

Plasma spray solutions

Praxair Surface Technologies, Inc. and TAFE Incorporated is a **world leader** in thermal spray equipment, materials and coatings technology. As a primary contributor to the development and application of plasma spray with equipment and coatings routinely used by the aircraft engine industry for OEM and repair coatings for over 45 years, Praxair and TAFE has designed a complete family of products reflecting years of equipment engineering and **coatings expertise**. Our plasma product line is certain to include a system that meets your specific quality, productivity, versatility and economic needs.

We recognize that the selection of a new plasma spray system is just the initial step. That's why Praxair and TAFE continues to **develop and perfect** new plasma powders and coatings to help push thermal spray technology toward an exciting generation of wear, oxidation and corrosion-resistant applications. We dedicate talented engineers to team with you to develop materials, processes and **coating solutions** that expand the market for cost-effective thermal spray applications.

Let us work with you to select the **best plasma spray system** and put it to work to maximize your output and returns. For more information, please contact your local Praxair and TAFE representative or contact our U.S. equipment headquarters:

Phone: **1-603-223-2100**
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E-mail: **psti-info@praxair.com**

One of the key advantages of the Model SG-100 gun is its ability to adapt to the Model 2086A ID extension, shown applying a TBC on an aircraft burner can.



A systems approach Systems

Integrated Systems

In order to produce superb plasma-sprayed coatings with a wide variety of materials, plasma spray equipment must perform consistently, whether the energy level is 15 or 80 kW. To provide consistent control over the complete range of plasma spray systems and power levels, Praxair and TAFE offers three plasma system options: (1) manual, critical orifice controlled; (2) computerized, mass-flow controlled; and (3) high power, computerized, mass-flow controlled.

Whether you need simple, reliable plasma spray equipment, a sophisticated, robust computerized system, or the high power PlazJet II plasma spray equipment, Praxair and TAFE has a solution for you. We take pride in offering a range of engineered systems; each includes the necessary safety engineered, plug and play modular components including power supply, arc starter, control console, powder feeder(s) and spray gun. This allows you to get up and running quickly.

Committed Resources

The decades of excellent performance provided by our plasma systems, including critical aircraft engine applications, are a reflection of our commitment and expertise in the field of Thermal Spray.



Praxair and TAFE's plasma systems are designed to produce quality coatings using our Model SG-100 gun, other outstanding plasma guns produced by us or most other manufacturers' plasma guns.

We can offer a complete plasma system that fits most requirements. Importantly, we support our hardware with unparalleled technical service and applications assistance, along with one of the most capable powder operations in the thermal spray industry. Praxair and TAFE's equipment options, powder quality and selection, and coatings know-how offer you the best value for a total plasma coating system.

Integrated Know-How

Our pioneering use of argon as the primary plasma gas gives:

- Easier/simpler ignition and startup
- An arc larger in diameter and "softer" than diatomic gas arc
- Less substrate heating due to shorter effluent plume
- Quieter operation; more stable arc region
- More consistent performance
- Cleaner coatings

Combine this with first-rate engineering backup, coating expertise and world-class powder and you can be assured of consistent reliable coatings.

Add it up and you will agree: Praxair and TAFE has the right plasma solution to meet your needs.

Manual/Economical (Model 3710)

The economy unit, at either 60 or 100 kW power levels, suitable for low to medium production rates.

Closed-Loop (Model 7700 UPC)

The computerized, 100 kW power level, mass flow-based "universal" controller that operates most plasma guns.

High Power (PlazJet II)

For unparalleled, low cost, highest quality coatings, the PlazJet II operating at power levels up to 220 kW offers up to a 300 percent improvement over conventional plasma guns.



Each plasma spray system includes everything you need to produce outstanding coatings, whether your applications require a simple unit with a Model SG-100 gun (left) or a more sophisticated system with high powered PlazJet II (above).

Plasma processes for
Equipment Solutions

3710

3710 Economy Plasma Spray System

Features:

Critical orifice gas flow control

Built-in PC-100 power supply controller with digital displays

Two powder feeder control capability (either/or)
NFPA Type “Z” purging with audio/visual alarms
Best combination of economy and performance

3710 System Components

Model 3710 Plasma Spray Control Console

PS-1000 or HPS-100 Power Supplies

Plasma Spray Gun (e.g., SG-100, F4 and 9M, etc.)

Model HF-2210 High Frequency Arc Starter

Model 1264 Precision Powder Feeder



7700 UPC

7700 Computerized, Closed-Loop Plasma Spray System

Features:

Mass flow control of plasma and carrier gas

Manual and fully automatic, PLC-based process control

Intuitive, touch-screen interface terminal

Net Energy – closed-loop, real-time control of the energy of the plasma plume

Sophisticated data acquisition and maintenance software

7700 UPC System Components

Model 7701 Universal Plasma Controller HMI

Main Control Panel (MCP)

Primary Gas Control Module

Secondary Gas Control Module

Carrier Gas Control Module(s)

HPS-100 Power Supply

Plasma Spray Gun (e.g., SG-100, F4 and 9M, etc.)

HF/PS Power Module

Two Model 1264 Precision Powder Feeders



PlazJet II

PlazJet II High Energy Plasma Spray System

Features:

Computerized/PLC-based high energy plasma spray process control

Mass flow control of plasma and carrier gases

Large “recipe” storage capability with programmable process set points

Power levels up to 220 kW

Consistent coatings of the highest quality, every time at high spray rates

PlazJet II Components

Model 7700 PlazJet Controller HMI

Main Control Panel (MCP)

Primary and Secondary Gas Control Module

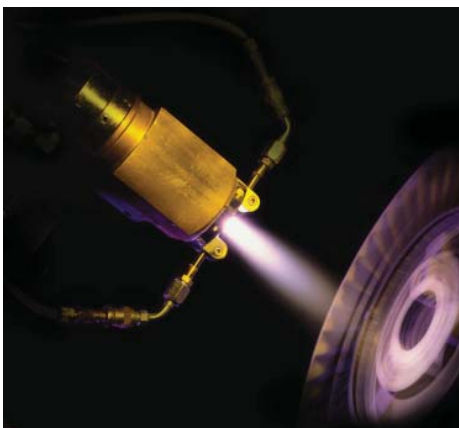
Carrier Gas Control Module

HPS-250 Power Supply

PlazJet II HE Plasma Gun

Model HF-2277 Power Module with HF-2210

Two Model 1264WL Weight-Loss Powder Feeders



Safety is not optional

Praxair and TAF A takes thermal spray safety very seriously. All of our plasma systems are engineered and built for productive and safe operation. Each system includes some or all of the following safety features, depending on operating characteristics:

Separation of volatile hydrogen gas into ventilated gas module

Separation of gas modules from the electrical components with adequate space and ventilation

Interlocked alarm circuits to monitor gas flows and pressures, and water supplies and flows to prevent conditions that could be hazardous to operators or equipment

NFPA Type “Z” purging with audio/visual alarms

Electrical safety is enhanced through the separation of electrical voltage sources into discrete wire-ways

Stainless steel flammable gas plumbing

Integrated Emergency Stop circuitry

Electrical enclosures meeting NEMA 12 specifications

Powerful versatility Powerful

Model 3710 Console

The economical Model 3710 Plasma Control Console is a compact, electromechanical-based plasma controller designed for production environments. The Model 3710 features “jeweled” critical orifice gas flow control for consistent, highly accurate and repeatable gas control that is relatively insensitive to back pressures, unlike similar gas measuring devices such as rotometers. Decades of reliable performance stand testament to the benefits of critical orifice technology. The low maintenance aspect of critical orifices means there are no periodic calibrations necessary to ensure accurate and consistent plasma gas flows. Simple to operate, highly repeatable and proven over time – all reasons to consider the Model 3710 controller when selecting your plasma system.

The Model 3710 incorporates safety interlocks that enhance safe operation and prevent gun operation in case of failure of the cooling water, power or gas pressure circuit, and a 24-volt NFPA Type “Z” purging malfunction alarm. Solid-state power control permits selection of the operating current before ignition and maintains the current setting within one percent of set point.

The Model 3710 includes two powder feeder controls (exclusive either/or) and can be configured with either a 60 kW or 100 kW power supply. Both are designed to provide precise amperage/voltage control and stability for high-quality plasma spraying. The Model 3710 is CE compliant.

Model 7700 UPC

The Model 7700 Universal Plasma Controller is the ultimate in plasma spray process control. The Model 7700 features closed-loop MFC of the gases with a robust PC/PLC control system in which the power of a PC-based touch screen operator interface terminal (OIT) is combined with the ruggedness of a PLC for process control.

The use of mass flow controllers provides highly accurate, repeatable gas flow control that is relatively insensitive to supply pressures. Plasma energy can be controlled by either current, kW or Net Energy.

The Model 7700’s color PC touch-screen OIT is simple and rugged. The Model 7700 software is intuitive to operate and features:

- Development mode (manual control)
- Production mode (full automatic control)
- Recipe storage
- Maintenance functionality
- Data acquisition
- Operation of most plasma guns
- Operates two powder feeders with an option for two more
- Optional remote diagnostics

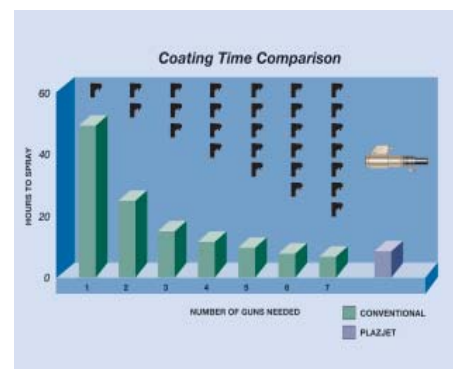
The Model 7700 UPC has been designed for production and is CE compliant.

The Model 7700 UPC utilizes a 100 kW power supply for maximum process flexibility.

Model 7700 PlazJet II

The PlazJet II is a high power (220 kW) DC plasma spray system that provides superior quality coatings at a dramatically lower cost than conventional plasma guns.

Based on the Model 7700 UPC, the PlazJet’s revolutionary gun design permits spraying three to six times that of conventional plasma with increased deposit efficiency. This increased deposition rate reduces cycle times to 1/3 to 1/8 that of previous times. The PlazJet II produces gas velocities four times faster than conventional plasma guns. This high velocity generates a harder, denser coating with virtually no porosity. Higher particle velocities also improve bond strengths. Higher bond strengths with ultra low porosity result in durable coatings with excellent finishing characteristics.



The PlazJet II high power plasma gun design is not just incremental, but revolutionary. It's not a 30 percent improvement, but more typically a 300 percent improvement over today's conventional plasma guns.

Advanced technology Technology

Model SG-100 Gun

Praxair and TFA's Model SG-100 plasma spray gun is regarded as one of the most flexible and durable plasma spray guns on the market today. The Model SG-100 is designed to produce exceptional plasma coatings, regardless of which system drives it. Operating at energy levels up to 80 kW in any of three modes -subsonic, Mach I and Mach II - the gun is suitable for a wide range of applications requiring metals, carbides or ceramics. The Model SG-100's unique design accepts internal and/or external powder injection at a variety of injection angles and features anodes and cathodes renowned for long service life. Internal injection provides the most efficient spraying condition and generates the highest-quality coatings. It also ensures maximum powder particle entrainment at the point of highest energy within the plasma stream by injecting the powder closest to the highest arc temperatures, providing optimum energy transfer and particle velocity, which combine to create high powder deposition efficiencies.

The Model SG-100's small number of self-aligning parts makes assembly quick and accurate, saving on down time. Flexibility, efficiency and proven excellence have made the Model SG-100 plasma gun an industry favorite.

The Model SG-100 can use a variety of process gases including argon, nitrogen, helium, and hydrogen. Using helium as a secondary gas greatly extends hardware life, reducing operational costs and rebuilding time. On average, a hardware set can last from 200 to 300 actual spray hours.

Model SG-100 features:

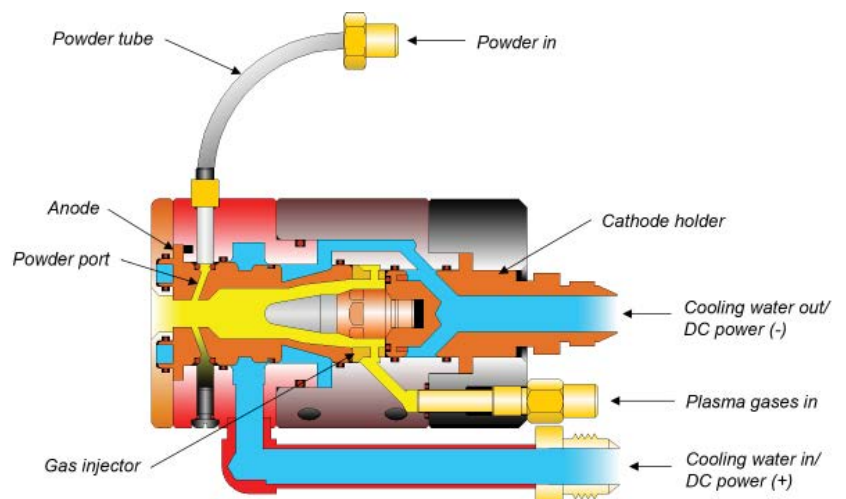
- Self-aligning components
- A range of hardware configurations
- Internal and/or external powder feed
- Extended life anodes and cathodes
- High deposit efficiencies
- Internal diameter capability

Model SG-200 Gun

The Model SG-200 plasma spray gun is a smaller version of the Model SG-100 designed for energy levels up to 40 kW. Specifically suited for machine-mounted applications, including true 90 degree ID coatings, the Model SG-200 works best in production environments requiring rapid, uniform and repeatable coatings.



Available as options for the Model SG-100 and SG-200 (above) are two external powder injection ports. These external ports can be used in place of, or in conjunction with, the internal ports.



Versatility and performance

Versatility

The versatility of the Model SG-100 gun extends the capability to coat internal diameters to as small as 38 mm (1.5"). The Model 2086A and Model 2700 extensions to the standard Model SG-100 produce quality ID coatings at energy levels up to 30 kW. Interchangeable components allow quick conversion from OD to ID operation, adding to the unmatched capability of the Model SG-100 gun. The Model 2086A extension can deposit coatings into diameters as small as 64 mm (2.5") is supplied standard with 45° spray angle hardware while configurations for 60° and straight ahead are also available. The Model 2700 can coat diameters as small as 38 mm (1.5") and is supplied with 45° hardware.

ID Spray

The SG-100 plasma gun design is simple yet robust, producing excellent coatings of all types and allowing easy conversion to ID spraying (Model 2700-12 shown).



Model SG-100 Hardware

The Model SG-100 gun operates in a number of modes (subsonic, Mach I and Mach II) to allow for optimum user flexibility. The parts are designed to be self-aligning and assembled easily and quickly while maintaining concentricity, i.e., the center line of the electrode on the axis of the nozzle (anode). The more precise the alignment is, the more centered the arc is within the nozzle. Good concentricity and proper gas flow patterns produce:

- Minimum heat loss to the nozzle
- Long nozzle (anode) life
- Simpler, more reliable powder injection into the plasma stream
- Minimal nozzle powder buildup
- Improved coatings (through improved powder injection, maximum heat to the powder and symmetrical arc position on the axis of the nozzle)

Precise, Matching Spare Parts

Aftermarket suppliers typically do not design, manufacture or test equipment, and stack tolerances are overlooked or simply not considered. Individual parts are merely copied. As a plasma spray original equipment manufacturer, Praxair and TAFE produces components with the understanding that 0.001" (25.4 μm) accuracy can dramatically improve or destroy performance.

Imitators just don't stack up

With tolerances specified to ensure gun operating consistency and long service life, our spare parts offer what poor imitations cannot: spray performance as designed and intended, resultant coatings of unsurpassed excellence and true value in every sense of the word. With all of that assurance and our unparalleled customer service and coatings development, why would anyone think of using out of spec facsimile parts?



Sophisticated process control Control

Net Energy

Many complex thermal spray coatings demand that the plasma process be controlled even more closely. The dynamic nature of plasma spray, along with strict requirements for process control verification and diagnostics, requires robust system design and sophisticated, closed-loop computer control. That's when it is time to consider the uniquely qualified Praxair and TAFE Model 7700 UPC or PlazJet II systems with Net Energy control software to produce unparalleled plasma stability through advanced engineering. With constant power input, the energy in the plasma effluent that heats the powder can vary over time due to minor changes in the arc caused by fluctuating arc terminating conditions. Simply put, the more stable and consistent the plasma energy (plasma shape and temperature), the better and more repeatable particle heating and thus the plasma coating.

By controlling the actual energy in the plasma effluent and making real-time adjustments to maintain the desired constant output energy, the Model 7700 UPC and PlazJet II systems offer the capability to produce the highest-quality plasma coatings, every time.

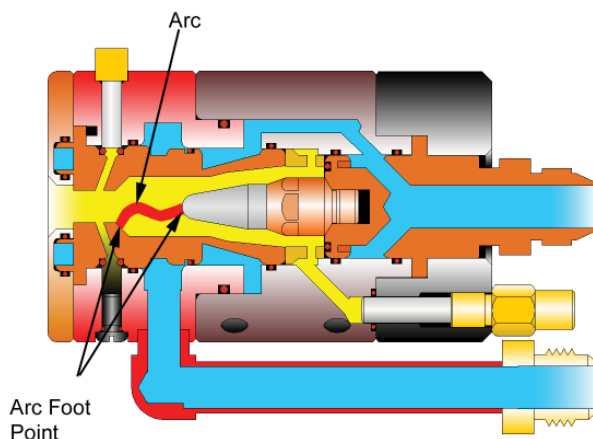
The Net Energy function regulates the closed-loop control of the plasma energy using plasma gas flow and DC current. It permits the Model 7700 UPC or PlazJet II plasma control systems to react to the changing physical condition of the plasma process hardware, automatically adjusting spray parameters to maintain a constant powder heating region. By controlling the energy where the powder is heated, the controller maintains repeatability of the process from one production run to the next, despite normal gun component variations/wear and cable degradation. When operating parameters range outside preset limits or when components fail or need maintenance, the unit alerts the operator.



Among the advanced plasma control options available with Net Energy are the integrated PC/PLC-based Model 7700 UPC (above) and the unique Model 7700 PlazJet II, a high power plasma spray system.

Net Energy – What is it?

The DC arc, which heats the plasma gases, fluctuates and oscillates within the anode at very high frequency (15,000 cps), hence the loud noise generated. Arc termination points (foot points, see sketch) and conditions on the cathode and anode arc point surfaces vary due to material ablation, roughening and minute oxidation/changes in metallurgical composition. These variations effect arc voltage, amperage and heat loss to these components. Net Energy senses this and varies the DC power input to keep the exit plasma energy constant and thus powder heating conditions constant.



Precision powder feeding

Model 1264 Powder Feeder

Praxair and TAFE's unique, time-tested Model 1264 feeder operates on a volumetric principle that directly controls the powder feed rate by speed of a pick-up wheel. When the powder feeder is in operation, holes in the variable-speed wheel fill with powder. Gravity, carrier gas, and the rotation of the wheel work in concert to deliver powder to the gun. One advantage of this type of powder feeder is that it is not sensitive to gun back-pressure.

The Model 1264 Powder Feeder is an open loop, pressurized unit specifically designed for HVOF and other thermal spray applications. The Model 1264 feeder is economical, easy to operate, and requires very little maintenance. Its proven design has become the standard for thermal spray powder feeding in industrial environments, offering unparalleled precision and repeatability of powder delivery. Recent design improvements further enhance the Model 1264 feeder's consistency and compatibility with Plasma systems such as the Model 3710, Model 7700 UPC, and PlazJet II equipment.



The Model 1264 Powder Feeder is a paragon of performance and versatility. Whether it is feeding fine oxides or coarse, dense alloys, the Model 1264 delivers powder accurately and consistently. Decades of precision feeding are proof of the reliability of the Model 1264.

Model 1264i Powder Feeder

Based on the proven Model 1264 design, the Model 1264i increases powder feed reliability and consistency by offering state-of-the-art controls technology such as a PLC for process control and an easy-to-use touch-screen operator interface that can be remotely mounted. Closed-loop RPM control with high/low warnings and alarms increases powder feedrate control to improve coating reproducibility. Additional enhancements include a 50 percent larger, removable, quick-change powder hopper to improve productivity and a higher pressure rating to 125 psi (862 kPa).

Model 1264WL Powder Feeder

The Model 1264WL powder feeder includes all the features of the Model 1264i feeder and improves powder feedrate stability with reliable closed-loop weight-loss control. Through rapid weight-loss over time calculations, the powder feeder is automatically adjusted to the pre-programmed powder feedrate and maintains that feedrate for the duration of the spray run. Features such as triple load-cell summing, rapid response time, user-programmable filters that reduce the effects of random noise (air movement and vibration) on the weight scale, a user-friendly touch-screen control, recipe storage, and maintenance screens all contribute to improved productivity, consistency, and ease-of-use.

With features such as high/low feedrate warnings and alarms, low powder warning and an automated powder trial profile set-up, the Model 1264WL powder feeder offers a new level of ease-of-use and reliability in weight-loss control capability that provides the precision and accuracy needed in critical production applications.



Perfecting the
application process.

Know-how

As a company dedicated to providing exceptional coatings solutions, Praxair and TAFE recognizes the added importance of providing thermal spray powders and applications assistance. We realize that your interest is the coatings you produce – their quality, consistency and cost, and the speed, efficiency and repeatability with which they are produced.

That's why we are proud to supply a family of thermal spray powders designed specifically for use with each type of plasma spray device. Yet we go one step further: The sole mission of Praxair and TAFE's coating technology department is to perfect each of our processes. All day, every day, we work to refine coating parameters for our systems and powders. And we are never more effective than when working in tandem with you, helping solve coating problems, developing new innovative solutions, or increasing the deposit efficiency of proven coating solutions.

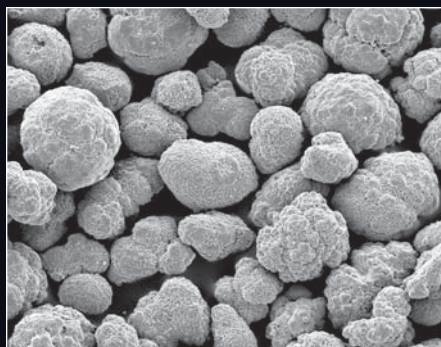
Plasma Powders

- High-purity gas-atomized metals and alloys, including MCrAlY powders of all types
- Spray-dried and sintered ceramic powders, including TBC stabilized zirconia
- Dense, metal-free chromium oxide powders produced by a proprietary process
- Spherical carbides of all types, including WC-Co-Cr and CrC-NiCr powders
- Cast/crushed and sintered/crushed carbide powders, including WC-Co and WC-Ni
- Proprietary, patent-protected Advanced Powder Technology (APT) powders featuring complete families in CrCr-NiCr and WC-Co compositions. These powders contain a fine carbide dispersion in a metal matrix that balances wear and corrosion properties and also provides a good balance between wear and ductility. They provide attractive cost savings capability due to their higher deposit efficiencies compared to conventional carbide powders.

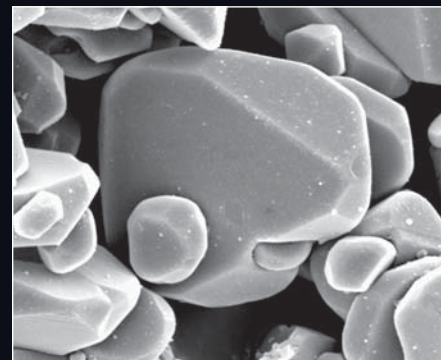
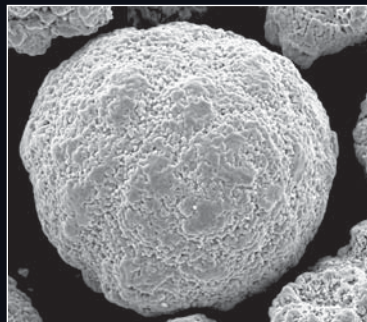
In order to get the maximum output from your plasma system, proper selection and use of premium thermal spray powders is a must. Look no further than Praxair and TAFE. Our state-of-the-art powder facility in Indianapolis, sets the new standard for world-class manufacture of thermal spray powders.

An ISO 9001:2000 approved quality system assures that our powders are produced to the highest quality standards and comply with the demanding requirements of the aerospace, medical, gas turbine, petrochemical and automotive industries, among others.

If required, we can customize a plasma powder, gun, complete system, or coating to meet the specifications of your unique application. Similarly, Praxair and TAFE's powder engineering team can work to match specific material needs, whether a new alloy, powder morphology or particle size distribution is required.



Utilizing multiple production methods, including argon gas atomization, spray-drying and sintering, and proprietary technologies, we make high-purity powders engineered to meet the exacting requirements of plasma spray systems.





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