amvic **Architect and Designer Notes**

Adapting Designs and Plans for AMVIC ICF Construction

June 2005

DESIGN PHASE

1. The main difference from frame construction is that you are dealing with thicker walls and need to accommodate that in the design. If using "6-inch" blocks, there is 6 inches of concrete sandwiched between two 2-½ inch EPS foam panels for a total wall thickness of 11 inches before finishes are applied. 8-inch block is 13 inches in finished thickness. To maintain the same interior dimensions of a stick plan, stretch the exterior dimensions on all sides.
2. ICF is used only for the exterior shell typically. Interior walls are usually framed conventionally.
3. The block can be cut to almost any dimension desired. Significant compromises to the design to accommodate the block are *not* recommended. Draw the plan to work within normal good design practices and the block can be adjusted to accommodate that.
4. Angle corners: There are 90-degree and 45-degree blocks pre-manufactured. Corners of any other angle can readily be field constructed with no difficulty.
5. Blocks are 16 inches high. Four inches can be taken off by ripping either the bottom or the top of AMVIC block. Blocks can also be ripped in the center. It is convenient, but not essential that the overall height of the walls either be right on the course intervals (16") or if it is greater than, then the greater than should be by at least a ½ course height (8") or more.

> Architectural details in Autocad and PDF format may be viewed and downloaded at: www.caddetails.com
>
> --select "Company Index" then "Amvic" and login as "guest"

6. Up to 4 stories can readily be built and engineered.
7. Interior floors are hung from ledgers (rim joists) attached to the concrete of the wall either with anchor bolts or with Simpson ICFLC ties. The floors can be installed at any height on the walls, irrespective of the block courses.
8. ICF construction lets you can do some different things.
    a. Title 24 limits on amounts of glass are largely a non-issue due to the high R-value of the rest of the wall (R-22-27).
    b. Shear value limits are also not an issue limiting amounts of glass or arches.
    c. Curved walls of nearly any radius can be built with far less difficulty than would be experienced in conventional construction.
9. Typically six-inch block will work in nearly all residential situations. Added strength can be gained by increasing the rebar schedule typically. If 6-inch block is used it will save 25% on concrete vs. 8-inch. The one case where 8-inch block is usually going to be necessary would be where more than 7-8 feet of retaining is involved, or where a wall is taller than 14 feet without an intervening diaphragm connection. In any case, the structural engineer is the final authority.
10. **Basements, daylight and full.** Dry comfortable basements of perfect quality can readily be constructed with Amvic ICF. On hillside properties it is most common to

design for a full basement under the structure. If needed retaining walls can be added at the sides to allow windows/doors to be installed bringing light and access to the sides at the rear, particularly if required for egress. ***Note: On a hillside, extending the basement to be a full basement instead of a half basement may be a very very inexpensive addition to the structure, costing less than $20-30 per sqft of added space. This is the case because the ICF already provides an engineered wall and in the case of a full basement there is a single perimeter footing as opposed to multiple footings for a half basement plus stem wall.*** We have full waterproofing details to properly assure dry and waterproof basements.

11. Projections and cantilevered overhangs are important considerations. The most straightforward approach is to support upper story concrete walls by placing them directly above a corresponding concrete wall below. Otherwise, detailed structural engineering and steel beams will be required with consequent disproportionate added construction cost.
12. In some cases it may make sense to switch over to conventional framing in a segment of the wall and that is acceptable. In such case, all structure above the wood or steel frame should continue as wood or steel.
13. **Elevated concrete floor systems** as well as flat concrete roofs are also possible. Concrete beams are formed and poured monolithically with the slab using either the Insul-Deck or the Lite-Deck systems. Free spans of up to 40 feet are possible. See www.litedeck.com or contact Amvic Pacific.
14. **Bumpouts.** To avoid bracing issues and simplify construction, short bumpouts in walls should extend outward by a minimum least 18″ using 6″ block and 20″ when using 8″ block.

The Amvic ICC Evaluation Report can be downloaded at
www.amvic-pacific.com/Downloads/Amvic ICC- ESR-1269.pdf

WORKING DRAWING PHASE – DETAILING.

1. Dimensioning. Generally you don't need to design to any specific dimensions. However, there are some standard dimensions that, if used, reduce construction costs due to reducing labor and minimizing waste. Guidelines are included on the last page of this guide.
    a. **For a wall segment with two outside corners**, the base minimum dimension that should be used is 41 inches when using 6-inch block and 45 inches when using 8-inch. This number represents the exterior dimension of a short and long leg of a standard corner block. If the wall segment is adjusted to increment this dimension in 12 or 24″ increments, this will assure that cut block can be reused with zero waste.
    b. **For a wall segment with an inside and outside corner**, (typical on a bumpout) the minimum dimension that should be used is 18″ for the 6-inch block and 20″ when using 8-inch. This short segment will require some additional bracing but works ok.
    A slightly larger bumpout of 30″ with 6-inch block, or 32″ with 8-inch block, will allow laying block to interlock in a running bond and will minimize bracing required.

2. **Garages.** The added cost to construct the garage from ICF is very small. If the garage is constructed with ICF, then the wall between the house and the garage which would otherwise typically be ICF, can be conventional framing, and as the garage door area has very little block due to the large openings, the amount of block added to do a 2-3 car garage is essentially only one to 1.5 side wall of block. Also, several of the costs associated with ICF construction are essentially fixed costs (deployment, pumping, redeployment) these costs don't increase proportionately if the small additional wall space to do a garage is included. The values of doing a garage in ICF are substantial: same fireproof nature as house, energy savings if heating, more comfortable all year otherwise, and same durable substrate for exterior cladding as the main structure. Also construction time is reduced by several days as opposed to doing garage framing separately after the ICF is constructed.

3. **Gables.** Gables of virtually any pitch may be constructed with ICF if desired, or you can switch over to conventional framing. If there is a cathedral ceiling in the interior space, completing the gable with ICF is the recommended solution. Alternatively the ICF wall can be stopped at the plate line and the gable framed conventionally.

4. **At corners**, the placement of window and doorjambs needs to respect that there is an 11-inch wall on the other side of the corner. ***Rule of thumb: doors and windows should be set in at least 16" from corners.*** Remember to leave added room for interior trim.

5. **Columns**. When forming columns of concrete, adequate space is needed to install rebar and properly place and vibrate the concrete. ***Rule of Thumb: The space between any two openings (door jambs or windows) should not be less than 12 inches.***

6. **Door and window bucks.** Bucks are a framework that holds back the concrete during the pour, provides the opening for insertion of doors and windows, and provides the fastening surface to which windows and doors are installed in the conventional manner. There are a couple of choices for bucks, wood or vinyl.

    a. **Wood bucks.** The simplest buck is a 2x12 or 2x14 that is ripped to the appropriate width to correspond to the block thickness and constructed into a box that is inserted into the wall. Pressure treated lumber can be used. Alternatively, non-pressure treated lumber can be used if a suitable moisture barrier is installed between the concrete and the wood such as conventional building paper.

    b. **Vinyl bucks.** Vinyl bucks, such as V-Buck are an alternative system. They are a little cleaner appearing on the job and have the advantage of being a non-biodegradable product and being more compatible with long term durability of the structure. Using a vinyl buck system provides greater assurance that you will not have future water or mold damage as the vinyl is not a wicking agent as wood is, is not a medium that will support mold growth, and is not subject to bio decay as is wood. Vinyl bucks will cost slightly more than wood, adding perhaps $1-2 per linear foot of window wrap at current prices.

7. **Windows.** With 11" or 13" thick walls, the option exists of mounting the windows to the exterior as is typical for frame construction, or recessing the windows to the inside with a deep exterior reveal.

a. **Flush Exterior mount.** In this case, the nail fin of the window is attached directly to the outer edge of the buck (either V-Buck vinyl or Wood) and the window is flashed normally as would be the case in conventional frame construction. On the interior, sheet rock wrapping of the sides and top are common, particularly with a large radius bull nose. If trimmed out with wood, bear in mind that the jams are quite large and consume more trim material than in normal walls.

b. **Recessed Mount.** If the windows are to be recessed to the inside then a second buck is installed within the frame of the main 11″ buck. This interior buck is affixed to the main buck and placed to the inside. The flashing on the window then attaches to this interior buck. The interior buck must be thick enough to allow for the width of the window flashing. The bottom of the buck must be sloped outward for drainage and an appropriate material specified for that sloped sill. *Important: In all cases, but particularly when recessing windows to the inside, it is critical to have all of the specs and measurements for the windows chosen before the bucks are constructed, and to build the bucks accordingly. Manufacturers differ in their definitions of rough opening required.*

8. **Corner windows** can readily be included either by employing a steel post in the corner, or by allowing sufficient height of the concrete lintel above the windows such that the engineer can detail a cantilevered beam over the window. Corner windows with all glass and no post in the corner are readily engineered. The lintel above will carry the load back to both walls.

9. **Bay windows** can be detailed by any of the following (a or b are preferred):

- *a.* Including concrete posts between windows (min 12″ between R.O.'s)
- *b.* Frame out the bay as a large open rectangle in the concrete with a concrete lintel above either in line with the wall, or following the line of the bay, and then to box out the bay itself with conventional framing. The advantage of this is that you provide greater structural strength of the structure by providing a continuous concrete band around the top.
- *c.* Break the concrete wall at the bay, and wood frame the entire bay *and* wood frame the rest of the structure *above* the window.
- *d.* Imbed structural steel posts.

10. **Doors.** The hinge side of a door needs to respect the thickness of the wall. Hinged doors that are hung in the ICF block should be installed so that the hinge is flush with the inside wall so the door can open fully without hitting the door jamb. Doors should be specified with jam extensions to reflect the 11-inch block plus the thickness of the interior and exterior claddings.

11. **Floor systems** are hung off of ledgers affixed to the sides of the ICF wall rather than stacked between levels. <u>Ledger bolt specification should bear in mind that the webs are on 6″ centers and the ledger bolt placement should be at multiples of that interval.</u>

12. Top plates: top plates can be either 6″ wide and recessed within the EPS foam sides, or the concrete can be screeded off flush with the top of the block, and an 11″ plate installed that extends to the edge of the block. Generally, anchor bolts are wet set and the plate installed subsequently.

13. Connectors:

    a. Ledger connectors. Simpson Strong-Tie has developed an ICF ledger connection system that reduces the labor & cost of installing ledgers/rim joists. Use of the Simpson ICFLC-CW will eliminate the need to install anchor bolts to handle the vertical loading. Use of this tie is recommended. Alternatively, anchor bolts can be set into the walls and used to attach the ledger. Details for both are included in the Amvic CADD details.

    b. Tension ties. If tension ties are required to transfer loads laterally between floors and walls, the ICFLC connector does *not* satisfy that requirement. An appropriate tension tie such as the Simpson PA will satisfy that purpose.

    c. Rafter/truss connection. The Simpson H3 connector is commonly selected to tie rafters to the top plate.

14. Ductwork: Generally try to avoid planning any ductwork in exterior walls. With the rebar in the wall, if ductwork is required on an exterior wall, probably a segment of wall would have to be furred out. Running ducts up interior walls greatly simplifies installation.

15. Plumbing: Where possible, keep plumbing on interior walls. Plumbing can be run in the outside walls, but vents and drain lines may have to be installed prior to the pour and it is generally easier to avoid that. Supply lines can easily be run in the block after the pour in the same manner as electric. In bathrooms it may be most convenient to fur out a wall section rather than imbed the plumbing in the ICF.

16. Electric wiring: Romex and boxes are installed after the pour and are installed in channels routed out of the 2 ½ inches of foam covering the concrete.

17. Electrical conduit. In commercial construction, if it is required, conduit can be placed into the concrete core as the walls are being assembled. What is easier and preferable however is to place the conduit in a channel cut into the foam after the walls are poured. In the latter cases, metal boxes should be employed that have side knockouts provided.

18. Trusses. An AMVIC ICF home is an energy-efficient home. You may want to consider specifying trusses (if you are using them) with a raised heel for added insulation.

19. Attic insulation. R-30 or better blown cellulose insulation over the ceiling is recommended.

20. Backing. Any especially heavy fixtures that will hang from the ICF wall such as heavier than normal cabinets should have backing installed before the walls are poured. (normal cabinetry can be securely attached by screwing into the face of the imbedded webs). The backing should be connected back into the concrete rather than being hung only from the webs. Either 2 x or 1-inch furring strips can be inlet into the foam using a hotknife and screwed to the webs thus providing a continuous fastening surface if such is required.

21. Backing for Curtain rods, towel bars, tissue holders, etc.
    Perforated steel backing plates ("Grappler" plates) are available as an ICF accessory. These plates can be pressed into the surface of the foam block at

locations where fixtures will be installed, and then the sheetrock installed over the plate and mechanically fastened to the adjacent webs. Subsequently, screws then will grab the perforated metal plate and be firmly held in place.

Other design and construction considerations:

1. **Utility penetrations**. Any penetration is easy to accommodate prior to the walls being poured and quite difficult afterwards. If there is uncertainty or future potential requirements, a small buck can be installed and filled with foam and left in place so that an opening can be made easily later. Exterior lighting, water faucets, dryer vents, service entrances, etc. are obvious candidates to pre plan.

2. **Waterproofing.** All ICF walls below grade require waterproofing. The recommended waterproofing system for all below grade ICF is a two part system:

   a. **AquaSeal's ICF Greenshield (or ePro EcoLine-R)** , are a water based, cold applied, rubberized, highly flexible liquid waterproof membrane is the first part. It is easily applied to the block by either spraying or rolling/brushing on and is specially formulated to bond effectively to EPS foam blocks. It is a vapor and liquid water barrier.

   b. A dimple board drainage mat or protection mat is recommended between the waterproofing membrane and the backfill, and **ProtectoWrap's ProtectoDrain 2000-V** or **CCW Miradrain 2000** are specifically recommended, although other similar products will work as well. This provides an air channel and open pathway to the footing drain for liquid water. It removes any buildup of hydrostatic pressure on the wall by carrying away the water.

   [Specifications for both above products are available at www.amvic-pacific.com]

   c. These systems require use of a standard foundation drain ("French drain") or Forma-Drain™ that is covered in drain rock for at least 6-12" and the drain rock covered in turn with filter fabric.

   d. When a. b. & c. above are done, it is effective to backfill with native soil rather than drain rock as the ProtectDrain maintains an open air/water channel.

3. **Flashing windows and doors.** A double layer of adhesive ICF membrane flashing is recommended for all door and windows. A 6-inch wide layer is first applied to wrap across from the wood or vinyl window buck and onto the EPS foam of the block. The flashing is "shingled" as conventionally, with the bottom strip applied first, then the side strips, then the top strip; in each case overlapping the prior strip. With windows, the window is installed on top of the waterproofing membrane nailing or screwing *through* the membrane, and then a second course of membrane that is 4" wide is installed over top of the nail flange of the window and back on top of the previous membrane. This double layer provides the best assurance of maintaining waterproofness.

4. **Termite protection.** Obviously termites can't eat concrete. Termites however, can *potentially* tunnel through the EPS foam to reach a food source (wood bucks, window or door jambs, or conceivably rafters and trusses.) This is very much a localized issue within our area, with some areas having greater problems than others. Waterproofing with a membrane by itself offers a level of protection when

the membrane wraps the footing. If you determine that complete termite protection is required, the easiest solution is to use ***Polyguard 650XTP Waterproofing Membrane with Termite Barrier.*** This membrane has SBBCI approval as a termite barrier. There are other solutions such as removing a 6" strip of EPS foam from the concrete above grade entirely around the structure as a termite inspections strip.

5. **Mixing block sizes.** Different thickness blocks can be combined either on subsequent levels or on different wall faces of the same level. In either case there is a two inch step that has to be accommodated either on the inside or exterior. This step in the block is usually hidden at either the top or the bottom of the upper floor joists.

6. **Engineering.** In the Northern California/Northern Nevada seismic zones, in all cases a structural engineer will be required to perform all of the structural calculations. Generally, using an engineer who is already familiar with ICF will be advantageous. In any case, the engineer needs to bear in mind that the concrete is the structure, not the foam. From an engineering perspective, this is simply a "poured in place" reinforced concrete wall, just the same as if wooden forms were being used.

   A listing of engineers who are experienced in residential ICF engineering can be found at www.amvic-pacific.professionals.htm

7. **Prescriptive Method.** The U.S. Department of Housing and Urban Development has published a set of prescriptive tables for structural engineering of ICF structures. The 2nd edition covers the seismic zones of the west coast. You can download the full report and tables at http://www.amvic-pacific.com/technical.htm or you can go to the HUD User website and order a bound copy.

8. **Testing Reports**. The primary product testing and evaluation report is issued by ICC Evaluation Service Inc. It is ICC ESR-1269 dated April 1, 2005. Copies are available at the www.icc-es.org website, or at the www.amvic-pacific.com website.

9. **Planning department approvals.** This varies greatly by local jurisdiction. Almost all Northern California and Nevada counties have approved numerous ICF projects and the procedures are fairly well established. Individual inspectors may occasionally not yet have seen a project but in virtually all cases their departments have.

10. **Architectural details** are available from AMVIC in several Autocad formats. You may order the files on a CDROM from your AMVIC distributor or download them from www.caddetails.com

11. **Special Engineering Inspections**. When 3000psi concrete is specified within the wall cavities, generally that mandates the requirement for a "special inspection" of the concrete during the pour by a qualified engineering technician. This varies somewhat by jurisdiction. In a few cases, architects have specified 2800 psi concrete, and a 6 sack mix, 6-inch slump. This generally will produce a concrete that will test well above the 3000 psi level, without incurring the expense of an onsite special inspector. It varies by county.

Vertical Coursing

4, 6, and 8-inch AMVIC Block is 16″ high. (The 10-inch block is 24″ in height.)

Changing block sizes. You can use thicker block on individual walls or on different levels and transition to a smaller block size above. Where a size change is made, the blocks are kept flush on the exterior and the 2″ jog is on the inner wall. That jog normally is concealed at the floor level with the jog occurring at either the top or the bottom of the intersecting floor trusses. In that case, floor heights must be planned to line up with the block size change.

Adjustments to height:

Wall heights can be adjusted by ripping block as required. Typically a course of block is ripped on either the first or last course.

Blocks can be ripped in the center as well creating 8″ high blocks, and both halves are usable due to the reversibility of the block.

Note that ledgers can be adjusted up and down without any restriction.

It is builder-friendly to have window tops come out on an even block line (or 1.5″ below) if possible. This is a labor and material saver during construction.

In multi-story construction, the window tops can be designed to come out on or 1.5″ below block line by manipulated the ledger up or down (adjusting the floor to ceiling ht). Nonetheless, any height can be made to work.

Course height		
1	**1′**	**4″**
2	**2′**	**8″**
3	**4′**	**0″**
4	**5′**	**4″**
5	**6′**	**8″**
6	**8′**	**0″**
7	**9′**	**4″**
8	**10′**	**8″**
9	**12′**	**0″**
10	**13′**	**4″**
11	**14′**	**8″**
12	**16′**	**0″**
13	**17′**	**4″**
14	**18′**	**8″**
15	**20′**	**0″**
16	**21′**	**4″**
17	**22′**	**8″**
18	**24′**	**0″**
19	**25′**	**4″**
20	**26′**	**8″**
21	**28′**	**0″**
22	**29′**	**4″**
23	**30′**	**8″**
24	**32′**	**0″**

AMVIC Technical Data

- EPS Thickness 2.5″ per panel, 5.0″ total
- EPS Material: Type 2 Flame Retardant Expanded Polystyrene (EPS), density 1.5 pcf
- EPS complies with requirements of ASTM E-84 and CAN/ULS-S701-97
- Thermal resistance with concrete Thermal Mass Effect: R-30+
- Sound insulation: STC-55
- Reinforcement placement complies with ACI 318
- Minimum concrete pouring temperature: Minus 4 degrees F.
- Fire Rating: 3+ hours
- Concrete wall: flat and solid
- ICBO Evaluation number ER-5948
- BOCA Evaluation Research Report No. 21-95
- SBCCI PST & ESI Evaluation Report No. 2212

Additional assistance can be obtained from: Amvic-Pacific phone: 530-265-9085

6″ Amvic Block
Wall segment “friendly” dimensions

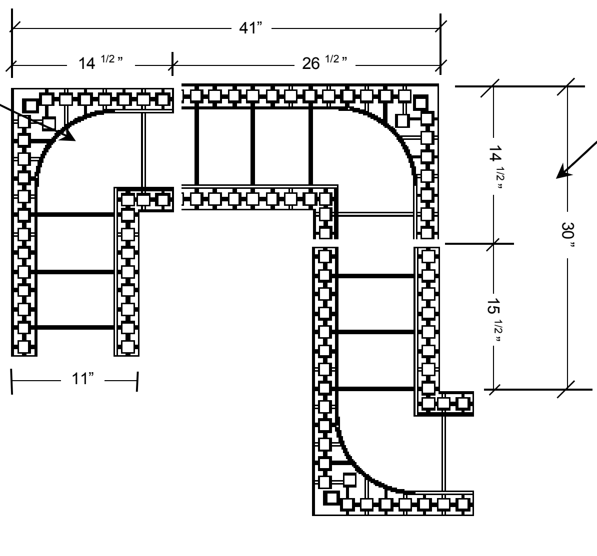
Note: Blocks are not exact and precise in their size — they’re only *approximately* 48″ long. They undergo expansion and contraction as a part of the manufacturing process, and may frequently average 1/32nd to 1/16th inch longer than nominal size. As they are all within a tolerance range this doesn’t affect their assembly in construction.

HOWEVER, if you try to calculate a long run of block to come out on an exact dimension it frequently doesn’t work as the variation in the block size accumulates. For example a wall segment of straight block that is 48′ long will be 12 blocks nominally.   However, 12 blocks interlocked with a running bond, can end up measuring 48′ 3/4″ inch with 1/16th oversize block.

AS A PRACTICAL MATTER, we do <u>not</u> recommend attempting to make long runs of block work out to even block sizes ... it just doesn’t work out.   For any wall segment longer than 6-8′, disregard block dimensions and make the wall segment work with good functional design for the structure. The block will be cut in the field to make it work. *It is never cost effective design to try to save 50¢ on block only to increase other affected costs by several dollars.*

However, for short wall segments of 6-8′ or less, it can reduce labor and lower construction cost (less waste) to respect the block sizes in dimensioning the wall.

Outside to Outside corners.   A minimum dimension that works is 41″ (for 6-inch block). That provides the ability to create a running bond overlap between the blocks.   Increasing the segment length by adding increments of 48″ would keep a wall length that would not require any block cutting.   Alternatively, incrementing from 41″ in 6-inch increments would require block cutting, but still maintain zero waste.



Outside to Inside corners.   A minimum dimension that works to maintain an interlock is 30″ (for 6-inch block). That provides the ability to create a running bond overlap between the blocks.   Increasing the segment length by adding increments of 48″ would keep a wall length that would not require any block cutting.   Alternatively, incrementing from 30″ in 6-inch increments would require block cutting, but still maintain zero waste.

* **With 8-inch block, bumpouts** (short wall segment with both an inside and outside corner) should be a minimum of 20″ and 32″ works even better.

Engineering Issues to Address

The following is a listing of observations gathered as we've seen various plans go through a variety of building departments. We have no pretensions of being structural engineers, rather this is an assembly of the items we've observed engineers including in the specs and/or building departments requesting on ICF construction projects. We make no representation that the list is complete nor are all items specifically necessary. The list is offered as a memory jogger for designers and engineers. All of the requirements below stem, we believe, from provisions in the UBC and ACI 318.0

Engineering issues to be specified in the plans:

- **Rebar specs and placement** (incl. size and grade)
  - General placement in *typical* wall
    - Size
    - Grade
    - Horizontal spacing (16" or multiples of that *please*!)
    - Vertical spacing (multiples of 6" are easiest to work with)

VERY IMPORTANT

  - Placement as above except in atypical walls (retaining, slender walls, etc.)
  - Bar placement around doors and windows (See Amvic Detail)
  - Corners
  - Variation in bar placement, if any, at the course where anchor bolts are installed for the floor ledger
  - Top course
  - Lintels
  - Footings
- **Footings:** Size of & rebar placement therein
- **Floor connections**
  - Ledger attachment (anchor bolts or Simpson ICFLC) (Amvic detail provided)
  - Attachment of floor joists or TGI's to ledger
  - Horizontal tension ties spec and spacing (frequently Simpson LTT/HTT tension ties or PA/HPA purlin anchors) if required
  - Beam pocket specification if required
- **Top sill plate**
  - Connection to wall top (Amvic detail provided)
  - Connection of rafters and/or trusses to top sill (commonly Simpson H3)
- **Concrete specification** in the walls
- Waterproofing below grade (Amvic provides a detail)