



Self-Assembly Buildings

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A non-profit organization providing technical and funding support for shelter construction to other 501c3's.

Assemble storage space quickly. **Insulated hangars, under \$2/sq.ft.**

DOWNLOAD FREE CONSTRUCTION GUIDE

Parts lists for 10 hangar sizes 12' to 40' span by any length.
Diagrams and construction photos.
Costs and material sources.

Slash construction costs for:

- refugee shelters
- aircraft hangars
- farm buildings
- yard storage
- pool enclosures
- fresh produce buildings
- boat storage
- poultry houses
- industrial park additions

Properties:

Light weight: a 40' x 28' aircraft hangar weighs under 700 lb.

Movable : Disassemble for compact moving.

Tax advantages: Temporary buildings (no foundation) qualify for first year write-off for business use and do not increase real estate tax.

Protect equipment by reducing condensation and daily temperature swings.

Materials:

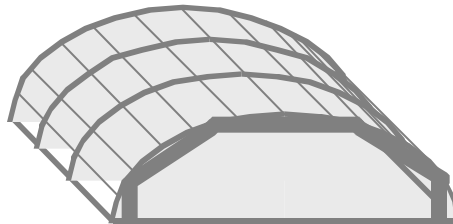
(a tarp anchored over fanfold insulation board on a greenhouse frame)

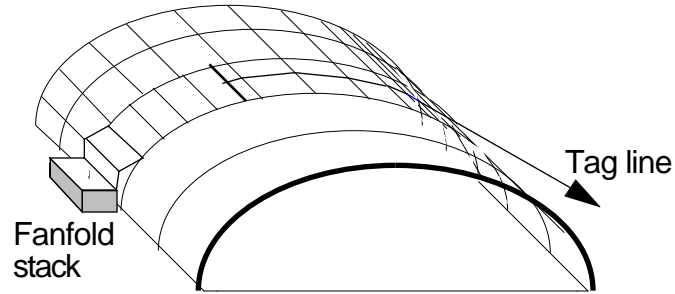
Frame: steel pipe purlins on PVC pipe arch ribs in ground sockets.

Roof: exterior grade woven poly film anchored over fanfold insulation board.

End walls: faced insulation board or alternative cladding on wood frame.

Durable shelter, quickly assembled





Simple fanfold enclosure.

STEPS

1. View these hangar uses for a need similar to yours.
2. Find the material cost in Table 1 for your selected size.
3. Download or print the CONSTRUCTION GUIDE & PHOTOS
4. Order the listed parts from local suppliers, and assemble.
5. **501c3 CHARITIES:** complete the MATERIAL COST APPLICATION for funding from a Fidelity Charitable Trust.

ADVANTAGES

- Simple assembly. Cut end walls for any hangar size.
- No footings or earth leveling required.
- Arch spans to 40', any length, extendable later.
- Eliminates interior condensation.
- Easy to disassemble. Fold panels and stack flat for moving.
- Mobility allows:
 - Income tax write-off in the first year of business use.
 - Uses where zoning and codes restrict permanent buildings.
 - Zero increase in property tax.
- Neither rusts nor requires painting.
- Materials are inert, non-nutritive, and recyclable.

USES

Refugee shelters

- Warehouse the components (insulation board, pipe, tarps) or locate suppliers for rapid deployment.
- Provide to refugees for their own assembly.
- Use for temporary quarters near the home restoration. Optionally retain as storage buildings.

Yard storage

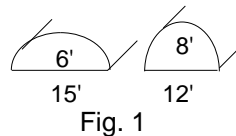


Fig. 1

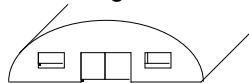


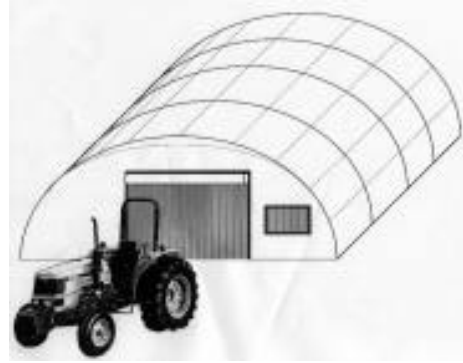
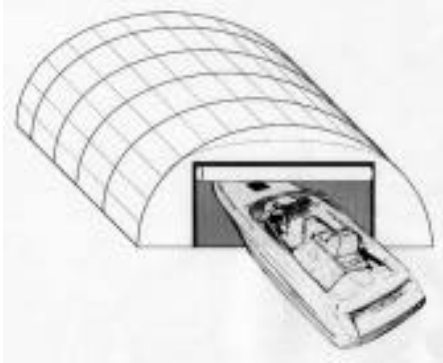
Fig. 2

Spans 12' to 40' by any length.
Adjust roof height by changing ground socket spacing (Fig. 1).

Open ended, or enclose one or both ends.

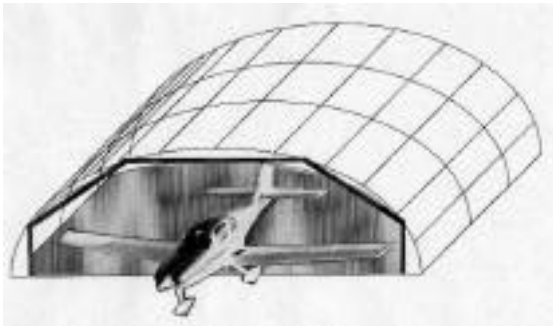
Cut & frame desired door and window openings in ends (Fig. 2). Add floor of choice.

Boat & equipment storage



Add a floor tarp to seal out moisture. Add galvanized channels or planking to prevent rutting under wheels. Or add floor of choice.

Aircraft hangars



Protect your plane and its electronics from the ravages of sun, condensation, hail, dust, and daily temperature cycling.

Simple roll-up door.

Or leave open-ended for just overhead protection.

See [Construction Guide](#) for airport owner fee options.

Poultry houses

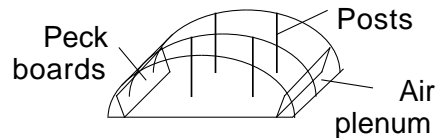


Fig. 3

Add 2' high vinyl-faced ply peck boards to protect the perimeter (Fig. 3).

Add removable rib support posts to increase snow load stiffening. Remove to harvest a flock or to change litter.

Use end-to-end ventilation, or use space behind peck boards as air plenums.

Replace insulation board ends with optional double wall translucent paneling.

Add optional geothermal ground heating/cooling (Fig. 4).

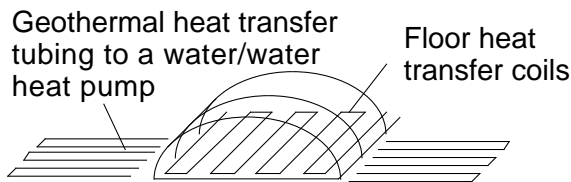


Fig. 4

Fresh produce storage

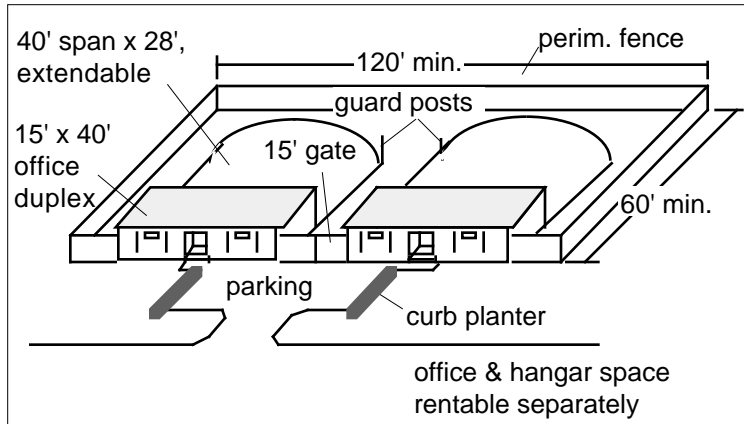
Add insulated floor.

Air tight for fumigation.

Add optional geothermal floor slab temperature control (see poultry houses).

To lengthen building, remove & replace one end.

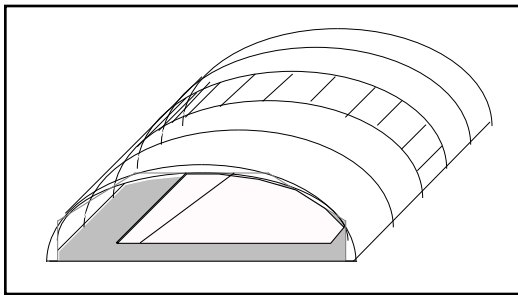
Industrial park warehouse additions



Use your existing high-cost space only for essential functions; add an attached or detached hangar for storage. Construction is accepted by many industrial park covenants and local building officials for these uses. Check fire insurance cost.

A 120' wide industrial or air park layout with two office buildings and attached hangars, 40' span by any length.

Pool enclosures



Remove the insulated ends and/or central fanfold over translucent roof film for summer use.

Or substitute double wall translucent ends (R3 insulation) for insulation board.

About Panel Inc.

Panel Inc., a 501c3 non-profit corporation of Delaware, donates storage buildings to tax-exempt 501c3 charities. It has no paid employees, solicits no funds, and accepts no government funding. All income is donated to 501c3's. Its president, Robert Nicholls, a registered engineer and civil engineering professor emeritus at the University of Delaware (1959 to 1993), provides services in construction management, materials, and geotechnical engineering.

Construction Objectives

1. Low cost.
2. Assembly by one person.
3. Assembly with materials widely available in the US and elsewhere.
4. Ease of size selection, using limited materials inventory.
5. Ease of maintenance and repair.
6. Low-weight, small-volume materials for easy transportation.
7. To protect stored equipment by providing insulation which (1) reduces daily temperature swings and (2) shields against condensation from roof drips and from moist ground.
8. No required foundation, to hasten assembly and qualify as temporary buildings, in order to ease permit requirements and provide business tax advantages.

Table 1. TYPICAL U.S. MATERIAL COSTS

Use this table to estimate costs of other hangar sizes

| Hangar No. | | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | |
|--|-----------------------------------|---------|-------------|-----|------------|-----|------------|-----|------------|-----|------------|-----|------------|-----|------------|-----|-------------|-----|-------------|-----|-------------|-----|
| Span x length x height, ft. | | | 40x28x16 | | 12x20x7 | | 12x30x7 | | 12x40x7 | | 20x40x8 | | 20x50x8 | | 20x60x8 | | 30x50x12 | | 30x60x12 | | 35x50x14 | |
| No. | Frame | Unit \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ | No. | \$ |
| f1 | Precut perim. stakes ** | 0.2 | 36 | 7 | 20 | 4 | 24 | 5 | 30 | 6 | 32 | 6 | 40 | 8 | 44 | 9 | 44 | 9 | 48 | 10 | 48 | 10 |
| f2 | 1x2-8' | 1.0 | 25 | 25 | 6 | 6 | 8 | 8 | 9 | 9 | 11 | 11 | 12 | 12 | 14 | 14 | 19 | 19 | 20 | 20 | 25 | 25 |
| f3 | 4" PVC (2') sockets, 10' | 10.6 | 2 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| f3a | 3" PVC ribs, sockets, 10' | 8.8 | 30 | 264 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 35 |
| f4 | 2.5" PVC, 10' | 7.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 28 | 4 | 28 | 40 | 281 |
| f5 | 2" PVC, 10' | 3.6 | 0 | 0 | 2 | 7 | 3 | 11 | 3 | 11 | 3 | 11 | 4 | 14 | 4 | 14 | 32 | 116 | 40 | 145 | 0 | 0 |
| f6 | 1.5" PVC, 10' | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 63 | 24 | 72 | 30 | 90 | 0 | 0 | 0 | 0 | 0 | 0 |
| f7 | 1.25" PVC, 10' | 2.0 | 0 | 0 | 8 | 16 | 10 | 20 | 14 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| f8 | 0.75" EMT purlins, 10' | 2.2 | 69 | 148 | 14 | 30 | 21 | 45 | 28 | 60 | 44 | 95 | 55 | 118 | 66 | 142 | 75 | 161 | 90 | 194 | 95 | 204 |
| f9 | 0.75" EMT couplings | 0.5 | 46 | 23 | 7 | 3 | 14 | 7 | 21 | 10 | 33 | 16 | 44 | 22 | 55 | 27 | 60 | 29 | 75 | 37 | 76 | 37 |
| f10 | 0.5" PVC sub-ribs, 10' | 0.8 | 24 | 19 | 6 | 5 | 8 | 6 | 10 | 8 | 18 | 14 | 21 | 17 | 24 | 19 | 28 | 22 | 32 | 26 | 35 | 28 |
| f11 | PVC cement | 2.0 | 2 | 4 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 4 |
| f12 | Self-lock nylon cable ties, 14" * | 0.1 | 260 | 13 | 60 | 3 | 70 | 4 | 80 | 4 | 100 | 5 | 120 | 6 | 140 | 7 | 160 | 8 | 180 | 9 | 220 | 11 |
| f13 | 7/8"x12' susp. ceiling angle ** | 2.7 | (for doors) | | | | | | | | | | | | | | | | | | | |
| f14 | 3/8" polyester strapping, 100' | 1.5 | 8 | 12 | 2 | 3 | 3 | 5 | 3 | 5 | 4 | 6 | 5 | 8 | 6 | 9 | 7 | 11 | 8 | 12 | 9 | 14 |
| f15 | Treated 2x4 studs & posts | | 9-16' | 72 | 4-8' | 15 | 4-8' | 15 | 4-8' | 15 | 4-10' | 18 | 4-10' | 18 | 4-10' | 18 | 6-14' | 42 | 6-14' | 42 | 8-14' | 56 |
| f16 | 4" nails, finish or common * | | | 4 | | 1 | | 1 | | 1 | | 2 | | 2 | | 3 | | 3 | | 4 | | 5 |
| f17 | Perf. plastic strapping, 10' | 1.7 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Cover | | | | | | | | | | | | | | | | | | | | | | |
| c1 | 3/8"-4x50' fanfold insulation | 28.0 | 13 | 364 | 4 | 112 | 5 | 140 | 6 | 168 | 9 | 252 | 11 | 308 | 12 | 336 | 15 | 420 | 17 | 476 | 19 | 532 |
| c2 | 1.5" screws and 1" washers | 0.1 | 150 | 18 | 40 | 5 | 50 | 6 | 60 | 7 | 70 | 8 | 80 | 10 | 90 | 11 | 100 | 12 | 120 | 14 | 140 | 17 |
| c3 | 3" tape, 100 ft. | 3.0 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 |
| c4 | Roof film | .08/sf | 30x60 | 144 | 20x20 | 32 | 20x30 | 48 | 20x40 | 64 | 30x40 | 96 | 30x50 | 120 | 30x60 | 144 | 40x50 | 160 | 40x60 | 192 | 50x50 | 200 |
| c5 | Floor tarp ** | .08/sf | 30x40 | 96 | 12x20 | 19 | 12x30 | 29 | 12x40 | 38 | 20x40 | 64 | 20x50 | 80 | 20x60 | 96 | 30x50 | 120 | 30x60 | 144 | 40x50 | 160 |
| c6 | 3' corner fence posts | 2.6 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 | 4 | 10 |
| c7 | 1' tent pegs | 0.6 | 8 | 5 | 6 | 4 | 10 | 6 | 10 | 6 | 10 | 6 | 14 | 8 | 16 | 10 | 14 | 8 | 16 | 10 | 14 | 8 |
| Rib tools | | | | | | | | | | | | | | | | | | | | | | |
| t1 | Socket driving cap & nipple ** | | 3" | 25 | 1.25" | 10 | 1.25" | 10 | 1.25" | 10 | 1.5" | 12 | 1.5" | 12 | 1.5" | 12 | 2" | 15 | 2" | 15 | 2.5" | 20 |
| t2 | Rib props ** | 4.5 | 2 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 2 | 9 |
| t3 | Rib bending lever ** | 1.0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| t4 | Split pipe guides | 6.1 | 2 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 2 | 12 | 2 | 12 |
| Total mats, \$ | | | 1302 | | 292 | | 382 | | 468 | | 707 | | 856 | | 982 | | 1218 | | 1411 | | 1684 | |
| * Or shorter ties & nails for smaller rib diameters. | | | ** Optional | | | | | | | | | | | | | | | | | | | |
| Heights (row 1) are approximate. Greater increases snow resistance, less makes it easier to tie top purlins. | | | | | | | | | | | | | | | | | | | | | | |
| Includes material for both hangar ends, except for #1, having an aircraft door in one end (Fig. 12). | | | | | | | | | | | | | | | | | | | | | | |

FAQ (frequently asked questions)

Q: Can I assemble a hangar by myself?

A: Yes, but hangars larger than about 30' span are much faster with two people, due to simpler handling of long ribs, etc.

Q: What maintenance is required?

A: Check the strapping tension after heavy winds or snows: re-tighten when needed. Replace the roof film every 10 years or so.

Q: How do the hangars behave in winds?

A: Expect racking in high winds, without structural damage. Re-tighten the diagonal wind strapping if needed.

Q: How do they behave in snows?

A: Expect rib distortion without permanent deformation. Re-tighten the rib cord strapping if needed to maintain original arch shape.

Q: How can hangars be economically strengthened for high winds and snows?

A: Winds: Add more diagonal wind strapping over purlins and over the roof film, initially or later.

Snows: Add rib support posts (Fig. 6) and/or scissors trusses (Fig. 10) of the CONSTRUCTION GUIDE, initially or later.

Q: How do they behave in hail?

A: Hail indents the roof film and its supporting foam board with little lasting damage, by observations to date.

Q: Should a floor be added before, or after, hangar assembly?

A: Add a floor any time. Placing a floor first allows better access. But weather, financing, scheduling, etc. may dictate adding it later.

Q: Can they be earth-bermed?

A: The foam board flexes easily and should not be bermed more than about six inches deep without adding more closely spaced interior supports (purlins or horizontal nailing strips).

Q: What is the insulation value?

A: R2, for the minimal single foam board plus roof film: Enough, in combination with the enclosed earth thermal mass, to reduce day-to-night temperature swings which cause moisture vapor transfer in stored grains or shorten the life of aircraft electronics. Increase insulation with added fanfold, or with Panel Inc. 2" or 4" (R16) folded panels.

Check local building codes for your intended use.

MISSION USES

- Refugee shelters
- Aircraft, equipment, supply hangars
- Workshops
- Visiting work team shelters
- Food preparation/dining shelters
- Medical aid shelters
- Sequential uses for the above

Hangar #1 (40'x28')

