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Analysis to Determine Thermal Mass Performance of a Typical 9-in. ICFA Form Wall

Dear Mr. Whitaker:

In accordance with your letter dated December 17, 1995, Construction Technology Laboratories, Inc. (CTL) has performed analyses to predict the thermal performance of a typical 9-in. insulated concrete stay-in-place form wall section. The analyzed wall was selected by the Insulated Concrete Form Association (ICFA) as being representative of the products produced by the ICFA member companies. The ENVSTD compliance program for ASHRAE/IES Standard 90.1 was used to determine the R-value of a frame wall that would have the same total heating and cooling load as the typical 9-in. ICFA wall in 38 cities located in U.S. and Canadian climate groupings. The analyses use dimensions and insulation properties provided by the ICFA. The analyses methods, assumptions, and calculated results are included in this report.

SUMMARY AND CONCLUSIONS

The steady-state thermal resistance (R-value) of the typical ICFA wall section was calculated by CTL using methods in the *ASHRAE Handbook - 1993 Fundamentals*. The calculated R-value of the typical 9-in. ICFA wall section, which includes resistances of air films, is 17.8 $hr \cdot ft^2 \cdot °F/Btu$. The wall section was assumed to consist of 2 in. of expanded polystyrene insulation on each side of a 5-in. concrete core. The interfaces between the concrete and insulation are assumed to be flat and parallel. The ties connecting the insulating layers are assumed to be plastic. Calculations assume no thermal bridges pierce the 9-in. typical wall section. The thermal resistance of the expanded polystyrene insulation was provided by ICFA and is assumed to be 4.17 $hr \cdot ft^2 \cdot °F/Btu$ per inch.

Results in this report are valid for other insulated concrete wall systems provided the wall has an R-value of at least 17.8 $hr \cdot ft^2 \cdot °F/Btu$ and a heat capacity of at least 12 $Btu/ft^2 \cdot °F$. All thermal bridges, including wood, concrete, or metal, must be accounted for using the the ASHRAE zone or isothermal planes methods when determining the R-value of a wall system.

Version 2.1 of the ENVSTD compliance program for ASHRAE/IES Standard 90.1 was used to determine the R-value of a frame wall that would have the same total heating and cooling load as the typical 9-in. ICFA wall section in 38 cities in U.S. and Canadian climate groupings for a prototypical residential building. The number of cities and range in R-values for low-mass walls with equivalent total load as the typical 9-in. ICFA wall section are as follows:

R-Value Range for a Low-Mass Wall with Equivalent Performance to the Typical 9-in. ICFA Wall Section	Number of Cities, Residential Building
No equivalent low-mass wall*	10
greater than 50	15
greater than 40 but less than or equal to 50	4
greater than 30 but less than or equal to 40	5
greater than 20 but less than or equal to 30	4
less than or equal to 20	0

* For these cities, no low-mass wall, regardless of the amount of insulation, has a total load as low as the 9-in. ICFA wall section.

CALCULATED EQUIVALENT PERFORMANCE OF THE TYPICAL ICFA WALL AND A FRAME WALL

The ENVSTD compliance program, version 2.1, for ASHRAE Standard 90.1—1989 was used to determine the R-value of a frame wall that would have the same heating and cooling load as the typical 9-in. ICFA wall section in 38 cities. The 38 cities represent a major city from each of the 38 climate groupings in the prescriptive portion of the standard. The calculated equivalent performance was determined for an above-grade wall in a typical residential building. The calculated equivalent performance is dependent on the building selected and the climate. The ENVSTD program was developed for commercial building compliance and may not be applicable to residential buildings; however, in our opinion, is adequate for comparison purposes.

ASSUMPTIONS AND METHODOLOGY

For the analysis of the prototypical building, the typical 9-in. ICFA wall was calculated to have a U-factor of 0.0561 (R-value of 17.8 $hr \cdot ft^2 \cdot °F/Btu$). The thermal resistance (R-value) and thermal transmittance (U-factor) were calculated by CTL using the method on page 20.8 of the *ASHRAE Handbook - 1993 Fundamentals*. The wall section was assumed to consist of 2 in. of expanded polystyrene insulation on each side of a 5-in. concrete core. The interfaces between the concrete and insulation are assumed to be flat and parallel. The ties connecting the insulating layers are assumed to be plastic. No thermal bridges pierce the 9-in. typical wall section. The thermal resistance of the expanded polystyrene insulation was provided by ICFA and is assumed to be 4.17 $hr \cdot ft^2 \cdot °F/Btu$ per inch. The combined thermal resistance of the interior and exterior air films was assumed to be 0.85 $hr \cdot ft^2 \cdot °F/Btu$. Assuming a density of 145 lb per cu ft for reinforced concrete, an average concrete thickness of 5-in., and a specific heat of concrete of 0.20 $Btu/lb \cdot °F$, the heat capacity was calculated to be 12 $Btu/ft^2 \cdot °F$, and the thermal resistance was calculated to be 0.3 $hr \cdot ft^2 \cdot °F/Btu$. The insulation was assumed to be integral as opposed to exterior or interior.

The prototypical residential building was assumed to be an 1800 sq ft ranch with a 20% window to wall ratio. The following characteristics were input in ENVSTD to determine loads for the analysis. The building had 424 sq ft of above-grade wall area and 84.8 sq ft of glazing area per orientation (north, south, east, and west.) The equipment power density was assumed to be 0.75 W per sq ft, the value for multifamily buildings in Table 8-4, page 29 of ASHRAE/IES Standard 90.1. The lighting power density was assumed to be 0.0 W per sq ft.

For each building and city analyzed, the glazing shading coefficient and U-value are those that meet the prescriptive requirements for that city and are printed in the far right column of the screen in the ENVSTD program.

ASHRAE/IES Standard 90.1 contains 38 alternate compliance packages or ACP tables. One major city from each ACP table was selected for use in this analysis. First, building characteristics and wall properties for the typical 9-in. ICFA wall were entered into the ENVSTD program, version 2.1. The ENVSTD program gave heating, cooling, and total loads for each building type and city. Then, the ENVSTD program was used to determine the U-factor of a frame wall with a heat capacity of 1 Btu/ft^2·°F that would have the same total load as the building with typical 9-in. ICFA walls. This was repeated for each city for the prototypical residential building. A conventional wood frame wall with studs at 16 in. on center and additional wood framing for plates, sills, and headers has a heat capacity approximately equal to 1 Btu/ft^2·°F.

RESULTS

The results of the analysis for the prototypical residential building are presented in Table 1. The first two columns list the city selected for the analysis and the corresponding ACP table in ASHRAE/IES 90.1. The next two columns list the glazing criteria for each city. These shading coefficients and U-factors were used as input in the analysis. The three columns under "Typical 9-in. ICFA Wall Load" lists the heating, cooling, and total building loads as determined by ENVSTD for the building with the typical 9-in. ICFA walls. The three columns under "Low-Mass Wall Loads" lists the heating, cooling, and total building loads as determined by ENVSTD for the building with frame walls that had the closest total load as that for the typical 9-in. ICFA walls. The U-factor and R-value are listed for this low-mass wall with equivalent performance to the typical 9-in. ICFA wall.

In some cases, indicated by "**" in Table 1, no low-mass wall with a heat capacity of 1 Btu/ft^2·°F, regardless of the amount of insulation, has a total load as low as the typical 9-in. ICFA wall. For these cases the U-factor and R-value listed are for the lowest load for a low-mass wall, and this load is greater than that for the typical 9-in. ICFA wall.

For the prototypical residential building, ten cities have no low-mass wall at any R-value that has a total heating and cooling load as low as the typical 9-in. ICFA wall. Of the remainder, the number of cities and range in R-values for low-mass walls with equivalent total load as typical 9-in. ICFA walls are as follows: fifteen cities have R-values of 50 or more, four have R-values of 40 to 50, five have R-values of 30 to 40, four have R-values of 20 to 30, and no cities have R-values below 20.

Table 2 contains data from Table 1 which has been extrapolated to various cities across the United States and Canada. The first three columns list the state (or province), city, and the corresponding ACP table in ASHRAE/IES 90.1. The remaining two columns list the U-factor and R-value for the low-mass wall with equivalent performance to the typical 9-in. ICFA wall as determined from the analysis presented in Table 1. The analysis was performed only for those cities in Table 1, also indicated by an asterisk "*" in Table 2. All cities within an ACP table climate grouping are assumed to yield the same result as the city analyzed in Table 1. In actuality, if analyses were performed for each city, values for cities within each climate grouping would be similar, but would vary.

DISCLAIMER

The wall analyzed is a typical wall as described by ICFA and may not be identical to walls constructed or represented by ICFA member companies. Results in this report are valid for other insulated concrete wall systems provided the wall has an R-value of at least 17.8 $hr \cdot ft^2 \cdot °F/Btu$ and a heat capacity of at least 12 $Btu/ft^2 \cdot °F$. All thermal bridges, including wood, concrete, or metal, must be accounted for using the the ASHRAE zone or isothermal planes methods when determining the R-value of a wall system.

It is important to note that the calculations of equivalent performance were not performed on all cities listed in Table 2. Data presented in Table 2 assumes that the equivalent R-value (U-factor) for all cities within an ACP table is the same. The calculated equivalent R-value may or may not be the same; however, it is our opinion that for comparison purposes results are similar.

These results are for particular buildings with particular characteristics in selected climates. The ENVSTD program is used for compliance with ASHRAE/IES Standard 90.1 and is not a building simulation program. Building performance is dependent on many factors besides wall properties. Also, both R-value and mass affect the building heating and cooling loads. Results should not be construed to indicate that the typical 9-in. ICFA wall has an R-value greater than 17.8. Rather, the typical 9-in. ICFA wall has performance equivalent to that of a low mass wall with higher R-values.

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Please contact me if you have any questions or need further information. Our telephone area code has changed to 847.

Sincerely,

M G Van Geem

Martha G. Van Geem, P.E.
Principal Engineer

Copies to:
Lance Berrenberg, American Polysteel Forms
Donald Pruss, GREENBLOCK WorldWide Corp.
Patrick Boeshart, Lite-Form, Inc.
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TABLE 1 — RESULTS OF PROTOTYPICAL RESIDENTIAL BUILDING ANALYSIS USING ENVSTD TO DETERMINE WALL WITH EQUIVALENT PERFORMANCE AS A 9-IN. ICFA TYPICAL FORM WALL*

Selected City, State	ACP Table	Glazing Criteria		Typical 9-in. ICFA Wall Loads			Low-Mass Wall Loads			Low-Mass Wall with Equivalent Performance	
		Shading Coefficient	U-Factor	Heating	Cooling	Total	Heating	Cooling	Total	U-Factor	R-Value
Honolulu, HI	1	0.500	1.150	0.392	56.143	56.535	0.418	57.219	57.638	<0.020	>50**
San Juan, PR	2	0.500	1.150	0.465	65.110	65.575	0.491	65.746	66.238	<0.020	>50**
Arcata, CA	3	0.756	0.648	4.397	9.417	13.814	3.557	10.258	13.815	<0.020	>50
Oakland, CA	4	0.628	1.150	4.351	13.101	17.452	3.811	14.714	18.525	<0.020	>50**
San Francisco, CA	5	0.556	0.791	2.384	11.703	14.088	1.758	13.395	15.153	<0.020	>50**
Los Angeles, CA	6	0.500	1.150	2.745	16.327	19.072	2.555	18.046	20.601	<0.020	>50**
Birmingham, AL	7	0.500	1.150	10.929	28.852	39.781	9.817	29.965	39.782	<0.020	>50
Atlanta, GA	8	0.362	0.804	10.228	21.865	32.093	8.966	23.127	32.093	<0.020	>50
Sacramento, CA	9	0.500	1.150	6.509	24.394	30.904	5.800	25.766	31.566	<0.020	>50**
Houston, TX	10	0.500	1.150	3.963	41.705	45.668	3.629	42.681	46.310	<0.020	>50**
Little Rock, AR	11	0.350	0.803	10.488	26.149	36.638	9.534	27.104	36.638	<0.020	>50
Tampa, FL	12	0.500	1.150	1.384	44.885	46.269	1.275	46.042	47.317	<0.020	>50**
Wichita Falls, TX	13	0.350	0.806	10.482	27.934	38.416	9.702	28.713	38.415	<0.020	>50
Las Vegas, NV	14	0.500	1.150	6.241	46.806	53.047	5.858	47.187	53.045	<0.020	>50
Miami, FL	15	0.500	1.150	0.331	55.762	56.093	0.230	56.691	56.921	<0.020	>50**
Orlando, FL	16	0.500	1.150	1.251	47.532	48.783	1.145	48.686	49.830	<0.020	>50**
Yuma, AZ	17	0.500	1.150	2.992	63.341	66.334	2.934	63.400	66.334	<0.020	>50
Phoenix, AZ	18	0.500	1.150	3.392	53.430	56.822	3.277	53.543	56.820	<0.020	>50
Seatule/Tacoma, WA	19	0.719	0.628	12.561	9.557	22.117	11.285	10.834	22.119	<0.020	>50
Medford, OR	20	0.577	0.659	11.414	17.556	28.970	9.881	19.091	28.972	<0.020	>50
Winslow, AZ	21	0.350	0.682	12.876	18.949	31.824	11.606	20.217	31.823	<0.020	>50
Nashville, TN	22	0.421	0.761	12.515	23.656	36.170	11.281	24.889	36.170	<0.020	>50
Oklahoma City, OK	23	0.350	0.744	13.693	23.932	37.626	12.613	25.012	37.625	<0.020	>50
Fort Smith, AR	24	0.350	0.778	12.136	26.278	38.414	11.141	27.273	38.414	<0.020	>50
New York (Central Park), NY	25	0.584	0.648	17.183	18.492	35.675	15.944	19.731	35.675	0.024	42.0
Chicago, IL	26	0.546	0.558	21.602	20.305	41.906	20.238	21.671	41.909	0.029	34.1
Erie, PA	27	0.646	0.536	21.258	14.569	35.827	19.977	15.848	35.825	0.031	32.5
Denver, CO	28	0.533	0.563	15.090	17.472	32.562	13.475	19.089	32.563	<0.020	>50
Saint Louis, MO	29	0.432	0.661	17.838	22.789	40.627	16.547	24.078	40.624	0.023	42.7
Dodge City, KS	30	0.378	0.640	17.914	21.066	38.980	16.597	22.384	38.981	0.023	42.7
Des Moines, IA	31	0.543	0.534	22.175	18.442	40.617	20.727	19.893	40.620	0.029	34.5
Flint, MI	32	0.650	0.497	23.291	14.743	38.034	21.914	16.118	38.032	0.032	31.3
Minneapolis, MN	33	0.606	0.450	28.347	18.403	46.750	26.902	19.846	46.748	0.035	28.7
Cheyenne, WY	34	0.628	0.473	16.836	15.399	32.235	15.204	17.033	32.237	0.023	42.9
Bryce Canyon, UT	35	0.731	0.450	17.412	15.326	32.738	16.046	16.688	32.733	0.026	39.1
Duluth, MN	36	0.730	0.450	32.800	10.411	43.212	31.615	11.599	43.215	0.040	24.8
Anchorage, AK	37	0.834	0.450	26.818	4.778	31.596	26.072	5.524	31.596	0.043	23.5
Fairbanks, AK	38	0.793	0.450	50.587	6.018	56.605	49.616	6.985	56.600	0.049	20.5

* The prototypical residential building was assumed to be an 1800 sq ft ranch with a 20% window to wall ratio. The equipment power density and lighting power density, respectively, were assumed to be 0.75 W per sq ft and 0.0 W per sq ft.

** For these cities, no low-mass wall with a heat capacity of 1 Btu/ft²·°F, regardless of the amount of insulation, has a total load as low as the typical 9-in. IFCA form wall. The U-factors, R-values, and low-mass wall loads correspond to minimum loads for that city and the corresponding U-factor and R-value.

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES†

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Alberta	Calgary	36	0.0403	24.8
	Cold Lake	38	0.0487	20.5
	Coronation	36	0.0403	24.8
	Edmonton	36	0.0403	24.8
	Fort McMurray	38	0.0487	20.5
	Grande Prarie	38	0.0487	20.5
	Lethbridge	33	0.0348	28.7
	Medicine Hat	33	0.0348	28.7
	Peace River	38	0.0487	20.5
	Red Deer	36	0.0403	24.8
	Rocky Mountain House	36	0.0403	24.8
	Vermillion	38	0.0487	20.5
	Whitecourt	38	0.0487	20.5
British Columbia	Abbotsford	27	0.0308	32.5
	Cape St. James	19	<0.020	>50
	Comox	27	0.0308	32.5
	Fort Nelson	38	0.0487	20.5
	Fort St. John	38	0.0487	20.5
	Kamloops	27	0.0308	32.5
	Penticton	27	0.0308	32.5
	Port Hardy	27	0.0308	32.5
	Prince George	36	0.0403	24.8
	Prince Rupert	37	0.0425	23.5
	Quesnel	33	0.0348	28.7
	Sandspit	27	0.0308	32.5
	Smithers	37	0.0425	23.5
	Spring Island	19	<0.020	>50
	Terrace	32	0.0319	31.3
	Tofino	19	<0.020	>50
	Vancouver	19	<0.020	>50
	Victoria	19	<0.020	>50
	Williams Lake	33	0.0348	28.7
Manitoba	Brandon	38	0.0487	20.5
	Dauphin	38	0.0487	20.5
	Portage La Prarie	36	0.0403	24.8
	The Pas	38	0.0487	20.5
	Thompson	38	0.0487	20.5
	Winnipeg	38	0.0487	20.5
New Brunswick	Charlo	36	0.0403	24.8

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
New Brunswick	Chatham	33	0.0348	28.7
	Fredericton	33	0.0348	28.7
	Moncton	33	0.0348	28.7
	Saint John	33	0.0348	28.7
Newfoundland	Battle Harbour Lor	37	0.0425	23.5
	Bonavista	37	0.0425	23.5
	Cartwright	38	0.0487	20.5
	Daniels Harbour	37	0.0425	23.5
	Deer Lake	37	0.0425	23.5
	Gander	37	0.0425	23.5
	Goose Bay	38	0.0487	20.5
	Hopedale	38	0.0487	20.5
	St. Johns	37	0.0425	23.5
	Stephanville	37	0.0425	23.5
	Wabush Lake	38	0.0487	20.5
Northwest Territories	Fort Smith	38	0.0487	20.5
Nova Scotia	Greenwood	32	0.0319	31.3
	Sable Island	27	0.0308	32.5
	Shearwater (Halifax)	32	0.0319	31.3
	Sydney	33	0.0348	28.7
	Yarmouth	32	0.0319	31.3
Ontario	Atikokan	38	0.0487	20.5
	Big Trout Lake	38	0.0487	20.5
	Earlton	38	0.0487	20.5
	Gore Bay	33	0.0348	28.7
	Kapuskasing	38	0.0487	20.5
	Kenora	38	0.0487	20.5
	London	32	0.0319	31.3
	Muskoka	33	0.0348	28.7
	North Bay	36	0.0403	24.8
	Ottowa	33	0.0348	28.7
	Sault Saint Marie	36	0.0403	24.8
	Sioux Lookout	38	0.0487	20.5
	Sudbury	36	0.0403	24.8
	Thunder Bay	36	0.0403	24.8
	Timmins	38	0.0487	20.5
	Toronto	32	0.0319	31.3
	Trenton	33	0.0348	28.7
	Wiarton	33	0.0348	28.7

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Ontario	Windsor	31	0.0290	34.5
Prince Edward Island	Charlottetown	33	0.0348	28.7
	Summerside	33	0.0348	28.7
Quebec	Bagotville	36	0.0403	24.8
	Baie Comeau	36	0.0403	24.8
	Lake Eon	38	0.0487	20.5
	Mont Joli	36	0.0403	24.8
	Montreal	33	0.0348	28.7
	Nitchequon	38	0.0487	20.5
	Quebec	36	0.0403	24.8
	Roberval	36	0.0403	24.8
	Sept-Iles	38	0.0487	20.5
	Sherbrooke	36	0.0403	24.8
	St. Hubert	33	0.0348	28.7
	Ste. Agathe des Monts	36	0.0403	24.8
	Val d'Or	38	0.0487	20.5
Saskatchewan	Broadview	38	0.0487	20.5
	Estevan	36	0.0403	24.8
	Moose Jaw	36	0.0403	24.8
	North Battleford	38	0.0487	20.5
	Prince Albert	38	0.0487	20.5
	Regina	38	0.0487	20.5
	Saskatoon	38	0.0487	20.5
	Swift Current	36	0.0403	24.8
	Uranium City	38	0.0487	20.5
	Wynyard	38	0.0487	20.5
	Yorkton	38	0.0487	20.5
Yukon Territory	Whitehorse	38	0.0487	20.5
Cuba	Guantanamo Bay	2	<0.020	>50**
Other	Koror Island	2	<0.020	>50**
	Kwajalain Island	2	<0.020	>50**
	Wake Island	2	<0.020	>50**
Puerto Rico	San Juan*	2	<0.020	>50**
Alabama	Birmingham*	7	<0.020	>50
	Mobile	10	<0.020	>50**
	Montgomery	10	<0.020	>50**
Alaska	Adak	37	0.0425	23.5
	Anchorage*	37	0.0425	23.5
	Annette Island	37	0.0425	23.5

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Alaska	Bethel	38	0.0487	20.5
	Big Delta	38	0.0487	20.5
	Fairbanks*	38	0.0487	20.5
	Gulkana	38	0.0487	20.5
	Juneau	37	0.0425	23.5
	King Salmon	38	0.0487	20.5
	Kodiak	37	0.0425	23.5
	McGrath	38	0.0487	20.5
	Nome	38	0.0487	20.5
	Summit	38	0.0487	20.5
	Yakutat	37	0.0425	23.5
Arizona	Phoenix*	18	<0.020	>50
	Prescott	21	<0.020	>50
	Tuscon	14	<0.020	>50
	Winslow*	21	<0.020	>50
	Yuma*	17	<0.020	>50
Arkansas	Fort Smith*	24	<0.020	>50
	Little Rock*	11	<0.020	>50
California	Arcata*	3	<0.020	>50
	Bakersfield	12	<0.020	>50**
	China Lake	14	<0.020	>50
	Daggett	14	<0.020	>50
	El Toro	6	<0.020	>50**
	Fresno	9	<0.020	>50**
	Long Beach	6	<0.020	>50**
	Los Angeles*	6	<0.020	>50**
	Mount Shasta	28	<0.020	>50
	Oakland*	4	<0.020	>50**
	Point Mugu	4	<0.020	>50**
	Red Bluff	9	<0.020	>50**
	Sacramento*	9	<0.020	>50**
	San Diego	6	<0.020	>50**
	San Francisco*	5	<0.020	>50**
	Santa Maria	5	<0.020	>50**
	Sunnyvale	4	<0.020	>50**
Colorado	Colorado Springs	28	<0.020	>50
	Denver*	28	<0.020	>50
	Eagle	35	0.0256	39.1
	Grand Junction	30	0.0234	42.7

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Colorado	Pueblo	28	<0.020	>50
Connecticut	Hartford	26	0.0293	34.1
Delaware	Wilmington	25	0.0238	42.0
District of Columbia	Washington	25	0.0238	42.0
Florida	Apalachicola	12	<0.020	>50**
	Daytona Beach	12	<0.020	>50**
	Jacksonville	12	<0.020	>50**
	Miami*	15	<0.020	>50**
	Orlando*	16	<0.020	>50**
	Tallahassee	12	<0.020	>50**
	Tampa*	12	<0.020	>50**
	West Palm Beach	15	<0.020	>50**
Georgia	Atlanta*	8	<0.020	>50
	Augusta	7	<0.020	>50
	Macon	10	<0.020	>50**
	Savannah	10	<0.020	>50**
Hawaii	Barbers Point	1	<0.020	>50**
	Hilo	1	<0.020	>50**
	Honolulu*	1	<0.020	>50**
	Lihue	1	<0.020	>50**
Idaho	Boise	28	<0.020	>50
	Lewiston	25	0.0238	42.0
	Pocatello	34	0.0233	42.9
Illinois	Chicago*	26	0.0293	34.1
	Moline	26	0.0293	34.1
	Springfield	29	0.0234	42.7
Indiana	Evansville	29	0.0234	42.7
	Fort Wayne	26	0.0293	34.1
	Indianapolis	26	0.0293	34.1
	South Bend	26	0.0293	34.1
Iowa	Burlington	26	0.0293	34.1
	Des Moines*	31	0.0290	34.5
	Mason City	33	0.0348	28.7
	Sioux City	31	0.0290	34.5
Kansas	Dodge City*	30	0.0234	42.7
	Goodland	28	<0.020	>50
	Topeka	29	0.0234	42.7
Kentucky	Covington	25	0.0238	42.0
	Lexington	29	0.0234	42.7

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Kentucky	Louisville	29	0.0234	42.7
Louisiana	Baton Rouge	10	<0.020	>50**
	Lake Charles	10	<0.020	>50**
	New Orleans	10	<0.020	>50**
	Shreveport	10	<0.020	>50**
Maine	Bangor	33	0.0348	28.7
	Caribou	36	0.0403	24.8
	Portland	32	0.0319	31.3
Maryland	Baltimore	25	0.0238	42.0
	Patuxent	22	<0.020	>50
Massachusetts	Boston	25	0.0238	42.0
Michigan	Alpena	33	0.0348	28.7
	Detroit	26	0.0293	34.1
	Flint*	32	0.0319	31.3
	Grand Rapids	31	0.0290	34.5
	Sault Sainte Marie	36	0.0403	24.8
	Traverse City	32	0.0319	31.3
Minnesota	Duluth*	36	0.0403	24.8
	International Falls	36	0.0403	24.8
	Minneapolis*	33	0.0348	28.7
	Rochester	33	0.0348	28.7
Mississippi	Jackson	10	<0.020	>50**
	Meridian	10	<0.020	>50**
Missouri	Columbia	29	0.0234	42.7
	Springfield	29	0.0234	42.7
	St. Louis*	29	0.0234	42.7
Montana	Billings	31	0.0290	34.5
	Cutbank	33	0.0348	28.7
	Dillon	33	0.0348	28.7
	Glasgow	36	0.0403	24.8
	Great Falls	32	0.0319	31.3
	Helena	32	0.0319	31.3
	Lewistown	33	0.0348	28.7
	Miles	33	0.0348	28.7
	Missoula	32	0.0319	31.3
Nebraska	Grand Island	31	0.0290	34.5
	North Platte	34	0.0233	42.9
	Omaha	26	0.0293	34.1
	Scottsbluff	34	0.0233	42.9

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Nevada	Elko	34	0.0233	42.9
	Ely	34	0.0233	42.9
	Las Vegas*	14	<0.020	>50
	Lovelock	28	<0.020	>50
	Reno	28	<0.020	>50
	Tonopah	28	<0.020	>50
	Winnemucca	28	<0.020	>50
	Yucca Flats	21	<0.020	>50
New Hampshire	Concord	32	0.0319	31.3
New Jersey	Lakehurst	25	0.0238	42.0
	Newark	25	0.0238	42.0
New Mexico	Albuquerque	23	<0.020	>50
	Clayton	28	<0.020	>50
	Roswell	23	<0.020	>50
	Truth or Consequences	23	<0.020	>50
	Tucumcari	23	<0.020	>50
New York	Albany	31	0.0290	34.5
	Binghampton	32	0.0319	31.3
	Buffalo	31	0.0290	34.5
	Massena	33	0.0348	28.7
	NYC - Central Park*	25	0.0238	42.0
	NYC - LaGuardia	25	0.0238	42.0
	Rochester	31	0.0290	34.5
	Syracuse	31	0.0290	34.5
North Carolina	Asheville	20	<0.020	>50
	Cape Hatteras	7	<0.020	>50
	Charlotte	22	<0.020	>50
	Cherry Point	7	<0.020	>50
	Greensboro	22	<0.020	>50
	Raleigh	22	<0.020	>50
North Dakota	Bismarck	36	0.0403	24.8
	Fargo	36	0.0403	24.8
	Minot	36	0.0403	24.8
Ohio	Akron	26	0.0293	34.1
	Columbus	25	0.0238	42.0
	Dayton	25	0.0238	42.0
	Toledo	26	0.0293	34.1
	Youngstown	26	0.0293	34.1
Oklahoma	Oklahoma City*	23	<0.020	>50

TABLE 2 - EXTRAPOLATION OF RESIDENTIAL BUILDING RESULTS FOR A 9-IN. ICFA FORM WALL FOR U.S. AND CANADIAN CITIES† (Continued)

State/Province	City	ACP No.	Low-Mass Wall with Equivalent Performance	
			U-Factor	R-Value
Oklahoma	Tulsa	24	<0.020	>50
Oregon	Astoria	19	<0.020	>50
	Medford*	20	<0.020	>50
	North Bend	3	<0.020	>50
	Portland	19	<0.020	>50
	Redmond	27	0.0308	32.5
	Salem	19	<0.020	>50
Pennsylvania	Allentown	26	0.0293	34.1
	Avoca (Scranton)	26	0.0293	34.1
	Erie*	27	0.0308	32.5
	Harrisburg	25	0.0238	42.0
	Philadelphia	25	0.0238	42.0
	Pittsburgh	26	0.0293	34.1
Rhode Island	Providence	26	0.0293	34.1
South Carolina	Charleston	10	<0.020	>50**
	Columbia	10	<0.020	>50**
	Greenville	8	<0.020	>50
South Dakota	Huron	33	0.0348	28.7
	Pierre	33	0.0348	28.7
	Rapid City	31	0.0290	34.5
	Sioux Falls	33	0.0348	28.7
Tennessee	Chattanooga	22	<0.020	>50
	Knoxville	22	<0.020	>50
	Memphis	24	<0.020	>50
	Nashville*	22	<0.020	>50
Texas	Abilene	12	<0.020	>50**
	Amarillo	23	<0.020	>50
	Austin	12	<0.020	>50**
	Brownsville	16	<0.020	>50**
	Corpus Christi	16	<0.020	>50**
	Del Rio	12	<0.020	>50**
	El Paso	12	<0.020	>50**
	Fort Worth	12	<0.020	>50**
	Houston*	10	<0.020	>50**
	Kingsville	16	<0.020	>50**
	Laredo	17	<0.020	>50
	Lubbock	23	<0.020	>50
	Lufkin	10	<0.020	>50**
	Port Arthur	10	<0.020	>50**