Self-Regulating Point Heating Performance Requirements

The severity of the winter weather conditions in the UK varies geographically and from year to year. To provide point heaters that will perform satisfactorily under even the most exceptional conditions would require large quantities of heat and therefore increase in capital and running costs.

With the rise in passenger numbers and claims by train operators against the infrastructure companies for frozen points, it has become cost effective to heat all points. This cost will be further reduced when point heating is installed during infrastructure upgrade and maintenance.

An effective electric points heating installation should operate in light wind down to an ambient temperature of – 25°C and against a precipitation rate of up to 150mm/hour at a maximum ambient temperature rate of 2°C per hour on a falling scale, to ensure that:

(a) Under frost or freezing rain conditions the switch rail does not freeze to the stock rail or the slide base plate.

(b) Under snow or hailstone conditions, accumulation on the slide base plate or between the switch and stock rails causing the improper closure of points is prevented.

At locations where drifting snow could substantially reduce the effectiveness of a points heating installation, suitable snow fences should, where reasonably practicable, be erected.

Selection of the Self-Regulating Point Heating System

Installations using 200W cartridge heaters, 100W to 200W pad heaters together with certain types of constant wattage strip heaters, are only effective down to an ambient temperature of – 15°C. These are not the most effective systems currently available.

However our GrayBar self-regulating strip heater, which has a high potential power output, is made of material that is non-conducting and because of this property has a unique application.

This type of heater, with an insulated sheath, is the recommended strip heater for point heating in 3rd and 4th rail DC electrified track where the conductor rail passes through or is adjacent to the points.

It is also the most suitable for installation in locations where the ambient temperature may drop as low as – 25°C in extreme weather conditions and to – 40°C (overseas) when using our double element heater strips.

The GrayBar self-regulating strip heater is also the only self-regulating product that can generate, when the weather conditions demand, a power output in excess of 200 Watts per metre (W/m) and is recommended by our UK and European customers as the preferred method of heating points.

Our strip heaters are also available in short lengths as emergency replacements for single defective pads and cartridge heaters.

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Self-Regulating Element Design Considerations

The heat output from the self-regulating strip heater depends upon the heat loss from the rail to which it is attached. I.e. the greater the heat loss the higher the heat output to maintain the rail at its optimum temperature to ensure that each rail is clear of snow and ice between the 'toe' and 'heel' end of the point. Therefore, unlike constant wattage heaters, the self-regulating heater is energy efficient along its length but can also increase its heat output in excess of 210W/m under the coldest conditions.

In addition the initial in-rush power allows the heater to quickly drive up the rail temperature to prevent the initial freezing of the points and/or the build up of snow and ice on the points if a sudden sharp frost or snow fall occurs.

Requirements for track circuit immunity can be met by the use of our insulated sheathed self-regulating element and insulated protective channel.

The GrayBar heater is unique in being the only self-regulating product to be designed and developed specifically for point heating and typical approximate power draw values are;

Temperature	*Watts per metre
+ 5°C	120-200+
0°C	130-200+
– 5°C	140-200+
– 10°C	145-200+
– 15°C	150-200+
– 20°C	155-200+
– 25°C	160-230

* Wind/precipitation minimum to worst case conditions

Installation of the Heating Element

GrayBar self-regulating strip heaters are installed onto the rails in a similar manner to other electric strip heaters but use a unique design of spring clip which remains firmly attached to the rail under even the most severe environmental conditions.

In addition, our self-regulating heater element when installed for point heating using spring clips, is NEVER positioned under the rail head as this is the most inefficient position for heat transfer into the foot if the rail and the strip is difficult to hold in place with spring clips. It is well known that constant wattage strips can fall off the rail after a short period of time as a result of poor design.

Switchpoints from size AV to HV should be supplied from a suitably rated transformer via an 8-core cable, with a minimum conductor size of 1.5mm² (GrayBar uses 4mm²), to a 4-way socket outlet block or off track connection box.
Unlike constant wattage heaters, self-regulating strip heaters are available in long strip lengths and these lengths are tabled in the appropriate Railtrack Standard.

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Self-Regulating Point Heating Integral Trackside Control Cubicle

The Control Cubicle is supplied complete with all switchgear, weather monitoring units and integral panel wiring and should be installed on a suitable, level, concrete base. The control cubicle enclosure must be located at least 3.5m from the nearest running rail and situated in a safe location to provide access for maintenance. Safe recess areas should not be obstructed.

A sealing compound should be applied between the enclosure and the concrete base to prevent ingress of water.

The weather monitoring control unit temperature sensors and snow detector form an integral part of the control cubicle enclosure and should be located where they can accurately monitor the weather conditions. Care should be taken to avoid locating the control cubicle where it may be protected from the elements e.g. bridges.

Due to the vulnerable nature and unreliability of rail temperature probes the use of these devices is not recommended and, with self-regulating point heating systems, rail temperature probes are not necessary because the heater element itself ‘reads’ the rail temperature along the length of the heater element.

Control Cubicle Design for Self-Regulating Point Heating

Self-regulating point heating systems can make use of the benefits of an integral design of control cubicle containing individual contactors, internal 100 volt transformers, secondary circuit protective devices and simple, reliable weather monitoring devices.

The GrayBar integral control cubicle has been successfully functionally tested in an environmental chamber with the air temperature reduced to – 25°C.

This design of heating system control enables the maintenance engineer to locate all the supply circuit components within a single enclosure thus avoiding the safety hazard of walking the trackside to maintain individual trackside oil filled transformers.

In addition the life of the control cubicle, circuit components and associated dry type transformers is extended to 25 years (note: jelly filled trackside transformers may have a shorter service life performance due to the effects of contamination).

Within the control cubicle the following are housed;

(a) An isolator on the incoming power supply.
(b) A contactor to control each integral transformer.
(c) An override switch.
(d) Primary and secondary circuit protective devices.
(e) Primary and secondary ‘healthy’ circuit lamp indication.
(f) Hours run meter.
(g) Cable entry glands.
(h) Multiple earth bonding.
(i) Thermostatically controlled internal cubicle heating.
(j) Identification labelling.
(k) Space envelope for Remote Condition Monitoring.

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Mechanical Requirements

The GrayBar cubicles are of a robust construction and are designed to be suitable for installation outdoors at a railway trackside location. The cubicles are designed to be 100% reliable throughout each heating period (historically from 1^{st} October to 1^{st} May each year but now continuous throughout year) and have a life expectancy of 25 years.

The total weight of the cubicle has been designed to be kept to a minimum to enable the enclosure to be easily manhandled to site in a safe and secure manner thus avoiding the need for heavy lifting equipment.

The standard of water ingress protection between the outer enclosure through to the internal circuit components is IP 66.

The cubicle enclosure is constructed of mechanically abraded stainless steel plate with a thickness of 2.5mm. Bespoke paint finishes are available to order and the paint finish is a primer etch coating with additional layers of powder coated non-reflective heat treated paint.

The doors are removable and include a locking handle with integral ASSA type B stainless steel barrel, which is easily interchangeable to suit specific customer security requirements.

The cubicle has effective air circulation with thermostatically controlled internal space heating and internal component sub assembly enclosures to prevent condensation.

The cubicle is designed to be installed on a concrete plinth with the root of the enclosure drilled for the purposes of fixing by the installer.

All nuts, bolts and washers are brass or zinc plated Class A, Zn 10 in accordance with BS 1706.

Identification Labels

Labels are provided on the equipment for the purposes of unique identification, safety, instruction and information in accordance with BS 5378.

Electrical Requirements

The electrical installation within the cubicles is in accordance with BS 7671.

The electrical equipment is suitable for operation in an outdoor environment and to be housed in a cubicle rated at IP66. All components conform to a MTBF of 15,000 hours. Reliability is designed to be 100% with a life of 25 years.

All live terminals and components are shrouded to prevent inadvertent contact.

The quality and rating of the circuit protection devices (fuses and MCBs) required in each cubicle are designed to be appropriate to the individual circuit requirements and are of a suitable rating to allow for the specific inrush characteristics of the self-regulating heater element.

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Points Heating Technical

For effective circuit discrimination each transformer primary circuit is protected by BS 88 cartridge fuses and each 110 volt secondary heater feeder circuit is protected by a double pole MCB.

All protective devices and components are mounted within clear fronted sub assembly enclosures mounted onto the backplate of the enclosure.

An anti-condensation heater is mounted inside the cubicle in an appropriate position and is controlled from a pre-set thermostat, which is also mounted in the cubicle.

A bulkhead type of lamp fitting is mounted inside the enclosure, which is controlled from the door-operated switch.

To isolate the mains supply into the cubicle a main isolating switch is fitted which can only be operated after opening the cubicle door.

A manual override facility is also included in the control cubicle to ‘override’ the weather monitoring devices and energise the heating circuit under all ambient conditions. This override facility is fitted for maintenance and test purposes only and in the event that the control cubicle is left in ‘override’ mode the circuit will revert to its normal ‘auto’ mode after 60 minutes.

Earthing and Bonding

All exposed and conductive parts are bonded together for connection to the incoming mains cable. The cubicle doors are also bonded using stranded copper, flexible, colour coded bonds. All additional earth bonds are connected to the mains earth bond using 16mm² copper conductor. An 18mm earth stud is also fitted to the outside of the control cubicle for bonding where OHL equipment is present.

Drawings

An ‘as built’ wiring diagram is supplied in a plastic sealed protective film which is attached onto the inside of the control cubicle door.

Cables

The control cubicle circuit components are connected via tri-rated stranded copper wires of a suitable conductor size with each conductor end terminated and numbered marker sleeves in full accordance with the ‘as-built’ wiring diagram and in accordance with BS 7671

All cables are terminated using the recommended ‘starfix’ terminations.

Where cables pass through holes in metalwork they are protected by the use of grommets, cable glands or bushings.

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Outgoing Cable Terminations

The control cubicle includes outgoing terminal blocks for terminating the 110 volt heater feeder cables which are installed by the site contractor.

Terminal blocks are designed to accept up to $4mm^2$ conductors with sufficient space to allow the 8-core heater feeder cables to be fitted with indent labels.

Cable glands are fitted into the cubicle outgoing enclosure to seal the heater feeder cables against moisture ingress.

Remote Condition Monitoring

Provision is made in the control cubicle wiring for connections to be made to a remote condition monitoring unit to be fitted either at the time of installation or at a later date. A space envelope is provided on the cubicle enclosure gearplate for the unit to be fitted.

Due to the nature of the GrayBar control cubicle, real remote condition monitoring is possible. Rather than only measuring the outgoing supply to the transformers, such as is the case with constant wattage; the current to each heater can be monitored. Complex data, such as the differences in temperature across each site, could be easily compiled

Inspection and Testing of the Control Cubicle

Each custom built control cubicle will be subjected to a factory test procedure which will be in accordance with BS 7671 and will include an insulation test, an inspection check of all wiring connections and indents in accordance with the 'as-built' wiring diagram and will also be subjected to a load cycle soak test.

The weather monitoring devices and the manual override switch are also tested.

On successful completion of the factory test, Part A of the GrayBar In-process Inspection sheet DR040 will be completed prior to despatch of the control cubicle to site.

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The Advantages of GrayBar Self-Regulating Switchpoint Heating

Many Constant Wattage Systems can involve modifications to the Permanent Way, extensive track possession times, can effect the integrity of signalling systems during installation and maintenance and are frequently prone to element failure.

GrayBar Self-Regulating Strip Heating Systems suffer none of these problems and provide the following advantages;

- Low power usage with the ability to respond directly to changes in ambient conditions and precipitation.
- Optimum power consumption (typically 30% saving).
- Focuses the heat onto the critical areas of the point between the ‘Heel’ and ‘Toe’ where and when it is needed.
- High long- term vibrations and impact resistance.
- Non-Filament Element giving long life (40+ years) with a 10 year service guarantee.
- Element cannot overheat or burn out.
- Flexibility of product; Easily conforms to rail profile and other Permanent Way obstructions.
- ‘Insulated ‘ product design giving additional immunity and compatibility with signalling systems and a strong safety case for mandatory use on 3rd and 4th DC Railway Networks.
- Long circuit lengths are possible for High Speed Turnouts.
- Supplied as a customised kit of parts.
- No unreliable Temperature Probes are required on track.
- A simplified and reliable Control System can be installed.
- Easily transportable to Site.
- Installation is fast and straightforward minimising Track Possession Times.

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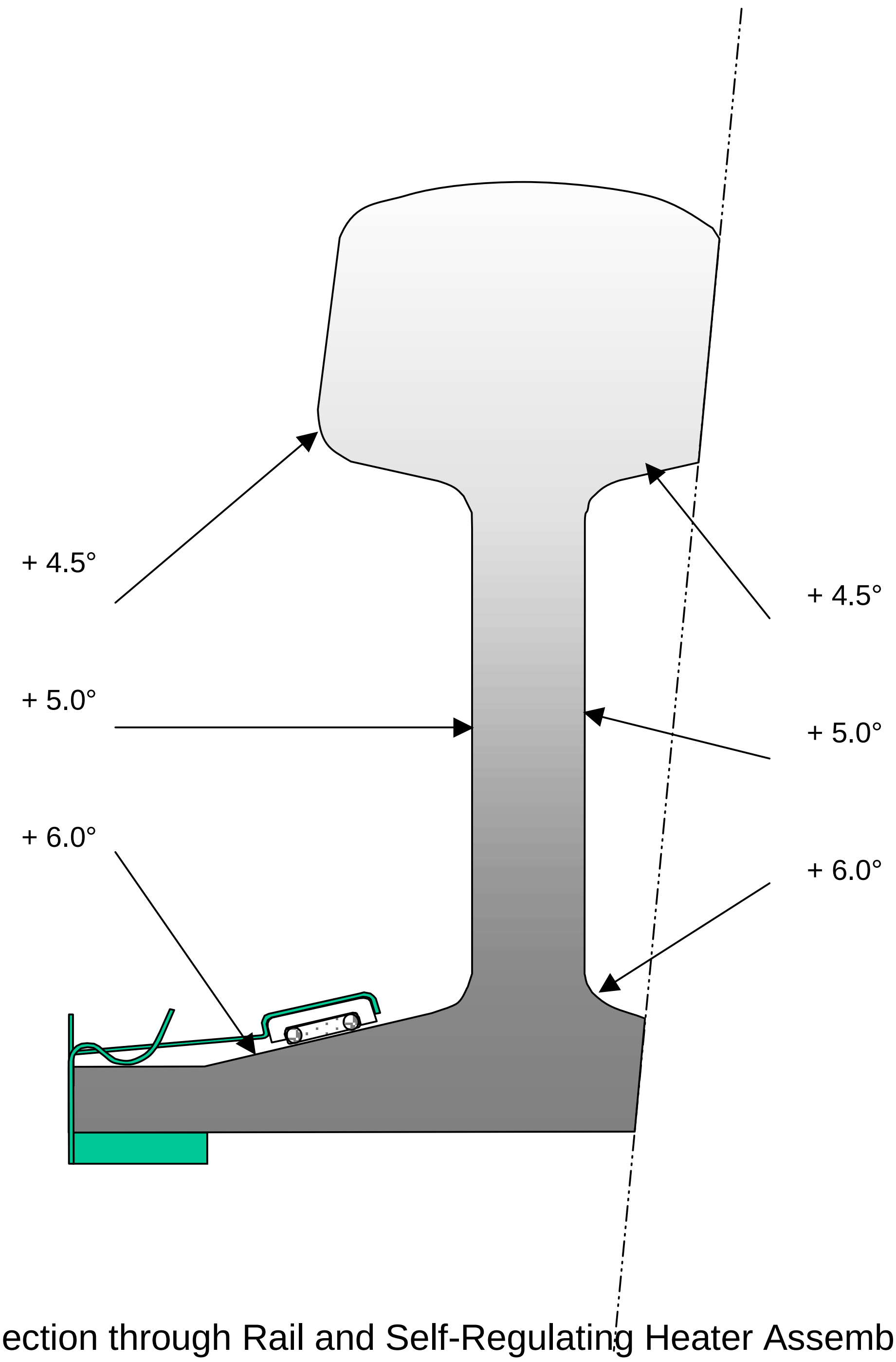
Points Heating Technical

Rail Temperature Distribution



Cross Section through Rail and Self-Regulating Heater Assembly

Data Source: GrayBar Test Chamber
Tolerance Error +/- 0.2°

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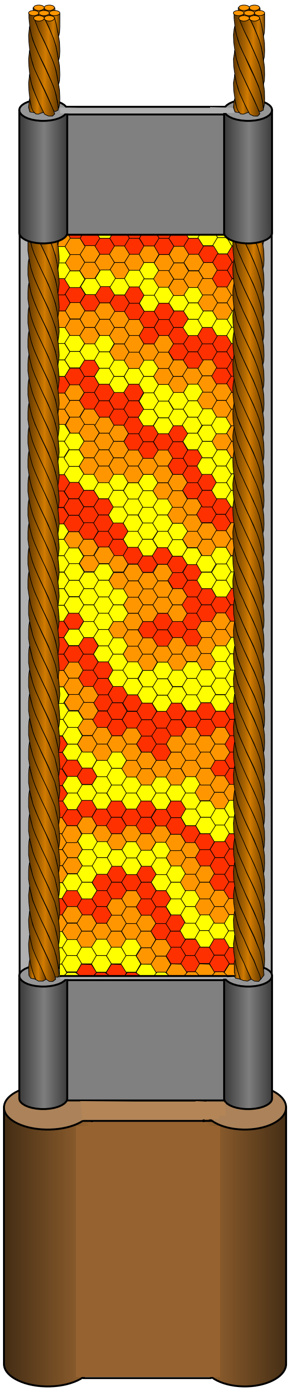
Self-Regulating Heater Operating Characteristics

The semi-conducting core polymer has a positive temperature coefficient (PTC) characteristic, which provides a variable resistance to current flow, directly dependant on temperature. Therefore at low temperatures the electrical resistance of the heater core is low, allowing higher current flow and higher heat output. Core temperature is a function of ambient temperature and wind speed.

As conditions become more severe, with decreasing ambient temperature or increasing wind speed, the heater increases output to maintain the rail above freezing point. This effect occurs independently at every microscopic length of element along the same heater strip. Therefore exposed sections of rail will receive more heat than those in sheltered areas, between platforms for example.

The self-regulating heater cannot overheat and therefore, unlike constant wattage heaters, suffer burnouts where it is not in contact with the rail. For example, to bypass stretcher bars or rail chairs and other obstructions.



Where the heater is cold, the core contracts microscopically, creating many electrical paths through the conductive carbon. The flow of electricity through the core generates heat.

In warmer sections, the core expands microscopically, erupting many electrical paths. The increased electrical resistance causes the heater to reduce its power output.

In hot sections, the microscopic core expansion disrupts almost all the electrical paths. With this high resistance to electrical flow, power output is virtually zero.

Cross Section through Self-Regulating Heater Strip

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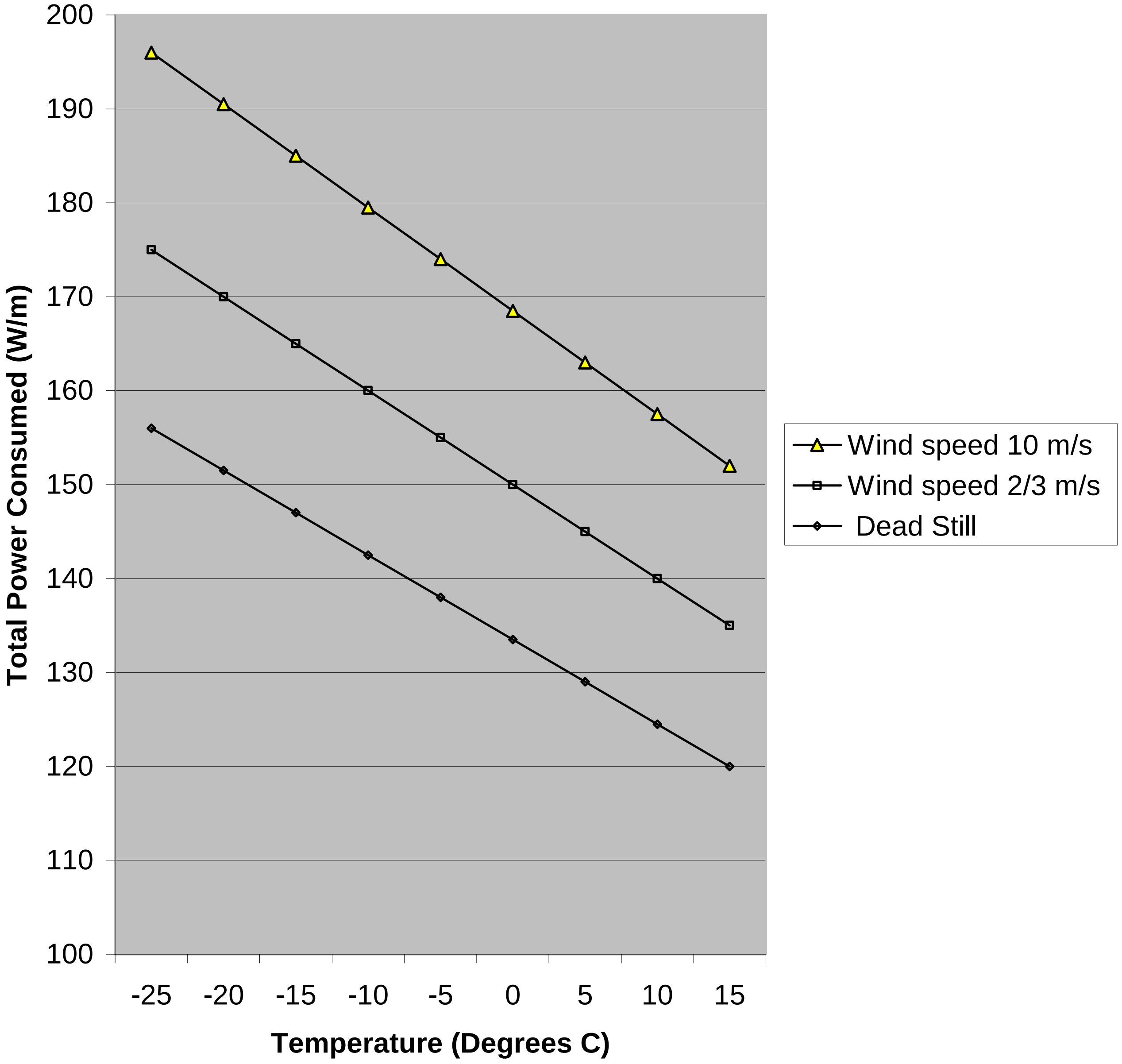
Typical Power Draw Characteristics for Single Element Switchpoint Rail Heater Configuration



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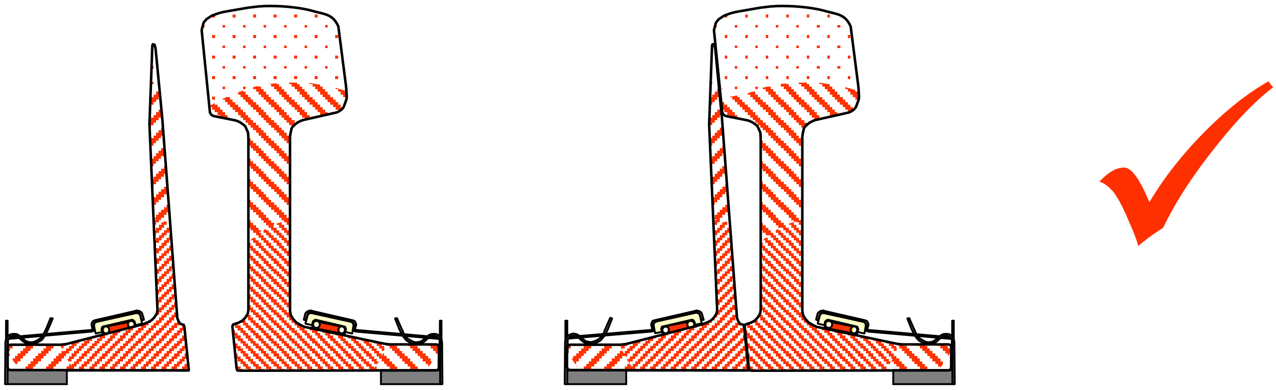
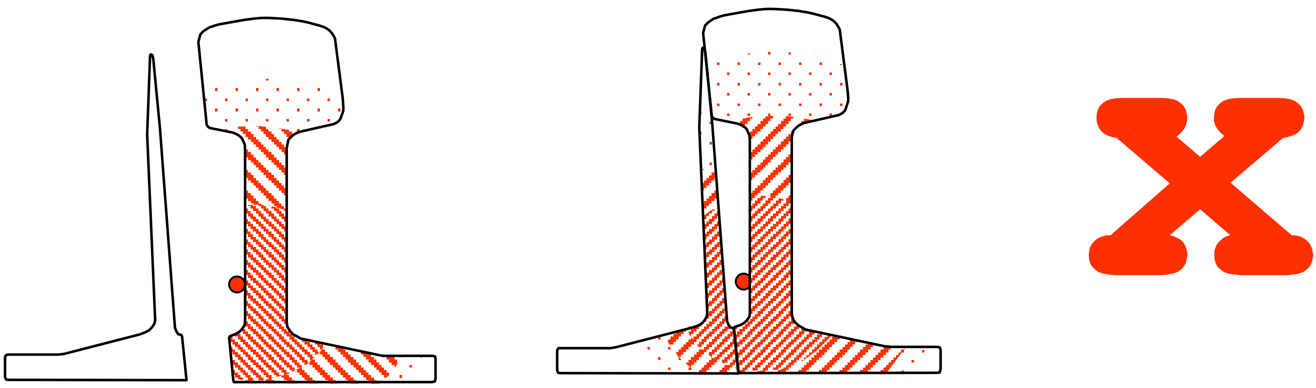
Points Heating Technical

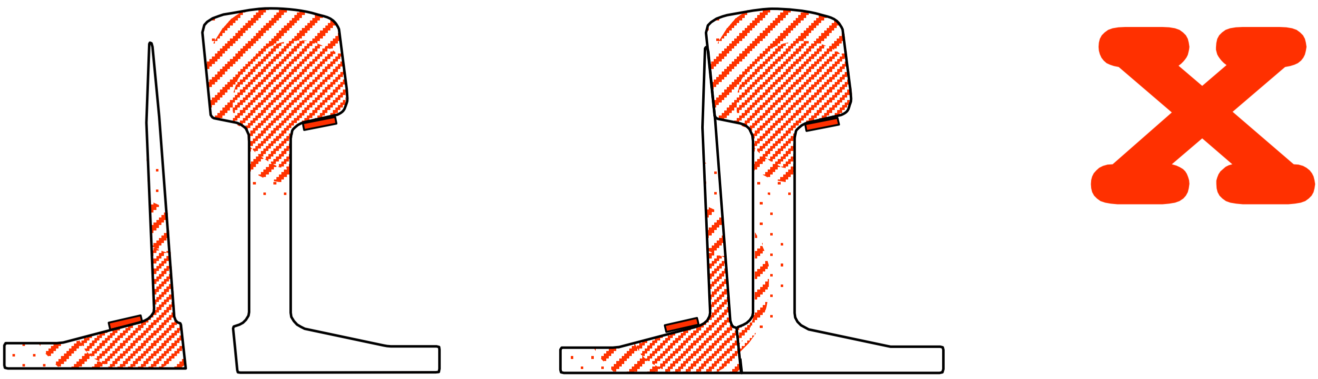
Heater Strip Placement



Heater strips must be positioned at the foot of the rail for effective heat transfer to the baseplate. All GrayBar points heating heater strips, on any rail section, are positioned at the foot of the rail.



Some constant wattage heater cables (outdated method mostly used in Europe) are placed in-between stock and switch rail. Completely ineffective to switch rail when point in open position and will not achieve Railtrack Specification RT/E/S/40045.



Poor stock rail heater placement for constant wattage heaters when used on rail section with non-slotted chairs. This configuration will not achieve heating to Railtrack Specification RT/E/S/40045 when using 200 W/m product.

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