

Radiant Heat and Wind Shield Solutions

Darchem Thermal Protection, a strategic business unit within Darchem Engineering, specialises in the design, development and manufacture of Radiant Heat and Wind Shields for the protection of personnel, equipment and structures from radiant heat, fire and inclement weather conditions.

Darchem offers two types of Heat Shield solutions based upon the incidental heat flux levels and the required reduction:

- **Darscreen™ Woven Mesh System**
- **Darflare™ Chevron System**



Darflare™ Chevron System installed on BP Bruce, UK North Sea

The Darscreen™ Woven Mesh System is designed for use with lower level heat fluxes, or for wind shielding, and is commonly employed as a vertical heat shield protecting critical equipment, structures, and personnel.

The Darflare™ Chevron System is designed for use with higher heat flux levels such as those experienced during flaring operations.

The science of Thermal Radiation

Thermal radiation is the transmission of heat by the propagation of electromagnetic radiation. Unlike other forms of heat transfer it does not increase and decrease linearly with temperature but proportionately to the 4th power of the absolute temperature. The relationship between temperature and thermal radiation is defined by the relationship:

$$q = \epsilon \sigma AT^4$$

Radiant heat flux is equal to the product of emissivity, Stefan-Boltzmann constant, area and the fourth power of absolute temperature

Thermal radiation forms part of the electromagnetic spectrum of which visible light, radio waves and microwaves are also part. Thermal radiation is generally referred to as heat flux and is measured in kW/m².

In general, thermal radiation can be compared to the behaviour of visible light; in that it emanates from a point or series of points and disperses in intensity equally in all directions. Therefore, the intensity of the heat will diminish as the distance from the heat source increases. This heat dispersion pattern should be simple to calculate given a relatively small heat source.

However, these heat sources are complicated large moving, three-dimensional entities such as fire, flares, and hot exhaust gases, complicating the heat dispersion pattern.

Design of Thermal Radiant Shielding

Thermal Radiation Shielding can be divided in to two distinct categories:-

- a) Continuous Shielding (steady state); as in the case of a flare tip on an Offshore Installation
- b) Fire Hazard Shielding (limited duration); where a piece of equipment is adjacent to a potential fire hazard for the time it would take to extinguish the potential fire.

For most design cases the same design process is used for both types of shielding and that is to design to the worst case steady state scenario.

Thermal Radiation Shielding design is substantiated by test work. It must be remembered that an actual fire scenario is not a point source of heat and a view must be taken to the proximity of the fire and the viewable area of the fire relative to the size of the protected item.

Heat Shield Designs

Each heat shield manufactured is individually designed based on the incidental heat flux levels and frequency, heat reduction target and any additional customer specific requirements.

Darscreen™ Woven Mesh System



The Darscreen™ Woven Mesh system is designed for lower heat flux levels. Although the system can be employed as a horizontal heat shield fitted directly below the flare tip, it is more commonly used as a vertical heat shield solution protecting critical plant, steelwork and personnel in the event of a fire, offering up to a 75% reduction in irradiance.

Darscreen™ Woven Mesh system installed on the Escravos Platform, Nigeria

The system is manufactured as a modular system with individual panels made up of a 1 or 2 layers of 4 x 4 or 8 x 8 woven mesh welded to a channel frame. Where a load bearing requirement is present, i.e. in a horizontal system, grating can be welded to the top edge of the frame. The individual panels are kept at a manageable size to allow ease of installation.

Where solid system barriers would prevent natural lighting and could trap gas the woven mesh system has excellent see-through properties and is naturally venting. The woven mesh system also puts less loading from wind pressure on the supporting structure than a solid barrier



Model showing mounting of Darscreen™

Wind Shielding



Darscreen™ can also be installed to protect personnel using walkways, stairwells, and other areas exposed to high wind conditions.

The use of a mesh system has the advantage over a perforated plate system by having better visibility for personnel and less risk of stagnant regions.

Also the loading on the structure is less and the wind reduction is more evenly distributed than that achieved with perforated plate.

A choice of mesh size is available to achieve the required wind reduction for the lowest cost.

Darscreen™ wind / heat shield protection for escape stair tower

Darscreen™ Radiation Shield Performance

Darchem can predict the reduction in radiation heat flux for various different configurations of Darscreen™ Woven Mesh heat shields. For a known incident heat flux on the hot face of the heat shield the attenuated heat flux can be predicted at set distances from the cold face of the heat shield. A spreadsheet has been created using comprehensive test data on vertical heat shields.

The following summary shows the predicted heat flux in kW/m^2 at a distance X from the cold face of the heat shield for different shield designs. In conjunction with the recommended exposure data, it can be seen that in this example, a Double Layer 8 x 8 Woven Wire Mesh shield would be necessary to reduce the stated input heat flux to an acceptable level for general areas where personnel may be exposed.



Summary of Radiation Shield Performance

Input Heat Flux (kW/m²)
 Distance **X** (mm)

Description	Heat Flux kW/m ²	Reduction on Input Heat Flux
8 X 8 Woven Wire Mesh Single Layer (25%)	2.0	84%
8 X 8 Woven Wire Mesh Double Layer (25%)	0.6	95%
4 x 4 Woven Wire Mesh Single Layer (56%)	4.3	66%
4 x 4 Woven Wire Mesh Double Layer (56%)	2.0	84%

Based On Vertical Radiation Shield
 Test Report No. DF/06/0004

Exposure Time against Radiation Level

Conditions	Maximum Exposure Time	Radiation Level kW/m ²
Greatest Solar Radiation	Continuous in Light Winds	1
Working areas where personnel are continuously exposed	Continuous in Light Winds	1.6
General areas where personnel may be continuously exposed		1.9-2.5
Emergency action areas: upper limit for working when wearing normal clothes and intermittently sprayed by water or sheltered	2 Minutes	4.7
Emergency action areas	30 Seconds	6.3
Immediate evacuation required	Few Seconds Only	9.5

Note: Maximum permissible personnel exposure level to radiation from flare and Sun, according to API RP521

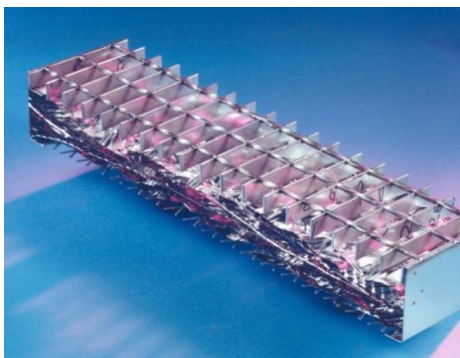
Darflare™ Chevron System

The Darflare™ Chevron system was developed in the early 1980's in collaboration with British Petroleum after experiencing problems on the Magnus Offshore Platform. The flare tip heat flux was higher than anticipated and the heat shield installed was buckling and distorting under normal operating conditions.

As a result the underlying steelwork was being compromised due to being exposed to temperatures beyond acceptable design conditions. Following the Darchem / BP Collaboration the Chevron system was developed and installed on the Magnus Platform. This not only resolved the problem but also offered a heat flux reduction of more than 90%.



Darflare™ Chevron System installed on the BP Magnus Platform, UK North Sea



Darflare™ Chevron System cross-section showing the load-bearing grating and underlying contoured foils.

The Chevron system is designed, through convective airflow through the panels, to reduce the radiant heat on the cold face of the shield to below 100°C during flaring ensuring that the structural steelwork is not compromised. The system is manufactured as a modular design with each panel made up of a fabricated perimeter consisting of a metallic edge skin with a load bearing supporting grating fixed to the top surface 'hot face' of the panel. Formed thin sheet foils provide a contoured surface to promote cold air convection up through the panel to the 'hot face'.

The bottom surface 'cold face' of the panel is supported by expanded metal to facilitate airflow and to hold the foil sheets in place.

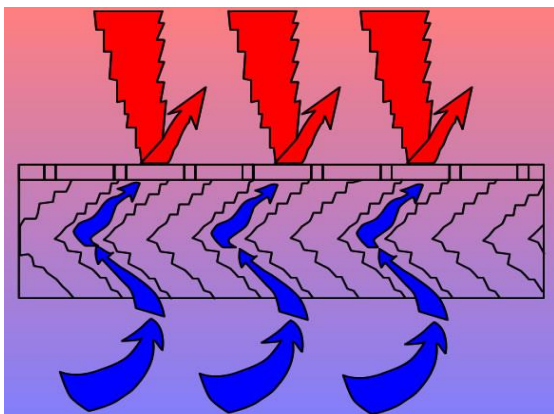


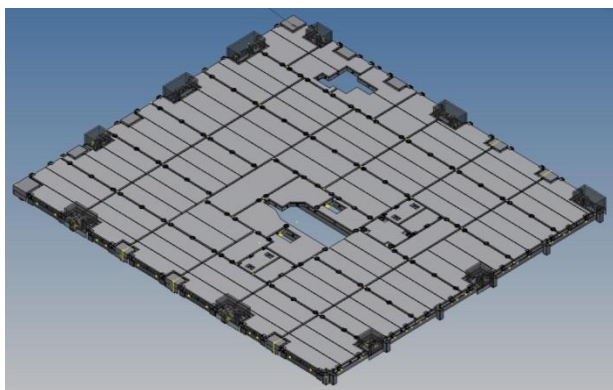
Diagram showing the cold air convection through to the hot face of the Darflare™ Chevron System



Completed panel sections incorporating grating and foils

The panels are assembled with a proprietary fixing system, designed to allow the system to expand during flaring intervals while holding each panel in place to the supporting structure.

To allow access for maintenance, hatchways can be incorporated in to the system, these are constructed using hinged access doors secured with shoot bolts, welded to the cold face of the shield.



Darflare™ heat shield model – overall design showing panel arrangement, access points and hand rail & pulling posts



Trial-build assembly of Darflare™ heat shield before shipment to customer

Principle Features of the Radiant Heat Shield Systems

- Lightweight:** Load bearing heat shields have a weight of circa 38 Kg/m² and the non-load bearing shields have a weight of circa 20 Kg/m².
- Cost Effective:** Darchem heat shields are competitively priced compared with solid systems. The systems can be designed and manufactured using both stainless steel and incoloy steel.
- Maintenance Free:** The Heat Shields are designed to be completely maintenance free during the projected life of the platform, even when subjected to thermal cycling from the operational flares and extreme environmental conditions.
- Heat Dissipation:** Darflare™ and Darscreen™ have a greater heat dissipation than their solid system counterparts. In the case of the Woven Wire System a solid plate barrier would have a greater touch surface temperature than the woven wire system.
- See-through venting:** The Darscreen™ Woven Wire system has excellent see-through properties and is naturally venting. Solid systems prevent natural light and could trap gas that may permeate from the adjacent process plant. The see-through properties reduces the claustrophobic effect that a solid system may present during normal operating conditions.

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