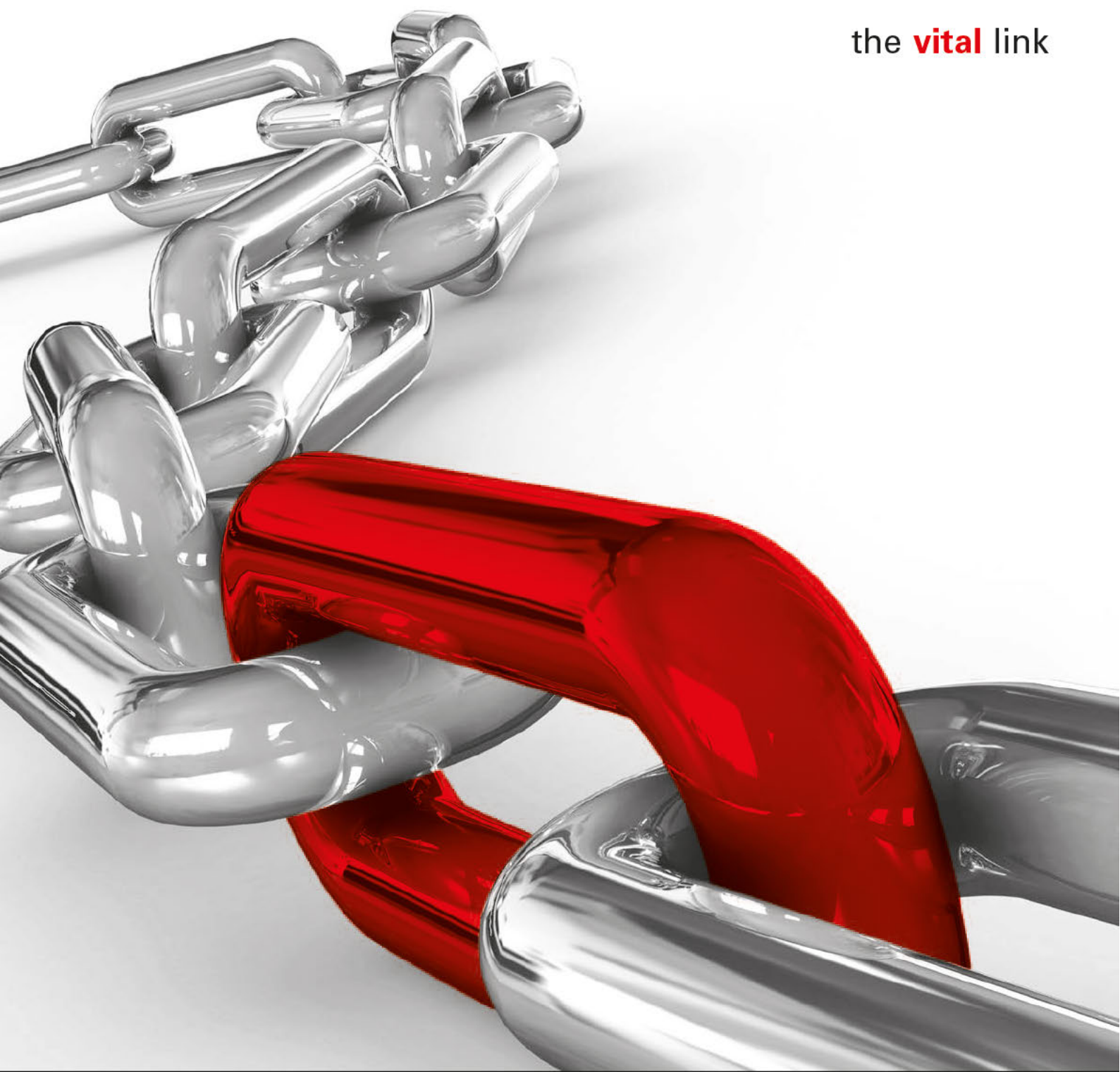


the **vital** link



**Bodycote**





2 Under pressure – Automotive engine components are lowered into a hot isostatic pressing vessel to be treated with Bodycote's proprietary Densal® process.



## The vital link

**Operating an international network of facilities and serving a wide range of industries including aerospace, defence, automotive, power generation, oil & gas, construction, machine building, medical and transportation, Bodycote is the world's largest and most respected provider of thermal processing services.**

**These services are a vital part of any manufacturing process and include:**

- Heat Treatments
- Metal Joining
- Hot Isostatic Pressing
- Metallic, Ceramic, Cermet and Organic Coatings

Thermal processing is a vital part of any manufacturing process and includes a variety of techniques and specialist engineering processes which improve the properties of metals and alloys and extend the life of components.

Without heat treatment aircraft engines would not last a single flight and car gearboxes might only last a week – if you were lucky. Without hot isostatic pressing the risk of catastrophic breakdown of metal components would be far greater and the carbon footprint of power stations would be dramatically higher. Without coatings, construction fixings would rust away and thousands of everyday objects would quickly lose their shine.

## Peace of mind for manufacturers for over 30 years

We never forget that our customers have invested time, money and resources in all the components we process, which is why quality comes as a standard part of our service, ensuring that all our customers' components are treated with care throughout. Our facilities hold numerous international, national and customer approvals appropriate to the services they offer and the markets they serve.

Bodycote's quality management systems, validated by major engineering OEM's, have been developed to meet the requirements of both ISO 9001 and environmental standard ISO 14001. Additionally, market-related standards such as AS 9100 for aerospace and TS 16949 for automotive have also been incorporated. Bodycote has also gained the prestigious Nadcap accreditation at a large number of locations throughout Europe and the USA, as well as approvals from major aerospace companies and their supply chains.

Additionally, our transport services are linked with process and production controls to deliver optimum logistics solutions for supply chain customers. Our customers can be confident their demands can be met, however stringent, with assured quality, cost-effectiveness and on-time completion every time.

## Our people - the heart of our business

The most important asset of any service company is its people, and Bodycote is no exception. As the world's largest provider of thermal processing services, Bodycote employs thousands of highly skilled staff around the globe – some of the best engineers, scientists and technicians in the industry. Our staff are encouraged to develop their skills through professional career development and our in-house training resources.

Bodycote has a proactive approach to the health and safety of our employees and is committed to the achievement of the highest practicable standards of safety and health. Appropriate health and safety policies and procedures are in force within all divisions of the company and each division is able to benchmark its safety and health performance and formulate strategies for improvements. Bodycote's accident rates are currently at an all-time low, having reduced year-on-year for the past four years.



## Research & Development – making innovations possible...

Bodycote's extensive facilities and expertise mean R&D projects can expand far beyond customers' in-house capabilities, helping to realise goals quicker and more cost-effectively.

Around the globe, Bodycote has dedicated R&D teams working on a variety of projects. When required, this may include the development of specific processes and equipment for a customer or verification of materials or designs, prior to their application.

In-house development and improvement of standard processes has led to Bodycote offering a range of proprietary processes such as Kolsterising®, Corr-I-Dur® and SheraCote®, which far outperform their standard counterparts.



## Additional services

Many of Bodycote's facilities have their own in-house laboratories for quality control and testing of material properties.

## Heat Treatments & Metal Joining

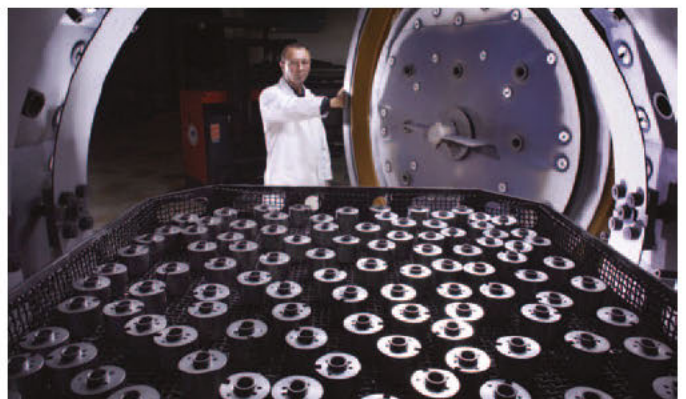
Although modern techniques are scientifically advanced, mankind has used heat treatment to improve the properties of metals for thousands of years; the first written evidence of quench hardening of weapons can be found in Homer's Odyssey, written in 880 BC, wherein the author compares the hissing of the burning stake plunged into the eye of the Cyclops to the sound made by the armourer's red hot sword during quenching.

Heat treatment is a controlled process used to alter the microstructure of materials such as metals and alloys to impart properties which benefit the working life of a component, for example increased surface hardness, temperature resistance, ductility and strength. Metal joining includes specialist processes such as electron beam welding, vacuum and honeycomb brazing; complex operations requiring a fusion of expertise and technology.

Bodycote offers an extensive range of heat treatment services and specialist metal joining techniques. With unmatched capacity and computerised systems, our facilities can process a wide range of component sizes to exacting standards with reliable, repeatable results.

Whilst offering all the heat treatment services you would expect from the world's leading heat treater, Bodycote can also provide advanced specialist services including:

- Automatic shaft straightening
- Corr-I-Dur® (a proprietary form of Ferritic Nitrocarburising)
- Cryogenic treatments
- Low Pressure Carburising (LPC)
- Nitrocarburising
- Hydrogen annealing
- Speciality stainless steel processes (S3P)
- Kolsterising® (surface treatment for Stainless Steel)
- Plasma surface technologies
- Thermal deburring
- Honeycomb brazing
- Vacuum brazing
- Electron Beam Welding (EBW)
- Mesh belt brazing
- BoroCote (High speed boronising)
- Low pressure nitriding





## Hot Isostatic Pressing (HIP)

HIP combines very high temperature (up to 2,000°C) with inert gas under very high pressure (up to 30,000 psi) – equivalent to the Mariana Trench 11,000m deep in the Pacific Ocean. HIP is used to eliminate porosity in castings and consolidate encapsulated powders to give fully dense materials. Dissimilar materials can be bonded together to manufacture unique, cost effective components.

Every week a typical Bodycote HIP plant will process many tons of titanium, aluminium, steel and superalloy castings, removing porosity and uprating the performance of parts such as turbine blades, medical implants and turbochargers.

When a project requires advanced materials technology, working with Bodycote HIP could provide the ideal development and production route, allowing the engineer to optimise conventionally formed parts and also to design components unobtainable by other means. Bodycote HIP research specialists are experienced in working with customers to develop novel materials and applications.

With the largest operational capacity in the Western world, and a wide variety of sizes of equipment, Bodycote HIP is able to accommodate large volumes of small product as economically as large individual components.

Bodycote's HIP services include:

### Densification:

- Superalloy castings
- Titanium castings
- Steel alloy castings
- Aluminium castings (DENSAL® / DENSAL®II)
- Medical implants (Ti & Co/Cr)
- Ceramics
- Glass
- Infra-red windows
- Tungsten carbide

### Powder Metallurgy:

- Bi-metallic and multi-metallic materials
- Simple shape billets
- Complex shape assemblies
- Near Net Shape (NNS) components
- Net Surface (NS) HIPped components
- Capsule design and HIP modelling

### Composites:

- Novel materials
- Metal Matrix Composites
- Diamond tools
- Diffusion bonding
- HIP brazing

## Surface Technology

Specialist coatings are used extensively to prolong the working life of components and protect them from environmental factors such as corrosion and abrasion. The range of coatings available from Bodycote covers a wide variety of applications, providing solutions for manufacturers in virtually every market sector. Bodycote has particular expertise in providing surface technology solutions to customers in the aerospace, power generation and oil & gas sectors.

Bodycote provides indispensable coating systems for durability, anti-corrosion, wear resistance, improved hardness and electrical conductivity. The combination of modern computerised control and unrivalled coating expertise means that Bodycote can offer specialist ceramic and thermal spray coatings, thermal diffusion, duplex coatings and organics systems.

Bodycote is a specialist provider of K-Tech coatings – a unique range of thermochemically formed ceramic coatings for the prevention of wear and corrosion in a wide variety of severe industrial applications including complex geometric shapes and internal bores.

Bodycote's surface technology services include:

### Thermal Spray Coatings:

- HVOF (High Velocity Oxy-Fuel)
- Plasma spray
- Arc wire spray
- Combustion spray
- Cold gas dynamic spray
- Flame spray

### Organic Coatings:

- Delta Protekt KL 100, Delta Seal, Delta Seal GZ
- Magni B18, Magni 565
- Xylan coatings

### Other Coatings:

- Thermochemically formed ceramic coatings (K-Tech)
- Ceramic densification
- Polymer and hybrid coatings
- CompCote® (Anodising-polymer composite)
- Nedox® (Electroless nickel-polymer)
- Tufram® (Hard anodising-polymer)
- Anodising (aluminium and titanium)

### Thermal Diffusion Coatings:

- Sherardizing
- Sheraplex®
- SheraCote®

### Mechanical Plating:

- Mechanical Zinc, Zinc/Tin, Zinc/Aluminium, Zinclad

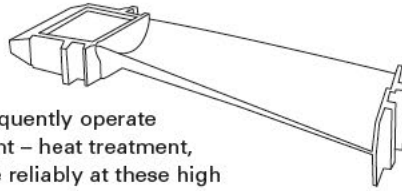
### Precision Machining & Surface Finishing



## The power to deliver – a component journey

### Land-based gas turbine blades and vanes

Like aircraft turbine blades and vanes, land-based gas turbine components used for power generation must withstand extreme temperatures in operation. These materials frequently operate at temperatures approaching their melting point – heat treatment, HIP and coating allows these blades to operate reliably at these high temperatures for extended periods of time.



The turbine blades begin life as nickel-based superalloy billets. This superalloy gives superior strength at high working temperatures



The billets are investment cast to form the blade shape and then fettled to remove casting material



The blade castings are HIPed to remove porosity and increase their creep and fatigue resistant properties

The blades are precipitation hardened to increase their strength at high temperatures

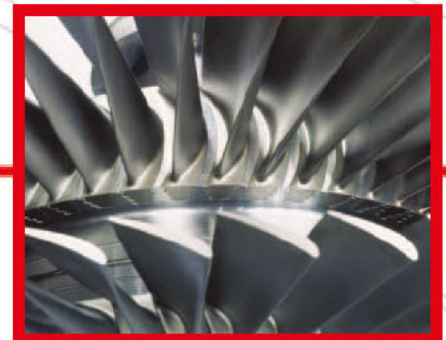


Honeycomb for abrasion seals is vacuum brazed onto the vanes' main sections

A thermally sprayed coating is applied to improve temperature resistance



Finally, the blades are machined prior to their assembly as part of an engine



End application – gas turbine engine

### Bodycote component journeys

This is just one example of how Bodycote brings together the huge wealth of knowledge and expertise from across the Group to provide the vital engineering services you need...

For more component journeys visit [www.bodycote.com](http://www.bodycote.com)

■ Denotes the parts of the component journey undertaken by Bodycote



## Caring for our environment

**Bodycote is totally committed to achieving environmental best practice throughout our business activities, ensuring that these meet relevant laws and regulations, that they are acceptable to the community at large, and that their environmental impact is reduced to a minimum. The company recognises that the pursuit of economic growth and a healthy environment are closely linked.**

Ever at the forefront of technology, Bodycote was one of the first thermal processing companies to use microprocessor controls to tightly control atmosphere and emissions and introduced its first load-forecasting systems over 20 years ago to reduce peak energy demand and minimise waste.


A proactive approach to improving energy efficiency means that Bodycote has implemented a variety of systems to reduce water and gas consumption and re-use energy. This continuing focus on lessening our impact on the environment has resulted in Bodycote advancing toward ISO 14001 environmental accreditation at all its facilities, with almost three quarters of the Group having already achieved this standard.

At every stage where Bodycote is involved in the manufacturing cycle, our operations aim to lessen the overall impact on the environment. The key to Bodycote's positive contribution lies in efficiency; as an aggregator of specialised engineering services, Bodycote reduces the carbon footprint of our customers' activities by increasing the lifespan of their products and using modern, energy efficient equipment.

Without Bodycote, companies would be using older technology and running their equipment at reduced capacity, both of which are a drain on energy and financial resources. Working with Bodycote enables customers to more easily commit to carbon reduction initiatives. In many geographic jurisdictions this can lead to additional value generation as carbon reduction legislation is brought in to force.







## How can energy intensive thermal processing be environmentally friendly?

**When you first consider the science of thermal processing from an environmental point of view, you may ask the question, 'How can such an energy intensive process help the environment?'**

However, if we consider a world without heat treatments, HIP or coatings the advantages become immediately apparent. Take an average car, for example – whether diesel, petrol, electric or gas, all need parts that are heat treated, HIPed and coated. For the wheels to turn bearings are needed, yet few people realise that it is thanks to heat treatment that the humble wheel bearing lasts the lifetime (and beyond) of the car. Certainly, better design and improved lubricants assist with this extended life, but without heat treatment a wheel bearing would be lucky to last a week. The same applies to gearboxes, final drives, engines and, in fact, all the moving parts of the vehicle.

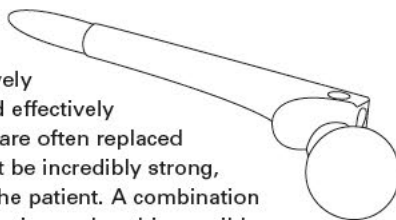
But it doesn't end there. Modern thermal processing techniques have allowed design engineers and manufacturers to use much lighter materials, such as aluminium, and have significantly prolonged component lifetimes. By treating the aluminium used for castings and suspension components, the weight of the vehicle is reduced, which in turn leads to reduced fuel consumption and improved efficiency. Without thermal processing, the average car would weigh substantially more and require frequent replacement of parts due to wear resulting in more mining, more transport, more machining, more waste – in short, a massive environmental impact.

So, whilst thermal processing is an energy intensive business, it is a vital part of the manufacturing chain and its use saves the energy it consumes many times over. The alternative would require the use of energy on such a scale that many of the things that we consider an essential part of modern day life would be economically unviable.

## Inner strength – a component journey

### Medical prostheses

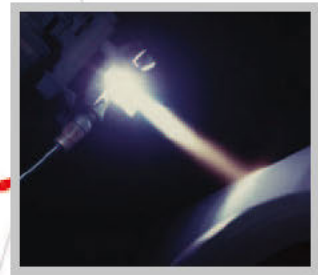
The stress on a hip or knee joint when a person jumps off a chair is equal to around 100 tonnes per square inch. Our bones, effectively composites, absorb such stresses regularly and effectively for much of our lifetime. When joints fail, they are often replaced with metal alloy implants. These implants must be incredibly strong, biocompatible, and able to last the lifetime of the patient. A combination of heat treatment, hot isostatic pressing and coating makes this possible.







Cobalt chromium alloy billets are investment cast to form implant shape



The castings are thermally sprayed with a biomedical coating to allow a bond to form between the implant and body tissue, promoting bone growth



The implants are then HIPed to eliminate porosity, improve fatigue life and enhance the bonding of the biocompatible coating



Solution and ageing heat treatment is used to strengthen the implant



End application – joint replacement

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Denotes the parts of the component journey undertaken by Bodycote

## Optimise your business resources

**Bodycote has become the partner of choice for the world's most respected and innovative engineering companies by providing highly efficient, cost-effective services to the highest quality standards through strategic investment in people and the latest technology, equipment and quality systems.**

By outsourcing non-core but vitally important thermal processing requirements to Bodycote, you can concentrate your business resources on your core competence.

Our services offer benefits to you through reduced equipment maintenance, capital expenditure, energy costs, people costs and a major reduction in CO<sub>2</sub> emissions, therefore significantly improving your carbon footprint. Bodycote operates a 24/7 service, using the latest technology and equipment, and a highly skilled, experienced workforce.

Bodycote has a long history of successful outsourcing partnerships – from global to local manufacturers. A pioneer of the 'factory gates' principle, Bodycote can bring its expertise to you or, alternatively, you can take advantage of the unrivalled capacity of our global, yet local, network of quality accredited locations.

Whether your requirements suit conventional subcontract support, a long-term business agreement or top-level strategic partnering, contact Bodycote today and find out how we can improve your business productivity, reduce your operating costs and deliver a reliable, quality assured service.





**Bodycote's outsourcing model has three levels:**

**Conventional subcontracting**

The foundation of Bodycote's business is the provision of services on a conventional subcontract basis, for customers without the required capability in-house, or who are experiencing an overload or breakdown situation, or do not possess the required technology.

**Long term agreements**

In many cases subcontracting relationships lead to component and service-specific long-term agreements, which embody protection and freedom from risk for the customer and Bodycote. These are often exclusive in character and provide the basis for mutual business development, with both companies freed to concentrate capital and other resources on core competencies.

**Strategic partnering**

Strategic partnering is Bodycote's revolutionary win-win approach to improving on the traditional subcontract processing method. Simply put, Bodycote brings the processing to you. To accomplish this, we may actually custom build a facility right in or near your plant to exclusively handle your needs, or manage and develop your existing facility. In return, you simply agree to use this facility.

By partnering with Bodycote the risks associated with regulatory compliance, environmental damage mitigation and climate change issues pass to Bodycote. Typically, our strategic partners find that using our efficient thermal processing facilities allows them to reduce their carbon footprint, therefore generating surplus carbon credits which, in many jurisdictions, can be traded for value.

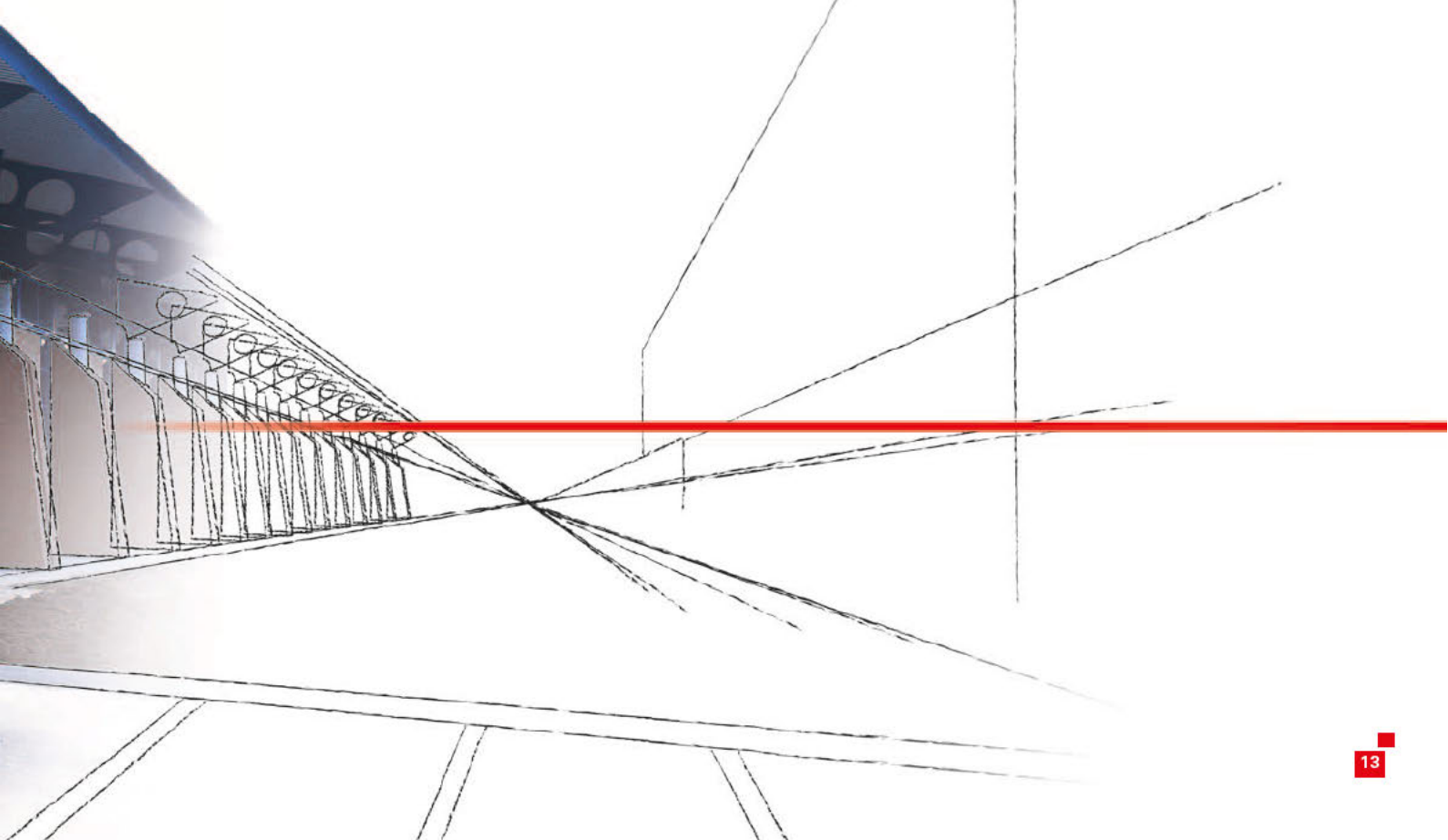
For example, if you have an existing heat treating facility, Bodycote may buy it, re-equip it, and take over its operation. This option offers immediate relief from all the problems well known to you such as your accounting, health & safety and environmental compliance departments.

Strategic partnering is especially effective when there is a high volume of work and one or more of the following conditions apply:

- Where rapid response times are required
- Where specialist processing is needed
- Where sequential processing is required (e.g. heat treating plus coating)
- Where absolute confidentiality is needed in relation to intellectual property

The benefits derived from strategic partnering in any particular case obviously depend on what specific problems exist with the current arrangements. The following is a list of general benefits that can be expected:

- Elimination of unneeded shipping, receiving, packing, unpacking, trucking, handling, and risk of loss and damage.
- Reduction in work-in-process inventory.
- Reduced processing costs, since more specialised equipment can be used.
- Reduced purchasing load, and reduced paperwork overall.
- Immediate ISO 9001 certification, other certifications as needed.
- Built-in overflow capacity guaranteed at other nearby Bodycote facilities.
- Elimination of duplicate quality checks.
- Better ongoing understanding by customer's engineering staff of interactions between product design, material, manufacturing, and processing.
- Future-proofing of the technology.



## On track – a component journey

### Rail clips

Rail clips are used to hold rail tracks to the sleepers. Heat treatment processing and corrosion resistant coating gives these clips the strength to hold the tracks in place under several hundred tonnes of train whilst being flexible and able to withstand the effects of weathering for many years.





Steel bar or strip is cut into pieces and hot forged into shapes and sizes required



■ The clips are heat treated to harden the steel and increase the yield strength for flexibility



■ Finally, the clips are Sherardized to improve their life expectancy against environmental corrosion, without reducing their fatigue life



End application – railway lines

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