EXPANSION OF LONG LENGTH SHEETS

Any piece of metal, free to move, will increase in size with an increase in temperature, and will decrease in size with a decrease in temperature. The magnitude of this thermal expansion and contraction varies between different types of metal, but for each metal, the change in length is proportional to the change in temperature and the sheet length. The change in sheet length can be calculated as:

$$\Delta L = 12(\Delta T)(L)(E)$$

where:
- ΔL = change in sheet length, inches
- ΔT = change in temperature, degrees F
- L = total sheet length, feet
- E = coefficient of linear expansion,
  - = 0.0000065 for Galvanized or Galvalume Steel
  - = 0.0000128 for Aluminum
  - = 0.0000099 for Stainless Steel
  - = 0.0000093 for Copper
  - = 0.0000165 for Zinc
  - = 0.0000370 for polycarbonate

When designing a structure, the expansion of the sheeting must be considered, especially for aluminum panels which expand twice as much as steel, and polycarbonate panels which move over five times as much as steel.

Standing seam roof systems like Fabral's 1 1/2" SSR are designed to allow for thermal movement of the sheets. Careful attention must be paid to the ridge and gable details and any roof penetrations. All of these transitions must allow for expansion and contraction. If they do not, fastener holes will elongate and leaks will occur. Fabral's Standing Seam installation manuals provide recommended details.

In exposed fastener systems, the expansion/contraction of long length sheets may cause fastener hole elongations beyond what the washer can cover which may cause leaks. Therefore, the overall sheet lengths must be limited. Fabral recommends limiting exposed fastened aluminum panels to 16’ long and steel panels to 40’ or 45’ maximum length. For run lengths longer that these, end laps with butyl sealant should be used.

Another important factor to take into consideration the temperature during the panel’s installation. It is best to install the panels in the spring or fall when the temperatures are in the average range for the year. If the panels are to be installed in the summer they will be in their longest length so you need to allow for contraction, or if installing in the winter they will be in their shortest length so you need to allow for expansion.

For standing seam panels, which are floating systems, the bottom of the panels are often hemmed and hooked onto a cleat or eave trim. In extreme cold the panel hem may be pulled closer to the cleat which will allow the panel to expand as needed during warmer weather. If installed during extreme heat a gap should be allowed between the panel hem and the cleat, so that the panels have room to contract during cold weather.

Even though exposed fastener panel systems don't float in the same manner as standing seam panels, expansion must still be considered. When the panels are installed during hotter temperatures, as it cools down the panels will try to contract which will pull on the screws, causing the screw holes to elongate around the fasteners. If the panels are installed during colder temperatures, when it heats up the panels will try to expand. This expansion can result in the screw holes elongating if the panel is stiff enough, but it can also cause the panels to bow and show oilcanning (a wrinkled appearance). This bowing is more common in aluminum and polycarbonate panels as they are not as stiff as steel. If bowing occurs it may be necessary to wait until hot weather, remove the fasteners which should allow each panel to expand as needed and lay flat again, and then replace the fasteners. If the panels must be installed during the summer or winter it may be best to pre-drill holes in the panels larger than the screw thread diameter to aid in expansion/contraction of the panels.

The tables on the following pages illustrate the change in sheet length calculated using the equation presented above.

Table 1
Change in Panel Length (inches) for GALVANIZED AND GALVALUME STEEL panels

PANEL LENGTH	TOTAL CHANGE IN TEMPERATURE IN DEGREES FAHRENHEIT						
	60	80	100	120	140	160	180
10	0.047	0.062	0.078	0.094	0.109	0.125	0.140
15	0.070	0.094	0.117	0.140	0.164	0.187	0.211
20	0.094	0.125	0.156	0.187	0.218	0.250	0.281
25	0.117	0.156	0.195	0.234	0.273	0.312	0.351
30	0.140	0.187	0.234	0.281	0.328	0.374	0.421
40	0.187	0.250	0.312	0.374	0.437	0.499	0.562
50	0.234	0.312	0.390	0.468	0.546	0.624	0.702
60	0.281	0.374	0.468	0.562	0.655	0.749	0.842
80	0.374	0.499	0.624	0.749	0.874	0.998	1.123
100	0.468	0.624	0.780	0.936	1.092	1.248	1.404
150	0.702	0.936	1.170	1.404	1.638	1.872	2.106
200	0.936	1.248	1.560	1.872	2.184	2.496	2.808

Table 2
Change in Panel Length (inches) for ALUMINUM panels

PANEL LENGTH	TOTAL CHANGE IN TEMPERATURE IN DEGREES FAHRENHEIT						
	60	80	100	120	140	160	180
10	0.092	0.123	0.154	0.184	0.215	0.246	0.276
15	0.138	0.184	0.230	0.276	0.323	0.369	0.415
20	0.184	0.246	0.307	0.369	0.430	0.492	0.553
25	0.230	0.307	0.384	0.461	0.538	0.614	0.691
30	0.276	0.369	0.461	0.553	0.645	0.737	0.829
40	0.369	0.492	0.614	0.737	0.860	0.983	1.106
50	0.461	0.614	0.768	0.922	1.075	1.229	1.382
60	0.553	0.737	0.922	1.106	1.290	1.475	1.659
80	0.737	0.983	1.229	1.475	1.720	1.966	2.212
100	0.922	1.229	1.536	1.843	2.150	2.458	2.765
150	1.382	1.843	2.304	2.765	3.226	3.686	4.147
200	1.843	2.458	3.072	3.686	4.301	4.915	5.530

Table 3
Change in Panel Length (inches) for STAINLESS STEEL panels

PANEL LENGTH	TOTAL CHANGE IN TEMPERATURE IN DEGREES FAHRENHEIT						
	60	**80**	**100**	**120**	**140**	**160**	**180**
10	0.071	0.095	0.119	0.143	0.166	0.190	0.214
15	0.107	0.143	0.178	0.214	0.249	0.285	0.321
20	0.143	0.190	0.238	0.285	0.333	0.380	0.428
25	0.178	0.238	0.297	0.356	0.416	0.475	0.535
30	0.214	0.285	0.356	0.428	0.499	0.570	0.642
40	0.285	0.380	0.475	0.570	0.665	0.760	0.855
50	0.356	0.475	0.594	0.713	0.832	0.950	1.069
60	0.428	0.570	0.713	0.855	0.998	1.140	1.283
80	0.570	0.760	0.950	1.140	1.331	1.521	1.711
100	0.713	0.950	1.188	1.426	1.663	1.901	2.138
150	1.069	1.426	1.782	2.138	2.495	2.851	3.208
200	1.426	1.901	2.376	2.851	3.326	3.802	4.277

Table 4
Change in Panel Length (inches) for COPPER panels

PANEL LENGTH	TOTAL CHANGE IN TEMPERATURE IN DEGREES FAHRENHEIT						
	60	**80**	**100**	**120**	**140**	**160**	**180**
10	0.067	0.089	0.112	0.134	0.156	0.179	0.201
15	0.100	0.134	0.167	0.201	0.234	0.268	0.301
20	0.134	0.179	0.223	0.268	0.312	0.357	0.402
25	0.167	0.223	0.279	0.335	0.391	0.446	0.502
30	0.201	0.268	0.335	0.402	0.469	0.536	0.603
40	0.268	0.357	0.446	0.536	0.625	0.714	0.804
50	0.335	0.446	0.558	0.670	0.781	0.893	1.004
60	0.402	0.536	0.670	0.804	0.937	1.071	1.205
80	0.536	0.714	0.893	1.071	1.250	1.428	1.607
100	0.670	0.893	1.116	1.339	1.562	1.786	2.009
150	1.004	1.339	1.674	2.009	2.344	2.678	3.013
200	1.339	1.786	2.232	2.678	3.125	3.571	4.018