RADIANT THEORY

All bodies with a surface temperature above absolute zero emit rays with wavelengths depending on the body surface temperature. Every facet of the surface emits rays in straight lines at right angles to the facet. When examined under a microscope, the surface of concrete or rough plaster is covered with numerous facets, each giving off radiant energy. Polished steel or similar polished surfaces show no such facet. Thus, a rough surface emits heat rays more efficiently than a polished surface.

The ability of a surface to emit by radiation is known by the term emissivity. This same term can be applied to the ability of a surface to absorb radiant heat. The perfect black body is an ideal surface, which completely emits or absorbs radiant energy. The rate at which heat is radiated by a perfect black body is a function of temperature.

The perfect black body is defined as having an emissivity of 1.00. All other surfaces have a lower emissivity, expressed as a decimal less than 1.00.

Figure 1 shows the emissivity of various products. For practical purposes it can be assumed that a good emitter is a good absorber.

Figure 1 Approximate Emissivity of Various Surfaces

Metals

Material	Polished	Rough	Oxidized
Aluminum	0.04	0.055	0.11 – 0.19
Brass	0.03	0.06 – 0.20	0.60
Copper	0.018 – 0.02	–	0.57
Gold	0.018 – 0.035	–	–
Steel	0.13 – 0.40	–	0.80 – 0.95
Lead	0.057 – 0.075	–	0.63
Nickel	0.045 – 0.087	–	0.37 – 0.48
Silver	0.02 – 0.035	–	–
Tin	0.04 – 0.065	–	–
Zinc	0.045 – 0.053	–	0.11
Galv. Iron	0.228	–	0.276

Refractories, Building Materials, Miscellaneous

Material	Emissivity
Asbestos	0.93 – 0.96
Brick	0.75 – 0.93
Carbon	0.927 – 0.967
Glass, Smooth	0.937
Gypsum	0.90
Marble	0.931
Oak, Planed	0.895
Paper	0.924 – 0.944
Plaster	0.91
Porcelain, Glazed	0.924
Quartz, rough, fused	0.932
Refractory materials	0.65 – 0.91
Roofing paper	0.91
Rubber	0.86 – 0.95
Water	0.95 – 0.963

RADIANT THEORY (cont.)

Figure 1 (cont.)

Paints, Lacquers, Varnishes

Material	Emissivity
Black lacquer	0.80 – 0.95
White lacquer	0.80 – 0.95
Enamel (any color)	0.85 – 0.91
Oil paints (any color)	0.92 – 0.96
Aluminum paint	0.27 – 0.67
Varnish	0.89 – 0.93
Polyester Powder	0.92 – 0.96

Therefore, a surface with a high emissivity factor would radiate more energy than one with a lower emissivity factor. For example: polished aluminum with an emissivity of 0.04 would have low radiant emissivity, but if it were painted with an enamel paint (emissivity 0.85-0.91) it would have a high radiant emissivity.

The invigorating effect of radiant heat is experienced when the body is exposed to the sun's rays on a cool but sunny day in spring. Some of these rays impinging on the body come directly from the sun and include the whole range of ether waves. Other rays coming from the sun impinge on surrounding objects, where they are increased in wavelength and reradiated to the body as low temperature radiation, producing a comfortable feeling of warmth. Should a cloud pass over the sun, instantly there is a sensation of cold; although in such a short interval, the air temperature does not vary at all. In searching for correct conditions compatible with the physiological demands of the human body, no system can be rated as completely satisfactory unless it satisfies the three main factors controlling heat loss from the human body: radiation, convection and evaporation. It is sometimes though that a radiant heat system is desirable only for certain buildings and only in some climates. However, wherever people live, these three f actors of heat loss must be considered. It is as important to provide correct conditions in very cold climates as it is in moderate climates.
Maintaining the correct comfort conditions by heating with low temperature radiation is possible for even the most severe weather conditions.

Panel heating and cooling systems function to provide a comfortable environment by controlling surface temperatures and minimizing excessive air motion within the space. Thermal comfort, as defined by ASHRAE Standard 55-1981, is "that condition of mind which expresses satisfaction with the thermal environment." A person is not aware that the environment is being heated or cooled. The mean radiant temperature (MRT) strongly influences the feeling of comfort. When the surface temperature of the outside walls, particularly those with large amounts of glass, begins to deviate excessively from the ambient air temperature of space, it is increasingly difficult for convective systems to counteract the discomfort resulting from cold or hot walls. Heating and cooling panels neutralize these deficiencies and minimize excessive radiation losses from the body.

Unlike most heat transfer equipment where performance can be measured in specific terms, the performance of the radiant panel is related directly to the structure in which it is located and an evaluation of this interrelationship is desirable. Research and testing of panel performance have been conducted by various independent researchers and manufacturers. Heat transfer between the radiant panel and the other room surfaces is well established in a boxlike room where the primary heat gains and losses are from the wall, floor or ceiling surfaces. Various investigators and manufacturers report increased cooling performance because of solar effects and ceiling-mounted lighting fixtures. This empirical information, which has been developed as a result of field testing, should only be used in consultation with manufacturers experienced in this field.

RADIANT THEORY (cont.)

Fortunately, most building surfaces have high emissivity factors and therefore absorb and reradiate energy from the active panels. This is significant because all surfaces within the room tend to assume an equilibrium temperature resulting in an even thermal comfort condition within the space. In much the same way that light energy from a lighting fixture illuminates the room so that all surfaces can be seen, a warm radiant panel emits energy that is absorbed and reradiated, and all surfaces become warm.

Warm ceiling panels are effective for winter heating because they warm the floor and glass surfaces by direct transfer of radiant energy. The surface temperature of well constructed and properly insulated floors will be 2 to 3 degrees F (1 to 2 degrees C) above the ambient air temperature, and the inside surface temperature of glass is increased significantly. Inside single-glass surface temperatures of 10 to 15 degrees F (5 to 8 degrees C) above normally observed glass surface temperatures are realized.

As a result, downdrafts are minimized to the point where no discomfort is felt. Installation with ceiling heights of 50ft. (15m) and single glass from floor to ceiling provide satisfactory results.

References: 2007 Ashrae Handbook (HVAC Applications Chapter 53), 1987 Ashrae Handbook (HVAC Systems and Applications Chapter 7).