Construct a double wall consisting of two framed walls forming a wide wall cavity for more insulation in the home’s exterior walls.

- Install a continuous air control layer per the detailed drawings shown in the Description tab. Seal all seams, gaps, and holes. The location of the air control layer will be determined by the type of double-stud wall being installed.
- Install a vapor control layer per the detailed drawings shown in the Description tab. The location of the vapor control layer is determined by the type of double-stud wall being installed and the climate zone where the home is located.
- Install insulation without misalignments, compressions, gaps, or voids.

OR

- Completely fill the entire cavity of the double-stud wall assembly without misalignments, compressions, gaps, or voids.
- ENERGY STAR requires that insulation fill the entire wall cavity and that insulation cover the interior studs to an R value of at least \( R-3 \) in IECC Climate Zones 1 to 4 or \( R-5 \) in IECC Climate Zones 5 to 8 (ENERGY STAR 2015).

See the Compliance Tab for related codes and standards requirements, and criteria to meet national programs such as DOE’s Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.
Double-stud wall construction is one option for high R-value walls. They are relatively inexpensive to construct and use readily available materials that construction crews may be more familiar with than other high-R-value options such as structural insulated panels (SIPS) and insulated concrete form (ICF) walls. Double-stud wall construction consists of two stud-framed walls set up next to each other to form an extra thick wall cavity that can be filled with insulation. Because the interior and exterior framing are separated by insulation, thermal bridging is also reduced or eliminated. Building Science Corporation, a Building America research partner, investigated several forms of double-stud wall construction including double-stud walls, truss walls, and offset frame walls in several research studies on high R-value walls.

- **High-R Walls Case Study Analysis** ([Straube and Smegal 2009](#)) - The analysis in this report includes a summary of historical wall construction types and R-values, current construction strategies, and wall types that will likely become popular in the future based on considerations such as energy and material availability.

- **Moisture Management for High R-Value Walls** ([Lepage, Schumacher and Lukachko 2013](#)) – This report explains moisture-related concerns for high R-value wall assemblies. Hygrothermal simulations were prepared for several common approaches to high R-value wall construction in six U.S. cities (Houston, Atlanta, Seattle, St. Louis, Chicago, and International Falls) representing a range of climate zones (2, 3, 4C, 4, 5A, and 7, respectively).

- **Monitoring of Double Stud Wall Moisture Conditions in the Northeast** ([Ueno 2014](#)) – This report explains moisture conditions in double-stud walls that were monitored in Zone 5A (Massachusetts); three double-stud assemblies were compared: 12” of ocSPF, 12” of cellulose, and 5-½” of ocSPF at the exterior of a double-stud wall (acting as a control wall).

BSC’s latest recommendations can be found at [www.buildingscience.com](http://www.buildingscience.com). Some of the forms they investigated are described below.

Double-stud walls would be designed and specified by the architect and implemented by the framers. Site supervisors should ensure that framers and trades responsible for air sealing, insulating walls, and installing windows are knowledgeable or trained in techniques required for double-stud wall construction and that skill level expectations are included in the contracts for these trades.

**How to Construct a Double-Stud Wall with Interior Framing and Cellulose Insulation**

One form of double-stud wall construction consists of an exterior 2x6 or 2x4 stud-framed structural wall and a second 2x4 nonstructural wall built to the inside with a gap in between of several inches. If the studs in each wall are installed at the same spacing (e.g., 24-inch on-center) they can be staggered, although research has shown only minor improvement (<R-1) when staggering the studs ([CARB 2009](#)). Plywood boxes must be installed around the rough-in spaces for installing windows, which are typically installed flush with the exterior wall. The cladding attachment is the same as normal stud-framed construction practice.

The example shown here uses a 2x4 exterior structural wall built at 16-inches on-center and a second minimum 2x3 wall that is nonstructural but is used to support drywall and electrical services. The two stud walls plus the gap in between provide a 9.5-inch cavity for cellulose insulation, which would have a clear-wall R-value (for that section of the wall without interruptions) of R-34 or a whole-wall R-value of R-30 ([Straube and Smegal 2009](#)). In this example, no vapor retarder is needed in warmer climate zones (1 through 4). A Class II vapor retarder is recommended in cold climate zones (5 and higher) ([Ueno 2014](#)). If one is installed, it should also be an air barrier/air control layer and it should be located on the exterior side of the interior wall. Care should be taken that insulation on both sides of this layer is fully aligned along the entire length of the wall.
Figure 1. This double-stud wall, consisting of a 2x4, 16-inch on-center exterior structural wall and a minimum 2x3 interior non-structural wall, provides 9.5 inches of wall cavity space filled with cellulose insulation for a whole wall R value of R-30.

Note: A vapor retarder is not required/needed for warmer climate zones (1 through 4) but a Class II vapor retarder is recommended for cold climate zones (5 and higher). This vapor retarder should also be an air barrier/air control layer and be located on the exterior side of the interior wall (image courtesy of BSC, 2015)

How to Construct a Double-Stud Wall with Outside Framing and Cellulose Insulation

Another form of double-stud wall construction consists of an interior 2x6 or 2x4 stud-framed structural wall and a second 2x4 non-structural exterior wall attached at each stud and cantilevered out. This frees up floor space compared to a traditional double-stud wall. The gap between the framing provides several inches for loose-fill or batt insulation (cellulose or fiberglass).

In this example, a 2x4, 16-inch on-center interior load-bearing wall is connected to a 2x4 exterior non-bearing wall to provide 9.5 inches of cavity width that is filled with cellulose insulation for a calculated whole-wall R-value of R-35. The air and vapor control layers are the plywood or OSB sheathing on the exterior of the interior wall. The permeance and location of vapor control is dependent on the climate zone (BSC 2008). In warmer climate zones (1 through 4) no vapor retarder is required/needed.
How to Construct a Double-Stud Wall with Open-Cell Spray Foam

A double-stud wall filled with open-cell spray foam (ocSPF) is an inexpensive way to decrease the air leakage susceptibility of double-stud walls commonly filled with cellulose insulation. The ocSPF acts to seal the OSB from any sources of air leaks between the exterior and interior stud walls (Lepage, Schumacher, and Lukachko 2013). In warmer climate zones (1 through 4), the ocSPF provides sufficient vapor resistance, provided that there is a ventilated cladding. In cold climate zones (5 and higher), a Class II vapor retarder (smart vapor retarder or vapor retarder paint) is needed (Ueno 2014). A Class I vapor retarder is not recommended in any of the climate zones.

In this example, a double wall is constructed consisting of a 2x4 exterior structural wall built at 16-inches on-center and an interior minimum 2x3 non-structural wall. The interior and exterior walls together form a 9.5-inch cavity that is filled with ocSPF for a calculated whole-wall R-value of R-37. In cold climate zones, additional levels of vapor control are required for this assembly; therefore, a smart vapor retarder is installed on the back of gypsum wall board. Alternatively, a vapor retarder paint can be used on the interior face of the gypsum board. No vapor control is needed in warmer climate zones.
How to Construct a Double-Stud Wall with Closed-Cell Spray Foam and Cellulose Insulation

The standard double-stud wall concept can be improved through the use of closed-cell spray foam (ccSPF) installed directly against the exterior wall sheathing. The remainder of the framing cavity is filled with loose-fill fiber insulation such as cellulose or fiberglass. This is described as a hybrid insulation strategy (Lepage, Schumacher, and Lukachko 2013). In this example, high-density spray foam provides increased air sealing and moisture protection, decreasing the risk of wintertime condensation on the interior side of the exterior wall while less expensive cellulose provides additional R-value.

This example again uses a 2x4 exterior structural wall built at 16-inches on-center and an interior minimum 2x3 non-structural wall providing a 9.5-inch cavity. The exterior wall is covered with plywood or OSB sheathing, then the inside surface of the sheathing is covered with 3.5 inches of high-density spray foam. The remaining 6 inches of the cavity is filled with cellulose insulation, which provides a calculated whole-wall R-value for this assembly of R-40 (BSC 2008). The high-density spray foam insulation is the vapor control layer; therefore, no additional vapor control is required. The amount of high-density spray foam insulation needed to control condensation at the sheathing is dependent on the climate zone.
Figure 4. This double-stud wall - consisting of a 2x4, 16-inch on-center exterior structural wall and a minimum 2x3 interior non-structural wall - has 3.5 inches of high-density spray foam applied to the interior surface of the exterior sheathing for air sealing and moisture control, plus 7.5 inches of cellulose insulation providing for a whole-wall R-value of R-32.4.

Note: The high-density spray foam insulation is the vapor control layer; therefore, no additional vapor control is required. The amount of high-density spray foam insulation to control condensation at the sheathing is dependent on the climate zone (image courtesy of BSC, 2015).

How to Construct a Truss Wall

The truss wall uses two sets of studs like the double-stud wall, but in this case the interior wall is the load-bearing wall. The interior wall can be constructed with 2x6 studs at 24 inches on-center or 2x4 studs at 16 inches on-center. The exterior wall is attached at each stud and hangs cantilevered outside of the foundation wall, which frees up floor space compared to a traditional double-stud wall. The interior and exterior wall studs are aligned and connected with plywood gusset plates toward the top, middle, and bottom of each pair of studs, and a plywood cavity closure at the top and bottom of the stud cavities. These gussets and closures provide stability so that the walls can be further apart, allowing more room for insulation. The bottom edge of the exterior wall drops below the sill plate, providing space that can be filled with insulation along the exterior side of the rim joist, thus minimizing the thermal bridging that can otherwise occur through the rim joist.

In this example a 2x6, 24-inch on-center interior structural wall is connected to a 2x3, 24-inch on-center exterior non-structural wall spaced to provide 12 inches of cavity width that is filled with cellulose insulation for a calculated whole-wall R value of R-36. The air and vapor control layers are the plywood or OSB sheathing on the exterior of the interior structural wall. A fully-adhered membrane on the outside of the OSB sheathing can be used. The permeance and location of vapor control is dependent on the climate zone (BSC 2008).
Figure 5. This truss wall - consisting of a 2x6, 24-inch on-center interior structural wall connected to a 2x3, 24-inch on-center exterior non-structural wall with plywood gussets - is spaced to provide 12 inches of cavity width that is filled with cellulose insulation for a calculated whole-wall R-value of R-36. Plywood or OSB sheathing is the vapor control layer. The permeance and location of vapor control is dependent on the climate zone (image courtesy of BSC, 2015)
Ensuring Success

Install the air control layer in a continuous manner.

An infrared camera used in conjunction with blower door testing may help indicate the thoroughness of insulation coverage and may also help detect air leakage through the wall, if a sufficient temperature difference exists between the outside and the conditioned space of the house. Insulation installation should be inspected by the site supervisor before drywall is installed.
Climate

The permeance and location of vapor control is dependent on the climate zone. In warmer climate zones (1 through 4), no vapor barrier is required/needed.
Training

Right and Wrong Images

Display Image: TE444_DoubleStudWall_Right-1_BSC-2014.jpg

Display Image: TE444_DoubleStudWall_Right-2_BSC-2014.jpg
CAD

INSULATED EXTERIOR STUD WALL

BLOCKING AS REQUIRED

CONTINUOUS BEAD OF SEALANT

INSTALL INTERIOR SCAFFOLDING PRIOR TO INSTALLATION OF FINISH ENCLOSURE

CONTINUOUS BEAD OF SEALANT

WOOD FRAME
FLOOR ASSEMBLY

CAD FILE: 317_CAD_2-8_Air_seal_double_walls_5-02043_GBA_1-31-12.dwg
PDF: 317_CAD_2-8_Air_seal_double_walls_5-02043_GBA_1-31-12.pdf
Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09)

National Rater Field Checklist

Thermal Enclosure System.
3. Reduced Thermal Bridging.
3.4 At above-grade walls separating conditioned from unconditioned space, one of the following options used (rim / band joists exempted):

3.4.2 Structural Insulated Panels OR; Insulated Concrete Forms OR; Double-wall framing.

Footnote 17) Up to 10% of the total exterior wall surface area is exempted from the reduced thermal bridging requirements to accommodate intentional designed details (e.g., architectural details such as thermal fins, wing walls, or masonry fireplaces; structural details, such as steel columns). It shall be apparent to the Rater that the exempted areas are intentional designed details or the exempted area shall be documented in a plan provided by the builder, architect, or engineer. The Rater need not evaluate the necessity of the designed detail to certify the home.

Footnote 20) Double-wall framing is defined as any framing method that ensures a continuous layer of insulation covering the studs to at least the R-value required in Item 3.4.1 of the Checklist, such as offset double-stud walls, aligned double-stud walls with continuous insulation between the adjacent stud faces, or single-stud walls with 2x2 or 2x3 cross-framing. In all cases, insulation shall fill the entire wall cavity from the interior to exterior sheathing except at windows, doors and other penetrations.

Please see the ENERGY STAR Certified Homes Implementation Timeline for the program version and revision currently applicable in your state.

DOE Zero Energy Ready Home (Revision 07)

Exhibit 1 Mandatory Requirements.
Exhibit 1, Item 1) Certified under the ENERGY STAR Qualified Homes Program or the ENERGY STAR Multifamily New Construction Program.
Exhibit 2, Item 2) Ceiling, wall, floor, and slab insulation shall meet or exceed 2015 IECC levels and achieve Grade 1 installation, per RESNET standards.


This topic is not specifically addressed in the IECC.


This topic is not specifically addressed in the IRC.

Double Wall Framing - Code Compliance Brief

Overview:

Double stud wall wood framing is not specifically addressed in the International Residential Code (IRC) or International Energy Conservation Code (IECC); it is neither encouraged nor discouraged. Minimum code requirements for insulation, moisture, and air leakage are based on a typical 2x4 or 2x6 (16" or 24" on center) single stud wall. Minimum insulation R-values specified in the IRC and IECC are based on assuming a single stud wall (e.g., R-19 cavity insulation will completely fill a 2x6 single stud wall). Double stud wall wood framing can obtain much higher R-values. Moisture and air leakage are addressed in the codes for a single stud wall but not for a double wall. Recommendations of where the vapor retarder and air barrier should be placed, based on research and testing, are described below.

Plan Review:

- **Insulation**: Since these walls will have a much higher R-value of insulation than minimum code, review the proposed installed R-value and how the overall building is meeting compliance (prescriptively, trade-offs, or performance based). If the latter of the two are proposed, confirm that the credit given for these higher R-value walls was calculated correctly (correct credit was given). For example, per the 2012 IECC in Climate Zone 5, the minimum insulation required in a wood-frame wall is R-20 cavity or R-13 cavity plus R-5 continuous insulation or insulated siding. Double wall framing can obtain values around R-30 or higher for cavity insulation.

- **Moisture**: In a double stud wall, the recommendation, based on testing and studies performed by Building Science Corporation, is to install the vapor retarders on the exterior side of the interior wall, dependent upon climate zone.
In the 2012 IRC, vapor retarders are required dependent upon Climate Zone and vapor retarder class. Vapor retarders are required in colder climates. If installed, it should be located on the exterior side of the interior wall (see Description tab) and care should be taken that the insulation on both sides of the vapor retarder is fully aligned with the barrier the entire length of the wall. Note: the IRC (Section 702.7) states Class I or II vapor retarders are required on the interior side of the frame walls in Climate Zones 5, 6, 7, 8, and Marine 4 with some exceptions for basement walls, below grade portion of any wall, or construction where moisture or freezing will not damage the material. The IRC defines material vapor retarders into three classes:

- **Class I**: Sheet polyethylene, unperforated aluminum foil.
- **Class II**: Kraft-faced fiberglass batts.
- **Class III**: Latex or enamel paint.

Class III vapor retarders are permitted where any of the following conditions are met per Table R702.7.1 in the 2012 IRC.

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Class III Vapor Retarders Permitted for</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Vented cladding over wood structural panels.</td>
</tr>
<tr>
<td></td>
<td>Vented cladding over fiberboard.</td>
</tr>
<tr>
<td></td>
<td>Vented cladding over gypsum.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 2.5 over 2 x 4 wall.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 3.75 over 2 x 6 wall.</td>
</tr>
<tr>
<td>5</td>
<td>Vented cladding over gypsum.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 5 over 2 x 4 wall.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 7.5 over 2 x 6 wall.</td>
</tr>
<tr>
<td></td>
<td>Vented cladding over fiberboard.</td>
</tr>
<tr>
<td></td>
<td>Vented cladding over gypsum.</td>
</tr>
<tr>
<td>6</td>
<td>Insulated sheathing with R-value ≥ 7.55 over 2 x 4 wall.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 11.25 over 2 x 6 wall.</td>
</tr>
<tr>
<td>7 and 8</td>
<td>Insulated sheathing with R-value ≥ 10 over 2 x 4 wall.</td>
</tr>
<tr>
<td></td>
<td>Insulated sheathing with R-value ≥ 15 over 2 x 6 wall.</td>
</tr>
</tbody>
</table>

- **Air Leakage**: Confirm on the plans that a continuous air barrier is specified on the interior side of the interior wall.

**Field Inspection:**

- The insulation completely fills the cavity with no compression or gaps.
- Vapor retarder (if applicable) is installed on the exterior of the interior wall properly.
- Air barrier is installed on the interior of the interior wall properly. All seams, gaps, and holes are sealed properly. The 2012 IRC, Table N1102.4.1.1 and IECC, Table R402.4.1.1 require a continuous air barrier be installed. Confirm corners and headers are insulated and the junction of the foundation and sill plate sealed. The junction of the top plate and top of exterior walls are sealed. Confirm the exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with the air barrier.

**Technical Validation(s):**

Building America Top Innovation Hall of Fame Profile

References and Resources*

1. **All About Larsen Trusses**
   - Author(s): Holladay
   - Organization(s): Green Building Advisor
   - Publication Date: July, 2011
   - *Website article interviewing the inventor of the Larsen truss, a history of its use, and a discussion of its advantages and disadvantages.*

2. **Building America Special Research Project: High-R Walls Case Study Analysis**
   - Author(s): Straube, Smegal
   - Organization(s): Building Science Corporation
   - Publication Date: March, 2009
   - *Report considers a number of promising wall systems that can meet the requirement for better thermal control.*

3. **Double Wall: Staggered or In-Line Studs?**
   - Author(s): Consortium for Advanced Residential Buildings
   - Organization(s): CARB, Steven Winter Associates, SWA
   - Publication Date: January, 2009
   - *Information sheet providing information about double walls in new construction.*

4. **High R-Value Wall Assembly-04: Double Stud Wall Construction**
   - Author(s): Building Science Corporation
   - Organization(s): Building Science Corporation
   - Publication Date: June, 2009
   - *Information sheet briefly summarizing double stud wall construction including the advantages and disadvantages of this construction strategy.*

5. **High R-Value Wall Assembly-04: Double Stud Wall Construction**
   - Author(s): Building Science Corporation
   - Organization(s): Building Science Corporation
   - Publication Date: June, 2009
   - *Information sheet briefly summarizing double stud wall construction including the advantages and disadvantages of this construction strategy.*

6. **High R-Value Wall Assembly: Double Stud with Spray Foam Wall Construction**
   - Author(s): Building Science Corporation
   - Organization(s): Building Science Corporation
   - Publication Date: June, 2014
   - *Information sheet briefly summarizing double stud wall construction including the advantages and disadvantages of this construction strategy.*

7. **High R-Value Wall Assembly: Truss Wall Construction**
   - Author(s): Building Science Corporation
   - Organization(s): Building Science Corporation
   - Publication Date: June, 2009
   - *Information sheet briefly summarizing double stud wall construction including the advantages and disadvantages of this construction strategy.*

8. **How to Install Cellulose Insulation**
   - Author(s): Holladay
   - Organization(s): Green Building Advisor
   - Publication Date: March, 2011
   - *Information sheet presenting techniques for installing cellulose insulation.*

9. **How to Install Cross-Laminated Timber (CLT)**
   - Author(s): Cross-Laminated Timber Institute
   - Organization(s): Cross-Laminated Timber Institute
   - Publication Date: February, 2018
   - *Guide providing instructions for installing cross-laminated timber.*

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*Note: All resources are available for free unless otherwise indicated.*
Moisture Management for High R-Value Walls
Author(s): Lepage, Schumacher, Lukachko
Organization(s): Building Science Corporation
Publication Date: November, 2013
Report explaining moisture-related concerns for high R-value wall assemblies and discusses past Building America research work that informs this study.

10. Thermal Enclosure System Rater Checklist Guidebook
Author(s): U.S. Environmental Protection Agency
Organization(s): EPA
Publication Date: October, 2011
Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

Contributors to this Guide
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