Northwest Portable Classroom Project

Retrofit Guidelines for the Pacific Northwest

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BUILDING AMERICA EFFICIENT PORTABLE CLASSROOM PROGRAM

RETROFIT GUIDELINES FOR THE PACIFIC NORTHWEST

Purpose: To ensure the most energy-efficient operation of existing portable classrooms by providing efficient and cost-effective envelope, air sealing and control measures. Implementation of these guidelines will help ensure lowest life cycle costs, maintain acceptable indoor air quality and comfort standards while providing a suitable learning environment.

These guidelines have been developed with support from the US Department of Energy's Building America Program partners and the Oregon Office of Energy, the Idaho Energy Division of the Department of Water Resources and Washington State University Energy Program.

Additional information is available at: http://www.BAIHP.org

Technical assistance regarding these guidelines is available from:

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- Idaho Department of Water Resources, Energy Division – Bob Minter: (208) 327-7970
- Oregon Office of Energy – Betty Merrill/Justin Klure: (503) 373–1581

Introduction: The decision to retrofit an existing portable classroom with energy-efficient measures is a complex one. While the lack of energy-efficient envelope measures may result in costly utility bills and comfort issues, the cost of installing most measures will likely not be cost-effective. There are specific instances where it makes sense to retrofit:

- In the event of a portable classroom that is scheduled for removal and demolition, retrofitting the classroom may be extremely cost-effective, in that the cost for retrofit is much less than the cost for disposal.
- In the event that building components are replaced, they should be replaced with the most energy-efficient possible.
- There are specific measures that are always cost-effective, or are cost effective in most situations.

Table 1 lists the potential retrofit measures for portable classrooms, and identifies instances where retrofitting the building component may be appropriate. Details for specific measures are listed below the table.

Table 1. Recommended Portable Classroom Retrofit Specifications

Component	Description	Component U-factor	Nominal R-value	Recommended
Envelope Measures				
Ceilings	T-Bar Ceiling	U-0.033	R30	When existing insulation is R-11 or less, or if insulation is replaced
	Rafter	U-0.033	R30	When existing insulation is R-11 or less, or if insulation is replaced
Walls	4 inch	U-0.077	R13	If siding is removed or insulation is replaced
	6 inch	U-0.053	R19	If siding is removed or insulation is replaced
Floors	Joists	U-0.041	R30	If insulation is replaced
Glazing		U-0.37[1]	n/a	If glazing is replaced
Skylights		U-0.5[1]	n/a	If skylight is replaced
Exterior Doors[2,3]		U-0.19	n/a	If door is replaced
Air Sealing				
Overall building leakage	Measured overall building leakage less than or equal to 8 air changes per hour (ACH) at 50 Pascals (Pa), determined by a blower door test.			In all cases
Penetrations in building envelope	All penetrations caulked or otherwise sealed to limit air leakage (see detail below)			As appropriate (see detail below)
Ceiling Air Barrier	T-bar drop ceiling	A 4-6 mil polyethelene air barrier shall be installed on the warm side of the insulation and caulked at penetrations, overlaps and at the outside edges of the ceiling/roof junction.		For all drop T-bar ceilings
	Roof rafter ceiling	A 4-6 mil polyethelene air barrier shall be installed under the insulation, stapled to the roof rafters, and sealed with caulk at the edges.		For roof rafter ceilings, if drywall is removed.

Table 1. Recommended Portable Classroom Retrofit Specifications (continued)

Mechanical Systems		
\HVAC control	The HVAC system shall be controlled by a 365-day programmable thermostat equipped with an occupancy sensor for ventilation system control.	In all cases
Ventilation System	A mechanical ventilation system must be provided, capable of providing 15cfm per occupant	In all cases
Lighting	All interior ceiling lighting shall be rapid start T-8 fluorescents with electronic ballasts with a CRI of 75. The controls shall be an on-off switch for each bank of lights.	If fixtures are replaced

[1]NFRC tested U-factor
[2]Door frame shall be of thermally improved material(s).
[3]Up to 1 ft^2 of security glass is allowed in doors.

Glazing and skylights
As the total square feet of windows is usually small in most portable classrooms (approximately 48 $ft.^2$), it is not cost-effective to replace old windows unless seals have failed, admitting moisture from the exterior.

Penetrations through building envelope
All penetrations shall be caulked or otherwise sealed to limit air leakage, including the following:

- *All window and door frames* - sealed to the building envelope. If the seal is made on exterior grooved siding, then the groove lines shall be sealed at the door or window frame.
- *Exterior-wall sole plates and the structural floor* - caulked using silicon caulking or approved alternate.
- *All receptacles, switches or other electric boxes in exterior walls* - sealed or fitted with outlet plate gaskets.
- *HVAC ducts* - sealed at interior surfaces where ducts penetrate the building envelope.
- *Around openings in the building envelope for HVAC and ventilation ducts, and wiring.*
- *All other penetrations in the building envelope.*

Ceiling air barrier
Most of the portable classrooms built after 1990 do not use sheetrock ceilings; rather, they incorporate a T-bar dropped ceiling with tiles. This type of ceiling typically has no air sealing to control air leakage, and represents a major source of heat loss in the classroom.

To combat this heat loss, a 4-6 mil polyethelene air barrier shall be installed above the ceiling tiles and below the insulation. All penetrations through this air barrier shall be sealed with silicone caulking; the same shall be done for any overlaps and the perimeter of the air barrier.

Portable classrooms that have the ceiling insulation installed in the roof rafters shall have the air barrier installed under the insulation, stapled to the roof rafters, and sealed with caulk at the edges.

HVAC Control

Most of the portable classrooms in the Northwest region are controlled by 7 day programmable thermostats. The result of this type of control is that the HVAC system operates throughout the year, even during holidays and vacations. Even new units that were installed during the study exhibited this behavior.

In addition, many portable classrooms are controlled by CO_2 sensors. The BAIHP study determined that CO_2 sensors can be unreliable as a control strategy, since they go out of calibration easily, and many HVAC installers and school maintenance personnel do not have the proper equipment to calibrate them.

New low-cost, 365-day programmable thermostats are available, with occupancy sensor control for the ventilation system; they are highly recommended for all portable classrooms, regardless of age. Estimated simple payback for these thermostats is 2-3 years.