Electric radiant panel heating

Category: Articles Author: Pavel Halama

1. Purpose of use

Electric heating panels are suitable to use where high user's comfort is demanded. It can also be used for very economic heating in environment where standard conventional heaters are less suitable. Radiation heatings of recommended types are suitable for assembly heights from 2,5 m up to 8 m. They can be very well combined with other heatings such as heating floors or convectors. They can also serve as a supplementary heating.

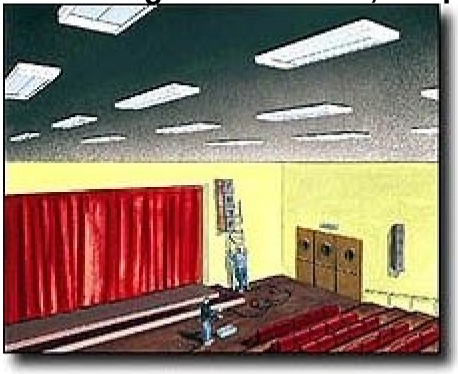
According to the heating mode we distinguish use of radiant panels :

in predominantly systematic mode of heating which can be used in objects where we expect relatively high level of comfort and which are well enough heating insulated

- public offices and administrative offices, company seats, schools
- cultural facilities, show-rooms
- medical arrangements
- commercial and sales centres
- manufacturing halls and warehouses

in interrupting heating mode when during meantime the walls, ceiling and floor temperature decreases to relatively low values.
These are less insulated objects with often high thermal capacity of walls. These are used only occasionally and it would be non-economic to heat the space in a standard way including heat storage into perimeter constructions. In these cases the radiant heating brings almost immediate feeling of warm through direct radiation on clothes and exposed body parts after coming to operation. Feeling of less comfort as a consequence of cold building constructions is compensated with extraordinary economy of operation. This is very important for high ceiling objects.

Typical objects in interrupting heating mode are heatings in churches, chapels, concert and lecture halls

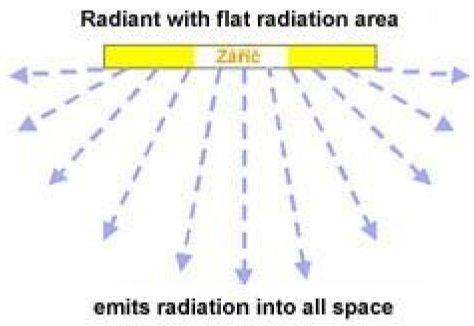



2. Typical design

Radiant panels are manufactured in two basic designs:

1) High-temperature panels - are equipped with flat radiation surface which guarantees radiation from up to 180°C angle (so called hemispheric radiation). Temperature at the surface of radiating segment is approx. 350°C. This high temperature enables relatively high density of radiant flow. That is why these panels are designed for suspending in high places 5-8 m.

Radiant with flat radiation area



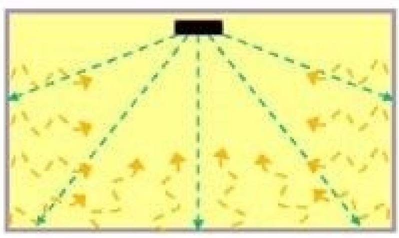
2) Low-temperature panels - have also flat radiating area. Contrary to high-level panels is the surface of radiating area max. 110°C. Density of radiant flow is lower. Recommended height of panels placement is 2,5-3 m.

3. Radiant heating advantages

- lower energy costs in comparison with conventional heatings
- does not lead to dust turbulations
- uniform distribution of heat in horizontal direction (difference of temperatures between floor and ceiling only 1-20°C)
- sounder environment with higher air moisture does not lead to mucosa membrane drainage and respiratory diseases
- has positive effect on people affected with arthral diseases
- full possibility for machines, furniture etc. placements
- no maintain of radiant panels
- long service life
- no emission, thrifty way of dealing with life environment
- high thermal comfort

4. Basis of radiant heat transmission

- each object with certain temperature has some inner heat energy.
- Heat energy is changing into electromagnetic oscillation which extends through space. If there is no heat supplied to the object, it cools down.
- When electromagnetic oscillation hits other object, it is absorbed by its surface and changes into heat energy. If the heat is not taken away from the object, it heats up.
- Electromagnetic oscillation is not bound to outer environment (medium) it can proceed even in absolute vacuum
- Most famous heat transmission via radiation is natural sun radiation heating the Earth surface.



Substantial part of radiated heat

reflect back to space

Radiating capacity of an object (intensity of radiation) STEFAN - BOLTZMANN rule:

$$E = \varepsilon \times C_o \times (T/100)^4$$

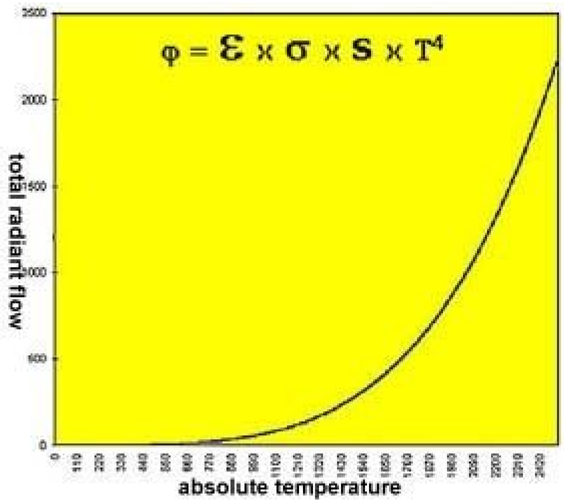
Energy radiated by the surface of an object is proportional to fourth power of absolute temperature.

E..... radiating capacity of an object (W/ m2)
ε .....proportionate radiating capacity - emissive potential
Co... emissivity coefficient of a perfectly black object (5,67 W/m2 . K4)
T.... absolute temperature (°C)
Total radiant flow - object radiant output with surface area S (m2)

$$P = E \times S \quad (W)$$

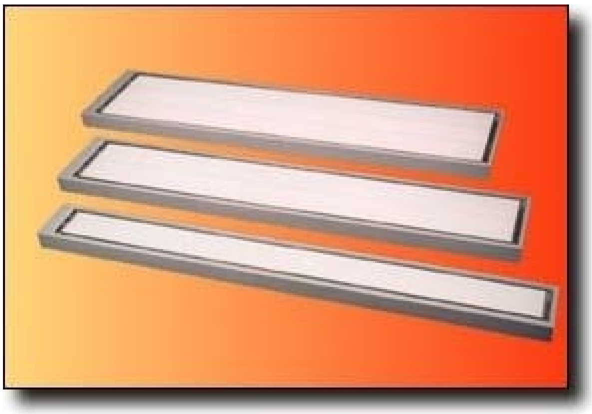
Higher temperature of radiating area › higher radiated

output (W)



5. Basic technical parameters of panels

High-temperatures panels - constructions
Aluminium segments with pressed-in heating rods are heating elements. Segments are equipped with special cover SILICATING which increases heat energy radiation into heated space. In accordance with output are panels equipped with 1,2 or 3 segments. Heat insulation is from mineral cotton wool. Panels are covered with sheet-metal varnished body.

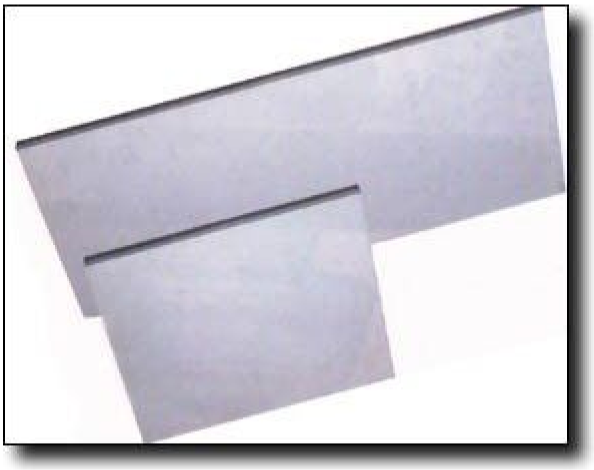


Basic technical data:

- surface segment temperature - approx. 350° C
- output line 900,1200,1800,2400,3000,3600 W
- covering IP X4
- tension 230 V or 400 V according to input

Low-temperature panels - construction
closed body from FeZn metal plate equipped with special inner surface Thermoquartz and outer surface Thermocrystal which increase emissivity of the panel. Heating element - heating foil or heating cable. Inner insulation is from mineral cotton-wool.

Basic technical data:



- surface temperature of radiating a rea approx. 90 - 110°C
- output line 300,600,700 W
- covering IP20, IP44, IP54, IP65
- voltage 230 V
- universal design - can be installed into cartridge view lower ceiling

Low-temperature panels with special design
panels for church pews heating - installation of church pews in vertical position in front of sitting people. Lower surface temperature approx. 80°C, IP20 - output line 100,200,270,330,400 W. Panels with increased covering - IP 54, IP 65 - for explosive environment EExell T3, panels output 700W, marking ECOSUN IKP, IN, IN - 2

6. Radiant heating design

When designing output, number and location of radiant panels it is suitable to proceed as follows:
1) calculate heating loss of a specific area Q [W]
2) select heating mode in accordance with the character of a future object operation

Systematic heating mode with good level of heating comfort:

heat passage coefficient to (U): walls < 0.5 W/m2K, floors at terrain < 0.5 W/m2K, ceilings < 0.35 W/m2K. Higher values to (U) increase operating costs and decrease heating comfort. Total input of all heaters set up to 20% higher than calculated heating loss because of higher heating system dynamics:

$$P = 1{,}2 * Q \text{ [W]}$$

to check the input size for area unit, whereas applies **P/S<150W/m2**
S .... floor surface of an area [W]

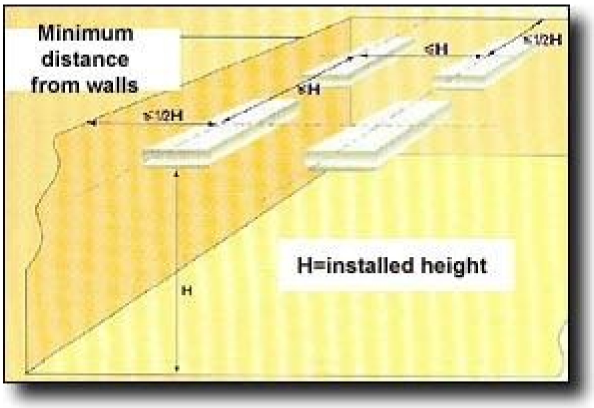
set minimal number of heating units n for creation of homogenous radiant field **n> S/H2**
H .... expected installation height [m]

The more heating units enable heating comfort but increases acquisition costs
calculate average input of one heating unit and from output line of appropriate type select closest face-value

Specify number of heaters according to total input

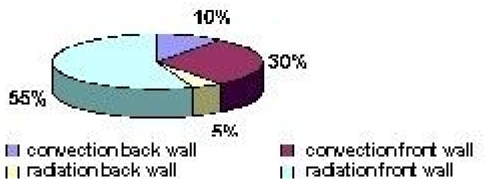
$$Pn = P/n \approx Pjm$$
$$n = P/Pjm$$

- propose scheme of even location of individual panels. It is necessary to respect frame distances and even distances of panels according to scheme figure



- determine installed height according to frame recommendation in table or through the use of nomogram

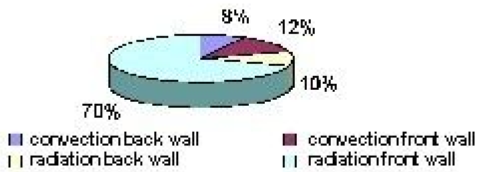
Share of components of energy transmission for radiant panel ECOSUN 600



for low-temperature panels is the conversion efficiency zone of total input into radiant

component approx. 50-55% according to the panel type

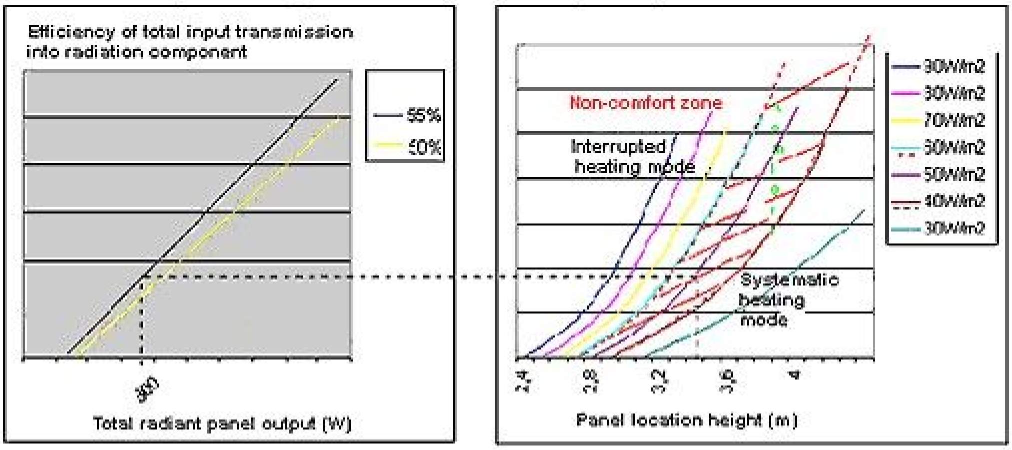
Share of components of energy transmission high-temperature panel ECOSUN S



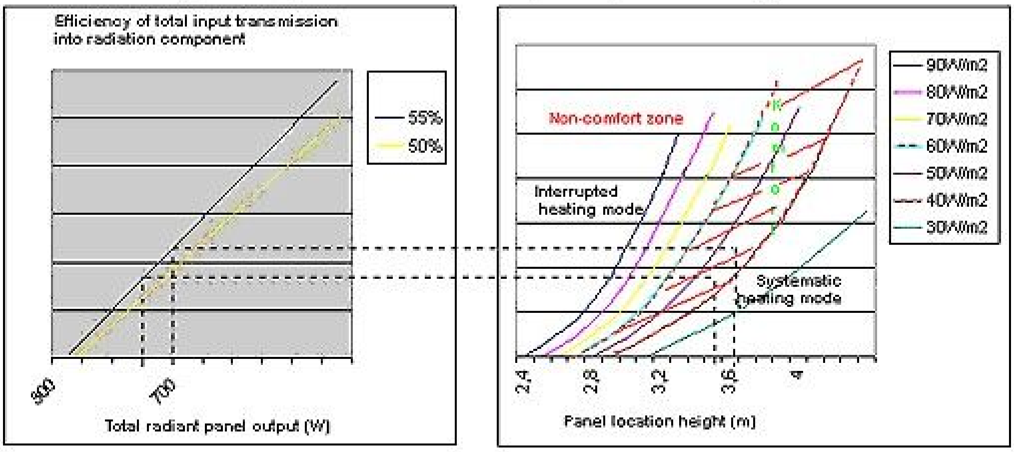
For high-temperature panels is the efficiency zone of transmission of total input into

radiation component approx. 60-70% according to the panel type.

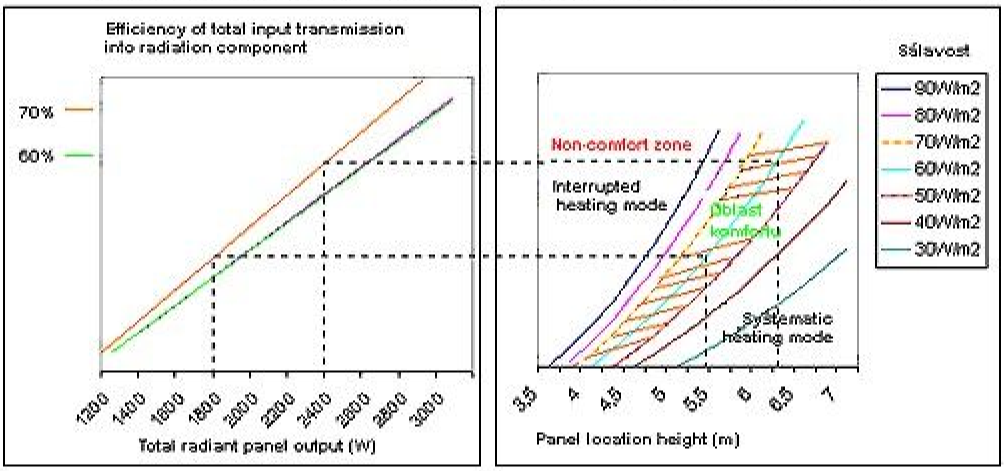
Nomogram for height determination of low-temperature panels ECOSUN E300W



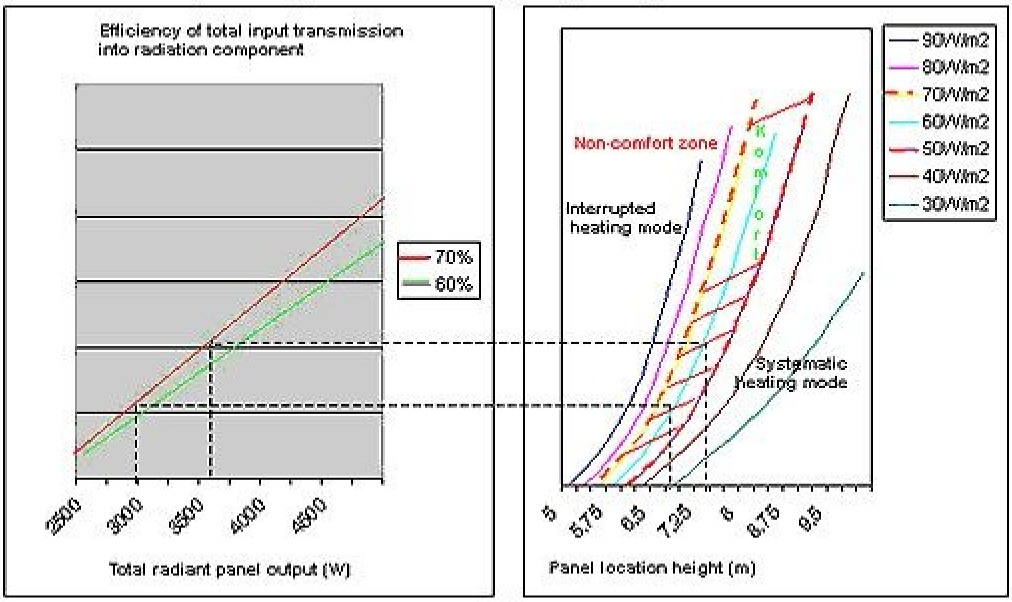
Nomogram for height determination of low-temperature panels ECOSUN - types 600 and 700W



Nomogram for height determination of high-temperature panels ECOSUN S (1200 3000W)



Nomogram for height determination of high-temperature panels ECOSUN S30-S36



will be < 8K, guarantees heating comfort.
After realisation we recommend to verify real size with temperature measurement.

Systematic heating mode with lower level of heating comfort

Zone heating is a mean of heating when only exposed, relatively small areas (case of little heated halls) are heated with radiant heat in large areas which are not globally heated

- heat passage coefficient of an object cover k (U) > 2W / m2K
- floor at least minimally heat insulated, if not, provide good quality insulation against humidity for objects without cellars
- set input according to the size of heating zone area, number and height of suspension H [m] panels. Request of higher radiation needs to use purely VT panels for zonal heating. Height of suspension moves

between 3,5-4,5 m.
We calculate with effective input
Pe=0,6 P (or 0,7P) (chosen panel input)
on effective zone area with size
S = (l + 0,6H) (W+0,6H) l....panel length [m], W....panel width [m]

- Basically when the suspension height is 4m, VT radiant panel of FENIX construction comprises effective area approx. 3,8 x 2,7m, roughly 10m2. Radiant flow density moves from 180 -220 W/m2 in accordance with VT panel output with 3 heating segments. This value should be higher than 150 W/m2.
- Recommended proceeding: In large objects happens while zonal heating uncontrolled circulation and cooling of own heated zone. In accordance with circumstances it is suitable to limit the zone with simple prefabricated or cloth construction with height at least 2,5m

Interrupted heating mode in objects heated for short-term stay of people. These are mainly churches, concert halls in historical objects etc. with high ceilings, social halls

These large area objects are very expensive to heat in interrupted mode with conventional heating devices such as storage heaters, convectors and various types of "radiants". These high operation costs are caused by the fact that it is necessary to heat very huge air content from low temperatures up to demanded temperature (comfort). And this all in relatively short time period. Because radiation heats the air only secondarily from radiated objects, comfort environment can be reached in such areas much faster. Therefore radiant heating is for interrupted mode of heating much more effective.

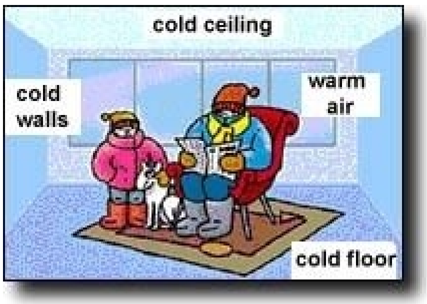
- heat passage coefficient of object cover k > 1.3 W/m2 K, often stone walls with high absorbing capacity for heat is concerned. Certain heat comfort is being achieved by direct radiation of people likewise for zone heating.
- size of installed heating input is being solved similarly to zone heating
- heat effect can be significantly improved through combination with electric heating floor. Cable is being laid directly under tiling with corresponding spacial input, if possible with heat insulated basis. This solution is very suitable for reconstructions of old objects or building new ones. Radiation of VT panels can reach then level approx. 70% of needed radiation for zone heating.

7. Heat comfort characteristics

It is not sufficient for heat comfort only to heat the air on certain temperature. Feelings of heat or cold perception are more complex and are influenced by:

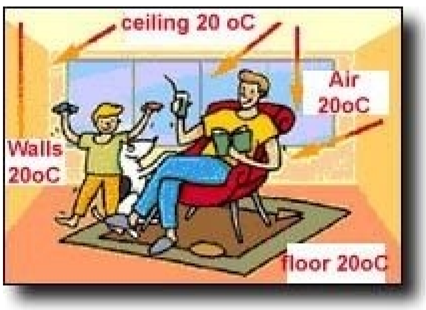
- temperatures of areas limiting the heated area
- velocity of air in room (draught)
- person's activity and his/her clothes

Determining importance have temperatures of areas limiting heated area e.g. walls, ceiling, floor, windows. Cool walls remove radiated heat from exposed skin and clothes. Cold walls or to the contrary high temperature of radiant source is perceived this way.



Example 1:
warm air up to 30°C
Walls, ceiling, floor up to 10°C
NON-COMFORT- too cold

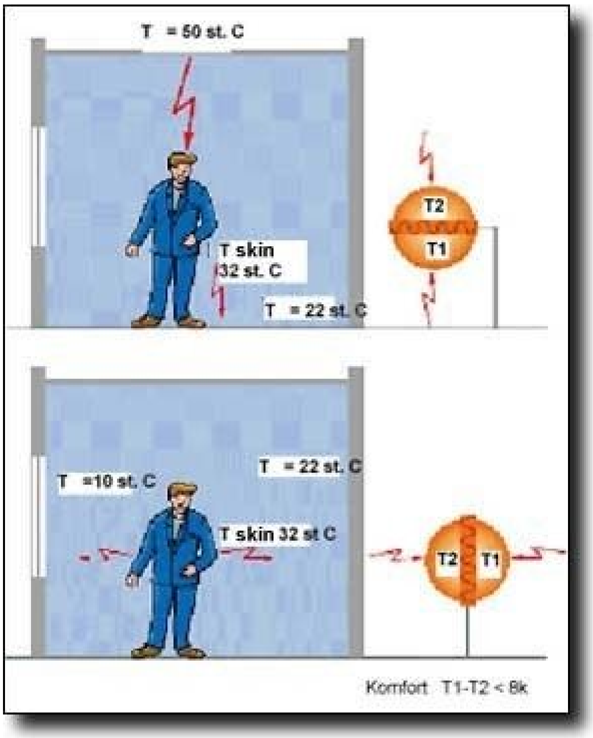
Example 2:
walls, ceiling, floor up to 25°C
Air up to 5°C
NON-COMFORT - cold



Example 3:
Walls, ceiling, floor up to 26°C
Fresh air up to 15°C
TOLERABLE

Example 4:
air 20°C, Walls, ceiling, floor 20°C
COMFORT !!!

In case of radiant heating, substances are heated inside of room including bounding surfaces and simultaneously proceeds cooling. This cooling is through heat conduction, radiation and also convection. For walls with large surfaces is the cooling process dependant on heat insulation degree. One of the criteria for assessment of environmental heat comfort is so-called asymmetry of radiant heat, especially in vertical direction.



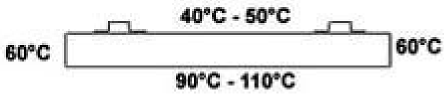
Height of the temperature measured at half-sphere of ball-shaped thermometer depends on the source temperature and at distance between source and measurement point. For reaching satisfactory heat feeling of a person exposed to a radiation the asymmetry respected must be max. 8 K.

Comfort environment may be characterised by relation between air and walls temperatures. Half of their sum should be around 18°C while air flow not more than 0,25 m/s and relative humidity 40-60%.

8. Operation technical parameters of ECOSUN radiant panels

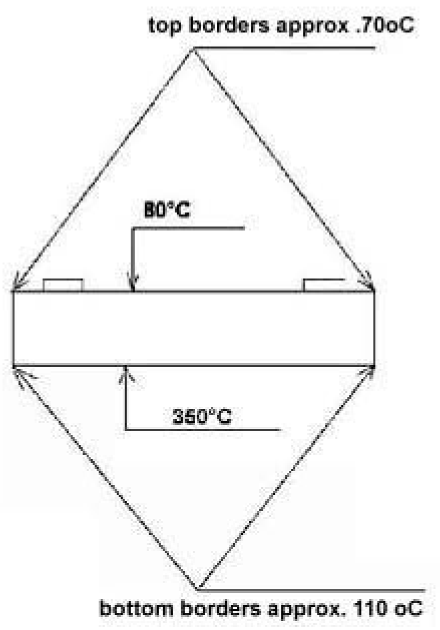
LOW-TEMPERATURE RADIANT PANELS							
Type	Dimensions	Mass	Input Wattage	Voltage	Coverage	Recommended Clearance Height	How Used
	(mm)	(kg)	(W)	(V)		(m)	
E 100 K	500x320x35	2,5	100	230	IP 20	vertical orientation	achieving a comfortable temperature for church pews, cashier booths, safe rooms, etc.
E 200 K	750x320x35	3,7	200				
E 270 K	1000x320x35	5,2	270				
E 330 K	1250x320x35	6,6	330				
E 400 K	1500x320x35	7,9	400				
E 300 U	592x592x30	5,0	300	230	IP 44	2,5 - 3,0	universal panel for residential and non-residential spaces, for installation on ceilings and coffer ceilings
E 600 U	1192x592x30	10,1	600			2,7 - 3,8	
E 700 U	1192x592x30	10,5	700				
E 700 IKP	1192x592x30	10,6	700	230	IP 54	after evaluation of local conditions	industrial and agricultural buildings, workshops, greenhouses, animal husbandry, coverage level determines allowable environments
E 700 IN	1192x592x30	10,9			IP 65		
E 700 IN2					EExell T3		

Surface temperatures of low-temperature panel

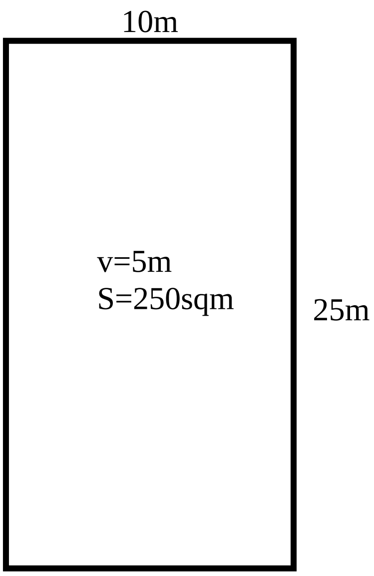


HIGH-TEMPERATURE RADIANT PANELS							
Type	Dimensions	Mass	Input Wattage	Voltage	Coverage	Recommended Clearance Height	How Used
	(mm)	(kg)	(W)	(V)		(m)	
E S09	1500x155x60	8,5	900	230 N	IP X4	after evaluation of local conditions whole-surface 5,0 - 8,0 zone 3,5 - 4,5	sporting halls, gymnasiums, halls, workshops, and agricultural buildings with environment fitting the given coverage
E S12			1200				
E S18	1500x256x60	13,5	1800	230/400 2N			
E S24			2400				
E S30	1500x357x60	18	3000	230/400 3N			
E S36			3600				

ECOSUN panel surface temperatures



Calculation sample of installed numer of radiant panels



Q= 27 940W
P=1,2*Q
P=1,2*27940
<u>P=33 528W</u>

P/S < 150W/sqm
33 528 < 150W/sqm
<u>134 <150</u>

Minimum numberof radiant panels (n): H=v
$n>S/H^2$
$n>250/5^2$
n>10
n_{min}=11

Pn=P/n
Pn=33528/11
<u>Pn=3048W (the closest S30 Pjm=3000W)</u>

n=P/Pjm
n=33528/3000
n=11,18
<u>n=11</u>

Pjm = S09 = 900W
S12 = 1200W
S18 = 1800W
S24 = 2400W
S30 = 3000W
S36 = 3600W

<u>To heat up this object is necessary to use minimally 11 panels of 3000W – S30.</u>