

Gas and Joining Technologies within Aerospace Manufacturing



Aerospace manufacturing challenges

BOC is the largest provider of industrial and specialist gases in the UK and Ireland, with over a century as the authority for providing gas and joining products, services and support within aerospace manufacturing.

BOC works in partnership with aerospace designers, assemblers, manufacturers and repairers in the development and production of civil and defence aircraft, helicopters, missiles, rockets and spacecraft. BOC supports the aerospace sector with the challenges they face in:

- Improving Buy-to-fly strength to weight ratios
- Improving productivity and efficiency through adopting leaner manufacturing processes
- Improving fatigue, wear resistance and corrosion prevention
- Innovative manufacturing processes of advanced metal alloys
- Joining technologies for composites and metal alloys

Thanks to our experience and unrivalled supply and distribution network, BOC is the only supplier who can provide an exhaustive range of world class gases, associated products and services, expertise and industry knowledge required to cover the wide range of gas processes used by manufacturers within aerospace manufacturing.

Combining our leading supply capabilities with unique services, BOC provides customers with:

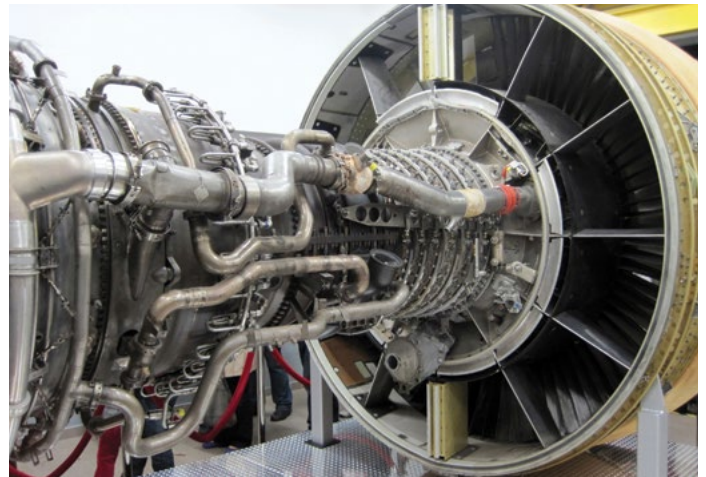
- Industrial gases provided through a variety of innovative package solutions
- Speciality gases and their mixtures
- Speciality gas equipment
- On-site facilities management services
- Everyday consumables
- On-site process/technical support
- Specialist PPE

Quality and reliability

As a member of the World-leading Linde Group, BOC combines over 120 years of gas supply expertise with Linde's global capability in optimising high value manufacturing processes, providing an outstanding portfolio of products and services.

With seven air separation units (ASUs) in the UK, the only gas supplier with an ASU in Ireland and with two dedicated special gases manufacturing facilities, BOC has an unrivalled production and distribution network providing customers with confidence in an uninterrupted gas supply across atmospheric gases and thousands of different specialist gases and gas mixtures.

In addition to security of supply, we recognise the importance of quality of our high purity and specialist gases. This is assured by our laboratory ISO9001 and ISO17025 accreditations, combined with the surety of full traceability and documentation.



How can BOC help you to meet your key manufacturing challenges?

With demands on aerospace increasing, OEM manufacturers are keen to adopt innovative and technologically advanced processes to improve Buy-to-fly strength to weight ratios, production efficiency, wear resistance; ultimately to improve performance.

To accommodate these demands, the sector is noticing a trend in the increased use of composite materials including carbon fibre reinforced polymers and epoxy resins in airframe structures along with metal alloys including titanium and nickel in components. The sector is investing in innovative manufacturing processes such as additive manufacturing to 'grow' components and surface technologies to improve anti-wear and anti-corrosion resistance.

BOC Industrial and specialist gases along with associated products are used for a wide range of different processes that address and support the adoption of these requirements.



Composite materials

Composite material use in aerospace has expanded over time. The use of composite materials now includes high-tech flight control components, fuselage and wing structures and components. The increase in demand is attributed to greater impact resistance and power-to-mass ratios.

Composites, such as epoxy resins and carbon fibre reinforced polymer (CFRP) make up as much as 50% of the total material mass used to produce the latest aircraft. Injected into an autoclave, BOC liquid nitrogen is used to provide heat suppression into the curing process to heat treat composite materials.

Additive manufacturing

Additive manufacturing processes such as laser sintering and electron beam melting are well established within aerospace manufacturing, in some cases reducing Buy-to-Fly ratios from 15 down to as low as 1. To date additive manufacturing has predominately been adopted within aerospace for prototyping, repairs and printing of low volume, non-critical, complex components.

Additive manufacturing provides increased design freedom to enable greater functionality of products, reduced part counts and provide significant weight savings (up to 60% weight reduction) and enables manufacturers to improve material utilisation and reduce energy consumption; whereas subtractive manufacturing processes led to the waste of expensive starting materials.

Powders such as titanium, nickel and other complex alloys are being adopted for their toughness, improved wear resistance and fatigue life. Turbine blades were among the first aerospace parts manufactured using additive processes. Produced in Titanium by an electron beam melting process, the blades are produced highly dense, void-free and incredibly tough.

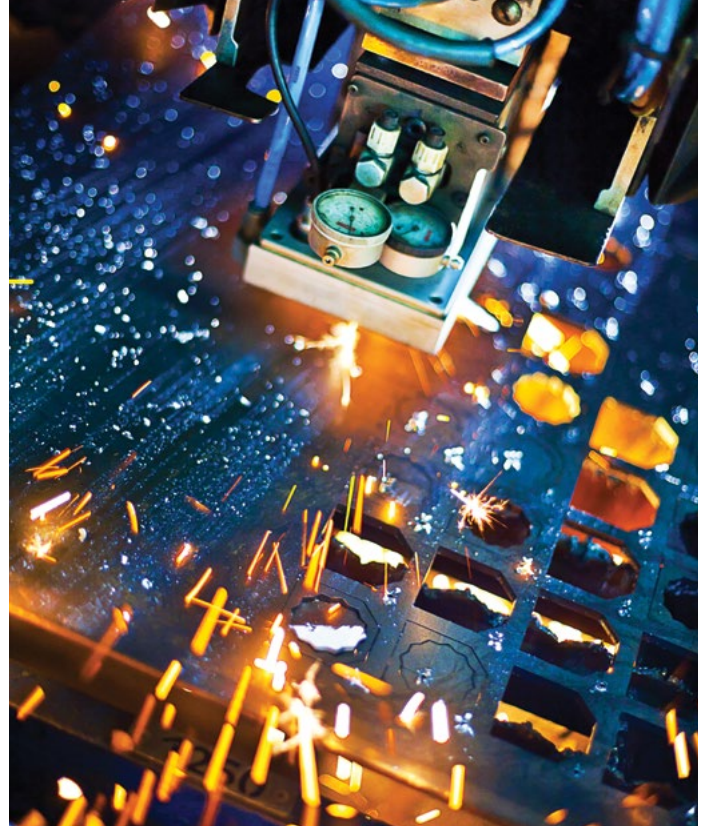
It is anticipated that additive manufacturing processes will continue to grow in the future, be introduced for the production of aircraft wings, embedding of additive manufactured electronics directly onto parts and further complex structure components.

Traditionally blanketed in Argon during the additive manufacturing process, BOC are exploring the benefits of utilising speciality gas mixtures and thermal management techniques that will improve the final properties and subsequent performance of the component.





HVOF spraying process required for flight critical applications



LASERLINE® gas solutions for Titanium, Aluminium and Nickel Alloy structures

Thermal spraying – LINSPRAY®

Thermal spraying has become increasingly important, both in the manufacturing of new and the repair of existing landing gear, engine components, turbine and compressor blades, housings, fuel nozzles, outer castings and combustion chambers. With increasing demands on component anti-wear and anti-corrosion protection, thermal spraying processes are often the coating method of choice. Its primary advantages are:

- Rapid material deposition
- Controlled coating thickness

During thermal spraying, plasma is produced by an arc which is constricted and burns in BOC supplied gases such as argon, helium, nitrogen, hydrogen or their mixtures. This causes the gases to dissociate and ionize; they attain high discharge velocities and on recombination, transfer their thermal energy to the spray particles in order to coat the component with the anti-wear and anti-corrosion barriers.

For flight critical applications such as landing gears, aerospace manufacturers have traditionally utilised chrome plating. More recently the trend has been to replace with a metal powder coating; deposited by High Velocity Oxy Fuel (HVOF) spraying process in BOC supplied oxy-hydrogen, oxy-propane, oxy-propylene and oxy-acetylene gases. BOC's technological developments and expertise support manufacturers in the application of HVOF spraying through both specially shaped nozzle attachments and world class thermal spraying gases and gas mixtures.

In HVOF and plasma thermal spraying processes, the heat input in the base material is often extremely high. When coating thin walled substrates, substrates with low thermal conductivity or temperature sensitive coating material, BOC's carbon dioxide cooling solutions through BOC patented nozzles, guarantee effective expansion and optimal jet constriction which control the coating temperatures.

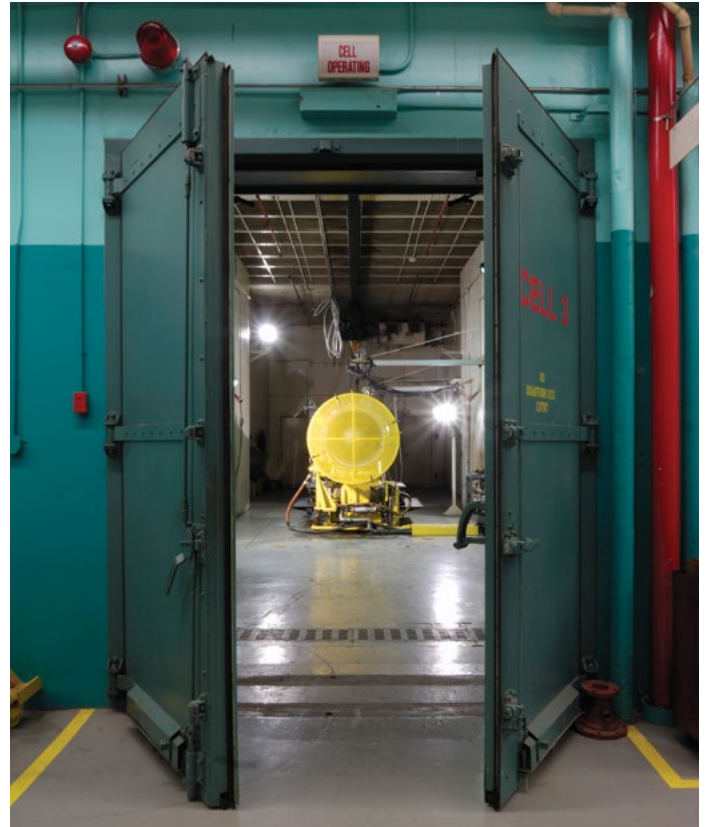
Laser cutting and welding

BOC understands the importance of achieving cut edge quality in the laser cutting and welding process of aluminium, titanium and nickel alloys, widely used in air frame structures and engine components. BOC are experts in providing world class nitrogen, oxygen and carbon dioxide gases to fully support requirements. In addition, a range of laser gas supply solutions are offered through LASERLINE® which includes:

- Industrial and laser gas mixtures
- A full range of supply options, from cylinders, through to liquid and on site generation
- Specialist gas control equipment
- Maintenance provision through our OnStream service
- Engineering support
- Technical support & advice



CRYOCLEAN® CO₂ snow pre-cleaning for painting and coating processes



Special gases for instrument and avionics calibration and environmental testing

CO₂ surface cleaning – CRYOCLEAN® Snow

BOC's patented CO₂ surface cleaning technology accelerates solid snow particles onto surfaces via compressed air. The fully automated cleaning process is used in pre-cleaning processes prior to painting and coating of a number of parts, removing unfused metal powder from laser sintering additive manufacturing processes, removal of flash from machined components, removing anti-corrosive oil prior to the joining of parts and removing any small contaminants from drilled and tapped holes.

The process commonly removes dust, grease, oil, release agents, residues, glues, adhesives and thin coats of paints, while providing a more efficient cleaning process than existing power-wash systems, a reduction in energy costs, is environmentally friendly and enables a smaller footprint.

Component and instrument calibration

BOC are experts in the field of component and instrument calibration. Component and instrument calibration is carried out using a range of high purity/zero grade speciality gases.

As part of the Linde Group, BOC has access to 20-25% of the world's commercially available helium, and manages the most diverse sourcing portfolios in the industry; ensuring security of supply and your peace of mind. Through investment in a UK helium transfill facility; BOC has more cylinders, liquid dewars, bulk tube trailers and people dedicated to its helium business than any other supplier in the UK.

Speciality gas mixtures supplied for equipment calibration meet the national standards set by the National Physical Laboratory (NPL), ensuring accuracy in producing Alpha Volumetric mixtures calibrated with a direct comparison to NPL standards.

BOC also provides full traceability of our gas mixtures and demonstrates the mandatory compliance and validated quality assurance as verified by our ISO 9001 and ISO17525 accreditations.

Heat treatment

Ensuring toughness, wear resistance and durability of metal alloys used within the manufacturing of components, is a critical process. Heat treatment processes such as annealing, brazing, carburizing and hardening are common place in aerospace. BOC's world class supply of liquid argon, nitrogen and hydrogen gases play an integral part within processes required to relieve stress, reduce oxidation, carburize, seal or harden metals.

Environmental testing

When in operation, civil and defence aircraft and helicopters are subjected to environmental changes including extreme temperatures through to vacuum states as found in space. With the introduction of environmental testing chambers, together with BOC Argon, Helium and Nitrogen gases, manufacturers can replicate these extreme conditions to ensure components are fit for purpose.

Gas system design and maintenance services

Safety is of paramount importance to BOC. Understanding and ensuring compliance with safety legislation is a necessity, but can be time consuming and complicated, requiring a detailed understanding of engineering, gases and regulations.

BOC have developed OnStream to assist customers in achieving the required compliance for safety legislations such as Pressure Systems Safety Regulations 2000 (PSSR).

Compliance

Currently any owner or user of a gas system which is pressurised above 0.5 bar (g) must be able to demonstrate the following:

- the system is working within safe operating limits
- a Written Scheme of Examination (WSE) is in place
- the system is regularly maintained and inspected by a competent body

It is a legal requirement to conform to PSSR. Failure to do so means your system is at risk of being shut down until compliance has been achieved.

BOC OnStream

The BOC OnStream service is designed for customers with fixed pressure systems, ranging from simple systems with a single regulator and short distribution pipe work to longer, more complicated systems with many control and outlet points. Even if equipment is currently in 'poor' condition, BOC can assist customers with upgrading systems to improve safety whilst delivering PSSR compliance, allowing customers to concentrate on their core business.

System design and installation

BOC is proud to have a network of engineers that work with customers to design a gas distribution system that meets customer specific needs. BOC ensures that systems are installed efficiently with a series of rigorous operational and safety checks carried out to ensure installations meet industry regulations and legislative requirements.

Breakdown response

It is BOC's objective to ensure customers are operational at all times. Engineers are equipped with the experience and tools to respond to breakdowns of both BOC and, by agreement, customer-owned equipment.



On-site equipment safety checks and safety training

Gas equipment must be checked regularly. The British Compressed Gases Association (BCGA) Code of Practice 7 (CP7 -The Safe Use of Oxy-Fuel Gas Equipment) and Guidance Note 7 (GN7 - The Safe Use of Individual Portable or Mobile Cylinder Gas Supply Equipment) recommend that regulators and flashback arrestors are checked annually and replaced every five years.

Checks need to be undertaken by a person who has sufficient practical experience of oxy-fuel gas equipment as well as theoretical knowledge of the functioning of the equipment, the properties of gases used, the potential defects and hazards that may occur and their importance to the integrity and safety of the equipment.

BOC CP7 and GN7 checks

BOC CP7 and GN7 checks are performed by a qualified BOC Industrial Inspector (certified by City and Guilds). The inspection includes:

- A thorough functionality and leak test of all components; regulators, flashback arrestors, hoses, torches and associated fittings
- A full report of the inspector's findings
- An update by the inspector on current health and safety and BCGA Codes of Practice

Safety training

BOC safety training courses are delivered through BOC's network of technical support engineers and cover a wide variety of aspects including the following:

- Gas characteristics
- Cylinders-identification and safety
- Cylinder handling
- Cylinder storage
- Gas equipment
- Assembly
- Lighting and shutting down procedures
- Legislation



One stop for your supply solutions

An uninterrupted, continuous and effective gas supply from BOC ensures customer productivity is maximised and finished product quality meets requirements. As the only industrial gases company in the UK to offer an exhaustive range of supply services, you can be sure of impartial advice on the best supply solution for your needs.

As well as a full range of standard small, medium and large size cylinders you can also choose from a broad selection of solutions and supply modes that provide even greater value.





Bulk storage

For large users; the most cost effective gaseous and cryogenic solution for continuous supply.



ECOVAR® – Onsite gas generation

Providing a continuous, reliable and independent gas supply for Oxygen, Nitrogen and Hydrogen.



Manifold cylinder pallets

Typically containing 15 cylinders, and recommended for users that require more gas than single cylinders; ideal when productivity is paramount.



CRYOSPEED®

Ideal for smaller volume users who require liquid product delivered directly into cryogenic vessels, and want to avoid the manual handling and downtime associated with single cylinders.



Cylinders

Offering a wide range of individual, high-pressure cylinders suitable for smaller volumes of gas. Available in numerous sizes and pressures, cylinders offer a high degree of versatility and flexibility, supplied in a range of packages from steel cylinders to innovative solutions including GENIE® and VIVANTOS®.

BOC's pioneering gas cylinder tracking system benefits customers through improved invoice accuracy and cylinder management, greater reliability and accuracy of stock holdings, improved handling of gas cylinder enquiries and improved traceability of gas cylinders.



GENIE® cylinders

More gas, more portable, more intelligent.

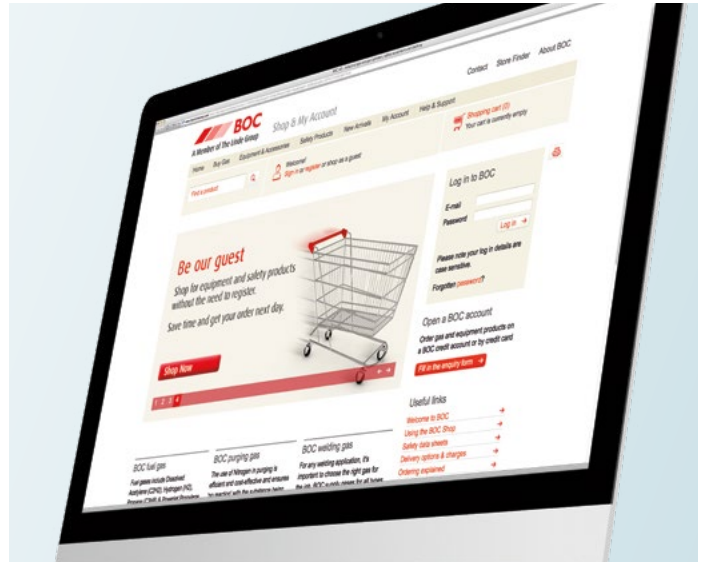
GENIE® is a revolutionary, mobile and lightweight cylinder package that transforms the way gas is used. A GENIE® cylinder contains 30% more gas than its standard steel equivalent, providing a longer usage time. It features a state-of-the-art digital display and low contents alarm indicating how much gas is remaining.

The GENIE® is the ideal cylinder for use in repair and maintenance applications as well as for manufacturers investing in additive manufacturing machines for prototyping applications, due to its small footprint and mobility.



BOC, tailored customer service

BOC provides customer services solutions to suit each customer from direct account management, to the use of our dedicated UK based customer service team. Our customer service centre, is available 24 hours a day, 365 days a year designed to respond to and resolve all your needs first time, every time.



BOC online

From our world class welding, healthcare and fuel gases through to our highest quality welding, cutting equipment, PPE and work wear, customers can buy from BOC online any time of the day, any day of the year. Visit boconline.co.uk/shop

LASERLINE® – laser gas control equipment

Whether you have a CO₂, Nd:YAG, excimer or diode laser, equipment quality as well is essential not only to maintain the laser's reliability but also to ensure the highest process productivity. BOC produces a range of laser gas regulation equipment which is designed and engineered to meet or exceed the high quality standards specified by today's laser manufacturers.

Specialist PPE & vending machines

BOC takes safety in the workplace very seriously, which is why we have selected a range of the most innovative and highly rated products on the market that are specifically suited for the needs of aerospace manufacturing. From disposable clothing, technologically advanced eyewear and chemically resistant gloves for assemblers, protective clothing for surface preparation through to PPE for fabricators, using our extensive industry knowledge of aerospace manufacturing, BOC can help you to provide a safe environment for your workplace.

For improved stock management and availability, BOC provide bespoke vending machines, specific to each manufacturing process.

Welding products

BOC's Industrial Welding & Supplies is the number one supplier of welding products to UK manufacturers. Our network of 72 Gas & Gear retail stores and in excess of 300 partners and agents ensures BOC can supply customers of all sizes with a range of services unrivalled by any of our competitors.

BOC's application experts

BOC's Technical Support Engineers (TSEs) are at the cutting edge of technological development of metal fabrication and gas consuming processes.

Day to day technical support is provided through a network of highly trained Technical Support Engineers (TSEs). They work with you to advise on the use of BOC's products efficiently and safely, delivered through a comprehensive range of safety training courses via open workshops held at your site.





Onsite facilities management

BOC's unique facilities management service manages gas requirements and BOC owned gas equipment for customers who have large and complex gas needs.

They operate as quality controller for all gas supplied to and mixed onsite. This includes the maintenance and calibration of analytical instrumentation to ensure compliance with all required legislation and safety standards as well as stock levels. Our service removes the need for your personnel to manage your gas supply and allows you to concentrate on what you do best.

Membership accreditations

BOC are members of, and work with a number of external associations, developing solutions to suit the existing and future needs of our customers.

Technological development and innovation

As part of the Linde Group, BOC has a global network of process experts and access to world class research and development facilities in Munich, Germany and at BOC's Manufacturing Technology Centre (MTC) in Wolverhampton.

The MTC has excellent links and partnerships with many key equipment manufacturers and industry bodies, equipping BOC to provide unbiased advice on the best solutions to suit specific manufacturing processes.

Catapult centre innovation development

BOC actively engages and works in partnership with a number of the UK's leading catapult centres and OEM manufacturers involved in aerospace innovations to develop future joining technologies.



Notes

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BOC is a Linde company, the Leading Global Gases and Engineering Business with a Mission to Make the World More Productive

We are the UK and Ireland's largest provider of industrial, medical, and special gases as well as related equipment, engineering services, and solutions to support them.

We produce, package, and distribute thousands of different types of gases to our customers every day. Our unrivalled range includes atmospheric gases, high purity gases and mixtures, refrigerants, and chemicals, for applications as diverse as cooling magnets in hospital MRI scanners to fuelling zero emissions vehicles and much more.

BOC offers tailored supply solutions for every size of customer; our cylinder customers enjoy a nationwide delivery and collection network; bulk customers the reassurance of 24/7 delivery; and for our high-demand customers we offer onsite production or dedicated pipeline supply.

And all of this is backed up by industry leading customer service, expert technical support and best-in-class levels of safety and environmental performance – the basis on which we have earned our reputation as a reliable and trusted partner.

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