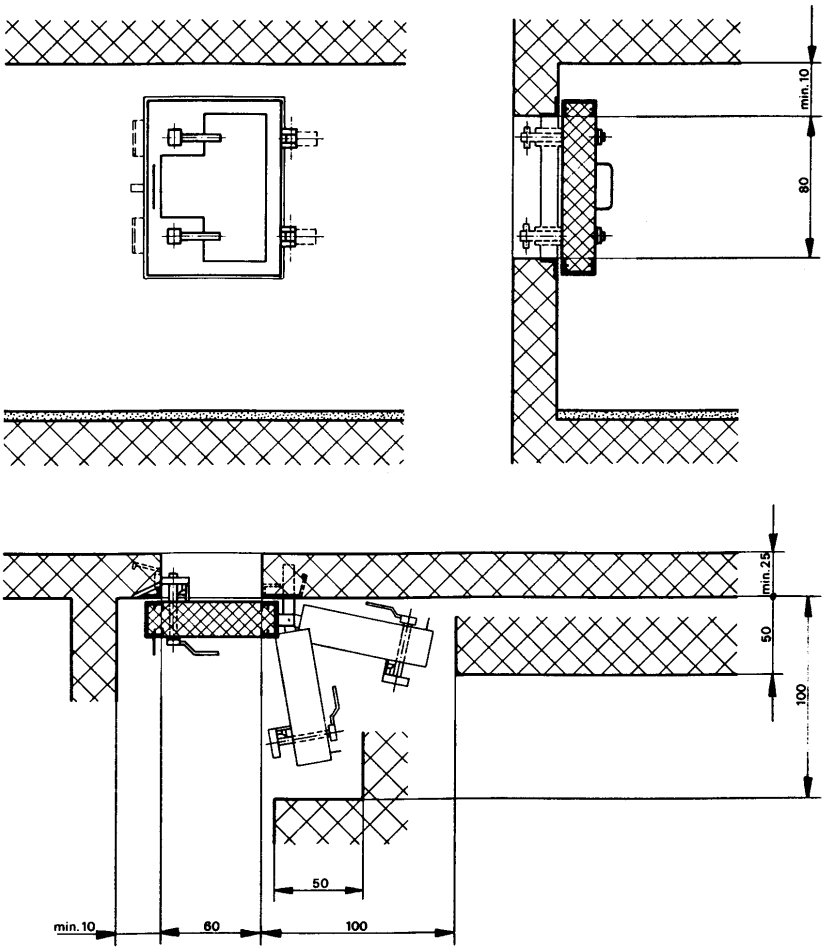
Armoured cover PD

Inside closure with 1 and 3 bar protection

Specification:

Supplier: LUNOR, G.Kull AG
CH-8041 Zurich

Design and production according to technical regulations of the Swiss Federal Office of Civil Defence.
Consisting of:
Door leaf in steel profile frame with rubber seal on all sides and welded-in reinforcement, removable lever locks on both sides. Internal levers with locking pin against accidental opening, air blast and ground shock vibration. Door frame in angular profile with massive anchors and double hinges. Steel parts not to be covered with concrete, coated with primer.



Armoured door, type PD
BZS-Nr. 74 PD
Frame dimensions:

Inner width:	60 cm
Inner height:	80 cm
Door thickness:	20 cm
Protection level:	3 bar
Weight without concrete:	140 kg

Installation requirements:
PD-covers generally open towards the inside (outside in special cases)
All doors should have a 4 cm free space both above the floor and under the ceiling
The doors and covers with their frames and anchors are to be placed in the forms in such a way that they are securely in place. Cast wall first. Only when the wall concrete has sufficiently set may the door leaf be filled with concrete and it is important that the door and cover leaves are closed and underpinned during the pouring of concrete. The distal pieces fixed to the locking device near the rubber seal guarantee the proper closing function.

Further details are given in the technical directives for installation, which are included with each delivery.

Modifications reserved

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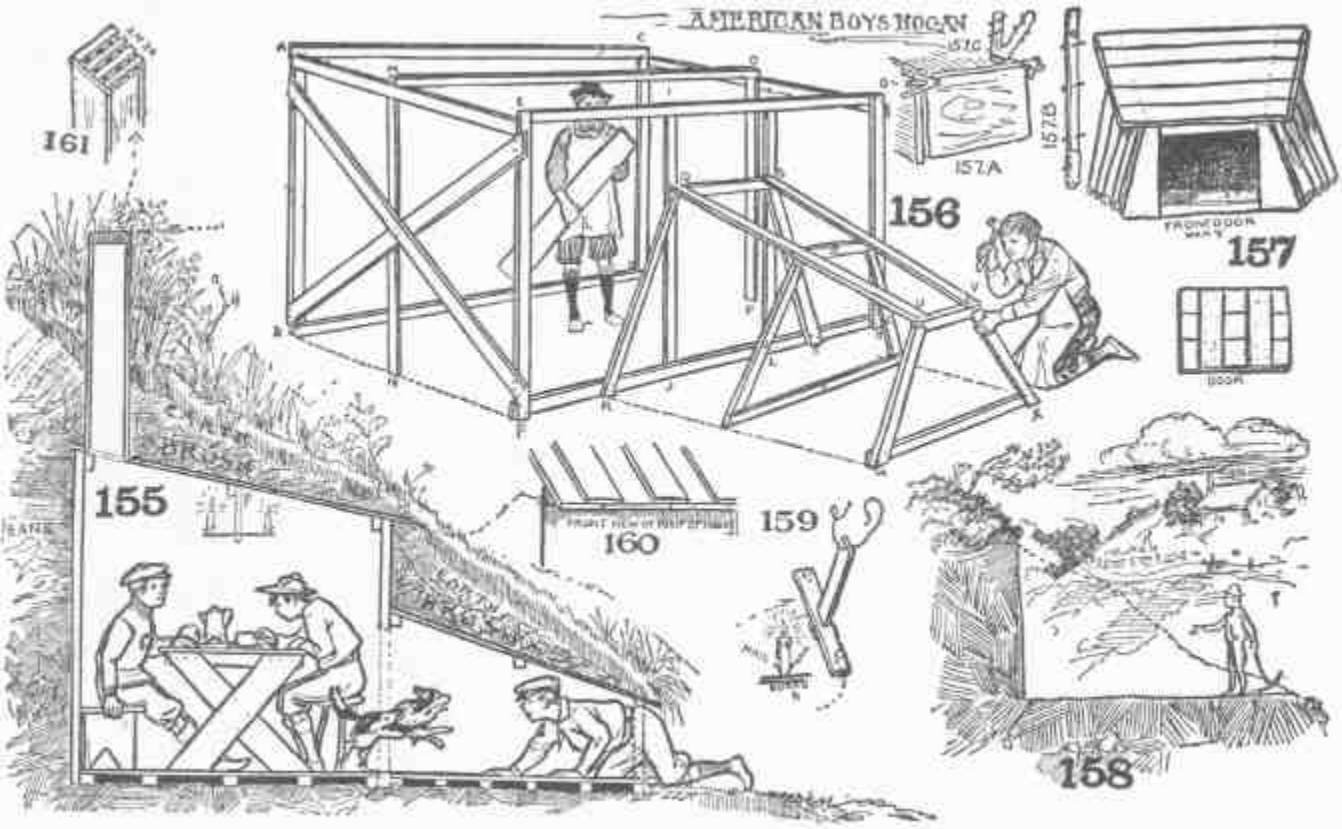


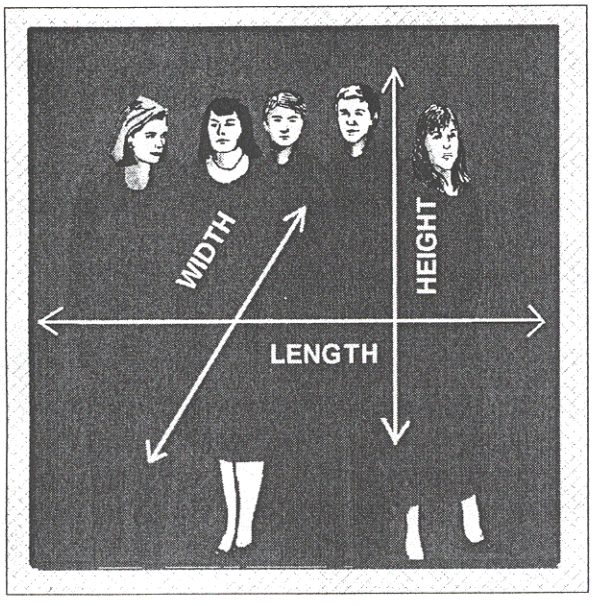
The original American boy's hogan or underground house.

Chapter 22

Shelter Design and Construction Considerations

A shelter project, like any other project, can seem overwhelming at the onset. A large, intimidating shelter project can be tamed by segmenting the project into smaller manageable units such as the shell, air system, power system, lighting system, water supply, etc. Deal with the project a segment at a time. And remember, what man can conceive and believe, man can achieve.

Space Requirements



Space requirements for shelter occupants should be considered from both a basis of square footage per person and cubic feet per person. The U.S. Government publications recommend a minimum of net 10 square feet per person. Net square feet is floor space that can also include walls, bunks, storage and fixed equipment. Try living in 10 square feet for two weeks, especially with children. What if it ends up being 60 or 90 days? Some of the larger shelters I am aware of have up to 50 net square feet per person.

Design Specification Questions

The following are questions, which when answered, can stimulate creative thinking and bring to light considerations that the first time shelter builder may have overlooked.

1. How many people is the project going to accommodate?

2. How many family groups does the above number of people represent and what sizes are these groups?

3. Do you want private rooms for family groups?

4. Where, generally, is the shelter going to be located?

5. Do you want blast protection or do you want fallout protection?

6. How long do you want to be able to remain in the shelter without having to come out? One month, two months, three months, nine months, or more?

7. How much of a food supply do you need to stockpile in or near the shelter? One month supply, two months, six months, one year, or more?

8. Do you want a separate clinic room in the facility?

9. Do you want to try to shield your sensitive electronic equipment from electromagnetic pulse?

10. Do you intend on having communication equipment, (i.e. shortwave, ham, etc.)?

11. Do you intend on having a decontamination area?

12. Do you plan on having a crawl-in or a walk-in entry way?

13. How deep are the wells in the area where the shelter is going to be built?

14. Do you want a pressurized water system with an electric well pump or do you want a hand pump or both?

15. Do you want hot water and flush toilets?

16. Do you want both a men's and a women's bathroom, or one bathroom?

17. Do you plan on having a water storage cistern?

18. How big of a cistern, in terms of balloon capacity, do you want or need?

19. How long do you want to be able to run your generators, (i.e. how long do you want the fuel to last)?

20. Do you want to have an extra generator for back up?

21. Do you want to incorporate the ability to run on battery power into the shelter's power system?

22. Do you want battery power as an emergency reserve or as a primary operating source?

23. How long do you want to be able to run on battery power without recharging the batteries?

24. Is the site for the shelter such that the shelter can be built into the side or into the top of a slope?

25. Are you concerned about the security of your shelter in the event of an emergency occupation?

26. Do you want to have an observation tower incorporated into your shelter which would enable you to have some control of the perimeter around the shelter site?

27. Is the shelter going to be connected to or part of any above ground structure?

You probably don't have the answers to many of these questions but hopefully they have caused you to consider some important aspects of shelter building that you hadn't thought of before.

Site Location Considerations

Proximity to Target Areas

When standing on railroad tracks, if you observe an oncoming train, the logical thing is to get out of the way. If you believe in the possibility of an oncoming nuclear war or natural disaster, the logical thing to do is to relocate out of any target areas or any potential area that could be drastically affected by earth

changes. If you live in the crime dominated inner city, what would be a better investment: buying bullet proof vests for your family or moving to a better neighborhood? In the same fashion, building a blast shelter because you live near a known target area, might not be as smart as moving to a non-target area (perhaps as little as ten miles away) and building a less expensive fallout shelter. When you see a locomotive coming down the tracks toward you, the most cost-effective thing you can do is get out of the way.

In order to be effective, shelters in target areas must be blast hardened; built to withstand the direct effects of a nuclear weapon. Even if you have a blast shelter, your first indication of a threat might be the flash of a strike. At that point, it is too late to run to your shelter.

It is my personal opinion that if you determine that you need blast protection, you should seriously consider relocating. Distancing yourself from target areas and areas of vulnerability has both practical and financial advantages. It is practical in the sense of avoiding the direct effects of a nuclear weapon and financial because building a fall out shelter is less expensive than building a blast shelter. Living close to a target area greatly reduces your chance of survival and greatly increases the cost of a shelter.

The best place to relocate to is a remote area, at least ten miles from any target area, and preferably, thirty miles away from any areas of major population. It would be ideal if this area was in proximity to other like-minded people.

Once a decision is made on a general location of a shelter there are certain factors which should be considered for specific locations.

Available Water

You can't live long without water. You should investigate how deep the wells are in the areas you are contemplating for a shelter and how many gallons per minute they produce. Water capability is an important issue. Drilling a 600 or 800 ft. well is expensive, and in the event of well pump failure, it is hard to pull up and service the pump. It is impossible to pump water with a hand pump from a well deeper than 250 feet.

I would highly recommend having a well for your shelter as water is very difficult to store over a long period of time. This subject is covered extensively in the water chapter earlier in this book.

Drainage

Drainage is very important. Consideration should be given not only for a high water table and its obvious complications, but also for the potential impact of unusual surface water runoff which could swamp the shelter.

Depth of Bedrock

It is wise to drill or dig a test hole to determine if there is any underlying bedrock that would obstruct the excavation necessary to accommodate the shelter. I know one shelter project in particular which spent considerable sums of money having to blast through unexpected bedrock.

Tactical Problems

It is ideal if the terrain around a potential shelter site enhances the security of the shelter's perimeter. In other words, it would be best to locate the shelter on a relatively high point which would give its observation tower

unobstructed tactical view of the area surrounding the shelter.

Access

Access is a two-edged sword. Too easy an access is not good because you don't want to be constructing your shelter under everyone's gaze and inspection. And you don't want to make it easy for someone not invited to make their way to your shelter. On the other hand, you want to be able to get to it in the winter if needs be. It won't be much good having a shelter you can't get to in time, even if it is an ideal tactical location. Another consideration relating to access is getting equipment and material to the site during the construction phase.

Earthquake Considerations

Buried structures have the advantage of being earth-integrated. In an earthquake, the ground accelerates causing structures above the ground to move back and forth in a rocking motion. On the other hand, structures buried in the earth are moved only slightly and then in sync with the surrounding ground. This can be compared to the way a ship tosses and rolls in a storm on the water's surface and a submarine below the surface moves stably within the sea.

You obviously do not want to build a shelter in close proximity to a known fault, but in general, a buried shelter has the best chance of surviving an earthquake, far better than any type of above ground structure. Nevertheless, shaking will occur. Supplies and equipment on shelves, generators, and water and fuel storage tanks should be properly secured.

Other Shelter Building Considerations

Cutting Into A Used Fuel Tank

D A N G E R

Extreme caution should be exercised when cutting into a used fuel tank. Over the years, numerous people have been killed by explosions resulting from trying to cut a hole in a used fuel tank. Tanks which contained diesel fuel are less susceptible to explosion than tanks which held gasoline. Old gasoline tanks are extremely dangerous to cut into. Regardless if it is an old diesel tank or an old gasoline tank, treat both kinds as if they were gas tanks. You can never be sure exactly what was in the tank.

A fuel tank does not need to have fuel in the bottom of it to be dangerous. The fuel vapors or fumes, mixed with air, will be ignited by a spark from a metal cutting saw or torch. The intensity of such an explosion can rarely be survived.

There are three ways to prevent fuel tank explosions when cutting into a tank. The first is to use dry ice, the second is to use compressed $C0_2$ and the third is to use exhaust off the tail pipe of a truck. The whole concept is to displace the vapor fumes out of the tank with $C0_2$ which is a heavy gas. Begin by making sure the tank is standing upright in its natural position. Then, open one of the plumbing access fittings on the top of the tank.

If using dry ice, put 20 lb. of the dry ice in the tank for each 1000 gallons of tank capacity. The temperature has to be warm enough

to facilitate the melting of the dry ice in order to produce the $C0_2$ gas. Wait until the dry ice has melted completely before cutting into the tank.

If using $C0_2$ compressed gas, insert a discharge tube from the tank of $C0_2$ into the access hole in the fuel tank and slowly let the gas fill the tank. Use 150 cu. ft. of compressed $C0_2$ gas for every 1000 gallons of tank capacity.

When using the exhaust from a truck you need a connecting piece of black flexible PVC waterline slightly larger than the exhaust pipe. Slip this waterline over the exhaust pipe and secure it with duct tape or a hose clamp so that no exhaust leaks out. Put the other end into the access hole in the top of the fuel tank. Turn on the engine and let the truck idle. Check the end of the water line to make sure the exhaust is coming out. Don't use a truck with holes in the muffler. The exhaust contains $C0_2$ gas which will displace the gas vapors out the top of the access hole so be sure not to tape this connection shut. A truck with a conventional 350 Chevy engine needs to idle 10 minutes for every 1000 gallons of tank capacity. Make sure the truck is tuned up and not running rich or having choke problems. You don't want to be putting unburned fuel and CO into the tank. CO can actually combust. A diesel engine would be better to use for this application if it is available.

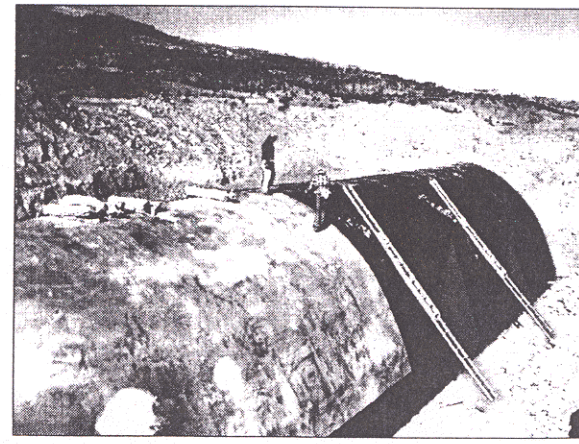
As an added precaution have someone duct tape the cut behind the cutting torch to prevent air from entering the tank during the actual process of cutting the hole. Any fuel you find in the bottom of the tank, once you've cut the hole, can be absorbed with sawdust, shoveled into empty feed sacks and properly disposed of.

N O T I C E

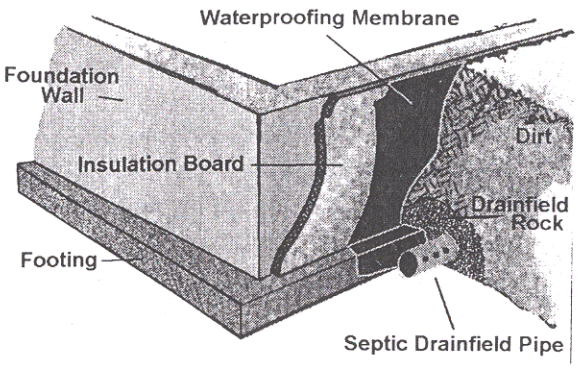
Unless you are knowledgeable and experienced in this area, you should purchase a tank which has already been cut open by a licensed fuel tank remover or purchase a new tank. This information is not intended to be encouragement or advice from the author in regards to cutting into a tank. If you decide to engage in such a dangerous and unpredictable activity, you will have to do it at your own risk!

Waterproofing

When constructing sub-earth homes and underground shelters which have shells comprised of porous materials, such as concrete or wood, make sure not to skimp on the waterproofing. There is nothing much worse than to backfill and landscape an underground shelter and then discover a leak. The only real solution is to call the backhoe or excavator back, uncover the shelter by removing the dirt, and re-do the waterproofing.



Putting on Paraseal Waterproofing



For waterproofing concrete shelters, a product called Para Seal is probably the best commercial product on the market today. Para Seal is a heavy mil P.V.C. material with a bentonite backing. It is a self-healing waterproofing system. If a hole is punctured through the P.V.C. and water seeps in, the bentonite swells up and stops the leak. Paraseal is made by Paramount Technical Products, 2600 Paramount Drive, P.O. Box 1042, Spearfish, SD 57783, (605) 642-4787 or (800) 658-5500. Another fairly good product is called ADF which is made by Tec Coatings, located in San Antonio, Texas.

For fuel tanks, the best material for waterproofing is epoxy coal tar. You can locate this coating material by contacting the nearest underground tank manufacturer or by ordering it through a commercial paint store.

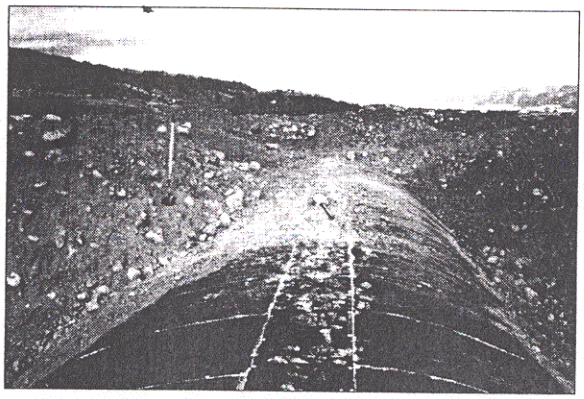
For culvert, a tar based foundation coat is adequate since the shell is galvanized material. Caution should be taken to make sure that the joints between sections and welded intersection joints are properly sealed to prevent leaking.

The steel quonset structures contain many bolt connections and tend to leak if not properly waterproofed. Polyurethane foam has been used successfully to waterproof this type of structure.

The newer generation of fiberglass shelters like the Subtec ES10 are considered to be watertight, but the old Theta modules have a tendency to leak.

Backfilling

Backfilling is the most critical construction phase of any structure system which relies on earth-arching for its structural strength. This includes fuel tanks, culvert, fiberglass pods, and steel quonset. The potential for serious problems with settling and deforming due to improper compaction should not be underestimated! Generally, the backfilling material should be screened in such a manner that nothing larger than a softball is placed within two feet of the surface of the tank or culvert. Larger rocks, due to the compaction pressure of the material above, tend to gradually migrate down onto the surface of the tank or culvert. This produces dents and point loads which can potentially compromise the structural integrity of the system.



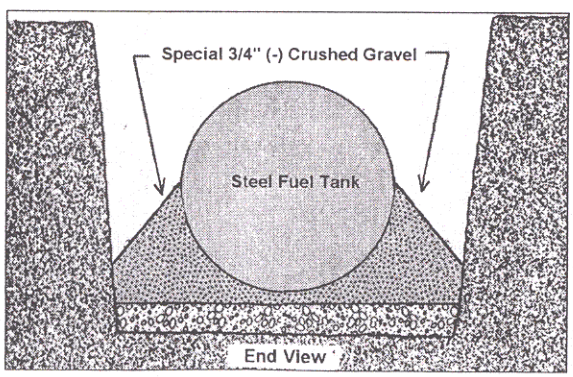
Backfilling the Shelter

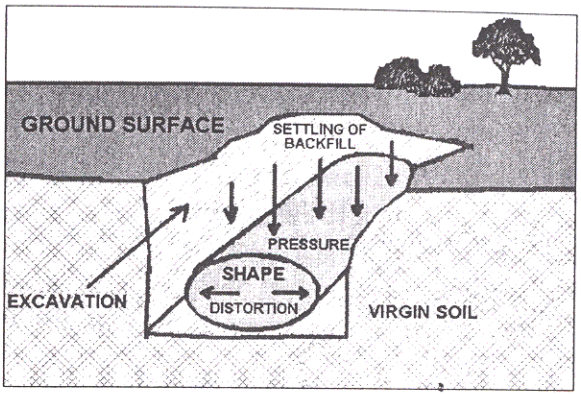
Earth-Arching

Earth-arching is a phenomena whereby the earth covering a "fully buried" structure, when subjected to an overpressure, acts as one integral unit, absorbs the pressure and as pressure penetrates down into the earth, the earth reduces and dissipates the pressure. The effect is that "fully buried" structures, without significant strength, only receive a fraction of the initial pressure which was applied to the surface of the ground, and survive without collapse. The term "fully buried" means the structure in question, be it a fiberglass dome, tank or culvert, is covered by at least a depth of earth which is equal to or greater than the diameter of the structure. In other words, earth-arching will not work if the shelter is not buried at a depth which provides an earth cover over the top of the shelter which is equal to or greater than the diameter or width of the tank, culvert or arch that it is covering.

Compaction

Another significant factor in relation to earth-arching effects is compaction. The earth-arching effect will not function to its capacity if the earth cover over the shelter is not uniformly compacted to a percentage of 95% Proctor. Compaction is not only important from the standpoint of achieving the earth-arching effect to protect the shelter in the event of an overpressure, but it is also important in terms of keeping the tank or culvert from deforming and deflecting during the settling process.





The Results of Poor Compaction

A simple way to test for this 95% Proctor density is to jam your heel into compacted earth and if it barely leaves an imprint you have approximately 95% Proctor density.

Compaction can be thoroughly accomplished with a wacker tamper applied to each 8 to 12 inch layer of earth cover. The flat side of the bucket of a large excavator can be used as long as a repeated pounding action is applied.

The final aspect of achieving the earth-arching effect is the aggregate nature of the soil. Silty and clay soils will not, even when properly compacted, produce the earth-arching effect. The overall material must not contain any more than 15% silty fines or clay. On the other extreme, if the compacted backfill is comprised of significant amounts of material which is larger than 12 inches in diameter, the earth-arching effect will be compromised. Both coarse sand and gravel work well and facilitate earth-arching.

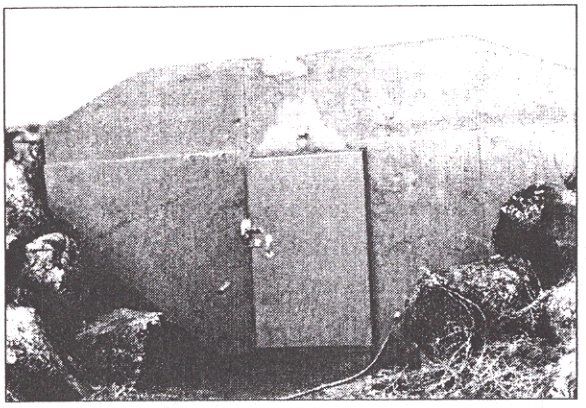
Landscaping Considerations

Efforts should be made to scrape off, stockpile and reserve any topsoil in the area on top of and around the shelter site. Be careful that this soil does not get used for backfilling, bedding pipes or other activities where earth with minimum rocks is needed. The topsoil may not seem all that valuable at the start of the project, but when the bulk of the project is done and it is time to landscape, the topsoil is extremely valuable. Not only should the soil be scraped off areas where excavations are going to occur, but also areas where subsoil from the excavation is going to be piled. The topsoil under these piles usually gets dug up and mixed in with the sub soil and thus wasted during the backfilling operations.

The landscape should also make consideration for security. Bushes, earth mounds, and large rocks should not be located on the grounds in such a way as to create concealment and cover for uninvited guests and intruders.

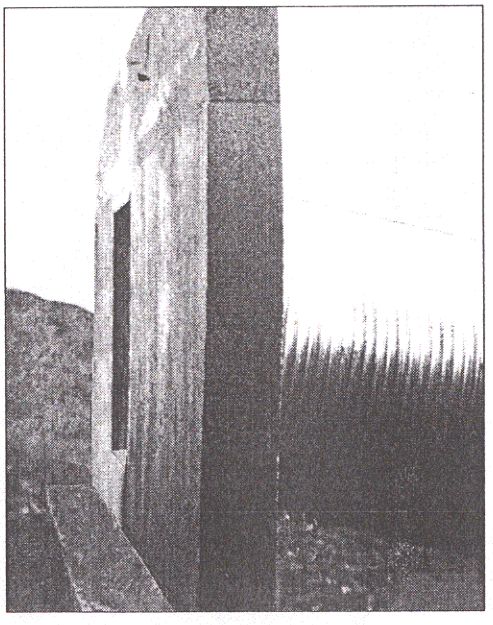
Doors

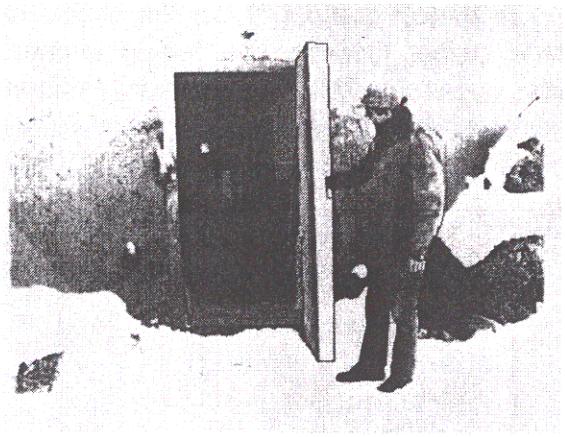
Shelter entry doors and hatches have three primary requirements: airtightness, security, and heat and overpressure resistance. An airtight seal is the primary requirement of any shelter door. This can be especially difficult to achieve with a homemade blast door. Doors built to resist heat, overpressure and thwart security threats are by their nature massive and difficult to get airtight seals on. One solution is to have a primary outer door which provides heat, overpressure and security protection and a secondary inner marine door which facilitates an excellent airtight seal.



Shelter Entrance Blast Door

Most shelters have doors which swing open to the outside (in contrast to doors that swing inward). The reason for this is that the door is easier to build that way. In the event of an overpressure, the outside pressure pushes the door onto the door frame and the door is supported by the frame on its entire periphery. The disadvantage is that rubble resulting from a blast can prevent the door from being opened, and if the shelter doesn't have an unblocked alternative entrance, the occupants must be freed by rescue teams coming from outside.





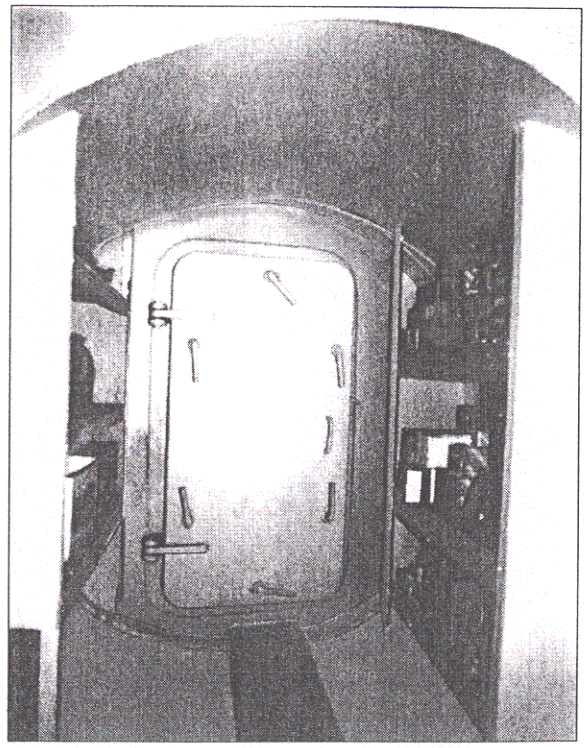
Doors opening to the inside allow occupants to open them even when blocked by accumulated rubble. These style doors are more difficult to construct because the overpressure is carried by dogs or pins which extend from the door into the door frame. These dogs transfer the overpressure to the door frame. Therefore, inwardly opening doors need to be small.

The best solution to being trapped inside a shelter by rubble is to have an alternative entrance/exit with a different profile, exposure and elevation. The idea here is that if one door is a horizontal surface walk-in type, then the other entrance/exit would be a vertical hatch coming up to the surface—ideally at a higher elevation. The problem of rubble blocking a vertical type hatch can be reduced by elevating the concrete reinforced hatch tube (see following pictures) several feet above the ground level, and have the hatch pivot horizontally to open, as opposed to flipping open vertically. One design which seems effective is the jack pivot type (as shown on the following page) which would allow occupants to lift the weight of any debris accumulated on top of the hatch.

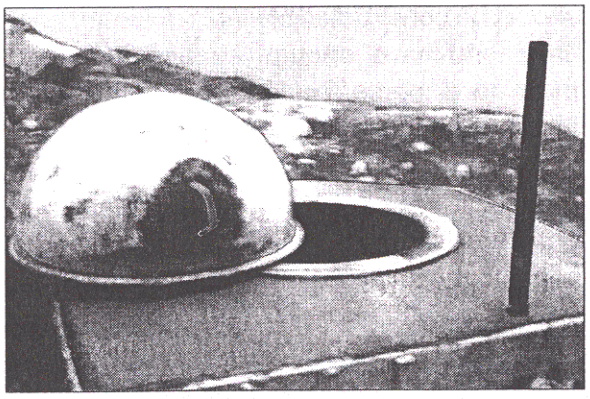
Door frames for exterior entry doors should be structurally substantial. In the case of a blast shelter, the door or hatch frame should be constructed of steel reinforced concrete and have enough surface area and mass to disperse the force of overpressure into the ground. This is important because if the overpressure is not transferred to the ground, it will be transferred directly to the entry tube which will be either crushed or driven into the shelter.

Doors should be outfitted on the inside with at least two chain binder arrangements which would tightly secure the door against the effects of negative overpressure and attempts by hostile individuals to make an unauthorized entry.

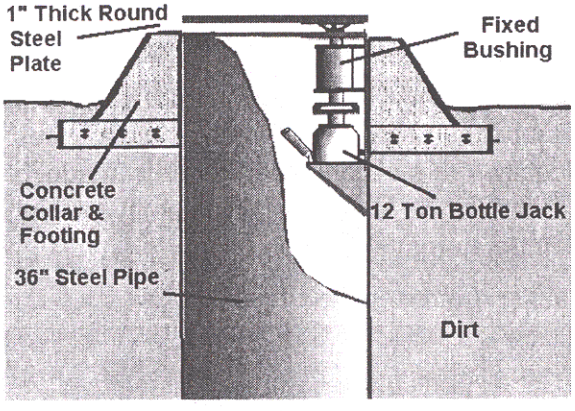
Another important aspect of doors are seals. Usually these are made of rubber. Rubber burns in case of intense surface fires. Ideally, fire-resistant fiber gaskets made of kevlar (which would retain integrity at high temperatures) should be used.



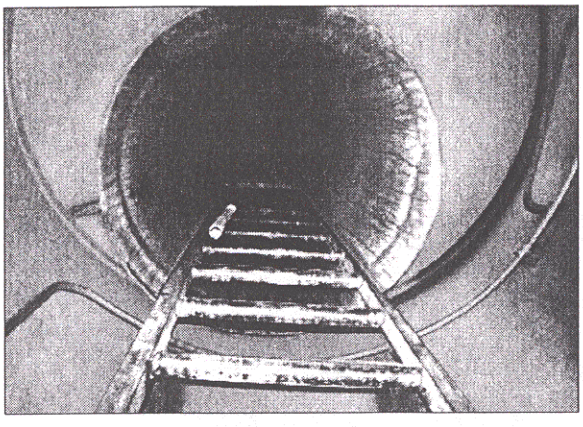
Marine Door



Pivoting Hatch Door
Vertical Entrance



Section of Vertical Entry Hatch



Vertical Entry / Exit
Looking Up From Inside Shelter

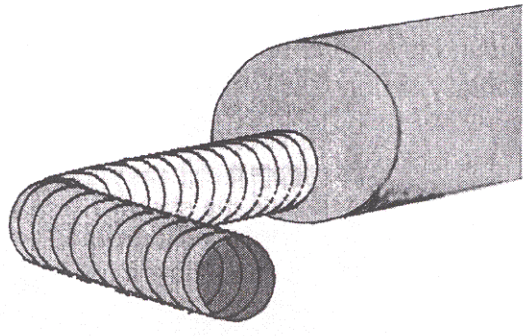
To protect the door from the effects of large caliber firearms and cutting torches, steel doors should be lined internally with at least 1 inch of steel reinforced concrete.

Entry Ways

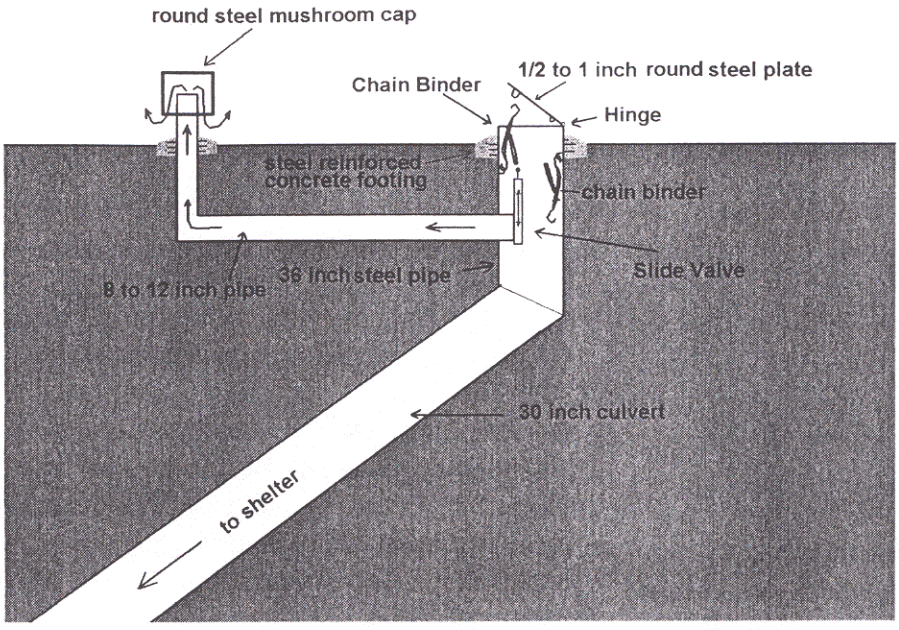
When designing shelter entry ways, the two factors which must be considered are attenuation of radiation and ease of access. The diameter, length and number of turns in an entry way will determine how much outside radiation comes into the shelter through the entrance way. Most shelter doors do not attenuate a significant amount of radiation. Shelter entrance way tunnels need to be configured so that they attenuate radiation, both gamma and neutron, and provide adequate access and escape.

Radiation attenuation is usually accomplished by extending the length of the entrance tunnel, incorporating turns in the entrance way tunnel, reducing the diameter of the entrance way tunnel, creating a barrier inside the tunnel, or any combination of these four.

Neutron radiation is only a problem in proximity to areas affected by the blast. Neutron radiation is not attenuated as easily



90 Degree Turn on Culvert Entry Way



as gamma radiation. Much more attenuation is needed to protect the occupants of a shelter from the initial deadly pulse of neutron radiation which will attempt to penetrate into the shelter through the entrance way in the areas affected by the blast.

You should never be able to open the door to a shelter and see directly into the shelter. If you can see into it, radiation can penetrate into it. One good test which will indicate how well the entrance way will reduce radiation is to open the hatch-ways and doors to your shelter and go inside to where the entrance way actually meets the shelter. Make sure no lights are on inside the shelter. Turn around and look back out the entrance way toward the outside. Observe how much sunlight, if any, is being reflected down the tunnel way from the outside.

The presence or absence of outside light being reflected down into the interior of the shelter via the entrance way tunnel is a good general indication of how adequately the tunnel will shield the occupants from the penetration of neutron radiation. Neutron radiation is much like light in its reflecting capabilities.

Neutron radiation has a scattering effect which enables it to effectively penetrate around corners. A 90 degree turn in a entrance way tunnel will only reduce the penetration of neutron radiation by 20%. In effect, 80% of the neutron radiation will get around the 90 degree turn in the entrance tunnel. A second 90 degree turn in the entry way tunnel will reduce the 80% that got around the first turn in the tunnel by a factor of 20%. In essence, if you had 9,000 rems of neutron radiation pulsing into the shelter entry way, the first 90 degree turn would reduce the neutron radiation to 7,200 rems and the second 90 degree turn in the tunnel would reduce this 7,200 rems to 5,760 rems. It is going to take many 90 degree turns and/or the addition of tunnel length and barriers to reduce the neutron radiation to a survivable level.

Barrier shielding is a practical solution to the penetration of neutron radiation. Substances with high hydrogen contents provide the best shielding and attenuation of neutron radiation. Stacking full water containers in the entrance way is one solution. Sandbags full of sawdust is another. The ideal neutron shielding barrier would be a massive, hinged interior door which contained an interior water bladder. Water is an excellent substance for shielding neutron radiation.

Gamma radiation is a product of airborne fallout dust particles and its presence will extend far beyond the area affected by blast. However, gamma radiation does not have the same scattering effects as neutron radiation. Generally speaking, one 90 degree turn in an entrance way will attenuate 90% of any gamma radiation coming in through the entrance way. If you had an entrance way with two 90 degree turns in it, the first turn would attenuate 90% of any gamma radiation coming through the entrance way allowing no more than 10% to pass the first 90 degree turn and the second 90 degree turn would reduce this 10% of the original gamma radiation by 90% allowing only 1% of the original radiation through the entrance way into the shelter. See the following chapter on Radiation Shielding for more detailed information on attenuating radiation in entry ways.

This does not take into account any attenuation of gamma radiation as a result of the length of the entrance way, its diameter or any shielding which the doors may provide.

You can start to see how much trouble and expense can be avoided by locating oneself and one's shelter away from known target areas which could experience the effects of blast.

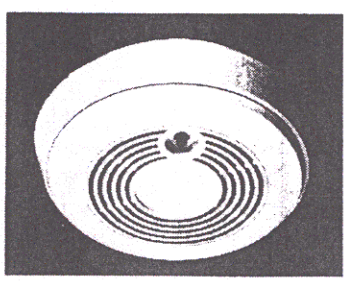
Walk-in type entrances have certain advantages and disadvantages. They can be a blessing when it comes to getting people and equipment in and out of the shelter quickly. If you have elderly people in your shelter group, a walk-in entry may well be a necessity. Having a crawl-in or climb-down type entrance way can make movement of people and equipment in and out of the shelter slow or in the case of larger equipment, impossible. Walk-in entry ways can provide the needed space for decontamination facilities and extra storage.

The disadvantage to a walk-in entry is that its nature involves utilizing a larger diameter pipe or culvert. This larger diameter dictates the need for more 90 degree turns and more tunnel length to effectively attenuate the increased radiation coming into the shelter through the larger entry way opening.

It is important to have more than one entrance way in the event that one becomes blocked by debris or compromised due to a security problem. In consideration of the latter situation, it would be good to make the alternate entrance-exit hidden on the surface, if possible.

Fire Suppression

The threat of fire should not be taken lightly. A fire in a confined area can lead to a rapid build-up of heat, hot gasses and smoke. The last thing you want is to have a fire that drives you out of a shelter at a time when outside conditions have driven you into the shelter. **Install smoke detectors**, have an ABC fire extinguisher, and if you have running water, have garden hoses in the shelter. Surviving a shelter fire will mean quick detection and quick suppression. Also, make sure flammable liquids are kept isolated in metal



cabinets or behind airtight bulkheads away from living areas.

Sewage Disposal and Sanitation

Toilets and sewage disposal are an obvious necessity. If you have a smaller shelter it may mean a chemical toilet and some sort of holding tank. In a larger shelter where you have running water, flush toilets are the way to go. This poses a problem with the disposal of the resulting sewage. The ideal is to have your shelter situated in the slope of a hill, enabling you to utilize gravity flow for removing waste water to a drain field. If you are looking for blast protection, you should consider that conventional septic tanks have little or no resistance to overpressure. This can be solved by building or purchasing a special blastproof tank or placing the septic tank under some portion of the shelter or its entryway where it will enjoy existing blast protection.

If you are not located in some sort of slope and cannot use gravity flow, a holding tank and pumping station must be used. This equipment is commercially available off the shelves at plumbing supply stores.

A popular subject when shopping for shelter space or designing shelters is per capita of persons per toilets. Ideally the shelter would have no more than 20 persons per toilet.

Being able to shower is an extremely important issue. Sanitation and cleanliness are not only important to prevent the spread of sickness and disease, but also have psychological benefits. Showers, unlike toilets, can be scheduled. One shower for every 25 persons should be adequate.

Government Regulations

All states have requirements for permits when electrical work is being done. Following electrical codes will greatly enhance the safety and performance of the shelter wiring.

Most counties have regulations regarding septic systems. If the shelter is a single purpose shelter you may be able to get an exemption as long as the sewer system is not being used.

Regulations in regard to plumbing permits vary from state to state and county to county.

Building permits are required in most areas. The only salvation for the shelter builder in this regard is that there is an appendix in the back of the U.B.C. codebook for Fallout Shelters. It is as liberal as can be and is the one thing you should politely bring to the attention of the building, plumbing, and electrical inspectors, the county sanitarian and state fire marshal, if they happen to come around.

Unfortunately, there are enough laws that if you get on the wrong side of the government, they can make your life miserable with arbitrary enforcement.

Most people who build shelters want confidentiality, and for good reasons. Unfortunately the government makes this very difficult.

The following is a reprint of the U.B.C. Appendix on Fallout Shelters.

1991 UNIFORM BUILDING CODE

APPENDIX

Chapter 57 (Pages 991 & 992)

REGULATIONS GOVERNING FALLOUT SHELTERS

Purpose

Sec. 5701. The purpose of this appendix is to establish minimum criteria which must be met before a building or building space can be constructed, occupied, used or designated a fallout shelter.

Scope

Sec. 5702. The scope of this appendix extends to building spaces designated for use as fallout shelters, including periods of drill and instruction for this purpose.

Definitions

Sec. 5703. FALLOUT SHELTER is any room, structure or space designated as such and providing its occupants with protection at a minimum protection factor of 40 from gamma radiation from fallout from a nuclear explosion as determined by a qualified fallout shelter analyst certified by the Office of Civil Defense. Area used for storage of shelter supplies need not have a protection factor of 40.

DUAL-USE FALLOUT SHELTER is a fallout shelter having a normal, routine use and occupancy as well as an emergency use as a fallout shelter.

SINGLE-PURPOSE FALLOUT SHELTER is a fallout shelter having no use or occupancy except as a fallout shelter.

PROTECTION FACTOR is a factor used to express the relation between the amount of fallout gamma radiation that would be received by an unprotected person and the amount that would be received by one in a shelter.

UNIT OF EGRESS WIDTH is 22 inches.

Occupancy Requirements

Sec. 5704. (a) **General.** Nothing in these regulations shall be construed as preventing the dual use or multiple use of normal occupancy space as fallout shelter space, providing the minimum requirements for each use are met.

(b) **Mixed Occupancy.** The occupancy classification shall be determined by the normal use of the building. When a normal-use space is designed to have an emergency use as a fallout shelter in addition to the normal use, the most restrictive requirements for all such uses shall be met.

(c) **Occupancy Separation.** No occupancy separation is required between that portion designated as a fallout shelter and the remainder of the building.

(d) **Space and Ventilation.** A minimum of 10 square feet of net floor area shall be provided per shelter occupant. Partitions, columns and area for storage of federal shelter supplies also may be included in net area. A minimum of 65 cubic feet of volume shall be provided per shelter occupant. A minimum of 3 cubic feet of fresh air per minute per person shall be provided.

In addition, the shelter shall have a ventilating rate sufficient to maintain a daily average effective temperature of not more than 820F. for at least 90 percent of the days of the year.

(e) **Illumination.** No special lighting levels are required.

(f) **Hazards.** Hazardous utility lines such as steam, gas and oil shall not be located in or near the shelter unless provision is made to control such lines by valving or other approved means.

Exits

Sec. 5705. There shall be no fewer than two widely spaced exits from a fallout shelter, leading directly to other spaces of the building or outdoors. Exits from the fallout shelter shall aggregate at least one unit of egress width for every 200 shelter occupants. In no case shall a single exit be less than 24 inches wide.

Flame-spread Index of Interior Surfaces

Sec. 5706. Interior surfaces of single purpose fallout shelters shall have a flamespread index not exceeding 200.

Minimum Design Loads

Sec. 5707. (a) **Dual-use Fallout Shelters.** In the case of dual-use fallout shelters, design live load required for the normal use shall govern, except that concentrated loads shall be considered.

(b) **Single-purpose Fallout Shelters.** Minimum live loads for floor design in single purpose fallout shelters shall be 40 pounds per square foot except that concentrated loads shall be considered.

Sanitation

Sec. 5708. Toilets, either flush-type operating from the normal water supply system, or chemical or other types, shall be provided on the basis of one toilet per 50 fallout shelter occupants. Fifty percent of the toilets may be provided outside the fallout shelter area. Empty water containers may be considered as fulfilling this requirement.

The Granddaddy Of All Underground Storage Areas

There are root cellars and then there are root cellars. This web page covers an underground storage container made from culvert. This concept is extremely bold in every way. When it comes to underground storage, this may very well be the granddaddy of them all. I am convinced this is one of the finest underground storage ideas you will find anywhere. This page features one of these storage areas, which should help you understand their possibilities and perhaps even get you thinking about what you would like if you designed one for yourself.

Jump within page to...

A bold new concept: Whoever thought of this ranks as a genius of the simple. Basically, this underground storage area is made in a culvert that was designed for bridging creeks. Culverts are thin steel pipes that are very strong, light for their size, inexpensive when compared to other types of construction, galvanized and therefore rustproof. They come in a wide variety of sizes, from as small as one foot in diameter to 20 feet in diameter and bigger. Because of the huge size possibilities, culverts can fit into just about anyone's underground storage needs. Our showcase structure was built into an eight foot culvert, however, many people building this type of shelter are now using ten foot culverts.

Easily and quickly constructed: This photo shows the culvert as it was near the end of construction. It is made from an eight foot culvert 50 feet long. Steel plates were welded onto each end to enclose the culvert. A one foot in diameter vent tube, again made from culvert, was placed in the top of the culvert on each end (not shown). The culvert coming off the top side of the main culvert at one end in the photo is a four foot culvert. Before the shelter was set into place, the culvert was rotated down so the small attached culvert was on the side of the main culvert. Then a length of four foot diameter culvert was welded on which became the entrance way. Before it was set into place, the entire outside surface, especially the welded portions, were sprayed with tar to prevent rusting. The floor inside the culvert was constructed from 2X4s and 1 inch plywood. This was placed in the culvert at the five foot wide point, being about 10 inches above the bottom of the

culvert. With the floor at this point, there is slightly over seven feet of head room when standing. Next came the door on the front of the entrance way. Our featured shelter has a small six by six foot porch built around the culvert entrance which has a wooden door to the outside. There is also a second inner door constructed from steel, enclosing the four foot diameter entrance culvert. All that remains to be done is to put in the walls and shelves.

Quickly set into place: The hole for this shelter was dug in one day. The shelter was brought in and set into place with the vents and entrance pipe welded into place the next day, then it was buried the third day.

Inexpensive for the size: The owner of our featured shelter spent $5,000 in 1990 on all aspects of constructing and burying this shelter. (It would cost about $10K now (1998) with the proper blast doors.) He did say that a lot of the wood for the floor and shelves was scrounged.

Plenty of room: Our featured shelter's 5 foot wide floor has 250 square feet of surface. Total storage area volume comes out to about 2,400 cubic feet.

Easily adaptable as an underground shelter: Our featured shelter has a bed, dresser, small living area, library, and a large storage area.

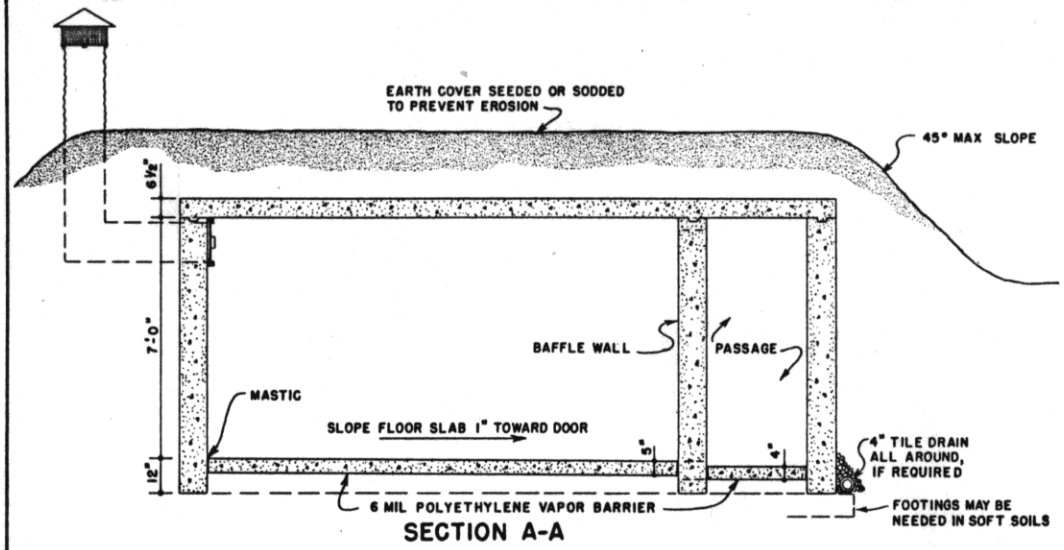
This photo shows the end of the shelter next to the entrance. Note the 4 foot diameter culvert coming off the left just before the bed. The entrance pipe wasn't put on the very end of the 50 foot long culvert for a very good reason - so the bed would fit. Note also the vent pipe in the ceiling. The owner said he would cut it off close to flush with the ceiling if he had to do it over again.

We show you the first photo again to explain the two rock towers on top of the shelter. These enclose the vents, and was done this way so kids couldn't shoot holes through them.

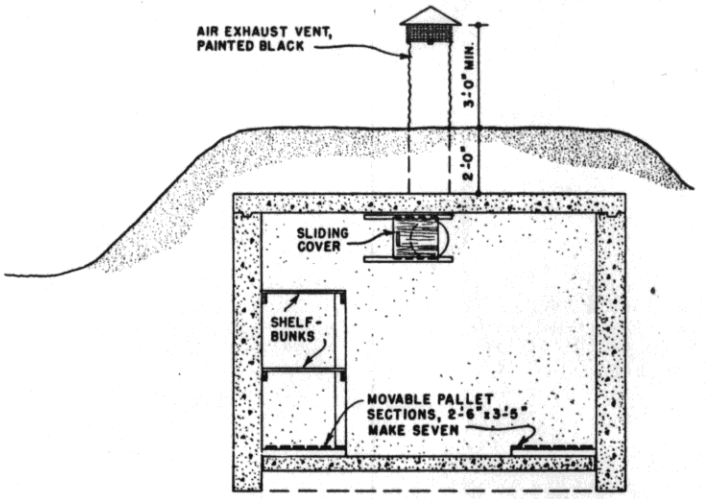
Your underground shelter can easily be hidden from view - no one even needs to know it's there: With a tiny bit of forethought and planning, the vents could be easily hidden by terrain, in shrubbery, a rock garden, or in carefully placed outbuildings. The same could be done with the entrance way.

Where to learn more: Sharon Packer, a nuclear engineer and the head of the Civil Defense Volunteers of Utah has written a 150 page 8 1/2 by 11 inch book called Nuclear Defence Issues. You should get one if you are contemplating building one of these shelters. This book sells for $25.00 and includes:

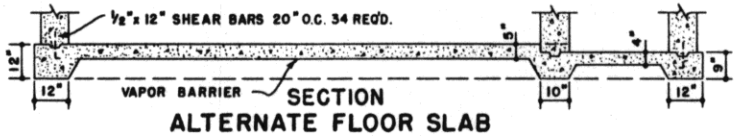
- National Security Affairs
- Weapons Effects
- Building the Shelter
- Post War Survival



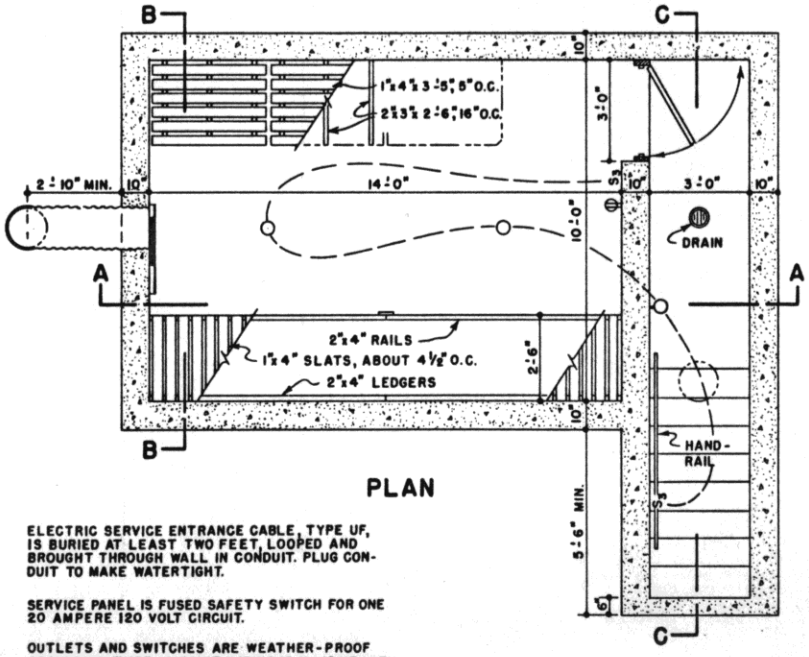
SECTION A-A



SECTION B-B



SECTION
ALTERNATE FLOOR SLAB



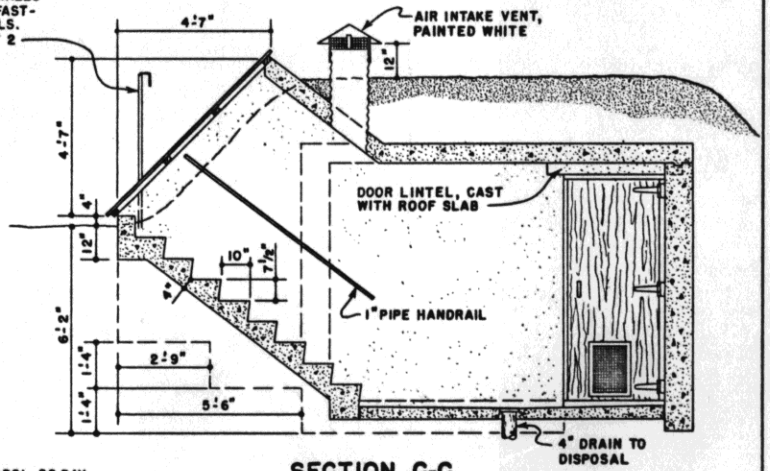
PLAN

ELECTRIC SERVICE ENTRANCE CABLE, TYPE UF, IS BURIED AT LEAST TWO FEET, LOOPED AND BROUGHT THROUGH WALL IN CONDUIT. PLUG CONDUIT TO MAKE WATERTIGHT.

SERVICE PANEL IS FUSED SAFETY SWITCH FOR ONE 20 AMPERE 120 VOLT CIRCUIT.

OUTLETS AND SWITCHES ARE WEATHER-PROOF GROUNDING TYPE. CIRCUIT WIRING IS No. 12 UF WITH BOND WIRE.

¾" PIPE DOOR STOPS EACH SIDE. SET IN CONCRETE WALLS AT A SLIGHT ANGLE OR FASTENED TO OUTSIDE OF WALLS. SEE HOOK DETAIL, SHEET 2



SECTION C-C

CONCRETE TO TEST 3,000 PSI, 28 DAY COMPRESSION. WATER-CEMENT RATIO, 6 GALLONS PER SACK.

CHAMFER OUTSIDE WALL AND ROOF CORNERS ¾".

APPLY TWO COATS OF BITUMINOUS WATERPROOFING TO OUTSIDE SURFACES.

ALL STEEL, EXCEPT REINFORCING BARS, SHALL BE HOT-DIP GALVANIZED OR OTHERWISE PROTECTED FROM CORROSION.

ALL LUMBER SHALL BE TREATED, AFTER CUTTING, WITH A COPPER NAPTHENATE PRESERVATIVE. A 15 MINUTE DIP IS SUGGESTED.

FACES AND EDGES OF PLYWOOD SHALL BE GIVEN TWO COATS OF OUTSIDE PENETRATING SEALER.

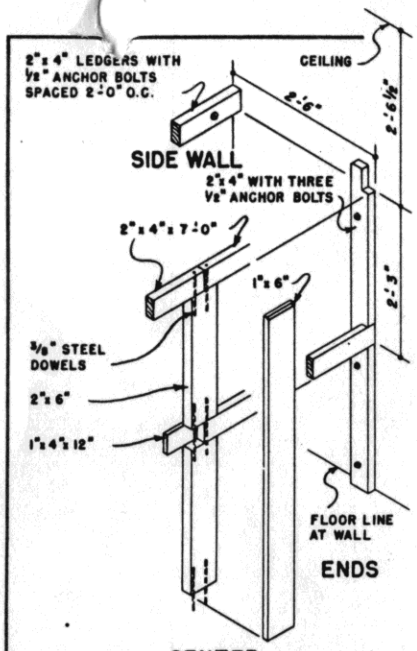
IF THE SHELTER IS TO BE USED BY MORE THAN SIX PERSONS, PROVIDE MECHANICAL VENTILATION.

SCALE: 0 1 2 3 4 FT.

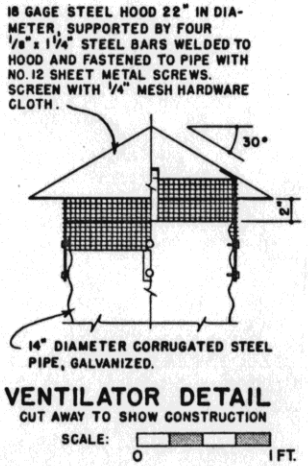
COOPERATIVE EXTENSION WORK IN
AGRICULTURE AND HOME ECONOMICS
DEPARTMENT OF AGRICULTURAL ENGINEERING
UNIVERSITY OF MARYLAND
AND
UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

STORAGE AND FALLOUT SHELTER
CAST CONCRETE CONSTRUCTION

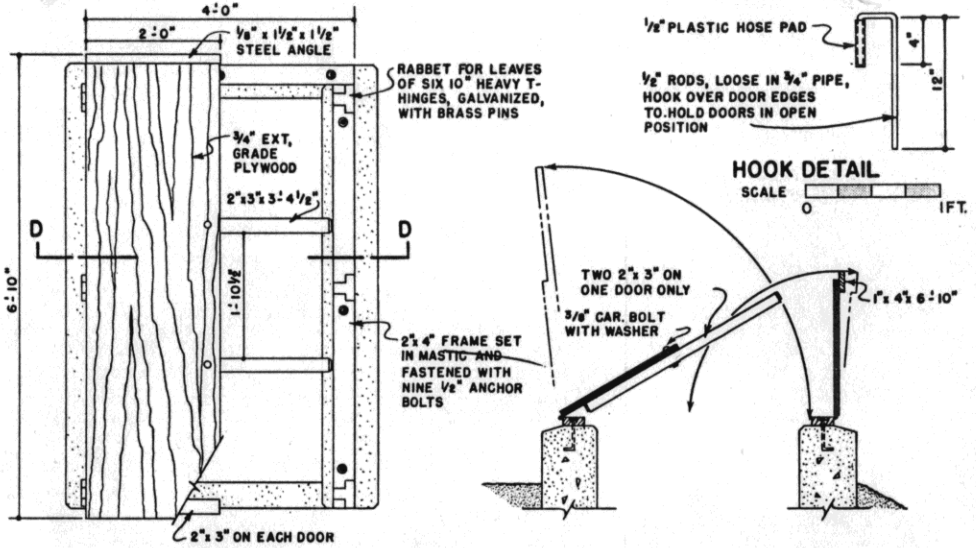
USDA '63 | EX. 5948 | SHEET 1 OF 2



CENTER
SHELF - BUNK SUPPORTS



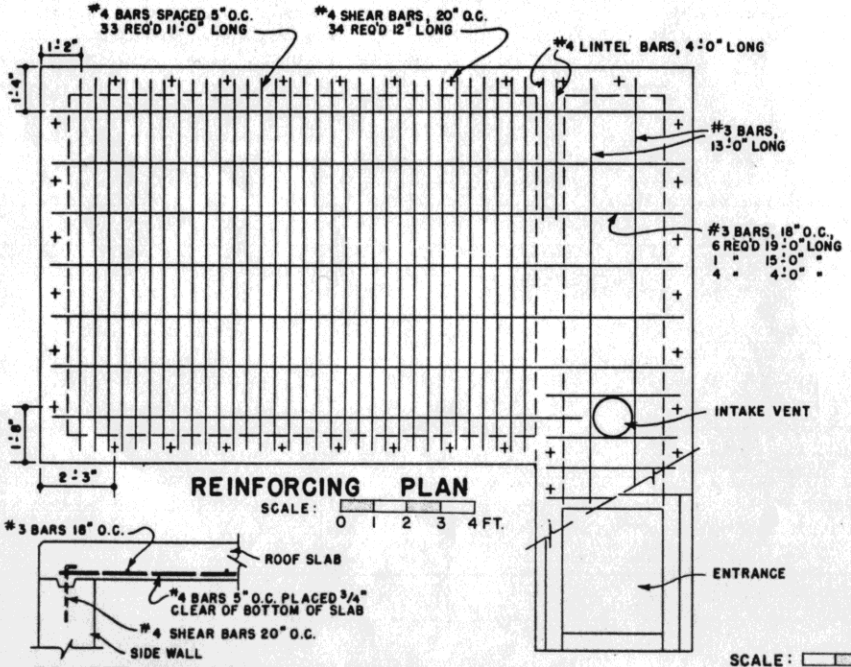
VENTILATOR DETAIL
CUT AWAY TO SHOW CONSTRUCTION
SCALE: 0 1 FT.



PLAN
ONE DOOR NOT SHOWN

SECTION D-D

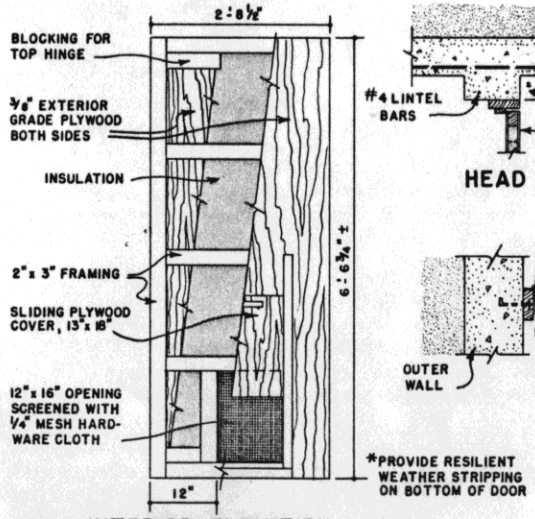
ENTRANCE DOOR DETAILS



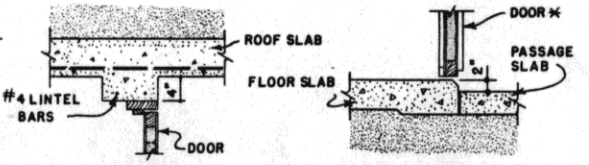
REINFORCING PLAN
SCALE: 0 1 2 3 4 FT.

REINFORCING DETAIL

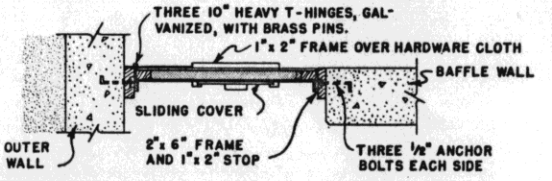
SCALE: 0 1 2 FT.
EXCEPT AS NOTED



INTERIOR ELEVATION
CUT AWAY TO SHOW CONSTRUCTION



HEAD
SILL



JAMBS

INNER DOOR DETAILS

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USDA '63	EX. 5948	SHEET 2 OF 2