UNHEATED BUILDINGS

Additional measures are required when using a FPSF on an unheated building. While a drainage layer is only recommended under wing insulation for heated buildings, a 6-inch drainage layer is always required under unheated FPSF designs. Additionally, the horizontal ground insulation extends not only as a wing beyond the perimeter of the building, but continues under the entire unheated portion of the building. This insulation layer can be installed either directly under the slab as shown in Figure 18, or entirely at one level as shown in Figure 19. In either case, the compressive load of the building on the insulation must be determined to compare to the compressive resistance of the foam (see design examples). The horizontal insulation must have a minimum of 10 inches of soil cover.

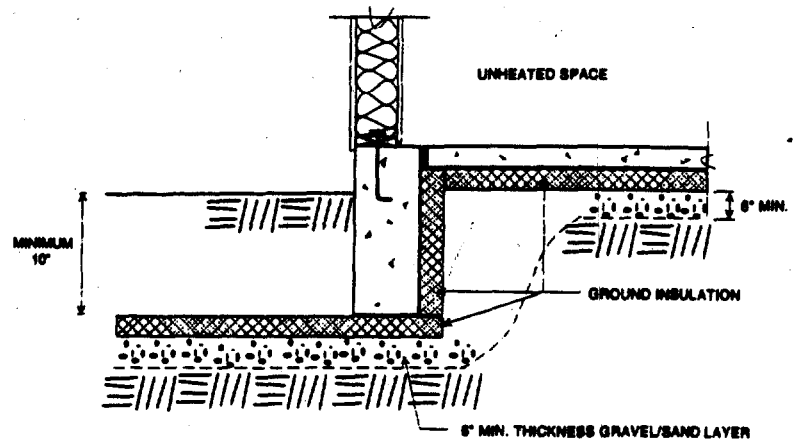

Figure 18. FPSF Design for Unheated Space with Independent Slab and Stem Wall.

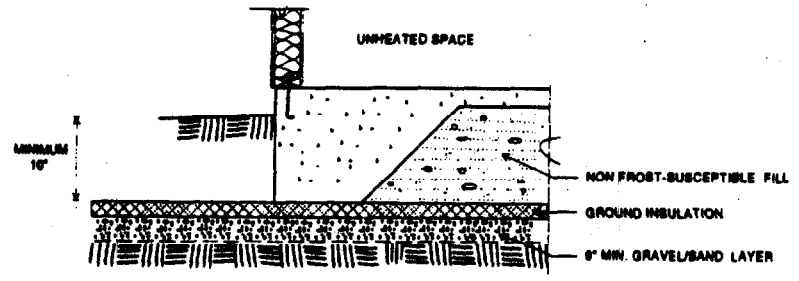

Figure 19. FPSF Design for Unheated Buildings with Insulation in Single Plane.

DETAILED METHOD FOR UNHEATED BUILDINGS

In following the detailed design procedure for unheated slab-on-grade buildings, the designer has the flexibility to increase foundation depths to reduce ground insulation requirements.

Figure 7 illustrates the variables for FPSF design of unheated buildings. The Appendix contains figures and tables for determining and selecting the design variables. The following steps outline the detailed design approach for unheated buildings.

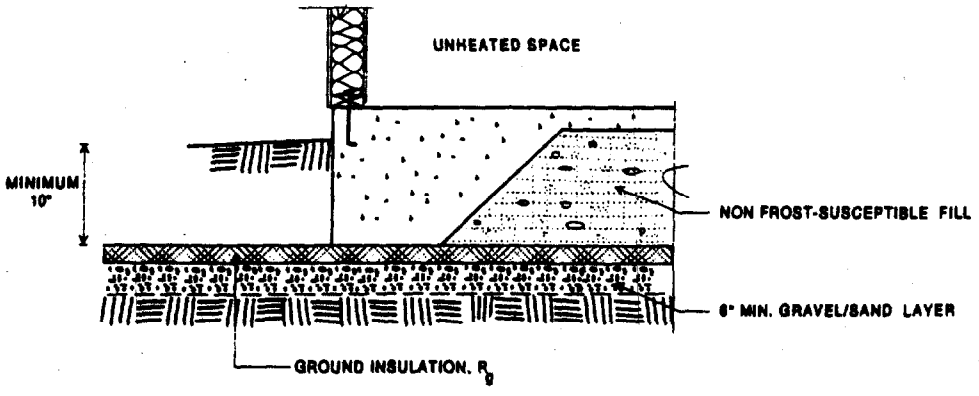

Figure 7. FPSF Design Parameters for Unheated Buildings.

Step 1: Determine Air Freezing Index, F_a, & Mean Annual Temperature

Select the 100-year return period design air freezing index, F_{100}, from Figure A1 or Table A3. Select the mean annual temperature (MAT) from Figure A2 or Table A3. This information was prepared by the National Oceanic and Atmospheric Administration's National Climatic Data Center specifically for use in FPSF design. The F_a values are conservative because they are not adjusted for the insulating benefit of a normal snow cover on the ground. A lower return period value may be used for less important structures or those that are resilient to infrequent ground freezing, such as detached garages. See Table A3 for F_a values at return periods less than 100 years.

Step 2: Select Placement of Ground Insulation

A continuous ground insulation layer with a 6-inch gravel or other non-frost susceptible base must be placed below the entire foundation of unheated buildings. The ground insulation must extend outside the foundation a minimum width, D_g, determined from Table A8 and shown in Figures 7 and A3. In unheated building foundations, D_g is the same at both corner and wall locations. Outside the foundation perimeter, the insulation must have a minimum of 10 inches of soil cover. D_g may be reduced by 1.25 inch for every inch the insulation is buried beyond the 10 inch minimum cover.

Step 3: Select the Minimum Effective R-value of Ground Insulation, R_g

Select the minimum required R-value, R_g, required for the ground insulating layer from Table A8 based on F_n and MAT from Step 1. R_g may be reduced by 0.3R for every 1-inch the underlying non-frost susceptible layer is increased beyond the 6 inch minimum thickness. R_g may also be reduced by 0.3R for every 1-inch increase in soil cover, above the 10 inch minimum, over the ground insulation.

Step 4: Select Thickness of Ground Insulation

Based on the required R_g value determined in Step 3, select an adequate thickness of XPS ground insulation assuming an effective resistivity of 4.5 R/inch. Recommended nominal thicknesses of XPS are 1", 1-1/2", 2", and 3". In severe climates, insulation may need to be layered to meet the required thickness.

SPECIAL CONDITIONS

Small Unheated Areas in Otherwise Heated Buildings

Where small (as defined in Figure A4 of the Appendix) unheated perimeter parts of an otherwise heated building are encountered, follow the design procedure for heated buildings and address the small unheated part as follows:

- Continue the vertical wall insulation of the heated part of the building along the exterior face of the small unheated part.
- Consider the small unheated area a corner location and provide protection, with wing insulation or increased foundation depth if desired, according to Step 7 of the design procedure for heated slab-on-grade buildings.
- Provide ground insulation as required for unheated slab-on-grade buildings under the small unheated area.

Large Unheated Areas in Heated Buildings

When an unheated building area does not meet the conditions for a small building part, it is considered a large unheated area. This situation is commonly encountered in homes with unconditioned attached garages. When large unheated areas are encountered, regard the heated and unheated sections as separate buildings and design the foundations accordingly.

Semi-Heated Buildings

If the anticipated operating conditions of the building are such that the lowest average internal monthly temperature of a building (or crawlspace) falls between 41 °F (5 °C) and 63 °F (17 °C), the building is considered semi-heated. In this case, design the foundation as a heated building and increase the minimum required foundation depth by 8 inches in both wall and corner areas.

Table A3.
Estimates of the Air-Freezing Index (°F-days) at Various Locations and Return Periods

LOCATION	MEAN ANNUAL TEMPERATURE (°F)	RETURN PERIOD ESTIMATES (F_n)				
		100-YR	50-YR	25-YR	5-YR	2-YR
ALASKA, ELMENDORF AFB	35.0	3427	3317	3190	2777	2347
COLORADO, DENVER	50.3	712	653	589	408	261
CONNECTICUT, HARTFORD	49.7	938	880	815	619	444
IDAHO, IDAHO FALLS	43.8	2353	2202	2035	1537	1092
ILLINOIS, CHICAGO	50.6	1433	1334	1225	904	625
INDIANA, SOUTH BEND	49.4	1379	1286	1183	880	270
IOWA, FORT DODGE	47.4	2132	2031	1917	1561	1216
KANSAS, TOPEKA	54.1	1000	919	831	581	376
KENTUCKY, LEXINGTON	54.9	720	642	560	343	190
MAINE, PORTLAND	45.0	1407	1353	1290	1091	889
MICHIGAN, LANSING	47.2	1529	1454	1370	1107	854
MINNESOTA, DULUTH	38.2	3126	3060	2984	2729	2448
MISSOURI, JEFFERSON CITY	55.1	903	804	700	427	234
MONTANA, LEWISTOWN	41.9	2473	2319	2147	1632	1170
NEBRASKA, NORTH PLATTE	48.1	1686	1582	1466	1118	805
NEVADA, ELKO	46.2	1526	1398	1258	867	551
NEW HAMPSHIRE, CONCORD	45.3	1599	1537	1466	1239	1010
NEW YORK, SYRACUSE	47.7	1213	1163	1106	925	744
NORTH DAKOTA, BISMARCK	41.3	3359	3239	3102	2659	2205
OHIO, MANSFIELD	48.2	1367	1278	1178	883	622
OREGON, BAKER	45.6	1446	1312	1167	771	466
PENNSYLVANIA, STATE	49.3	1169	1082	987	712	479
SOUTH DAKOTA, REDFIELD	43.9	3005	2885	2748	2310	1872
UTAH, OGDEN	50.8	1081	968	849	532	301
VERMONT, BURLINGTON	44.1	2054	1958	1905	1646	1379
VIRGINIA, BIG MEADOWS	47.2	1149	1062	966	690	458
WASHINGTON, SPOKANE	47.2	1232	1120	998	664	405
WEST VIRGINIA, ELKINS	49.4	1045	950	848	567	347
WISCONSIN, WAUSAU	42.4	2492	2427	2353	2106	1840
WYOMING, SHERIDAN	44.6	2283	2157	2015	1584	1181

Table A8
MINIMUM THERMAL RESISTANCE, R_g OF GROUND INSULATION AND HORIZONTAL EXTENSION, D_g, FOR UNHEATED BUILDINGS

Mean Annual Temperature (°F):		32	36	38	40	≥ 41
F_n (°F-day):	D_g (inches):					
750 or less	30	5.7	5.7	5.7	5.7	5.7
1,500	49	13.1	9.7	8.5	8.0	6.8
2,250	63	19.4	15.9	13.6	11.4	10.2
3,000	79	25.0	21.0	18.2	15.3	14.2
3,750	91	31.2	26.1	22.7	--	--
4,500	108	37.5	31.8	--	--	--

R_g value @ 2" Thickness

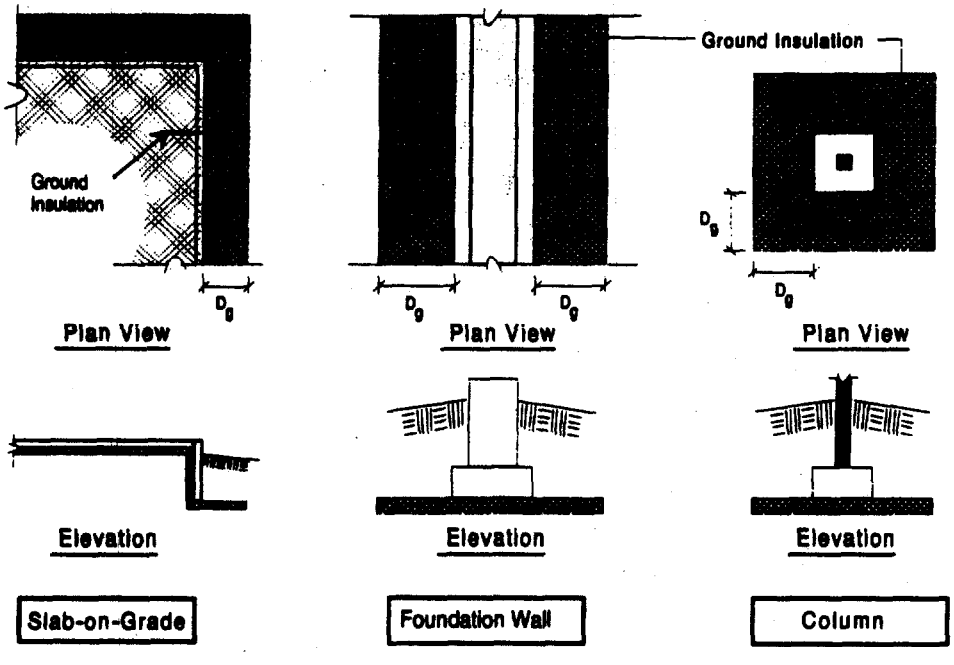

Figure A3. Ground insulation applications and requirements.