

# Reference List

## Tetronics International



Business Area	Process Supplied	Customer & Country	Throughput (TPY)	Scope of Supply	Product
<b>Environmental</b> (Eg. Industrial hazardous waste, Persistent Organic Pollutants and Chemical Hazardous Waste treatments)	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Sendai), Japan	26,400	Furnace, manipulators (main/start electrodes), clamps, seals, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Miyazaki), Japan	19,600	Furnace, manipulators (main/start electrodes), clamps, seals, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Contaminated Soils	GEKA, Germany ( <a href="http://www.geka-munster.de">http://www.geka-munster.de</a> )	-	70mm torch system, arc starter unit, control system, furnace camera. Plasma torch used as a heat source for the treatment of spent munitions and contaminated soils as part of a demilitarisation activity.	Vitrified product benign to the Environment.
	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Hiroshima), Japan	14,400	Furnace, manipulators (main/start electrodes), clamps, seals, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Tochigi), Japan	9,900	Furnace, manipulators (main/start electrodes), clamps, seals, control system	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Kouchi), Japan	21,000	Furnace, manipulators (main/start electrodes), clamps, seals, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Tsushima), Japan	17,000	Furnace, manipulators (main/start electrodes), clamps, seals, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Takuma (Sapporo), Japan	42,000	Furnace, manipulators (main/start electrodes), clamps, seals, single electrode plasma system control system. Bottom ash/ Fly ash treatment at 5833 kg/hr.	Vitrified Waste, benign to environment, suitable for use as a product.
	Treatment of Municipal Waste Ash	Hitachi Zosen (Hitachi City), Japan	10,000	Furnace, manipulators (main/start electrodes), clamps, seals, twin electrode plasma system, control system.	Vitrified Waste, benign to the environment and suitable for use as a product.

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<b>Environmental</b> (Eg. Industrial hazardous waste, Persistent Organic Pollutants and Chemical Hazardous Waste treatments)	Treatment of Municipal Waste Ash	Mitsubishi Heavy Industries (Iwaki), Japan	25,000	Furnace, manipulators (main/start electrodes), clamps, Seals, single electrode plasma system, control system. A two line installation originally treating 29% Fly ash/ Bottom ash at 1750 kg/hr.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Municipal Waste Ash	Hitachi Zosen KAMO (Kamo City), Japan	14,000	Furnace, manipulators (main/start electrodes), clamps, twin electrode plasma system, seals, control system Bottom ash/ Fly ash 1250 kg/hr.	Vitrified Waste, benign to the environment and suitable for use as a product.
	Treatment of Inorganic & Organic Wastes	CSM, Italy ( <a href="http://www.c-s-m.it/">http://www.c-s-m.it/</a> )	720	Twin 38mm shrouded torches, 500 kW power supply, manipulation, furnace, water/gas manifolds, pump chiller unit, control system, liquid and solids feed system, off-gas treatment. The system was designed for the treatment of a wide range of waste materials.	Vitrified waste and treated gases. Vitrified waste suitable for use as a product.

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<b>Metals Recovery</b> (Eg. Precious Metals, Platinum Group Metals (PGM) and Base Metal recovery)	PGM Recovery from spent autocatalyst materials.	Duncan Recycling & Refining, USA	2,000	Furnaces, single plasma torch system (duty and standby), power supply, manifolds, feed preparation, furnace feed system, pump/chiller system, control system, product handling and dressing system, CEMS system and off-gas system.	Products enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent autocatalyst and industrial catalyst materials	Russian Client	1,850	Furnace, plasma torch system, power supply, manifolds, feed preparation, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Products enriched with Platinum Group Metals and Plasmarok®.
	Electronics Waste Smelting Plant (single graphite electrode)	BlueOak, USA	7,000	Entire plant but without slag and metal handling (i.e. formulation, feeding, furnace, graphite electrode, power supply, water and gas system, off gas system, control system)	Products enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery	Heesung, South Korea	2,700	Full scope of supply excluding blending	Products enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent autocatalyst materials.	German Client	1,850	Furnaces, single plasma torch system (duty and standby), power supply, manifolds, feed preparation, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Products enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent industrial catalyst materials	Furuya Metals, Japan	1,000	Furnace, single plasma torch system, power supply, manifolds, feed preparation, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Products enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent autocatalyst and industrial catalyst materials	Chinese Client	2,000	Furnaces, single plasma torch system (duty and standby), power supply, manifolds, feed preparation, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Products enriched with Platinum Group Metals and Plasmarok®.
	e-Waste/PGM recovery from spent autocatalyst and industrial catalyst materials	Solar Applied Industries, Taiwan	1,850	Furnaces, single plasma torch system (duty and standby), power supply, manifolds, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Products enriched with Precious Metals and Platinum Group Metals and Plasmarok®.

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<b>Metals Recovery</b> (Eg. Precious Metals, Platinum Group Metals (PGM) and Base Metal recovery)	PGM Recovery from spent autocatalyst materials	PPUK, UK	2,000	Furnaces, plasma power supply, single plasma torch system (duty and standby), manifolds, feed preparation, feed sampling, feed analysis feeding system, pump/chiller system, control system, product handling and off-gas system complete with continuous emissions monitoring (CEMs). A complete turnkey installation including new consolidated Environmental permit.	Product enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent autocatalyst and industrial catalyst materials	Heesung PM Tech Korea. ( <a href="http://www.hspmtech.com/">http://www.hspmtech.com/</a> )	3,500	Furnace, single plasma torch system (duty and standby), power supply, manifolds, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Product enriched with Platinum Group Metals and Plasmarok®.
	PGM Recovery from spent autocatalyst and industrial catalyst materials	Heesung PM Tech Korea. ( <a href="http://www.hspmtech.com/">http://www.hspmtech.com/</a> )	1,750	Furnace, single plasma torch system (duty and standby), power supply, manifolds, feed preparation and furnace feed system, pump/chiller system, control system, second torch/furnace product handling and off-gas system.	Product enriched with Platinum Group Metals (PGMs) and Plasmarok®.
	Plasminox® Recovery of metal values from mixed stainless steel plasma waste	Thyssenkrupp (TKS) plant, Italy, operated by Harsco Metals	30,000	Single arc plasma carbothermic smelting system, power supply, feeder manipulation, clamps and seals, control system, off-gas treatment. The plant is able to handle the EAFD by-products that are generated. The current throughput is 8,000 dry tonnes per year. In an average tapping cycle of 4 hours, i.e. a semi-continuous batch operation, 17.9 tonnes of blended feed containing 13.5 tonnes of dried by-product dusts produces around 5.1 tonnes of ferro-alloy and 2 tonnes of slag. The furnace is operated at up to the maximum rated current of 20,000 amps at 350 volts (a 7 MWe installation).	Ferroalloy containing Chromium, Nickel and Molybdenum and a slag suitable for use as a product.
	PGM Recovery	Multimetco, USA	6,000	Furnace, single plasma torch system, power supply, manifolds, furnace feed system, pump/chiller system, control system, product handling and off-gas system.	Product enriched with Platinum Group Metals and Plasmarok®.

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<b>Metals Recovery</b> (Eg. Precious Metals, Platinum Group Metals (PGM) and Base Metal recovery)	Recovery of stainless steel EAFD	Outokumpu, Sheffield, Stainless Melting and Continuous Casting (SMACC) formerly Avesta	8,000	Single arc plasma carbothermic smelting system, power supply, feeder manipulation, clamps and seals, control system, off-gas treatment. The plant is able to handle all of the residue by-products that are generated. The current throughput exceeds 24,000 dry tonnes per year. In an average day 2.5 tapping cycle are achieved and 470 kg of metal is produced per tonne of EAFD. The furnace is operated at up to the maximum rated current of 7,000 amps at 260 volts (a 2 MWe installation).	Ferroalloy containing Chromium, Nickel and Molybdenum and a slag suitable for use as a product.

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<b>Clean Heat</b> (Eg. Steel, Titanium and high quality Glass production)	Steel Tundish Heating	Pohang Iron & Steel Co.Ltd, Korea	-	1.2 MW twin torch TPH System.	Bloom: 3 strands	High quality carbon and alloy steels
	Steel Tundish Heating	Pohang Iron & Steel Co. Ltd, Korea	-	1.0 MW twin torch TPH System.	Thin strip caster	Stainless steel
	Steel Tundish Heating	Pohang Iron & Steel Co.Ltd, Korea	-	1.7 MW twin torch TPH System.	Bloom 4 strands	High quality carbon and alloy steels
	Titanium Melting	Toho Titanium, Kanagawa, Japan	-	One 100 kW plasma torch.	-	Titanium alloy products
	Titanium Sponge Welding	Kobelco, Japan	-	Two 100 kW plasma torches.	-	Titanium alloy products
	Steel Tundish Heating	SHI, Kashima, Japan	-	1.5 MW twin torch TPH System.	Slab: 1 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp. Yawata, Japan	-	1.5 MW twin torch TPH System.	Slab: 1 strand Bloom: 3 strand	Medium and low carbon steel
	Steel Tundish Heating	Nippon Steel Corp, Kimitsu, Japan No.2CC-1	-	1.2 MW twin torch TPH System.	Slab: 2 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp, Kimitsu, Japan No 2CC-2	-	1.2 MW twin torch TPH System.	Slab: 2 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp. Kimitsu, Japan No. 3CC-3	-	1.2 MW twin torch TPH System.	Slab: 2 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp, Kimitsu, Japan No. 3CC-4	-	1.2 MW twin torch TPH System.	Slab: 2 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp, Hirohata, Japan No. 3CC-	-	1.2 MW twin torch TPH System.	Slab: 2 strand	Medium and low carbon steels
	Steel Tundish Heating	Nippon Steel Corp, Nagoya, Japan	-	2.0 MW twin torch TPH System.	Slab: 2 strand	Medium and low alloy steels

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<b>Clean Heat</b> (Eg. Steel, Titanium and high quality Glass production)	Steel Tundish Heating	SHI, Wakayama Japan	-	2.4 MW twin torch TPH System.	Billet: 6 strand	Carbon and low alloy steels
	Titanium Melting	Toho Titanium, Chigasaki, Japan (2)	-	Two 100 kW plasma torches.	-	Titanium alloy products
	Tundish Heating	Carpenter Powder Products	-	1.0 MW single torch TPH System.	Powder atomiser	High quality alloy steel powder
	Silica Glass Melting	Toso Quartz, Sakata, Japan; Kyushu, Japan	-	100 kW twin torch system; 150 kW twin torch system	-	Optical quality silica ingots
	Glass Melting	Zybek, USA	-	300 kW twin torch system	-	Glass



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<b>Gasplasma®</b>	Energy from Waste – Gasplasma®. MSW and Commercial wastes	Port Fuels & Materials Services Inc., Canada	170,000	Complete Gasplasma® Syngas Generation Plant.	20MW of clean, high quality syngas that will be used directly in highly efficient gas engines to generate power.
	Energy from Waste – Gasplasma®. MSW, commercial and Industrial wastes	Advanced Plasma Power, UK	n/a	Supply of pilot Gasplasma plant for demonstrating the Gasplasma Energy from Waste process.	Pilot plant

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<b>Advanced Materials</b>	Nanopowder Production Facility	Intrinsiq Materials, UK	-	Two complete plasma systems each comprising plasma torches/electrodes, furnace, power supply, manifolds, manipulation, control systems, powder feed systems, product collection and off-gas treatment systems.	Metal and metal oxide nanopowders
	Production of Nanopowder	Various	Orders up to 5 kg	Use of existing plasma systems at Tetronics Ltd.	<ol style="list-style-type: none"> <li>1. Barium Zirconium Titanate nanopowder</li> <li>2. Kaolin</li> <li>3. Zinc Oxide nanopowder</li> <li>4. Niobium Oxide powders</li> <li>5. Aluminium nanopowder</li> <li>6. Powder Spheriodisation</li> </ol>

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<b>Research Projects &amp; Grants</b>	Integrated solution for the treatment of e-Waste	Tetronics International, Metech Recycling, Vale Europe	n/a	TSB grant awarded to design and develop a plasma system for the recovery of precious metals from e-waste. The novelty of this system, will be the use of a dedicated, copper based recovery process, instead of the iron-based process used for high efficiency automotive exhaust and industrial catalyst PM recovery. The aim of the project is to both shorten the supply chain and halve the overall losses for precious metal recovery from e-waste.	Products enriched with Precious Metals and Plasmarok®.
	Treatment of Intermediate Level Nuclear Waste	Tetronics International & Costain	n/a	TSB grant awarded to design and build a prototype plasma system for nuclear waste vitrification. The system will both reduce the volume and significantly enhance the stability of the final waste product to be stored, with the ultimate goal of reducing the overall cost of managing nuclear waste.	Stable inert secondary aggregate.
	Integrated solution for Air Pollution Control (APC) residues using DC Plasma technology	DTI, UK	n/a	Grant awarded to establish new ways to recover the material value, as products, from the treatment of hazardous waste to render them stable and inert. Specific attention was paid to the recovery of acid as the waste is highly chlorinated (25 – 25% Cl) and the production of an inert aggregate product. The project delivered regulatory, technical, commercial and engineering definition of the optimised solution.	Stable inert secondary aggregate. Product and a recovered HCl solution
	DTI Special SMART Award for 2 <sup>nd</sup> Generation Nanopowder Production Facility.	Tetronics Ltd, UK	-	Twin plasma torches/electrodes, furnace, manipulation, manifolds, control system, power supply, collection system, powder feed, off-gas treatment system.	Metal and metal oxide Nanopowders & micron powders
	Treatment of Municipal wastes to produce high value construction materials	EU Framework 6, R&D Project	-	Pilot scale plasma system, including electrodes and their manipulation, furnace, power supply, manifolds, off-gas treatment and control system. This project utilised the material engineering capabilities of a plasma facility to interface with traditional means of manufacturing shaped ceramic products.	Coloured tiles for the building industry
	Research Torch– Titanium Melting	University of Birmingham, UK	n/a	Research torch– Titanium melting	Torch
	Aluminium Nanopowder production	DERA, UK	500g per run	Single graphite electrode, furnace, product collection, off-gas treatment system, power supply, control.	Aluminium nanopowder

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<b>Research Projects &amp; Grants</b>	Research Plant – Titanium Melting	University of Surrey, UK	n/a	Research plant – Titanium melting	Titanium melter
	BRITE Award for Synthesis of Ultrafine Aluminium Nitride Powder	Tetronics Ltd UK	-	Plasma system with torches, furnace, manipulation, manifolds, control system, power supply, collection system, powder feed, off-gas treatment system.	Aluminium Nitride nanopowders
	Plasma System – Gas Heating	Inasmet, Spain	n/a	Plasma system – Gas heating	Gas heater
	Research Plant – Tundish Heating	EDF, France	n/a	Research Plant – Tundish Heating	Tundish heater
	Research Plant – Tundish Heating	Cenim, Spain	n/a	Research Plant – Tundish Heating	Tundish heater