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Low-Cost Cold Storage Room for Market Growers

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Introduction

Fresh fruits and vegetables start to deteriorate as soon as they are harvested because they are cut off from their source of water and nutrition. They lose weight, texture, flavor, nutritive value, and appeal. Cooling significantly slows down the rate of deterioration, thereby increasing the storage life of the produce. The cooler the temperature, the slower the deterioration and the longer the storage life. Much commercial produce is stored at temperatures just above that which will cause freeze damage to the product so that it can have the maximum possible shelf life (multiple weeks or even months) and be transported very long distances.

Market growers—those selling through farmers' markets, farm stands, or community-supported agriculture (CSA)—typically sell their fruits and vegetables within a few days of when they were picked. They can get premium prices for what they grow because of its "localness" and freshness. In this situation, long storage times at very low temperatures may not be needed, and the high cost for commercial or industrial-grade cooling equipment is difficult to justify. But fresh produce will still deteriorate substantially within a day or two if it is not cooled at all from ambient conditions, especially during the hot summer months. Lower-cost cold storage options can benefit market growers by helping preserve produce freshness and quality for a few additional days. Produce losses can be significantly reduced, especially for growers transitioning to a higher level of production who have excess produce to carry over from one day's market to the next.

Air Conditioner for Refrigeration

A standard window-mounted room air conditioner can provide a low-cost cooling source, but if a producer tries to use it to cool below about 65°F, the cooling coils will freeze up. This limitation can be overcome by outfitting the air conditioner with strip heaters, a thermostat, and a timer to create a defrost cycle that alternates power between the strip heaters and the compressor. At least one manufacturer now offers an off-the-shelf control unit that does the same thing. The control unit is called CoolBot™, and it is available from Store It Cold LLC for about $300.

The air conditioner can be sized to give enough cooling capacity to cool a certain size cold room the maximum amount needed, down to a temperature of 33°F, according to the company's guidelines given for the Coolbot unit. A smaller air conditioner may be sufficient to cool the same size room enough (down to maybe 55° to 60°F) to take the field heat off a wide range of fruits and vegetables and significantly improve produce quality as compared to storage at ambient conditions.

It should be noted that different produce has different optimum storage temperatures. Many produce items do best at very cold temperatures, just above freezing, but other produce typically handled by market growers, such as cucumbers, peppers, potatoes, watermelons, squash, and beans, do best at higher temperatures of 45° to 60°F. Tomatoes are probably best stored in the 55° to 60°F range; if they are stored at too cold a temperature, they become mealy.

For further information on storing produce, see the following online resources:

- HortFact-7002, "Recommended Storage Conditions for Vegetables" at http://www.uky.edu/Ag/Horticulture/comveggie.html, or
- Chapter 7 of "Small-Scale Postharvest Handling Practices" from the Food and Agriculture Organization of the United Nations at http://fao.org/docrep/009/ae075e/ae075e15.htm.

Cold Room Construction

To demonstrate its feasibility, a low-cost cold room was constructed from building materials available from building supply stores and cooled by a room air conditioner and the CoolBot control unit. The room, which measures approximately 8 feet by 10 feet by 8 feet tall (outside dimensions), offers enough space for walk-in cold storage for a significant amount of produce, yet is small enough to fit into many existing barns or other covered storage spaces. The floor, walls, and ceiling were constructed using 2 x 6 (floor) or 2 x 4 lumber, and they were insulated with batt insulation and foam board covered with plywood sheathing inside and out. The floor, walls, and ceiling were all insulated to an R-value of 19, a standard value for coolers.

The only nonstandard material used in the demonstration unit was a high-density R-15 batt insulation that achieved the desired insulation value in the walls and ceiling using 2 x 4 rather than 2 x 6 studs. This helped make the unit lighter and more portable. The walls and ceiling could be constructed using 2 x 6 studs and standard R-15 batt insulation for

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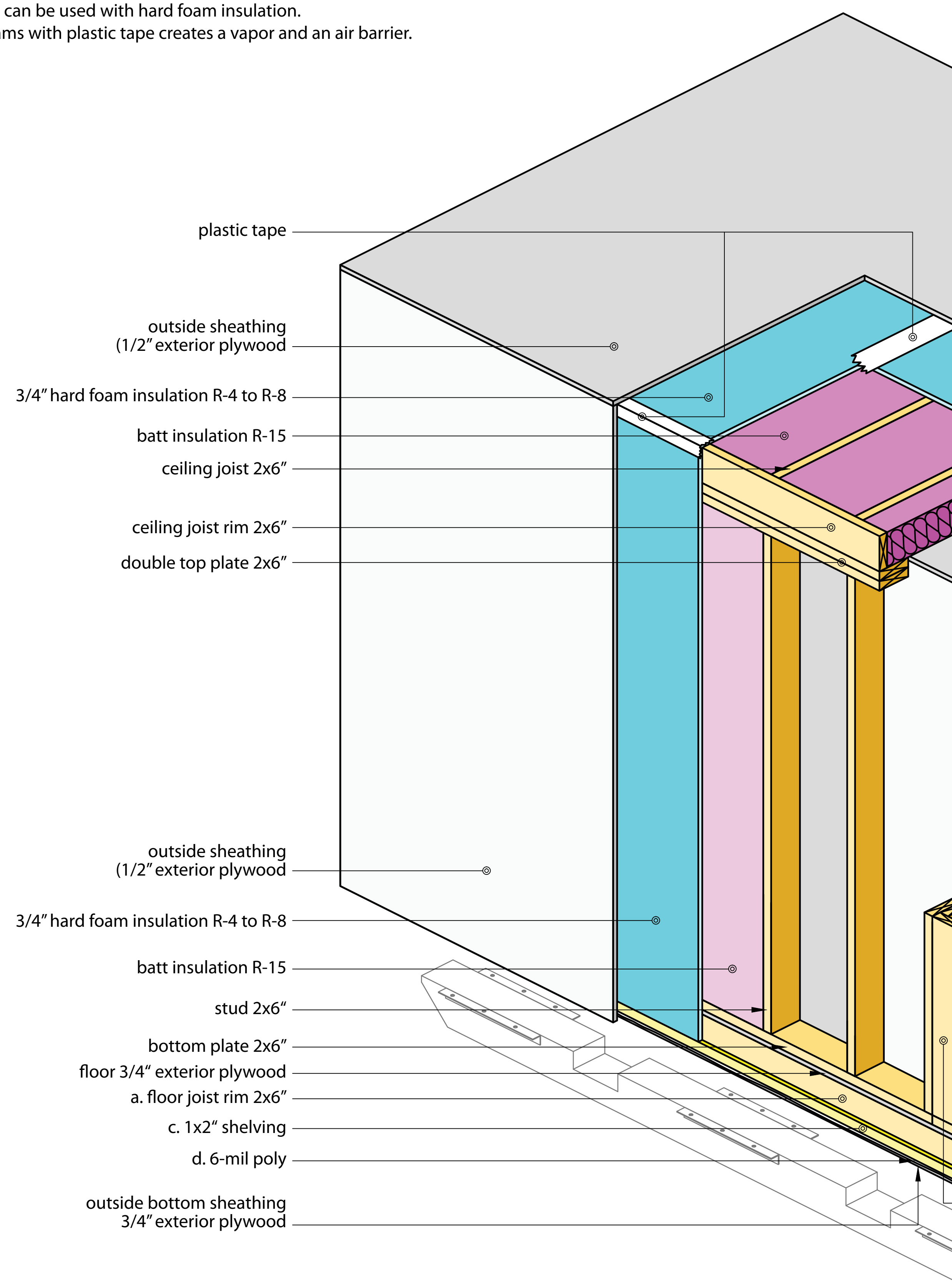
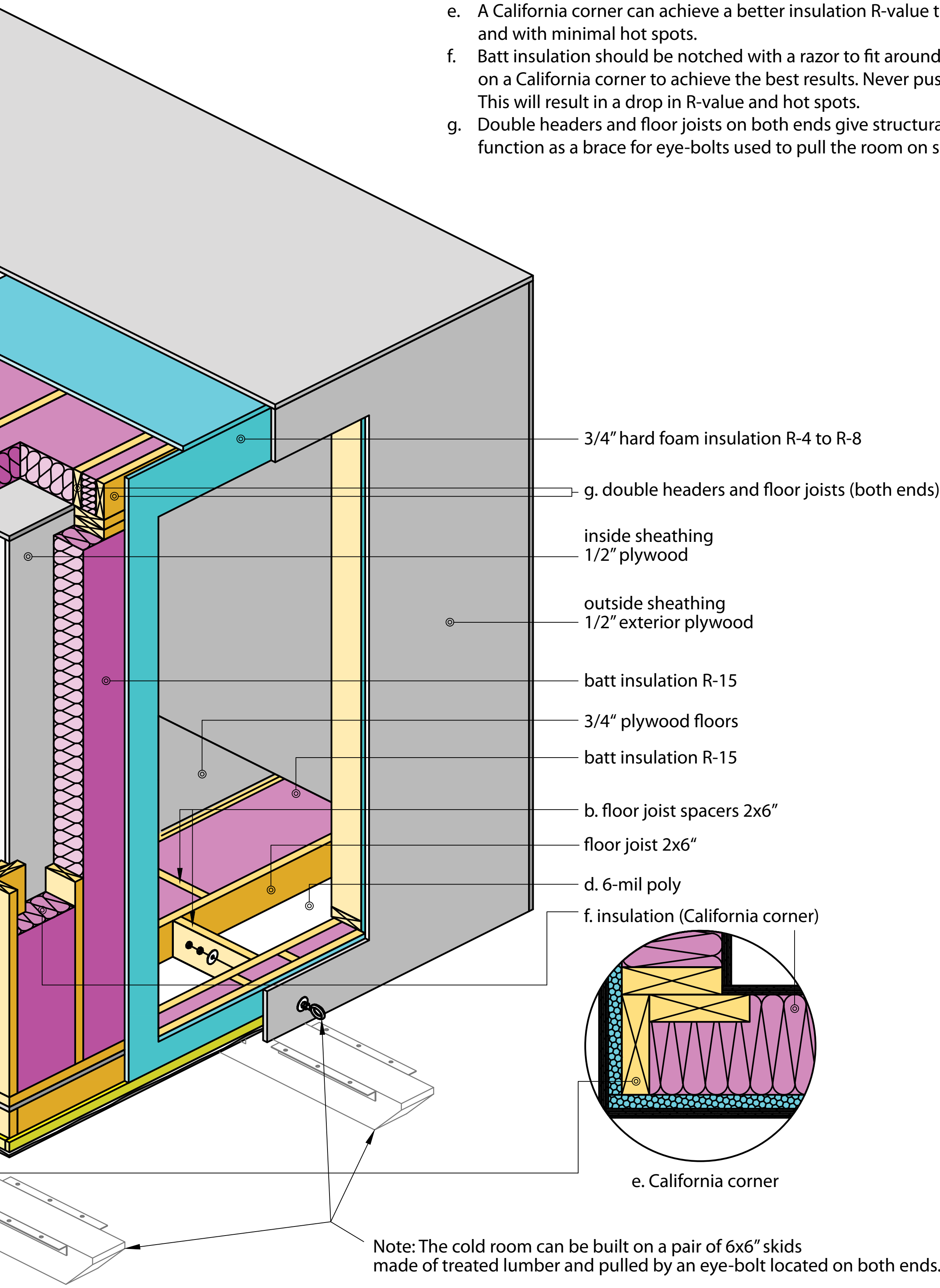
Note: Layered sectional schematic of a cold storage room, 8′x8′x10′, 2x6″ frame 16″ on center (size can vary)
When faced batt insulation is used, facing must be placed toward the outside wall.
Open-faced batt insulation can be used with hard foam insulation.
Sealing the foam at the seams with plastic tape creates a vapor and an air barrier.



a. Floor joist rim, rim, and joist are 2x6" and framed 16" on center.
b. Place spacers between the floor joists for support.
c. Use 1x2" shelving to trim the floor joist rim supporting the hard foam insulation.
d. 6-mil poly is applied on top of outside bottom sheathing and below floor insulation. Allow a generous overhang. This creates an airspace and vapor barrier substituting for the barrier the hard foam insulation creates. Foam was not used under the floor because foam compresses under weight.
e. A California corner can achieve a better insulation R-value than conventional corners, and with minimal hot spots.
f. Batt insulation should be notched with a razor to fit around inside corner board on a California corner to achieve the best results. Never push insulation into corners. This will result in a drop in R-value and hot spots.
g. Double headers and floor joists on both ends give structural strength and function as a brace for eye-bolts used to pull the room on skids.



about the same cost. Since this is a cooler, sealing for vapor barriers is to the outside (the hotter side) of the constructed walls.

Although the cold room was constructed with exterior-grade plywood and paint, it was designed to be used under roof cover such as in a barn. A roof was added to the demonstration unit later so that it could be left outside exposed to the weather for periods of time without leakage into the walls, which will damage the insulation. The roof was specially designed to withstand damage during transport. A simpler roof and siding designed to shed water could be added to this unit if it is needed to serve as a stand-alone outside building.

The demonstration unit was mounted on skids made out of 6 x 6 treated lumber so that it could be dragged around and to make the base sturdier for lifting the unit for transport. A cold room could be built in place without the skids if it is not going to be moved. In that case, a proper foundation should be used. If the floor is built out of wood, it should not sit directly on the ground. Note that it is a good idea to insulate the floor, even when a concrete floor is used, because there are significant thermal losses through the floor in a cooler. Also, consideration should be given to including a drain in the floor, as vegetables to be stored are sometimes brought in wet.

A drawing showing construction details is included to aid in building the cold room. Detailed construction plans and a materials list with costs are available online at the Department of Biosystems and Agricultural Engineering Web site at http://www.bae.uky.edu/ext/Specialty_Crops/. It should be noted that the costs are as of June 2009 and are from a major building supply chain. The costs will vary depending on suppliers and will change over time.

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