PWR
ADVANCED COOLING TECHNOLOGY®

For all thermal system requirements, PWR is your development and innovation partner to help design, develop, manufacture and test all cooling solutions by; "Engineering The Unfair Advantage"















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PWR is a global designer, manufacturer and supplier of technically advanced high performance cooling solutions, investing in research and development to provide solutions to our customers using advanced cooling technology. We adopt a flexible manufacturing approach and take pride in supporting our customers through a truly unique system of technical partnership.

OUR VISION

The Global Leader in Cooling Technology Inspired by Engineering Excellence

Through passionate people and innovative solutions we lead the way in advanced cooling system design and supply, to exceed the expectations of our global partners across diverse industries.

QUALITY CERTIFICATIONS

AS9100 - PWR Australia and PWR North America

AS9100 is a global quality standard that sets requirements for processes related to safety, products, and performance in the aviation, space, and defence industries. The PWR team has always committed itself on quality and customer service and are extremely proud to have earned such a prestigious certification and look forward to what we can achieve with this milestone.

Nadcap® Accreditations for Chemical Processing and Heat Treating - PWR Australia

PWR is pleased to advise that it has secured Nadcap® Accreditations for its chemical processing and heat treating applications. Nadcap® has recognised PWR for its commitment to continual improvement in aerospace quality. The accreditation follows recent site audits of both chemical processing and heat treating applications.

PWR is now formally listed on the Quality Manufacturers List (QML) for both processes. This allows PWR to perform vacuum brazing, heat treating, hard anodizing specifications and Nadcap's stringent requirements. and conversion coatings, together with supporting conformance processes, to industry specifications and Nadcap's stringent requirements. Building on our existing AS9100D certification, Nadcap accreditation demonstrates PWR's determination to ensure quality is at the centre of everything we do. This milestone allows PWR to be the only Australian company to offer both Nadcap accredited heat treating and chemical processing within the same business.

ISO14001 - PWR Australia and PWR North America

ISO 14001 is an international standard prescribing a structured approach to environmental protection. It enables organisations of all sizes to develop and implement policies to deliver environmentally responsible and sustainable business practices.

IATF16949 PWR North America

IATF 16949:2016 is one of the world's most used set of standards for quality management in automotive products. The requirements delineated in IATF 16949:2016 cover every aspect of the production process.

CAPABILITIES

- Additive manufacturing
- Clean Room Assembly
- Coatings and Cleaning processes
- CNC Machining
- CNC Sheetmetal and Stamping
- CT Scanning
- Engineering and Design
- Low and High Volume Production
- Modular Assembly
- Prototyping and Custom Manufacturing
- Quality Control
- Research and Development
- Simulation
- Testing and Validation
- Tooling, Jig and Fixture Design and Manufacture
- Vacuum brazing and Heat Treatment
- Welding and Fabrication

PRODUCTS

- Tube and Fin Heat Exchangers
- Bar and Plate Heat Exchangers
- Additive Manufacturing
- Liquid Cold Plates
- Micro Matrix Heat Exchangers (MMX)
- Custom

MARKETS AND INNOVATION

- Motorsport
- Defence
- OEM
- Aerospace
- Electric and Hybrid Vehicles
- Performance Aftermarket
- Renewable Energy
- Industrial

CERTIFICATIONS / ACCREDITATIONS

- AS9100
- Nadcap® Accredited – Heat Treatment and Chemical Processing
- ISO 14001:2015
- DECS Registered for MIL exports
- ITAR Compliant
- CAGE: Z0UP4
- DUNS: 740065990
- IATF16949

PWR PRODUCTS

Tube and Fin Heat Exchangers

Our extensive experience and years of research and development in tube & fin heat exchanger technology has allowed PWR to develop fully customisable heat exchangers that can be tailored to extract the best performance for your application.

PWR has designed and produced an extensive range of tube and fin geometries allowing us to optimise core constructions to achieve lightweight and high performing coolers. Whether the heat exchanger be a water radiator, oil cooler, charge air cooler or refrigerant application we have dedicated core specifications that can be tailored to maximise cooling performance. PWR has also developed specific tube and fin combinations to optimise thermal management for coolers in applications like battery cooling, motor cooling and electronics cooling.

With tube & fin heat exchangers PWR also has the ability to completely customise not only the size of the cooler but the shape as well. With the ability to produce 2D profiled coolers and free-form coolers PWR can design a tube fin cooler to maximise heat exchanger face area and minimise packaging space.

To further optimise airflow through the cooler tube & fin heat exchangers can be constructed through inclining the tubes to better align them with on-coming airflow and allowing for more aggressive cooler installation angles.

In addition to manufacturing bespoke cores in-house PWR also offers fully tanked tube & fin heat exchangers. Through a variety of tanking options from traditional sheetmetal to billet machined and additively printed tanks we can further optimise cooling performance through our design expertise. Additionally, PWR can also offer services like inspection, bonding, passivation and flushing to deliver turn-key cooling solutions.

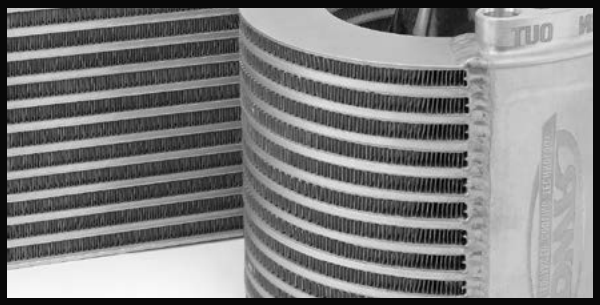
Bar and Plate Heat Exchangers

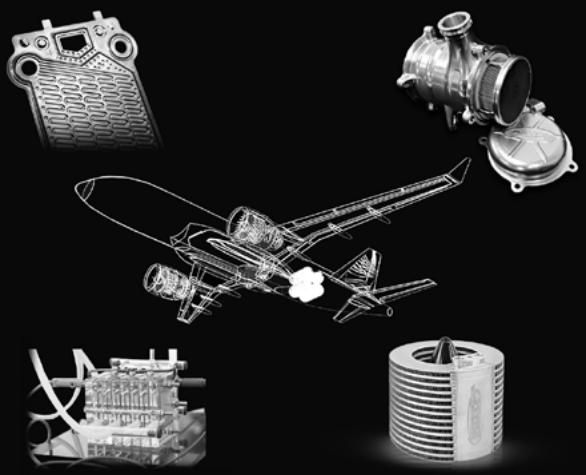
Along with producing tube & fin style heat exchangers PWR also has a wide-ranging ability in producing bar & plate style heat exchangers. Typically known for their increased robustness and durability innate to its design PWR has a wide range of bar and plate construction options that can be tailored to meet a project's requirements and optimise performance. Through our extensive research and development PWR has a new look on old technology through advancements in fin geometry, lightweight yet durable components and ability to shape coolers.

From robust and heavy-duty bar & plate solutions designed to succeed in the most demanding conditions in Mining and Defence applications to lightweight coolers for Aerospace and Motorsport PWR can meet your needs.

Much like our tube & fin heat exchangers PWR's bar & plate coolers can also be fully customised not just in size but also in shape with the ability to profile the shape of the coolers to optimise heat exchange area and minimise packaging space.

Like all of our products PWR can deliver bar & plate coolers as part of a turn-key solution ready to drop right into your application.





Hydrogen Fuel Cell Cooling Systems

Due to our history with light weight materials and efficient heat exchange, PWR solutions can be found in various hydrogen fuel cell applications (HFC). This can range from the bipolar plates within the HFC itself, through to cooling of propulsion systems, energy storage systems, compressor systems and heat exchangers for cryogenics temperatures.

PWR ADVANCED MANUFACTURING

PWR manufacture bespoke components for land, air and sea-based platforms and have the capacity to undertake many of the rigorous validation tests in house. Our ability to partner at the conceptual phase of a project to aid our customers with design, simulation, prototyping and product validation is a key attribute.

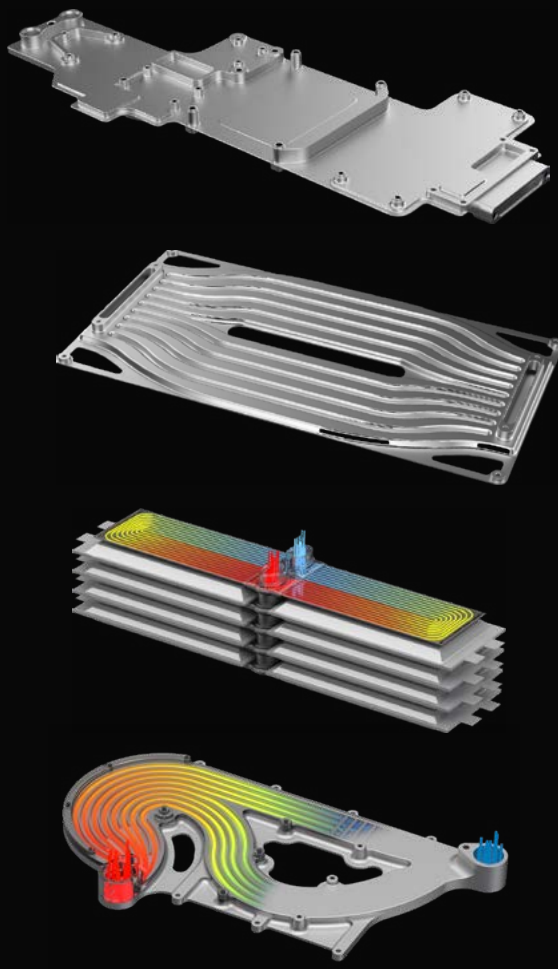
Liquid Cold Plates

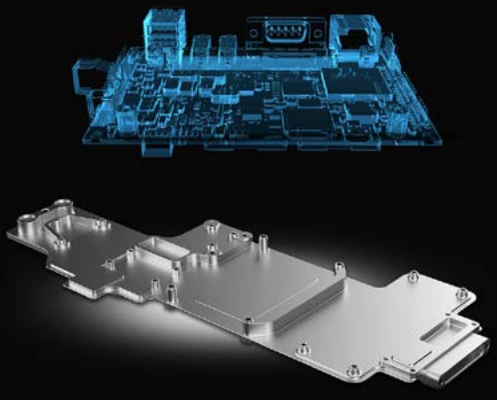
PWR has a range of manufacturing options for liquid cold plates used in applications like battery and electronic cooling.

PWR manufacture liquid cooling plates and brazed chassis for Aerospace, Defence and Motorsport markets. These components are used in a variety of end applications such as radar systems, autonomous vehicles, energy storage systems and power electronics cooling applications.

PWR have a state-of-the-art vacuum brazing furnace rated to 1300°c and suitable for Aluminium brazing at class 1, together with higher melting point superalloys rated at class 2. Coupled with our in-house machine shop we are able to produce billet machined vacuumed brazed cold plates with complex internal cavities to increase thermal performance and assist with more uniform surface temperatures. Through post braze heat treating and post-machining processes stiff yet lightweight cold plates can be produced.

A range of pressed cold plates and wave MPE (multiport extrusion) tube options are also available for cylindrical and pouch cell battery cooling.





Electronics and Embedded Systems Cooling

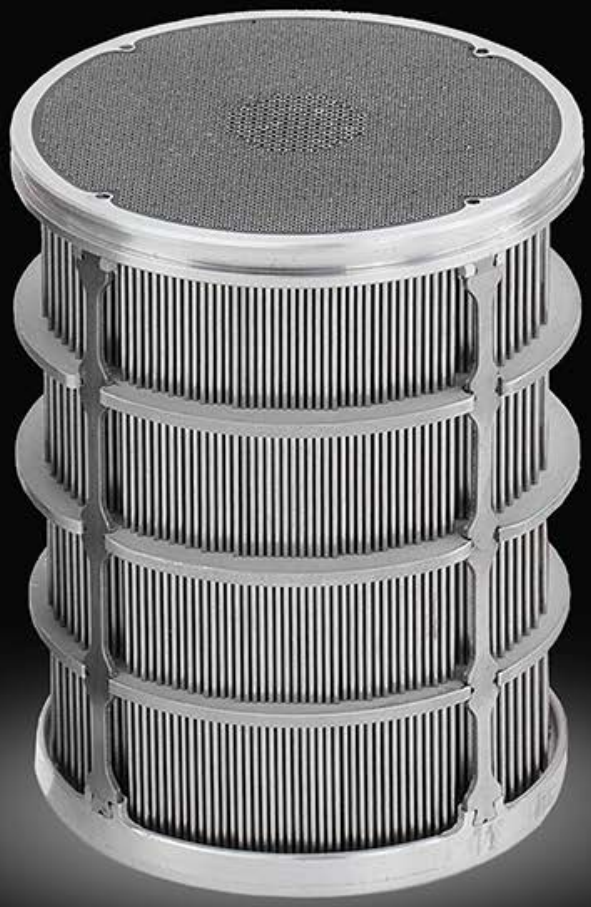
PWR manufacture a range of vacuum brazed and controlled atmosphere brazed cooling plates, chassis's and enclosures, suitable for Air, Land and Sea. These solutions provide ruggedised cooling of single board computers, inverters, DC/DC converters, switches, servers and avionics enclosures. The manufactured solutions can accommodate various form factors to suit common standards, such as VITA 48, and can be build to print or full support from concept design through development, manufacture, testing and production.

Micro Matrix Heat Exchangers (MMX)

Offering unrivalled performance in compact liquid–liquid cooling PWR has a range of Micro Matrix Heat Exchangers or MMX.

MMX heat exchangers are extremely efficient, compact and light weight solutions which are constructed from an array of hollow micro tubes, similar to hypodermic needles, that range in sizes from 0.3mm diameter to 1mm diameter. These thin wall tubes provide exceptional surface area in a compact package to maximize heat transfer in liquid-liquid, liquid-air or liquid-phase change material applications.

This technology has many advantages for Aerospace and Defence due to the ability to reduce thermal signature, increase payload, flight time and reduce space claim.



LOW AND HIGH VOLUME PRODUCTION

PWR has applied a group structure which allows the team to engage with the customer at the concept phase of a high volume production run. Partnering with customers and OEM's at this early stage in a project allows PWR to support our customers in full to ensure the end products is engineered to provide optimised performance, whilst adhering to packaging & design constraints, operating conditions and mass limitations.

In the concept phase PWR work in parallel with the customer to develop the prototype cooling systems. These systems are defined in the first instance through internal simulation tools, to predict performance of each component. Once complete, the prototype unit can then be physically tested in our thermal calorimeter wind tunnel or electronics cooling plate test rig. This equipment allows real world testing of the components and the generation of a matrix of test data which our customers can then input into their internal models to close the loop on steady state or transient performance.

Once protype performance is approved the project will move to the next phase of testing and pre-production parts. At this stage PWR have internal modelling and simulation tools to perform computational fluid dynamics (CFD) and Finite Element Analysis (FEA) on the part in readiness for production design & manufacturing processes. PWR can also complete a mix of internal testing and external 3rd party testing to complete Design & Validation Processes (DVP) on the parts, to verify batch performance, operating characteristics, and durability.

PROTOTYPING AND CUSTOM MANUFACTURING

PWR Advanced Cooling Technology specialises in the design and manufacture of prototype and custom heat exchange products and is resource ready for all of your additive manufacturing and billet machining requirements.

From the beginning, PWR identified that not every customer or indeed project requires the same thermal management solution to achieve a desired outcome. In acknowledgment of this, PWR is dedicated to providing a focused service on delivering bespoke, engineered cooling solutions to meet specific design and performance criteria for any application, in any industry.

Complimenting this solution orientated service is PWR's ability to produce heat exchangers utilising a range of manufacturing technologies:

- Tube and Fin Heat Exchangers
- Bar and Plate Heat Exchangers
- MicroMatrix Heat Exchangers
- Cooling Surface (Liquid Cold Plates) Heat Exchangers
- Additive Manufacturing

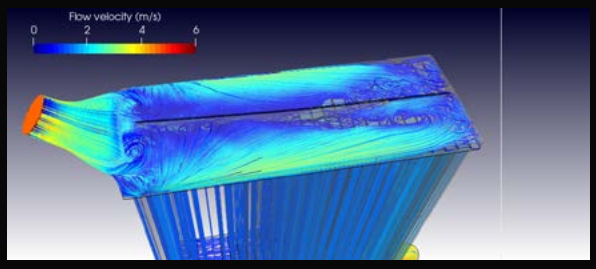
Through careful selection of industry leading equipment and machinery, PWR remains versatile and able to customise these various manufacturing technologies to optimise the size, shape and performance outputs of the heat exchanger, regardless of the chosen manufacturing technology, to best meet your project requirements irrespective of the build volume.

Furthermore, all heat exchanger components are produced from raw material within PWR's two manufacturing facilities ensuring that we remain ultimately flexible, and without extensive lead times to best fulfil your cooling requirements.

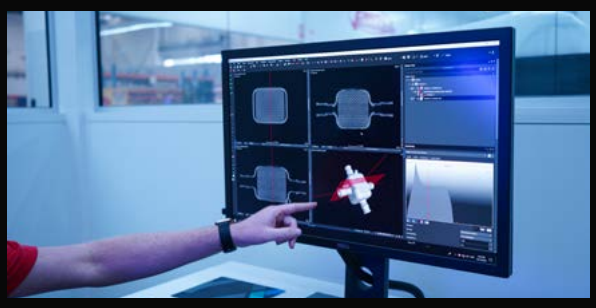
RESEARCH AND DEVELOPMENT

PWR's research and development (R&D) capabilities are constantly evolving with the times. With global markets and customer requirements forever changing, and ongoing advancements in technology and materials science, PWR continue to diversify their skills and R&D capabilities across a range of key areas.

Although PWR's global success grew rapidly from within the motorsport industry, in today's climate, PWR offers a larger selection of cooler types and R&D services to a broader market, including several emerging industries. Previously, PWR specialised in the production of aluminium-only heat exchangers which saw competencies focused around more traditional activities such as metal fabrication, assembly, brazing, welding, and performance testing. Whilst maintaining these core competencies, ongoing investment into R&D has seen PWR's skill set and capabilities grow significantly.



PWR now manufactures coolers in a variety of shapes and sizes and from a mixture of materials in addition to aluminium. Extensive R&D programs have led to the development of specific processes and techniques for assembling irregularly shaped coolers, joining dissimilar materials, precision machining, heat treatment, and various chemical and mechanical surface treatments. Coupled with in-house Computational Fluid Dynamics (CFD), Finite Element Analysis (FEA) and Wind Tunnel validation, PWR has positioned themselves to offer well-balanced, full-service R&D solutions.



Adding further weight to PWR's R&D capabilities is a 32-tonne industrial size Computed Tomography (CT) scanner. The Yxlon FF85 CT scanner has an inspection envelope of 1000mm height x 850mm diameter, allowing parts as big as 2000mm height x 1500mm diameter to be interrogated with full 360° rotation. Having up to 450 kV electrical potential, 320 W of tube power and with a focal spot size of less than 6µm, this instrument gives PWR full insight into weld penetration, inclusions and porosity, braze quality, internal product features and geometry that would otherwise be unknown without destruction. Used primarily for R&D and quality assurance, this CT scanner opens-up a multitude of potential for product development and non-destructive testing at PWR and for external partners and research institutions alike.

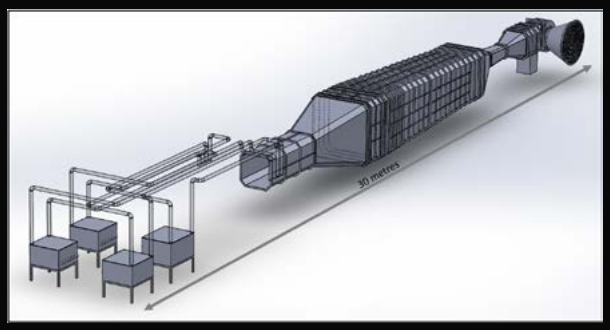
Extending PWR's R&D and manufacturing potential even further, is the new additive manufacturing department. This currently includes two 3D metal printers and an SLA printer an array of FDM printers for prototyping and small batch production. To learn more please visit our Additive Manufacturing capabilities.

Bolstering PWR's capabilities further includes the addition of a dedicated vacuum brazing division, dedicated heat treatment facility and automated anodising and chemical conversion line.

PWR works closely with their customers from initial concept development, through to prototyping, testing, and final production. Having a vast portfolio of R&D tools and specialists make PWR an ideal partner to research and develop your cooling needs.

TESTING AND VALIDATION

PWR is well equipped to undertake a broad range of in-house testing to satisfy stringent customer requirements whilst maintaining the shortest production turnaround time possible. Rigorous testing procedures follow the entire production cycle through every step, from the acquisition of raw materials to the design and manufacturing of final products ready for delivery. PWR have acquired a substantial library of test equipment over the years. From handheld test gauges, to Computation Fluid Dynamics (CFD) and Finite Element Analysis (FEA) software, to the largest Wind Tunnel and industrial size Computed Tomography (CT) scanner in the Southern Hemisphere. Due to the uniqueness of products and processes, PWR also continuously evolve their own array of internally designed bespoke test equipment to support and fulfill rigid requirements of their customers.



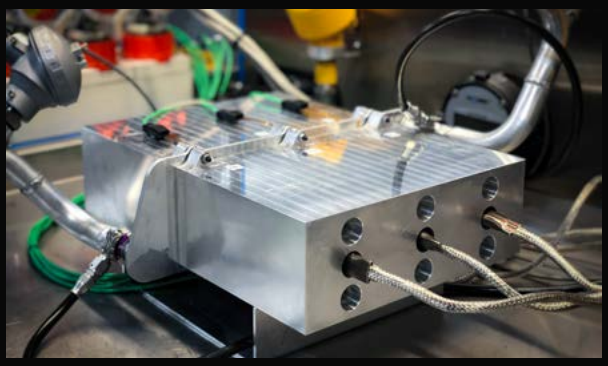
To ensure utmost quality and shortest lead-times are maintained consistently across all products, PWR's supply chain together with their own strict manufacturing processes, are constantly being assessed at every step of the production cycle. PWR Trained Quality Inspectors and Engineers utilize various test equipment such as XRF scanner to verify the composition of raw materials; surface roughness gauge to confirm surface finish of machined parts; Rockwell hardness tester to validate heat treatment processes; and surface coating thickness gauge to verify and validate passivated and anodised parts and assemblies.

PWR manufactured subcomponents are tested inhouse prior to assembly. This helps reduce downtime, waste, and reworking. For example, PWR manufacture their own air-fin and internal tube turbulators from raw aluminium coil material, ranging in thicknesses from 0.06mm to over 1.0mm. It is imperative to verify the formed component prior to assembly and brazing. PWR have designed and built their own dedicated turbulator test rig to help measure and maintain consistency across all repeated production runs. From prototyping to final production, consistency in pressure drop and thermal performance can be guaranteed.

Where PWR's testing capabilities really excel and what differentiates PWR amongst its competitors, is the ability to test and verify final product performance, not only for internal research and development programs, but also for customers and end-users alike. Whether designed and manufactured by PWR, or competitor parts for benchmarking, PWR have the ability to test and measure a range of coolers against a series of performance criteria all under one roof. Data obtained from PWR's Wind Tunnel for example (heat rejection vs pressure drop) has proven to be invaluable for customers in the motorsport (Formula1, Nascar, DTM, WRC, MotoGP, etc) and aerospace arena, assisting them with the development of their own products and predictive models as well as keeping PWR ahead of the field. Coolers may be tested against a number of boundary conditions using standard fluids in PWR's inventory, or customers' own supplied specialty fluids. Temperatures and pressures ranging up to 300°C and 550 kPa(G) are commonly seen in the Wind Tunnel while testing Formula1 charge-air coolers for example. Durability (cyclic) testing is another service offered by PWR to prove product quality and expected service life.

Being able to perform all these tests in-house, means customers can expect the shortest lead-time between prototyping and final product delivery whilst maintaining the highest quality PWR are known for.

Whilst traditional coolers (water-air, oil-air & air-air) are still the most common types of coolers tested at PWR, recent trends in global electrification have led to PWR extending their manufacturing and testing capabilities in the area of non-traditional coolers such as cold plates. Used extensively in the cooling of electrical power storage, power conversion and power generation modules, cold plates are in increasing demand. PWR's bespoke cold plate test rig enables the designer to verify prototype performance prior to commissioning a full production run. The test rig is designed to measure surface temperatures of heat input modules and cold plate assemblies for various loads (constant heat flux) and various cooling fluid flow rates.



Weighing approximately 32 tonne, PWR's largest investment to date in a single piece of test equipment occurred with the purchase of one Yxlon FF85 CT scanner. With an inspection envelope of 1000mm height x 850mm diameter, parts as big as 2000mm height x 1500mm diameter may be interrogated layer by layer with full 360° rotation. Having up to 450 kV electrical potential, 320 W of tube power and with a focal spot size of less than 6µm, this instrument gives PWR full insight into weld penetration, inclusions, and porosity, braze quality, internal product features and geometry that would otherwise be unknown without destruction. Used primarily for research & development and quality assurance, this CT scanner opens-up a multitude of potential for further product development and non-destructive testing at PWR and for external partners and research institutions.

Other testing capabilities at PWR include pressure testing of individual cores prior to tanking and of final assemblies post welding; leak-down testing of final assemblies (with air or helium) and hydraulic burst testing up to 7000 kPa(G), including automated hydraulic cyclic testing. PWR have also recently increased their capacity to flow test up to 10 radiators (in parallel) in response to the ever-increasing demand and production requirements.

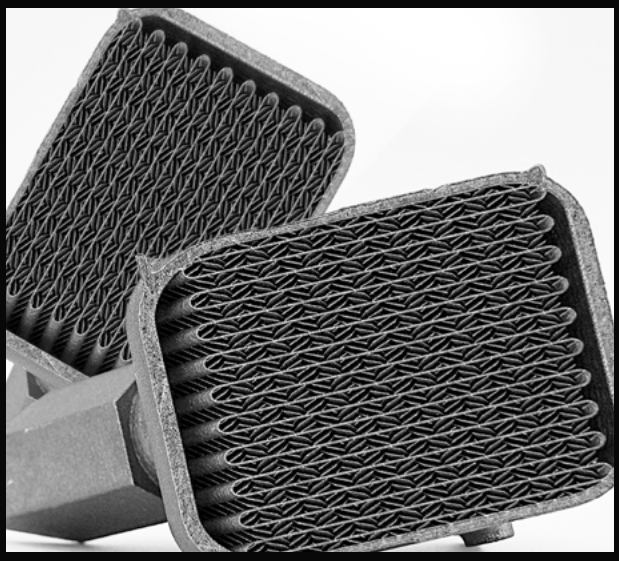
Being able to perform all these tests in-house, means customers can expect the shortest lead-time between prototyping and final product delivery whilst maintaining the highest quality PWR are known for.

ADDITIVE MANUAFACTURING

Additive manufacturing has been growing in capabilities and effectiveness for more than a decade, but it has been only recently that the technology has matured enough to breakthrough into many industries. While polymer resins and plastics were forerunners for additive manufacturing (or 3D printing), the aerospace industry played a significant role in the development of metal printing. PWR has taken advantage of the early development of both resin and metal printing while working with specific partners to adapt the technology to thermal management applications. PWR focuses on plastic and metal additive processes and materials that support our business model of engineering the unfair advantage and supplying customers with the highest quality and shortest lead time.

PWR is leading the thermal management industry with specific technology developments to apply metal additive manufacturing to improve the performance and manufacturing of our products. The laser powder bed fusion process of aluminium forms the basis of the metal additive manufacturing process at PWR. As was recently announced, PWR has chosen VELO3D as a partner to develop printing of next-generation, high-performance heat exchangers and thermal management products. The unique VELO3D printing process allows for support-free or fully floating parts which reduces labor and lead time. The support free nature of the printing can be carried down to angles as low as 10o which contributes to superior surface finishes and low porosity. For example, walls < 0.3mm can be printed with no porosity while structures < 0.2mm are possible. For the customer, this means thinner, more complex heat exchanger designs with unmatched performance. PWR anticipates the use of metal additive manufacturing in custom automotive, military, aerospace and industrial products.

PWR has in-house capability for printing polymer resins using a Stereolithography Apparatus (SLA) printer powered by Digital Light Projector (DLP). This type of layer-by-layer additive manufacturing is capable of fabricating detailed parts due to the use of light to cross-link (or join) the photo-reactive polymer resins. PWR is using the SLA process primarily to support the fabrication of parts using the PerForm resin by Somos. This material is building a reputation in manufacturing and the automotive industry due to its high strength and high temperature resistance. Specifically, the PerForm material can be printed with accuracy of 0.08-0.10mm while having tensile strengths up to 80 MPa. The polymer resin exhibits some of the highest temperature compatibility with heat deflection temperature (HDT) as high as 268oC. These materials properties allow PWR to take advantage of PerForm for fast tooling as well as integration with metal parts in heat exchangers to save weight, speed lead time and improve shock resistance.



PWR have high temperature polymer SLA and aluminium powder DMLS additive manufacturing machines in house, which together with specific technical agreements, allows us to produce world leading aluminium heat exchangers featuring super thin walls and minimal use of support structure.

PWR have formed a technical partnership with US based additive manufacturing machine maker Velo 3D. This strategic partnership has allowed PWR to take possession of the world's first Velo 3D Sapphire machine suitable for Aluminium powder. Velo 3D are already a disrupter in the additive Aerospace market for Titanium and Inconel due to their unrivalled 200:1 height to thickness build ratio and 10° unsupported build angles.

Along with producing heat exchangers PWR makes use of additive manufacturing methods to rapidly produce prototype test parts and along with producing heat exchanger tanks and other cooling components not possible with traditional manufacturing methods.

COATINGS AND CLEANING PROCESSES

PWR is a NADCAP accredited chemical processing facility and delivers a number of “Special Process” surface treatments and coatings as per international standards and specifications. These Special Processes are carried out in a purpose built, automated, and controlled chemical processing facility, enabling consistent, high-quality results for products undergoing treatments such as pre aluminium vacuum braze cleaning, type II chromate conversion coating and type III hard anodize coating.

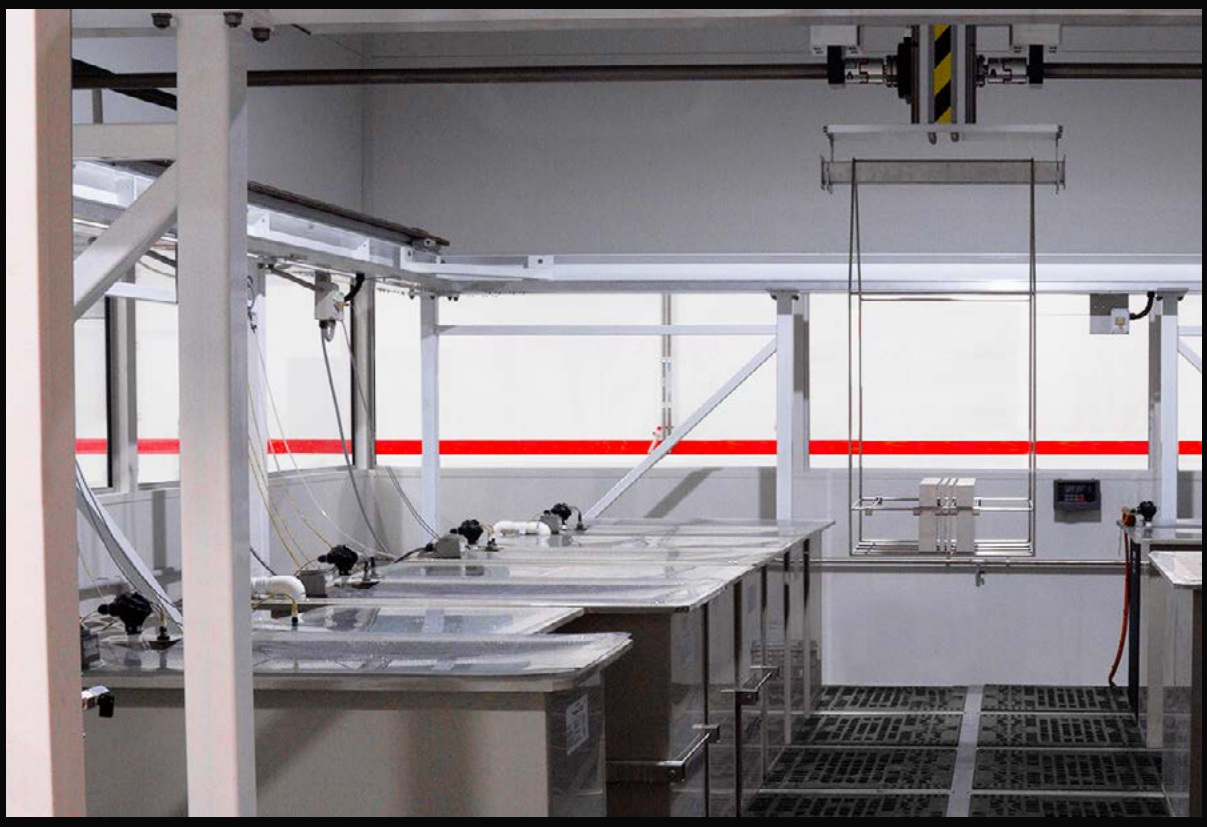
Chemical surface cleaning operations are utilised for the preparation of components that require Aluminium Vacuum Brazing as per AWS C3.7 in PWR’s state of the art Vacuum Furnace. This produces a surface quality that is contamination free and prepared for the fluxless vacuum brazing process.

Chemical cleaning of aluminium product is employed prior to the application of coatings where an oxide and contamination free surface is required to ensure the quality of the coating.

Coatings are applied using the same automation and control as the cleaning operation, providing superior coating quality and repeatability. Current PWR authorised coatings include the following:

- Type II Chemical Conversion Coatings as per MIL-DTL-5541,
- Type III, Class 1 Hard Anodize Coatings as per MIL-PRF-8625

Additional chemical processes are available upon request. PWR, through our network of national and international suppliers, also have collaborations with other associated surface coating specialists that include Powder Coating, Cerakote and Painted Epoxy High Solids Coatings in accordance with military specifications.



VACUUM BRAZING AND HEAT TREATMENT

PWR is a NADCAP accredited heat treat facility capable of vacuum brazing in accordance with AWS C3.7 standard as well as solution treating and artificial ageing in accordance with AMS2770.

Aluminium Vacuum Brazing is a fluxless brazing process that is performed under high vacuum in a heated chamber using pre-placed or clad aluminium filler material. This process allows for the incorporation of internal fluid passages or galleries that can be used for the control of heat inputs/outputs of components that have specific heat operating ranges. Some advantages of Aluminium Vacuum Brazing include:

- High strength joints in heat treatable aluminium alloys that enable light weight heat exchangers to be manufactured with superior structural integrity;
- Fluxless brazing meaning no potentially harmful residues or contaminates;
- Excellent conductivity, both thermal and electrical, providing exceptional heat rejection characteristics while maintaining electrical integrity;
- Greater freedom in design of products with intricate internal fluid passages or thin wall applications;
- Greater reliability and durability in high stress design application compared to bolted or adhesive bonded applications; and
- Relative low cost solutions for high end designs.

In association with Aluminium Vacuum Brazing, returning heat treatable brazed workings to a tempered state, through Solution Heat Treatment and Artificial Aging, is key to the performance and structural integrity of high stress components. This is achieved in the PWR, specially designed, Solution Heat Treatment Furnace. This specialised equipment incorporates PLC controlled heating cycles with an automated, programmable, integral spray quench system that reduces residual stress during the quenching operation resulting in stable, high quality post braze components ready for final machining processes.

Applications for Aluminium Vacuum Brazed and Heat Treated components include, but are not limited to the following:

Cold plates – for both land based and aeronautical applications, cooling electronic components and power units;

- Formula 1 and Formula E race-car platforms
- Battery cell cooling/heating for electric vehicles;
- Autonomous vehicles;
- Airborne electronics and enclosures;
- Radar installations and other military applications.

Vacuum Brazing is not limited to Aluminium. PWR's capability also extends to high strength superalloys including Titanium, Nickle based and Chromium based metals such as Inconel and Heat Resistant Stainless Steels. These materials may also be brazed in the vacuum furnace with such alloy fillers as Silver, Nickle and Gold to provide superior joint interfaces.

PWR extends its brazing capability with two Controlled Atmosphere Brazing (CAB) furnaces, the first being a continuous belt with the second being a single batch type furnace. Controlled Atmosphere Brazing processes are performed in a Nitrogen atmosphere where pre-fluxed assemblies are joined together with pre-placed clad aluminium fillers, sheets or pastes that produce strong, leak-free joints in lower strength aluminium alloys for applications such as Radiators, Oil Coolers, Intercoolers and other Heat Exchangers.

CNC MACHINING

Machining at PWR can be broken-down into three various sections but also allowing different options in each section.

3 Axis Machining:

With currently 11 machine cells available ranging in X travel from 710 mm to 1525 mm and spindle RPM of 14,000 component manufacturing can be finite optioned to suit drawing specification and best machine suited. All machines feature intuitive Probing systems for both work datums and tool probe features for speed, precision, and repeatability of set-up.

All machine cells work as 3 axis but also have the following features available:

4 Axis Machining:

From a chuck to advanced material holding devices a component can be manufactured in less operations but also ensuring better accuracy between faces if a part allows this style of manufacture. Where possible we utilise this method to also reduce set-ups and to increase productivity.

5 Axis Machining:

PWR has recently acquired additional 5 axis devices to complement the 3 axis machine cells that add 4- and 5-axis capabilities giving more machining options over a 4th axis rotary table, these have a working Dia of 267mm and can run all 5 axis simultaneously.

These state of the art 5 axis machine cells are optioned to 18,000 RPM with 120 tools magazines and various styles of palletised systems for light-out operation. We currently operate two banks of machine cells joined to an 18-pallet system X two off, these have a working window of X 600mm.

Additionally, we have two banks of 5 axis machines that are equipped with a 12- pallet system each, fitted out with 120 tools options, 18,000 RPM and a working window of 700mm is achievable.

These machine cells operate at the highest level of complexity around 5 axis machining, partnering with the best tooling suppliers and work holding to fully option the output from these machines, we operate 24 hours a day, 7 days a week with machine monitoring for productivity.

Turning Section:

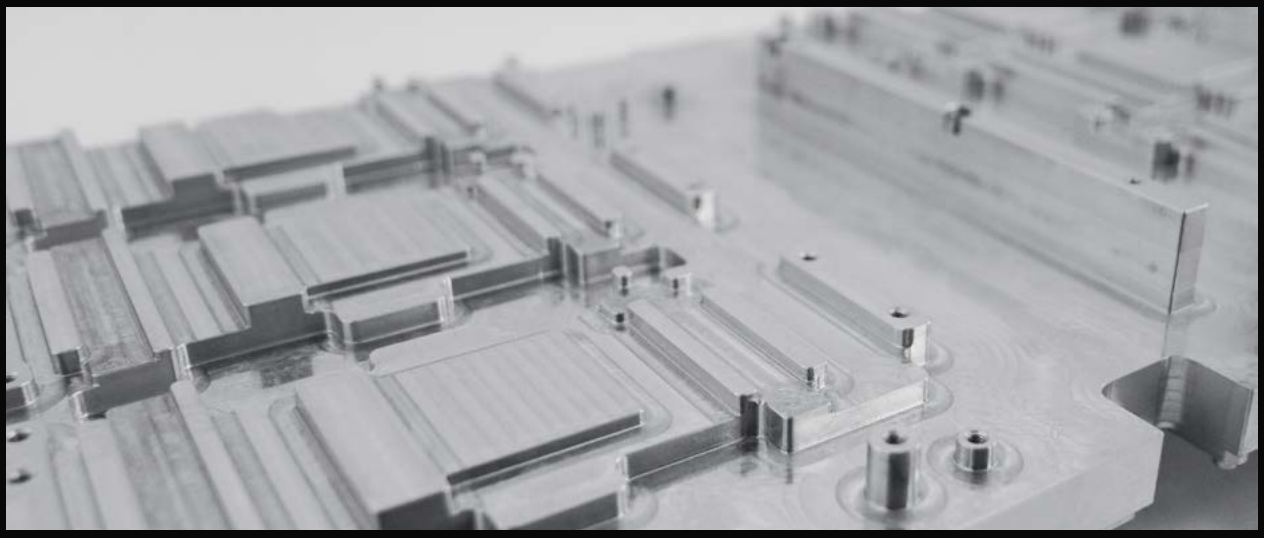
Capabilities within the turning section include 5 axis, twin spindle, mill-turn options, and bar feeders for lights-out operation. With Max Dia of 660mm X 995mm part lengths achievable we can cover a broad spectrum of turned components from a One off to Production Qty's

Programming Department:

Complexity of machined components have been addressed with Master-Cam as our chosen CAM software partner and has been developed around PWR's machining strategies for optimal 5 axis engagement, this has been a multiple year decision ensuring we are up to date with training and technical issues. We have multiple seats allowing for 3, 4 and 5 programming across our two locations allowing for 24 hour around the clock programming. Our CAM Software is backed up by our Simulation Software from NCSimul ensuring no tool or machine crash can occur giving safety to the technician and the machine cell.

Machines On-Site:

- DM-2, X711, Y406, Z394 MM, S12,000 RPM: QTY 4 OF
- VF3-SS, X1016, Y508, Z635 MM, S12,000 RPM: QTY 1 OF– 5 Axis Table Fitted
- VF4-SS, X1270, Y508, Z635 MM, S15,000 RPM: QTY 5 OF– 4 and 5 Axis Tables Available
- VF5-XT, X1524, Y660, Z635 MM, S12,000 RPM, QTY 1 OF– 4 Axis Table Available
- Variaxis I-600 Smooth, 600mm Part Length, 18,000 RPM, 18 pallet, QTY 4 Of
- Variaxis I-700 Smooth, 700mm Part Length, 18,000 RPM, 12 pallet, QTY 2 Of
- Integrex 200-IV, Twin Spindle, Bar Feeder, 660 MM Max Dia x 995 MM Max Length, Mill-Turn Capability. 1 Of
- Quick-Turn 6T, Bar Feeder, 40 MM Max Dia. 1 Of




Mazak
Mazak
SMOOTH

CNC SHEETMETAL AND STAMPING

The sheet metal department is a key area in the PWR facility that services many other departments including but not limited to core build teams, fabrication/assembly teams, cold plate/micro matrix build teams, and prototyping/testing teams. The supply of sheet metal components to these areas makes for a high demand environment and it is critically important that we maintain work order deadlines, sufficient resource efficiency, and a high level of quality control processes.

The natural evolution of the company and the industry means that the sheet metal parts are often extremely intricate components requiring robust processes and advanced machine operation. Components in regular production include but are not limited to:

- Core side bands and header plates
- Consumable parts required to assist core build processes
- Assembly side bands, tanks, brackets, and fan shrouds
- Templates and jigs required to assist fabrication/assembly processes
- Various plates and components for cold plate/micro matrix parts
- Large scope of work for product prototyping and development
- Components to support various in-house testing methods and auxiliary processes

These sheet metal components are being produced from our raw sheet material stock that we have on site which includes but is not limited to 1000, 2000, 3000, 5000, and 6000 series aluminium alloys.

Through the growth of the company and the evolution of its sheet metal requirements PWR has maintained its relationship with Japanese machine manufacturer AMADA. The PWR facility now houses five state of the art sheet metal fabrication machines of the AMADA brand including:

- 1 x DCT Series Shearing Machine (DCT3065)
- 2 x AE-NT Series CNC Turret Punch Press (AE2510NT)
- 1 x LCG Series CNC Laser Cutter (LCG3015AJ) With LST Series Shuttle Table (LST3015G)
- 1 x HG Series Brake Press (HG8025)

The DCT Series Shearing Machine is an electric guillotine used for cutting sheet metal as required. The guillotine has a 3m blade capable of shearing through aluminium and steel materials between 0.5 and 6.0mm. The guillotine is used for cutting simple rectangular parts for production and cutting sheet material down to manageable size blanks for turret and/or laser cutting processes.

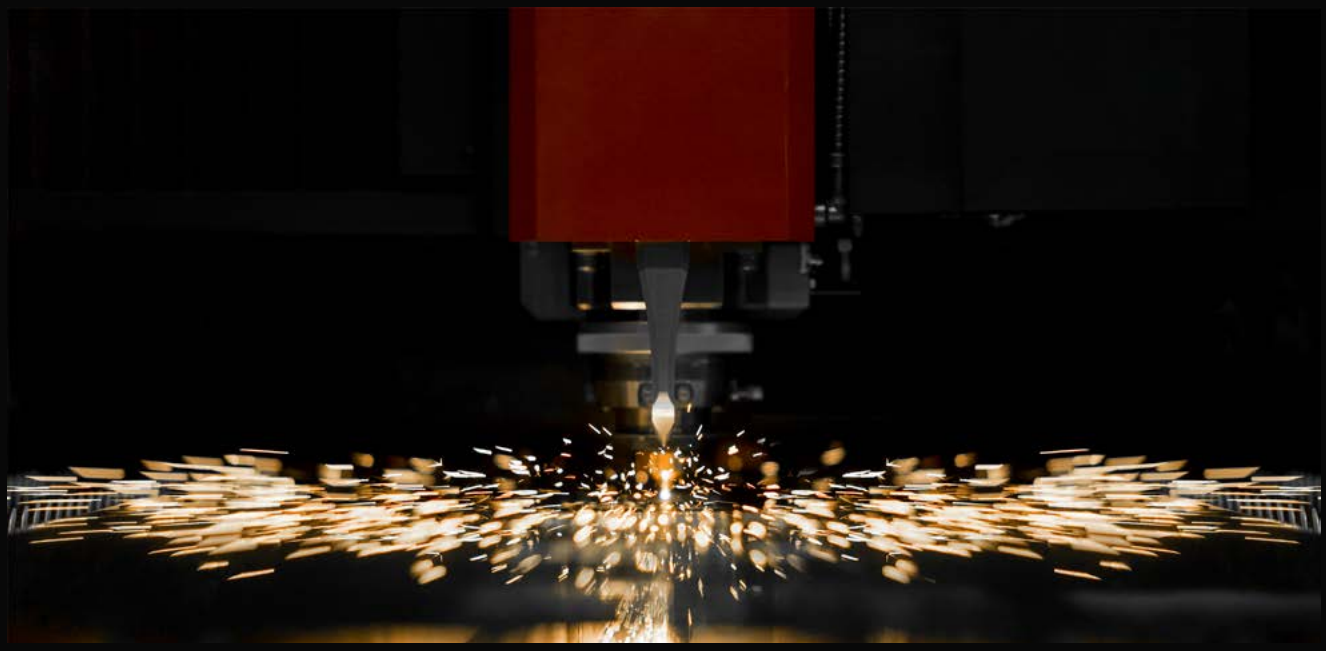
The AE-NT Series CNC Turret Punch Press is a blank cutting machine using a series of custom tooling held in a tooling carousel. The machine operates from a program which instructs the machine to select the desired tool, move the sheet to the location required and punch the tool through the material, cutting out the finished parts to the designed geometry. The turret press, with current tooling, is capable of punching aluminium and steel materials between 0.5 and 3.0mm.

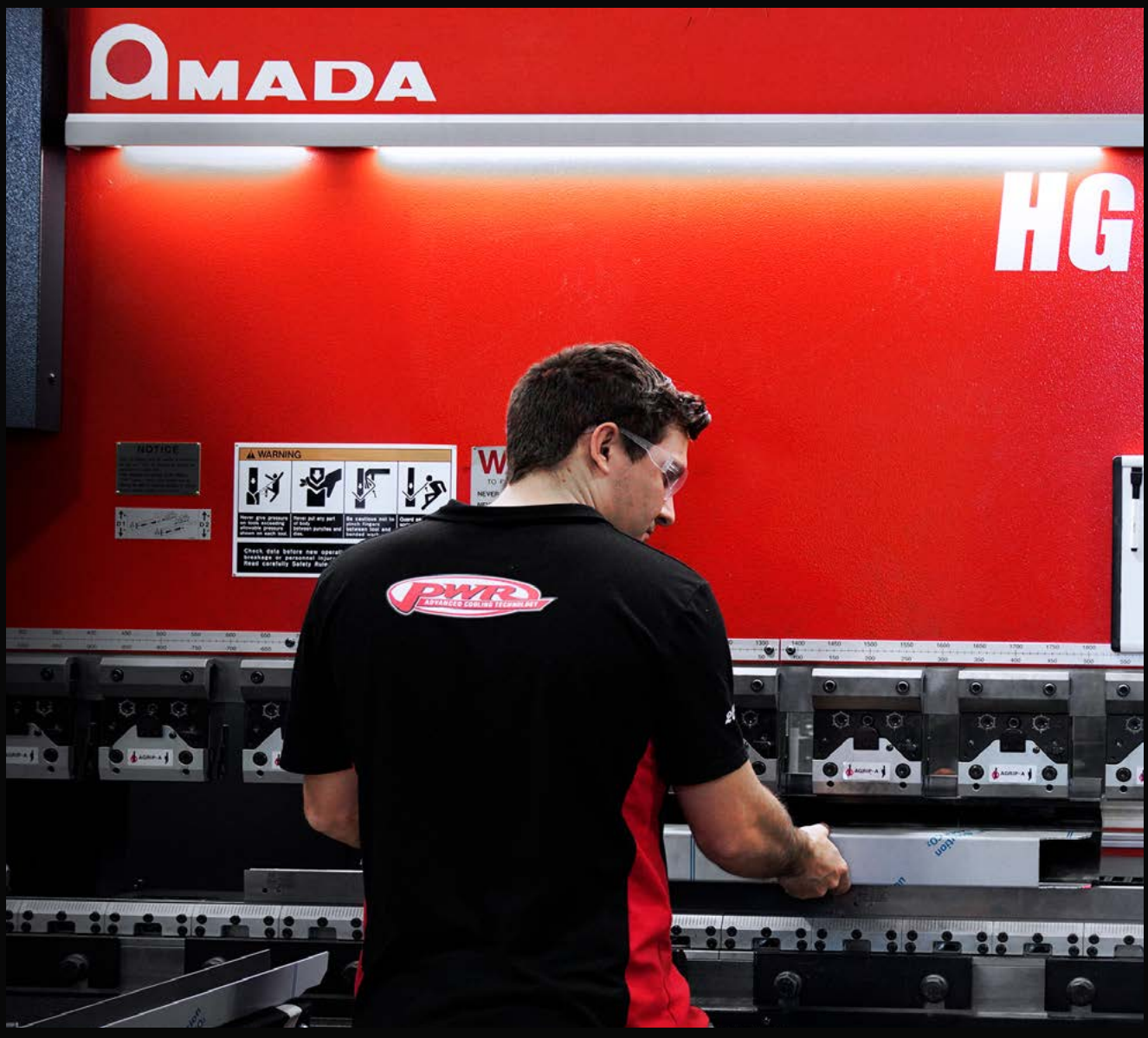
The LCG Series CNC Laser Cutter is a fibre laser cutting machine using a powerful 6 kilo-watt laser to burn away material with assistance from a specialised high-pressure gas. The laser cutter uses the 'melt and blow' method where the laser is turning the material to molten metal and the assist gas is used at high-pressure to blow away the molten material leaving a clean cut line. The laser cutter is capable of cutting aluminium and steel materials between 0.1 and 25.0mm.

The laser cutter is also fitted with an LST Series Shuttle Table which is a second open sheet bed that can be loaded whilst the enclosed bed is in operation. The shuttle can then be automatically or manually interchanged to allow optimal machine efficiency and ease of material loading.

The HG Series Brake Press is a hydraulic brake press used for bending sheet metal components as required. The material is pressed between a suitable punch and die to bend the material to the angles and shapes as designed. The brake press has a 2.5m maximum bend length and, with current tooling, is capable of bending aluminium and steel materials between 0.5 and 4.0mm.

All these sheet metal fabrication machines have increased the company's capabilities and allow PWR to stay ahead of the game in terms of sheet metal manufacturing and allows our products to compete on the world stage.




AMADA
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PWR

ENGINEERING AND DESIGN

To remain at the cutting edge of Advanced Cooling Technology, PWR employs an extensive Engineering and Design resource, assembled to compliment the state-of-the-art manufacturing facility.

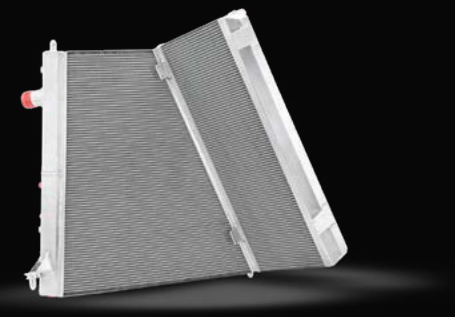
In addition to and drawing from an extensive in-house R&D facility, our engineering capability allows for PWR to collaborate on projects from the initial scoping phase, through design, prototyping, testing and volume production, all from within a single facility to ensure responsive service, and engineering integration throughout the project.

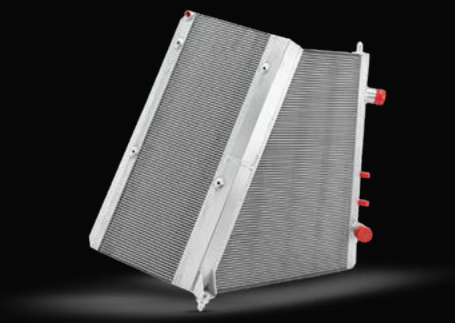
Removing the design burden from our customer is integral in our working philosophy and is supported by PWR's ability to add value to the project through contributing engineering and design input based upon empirical performance data, simulation and developed design solutions.

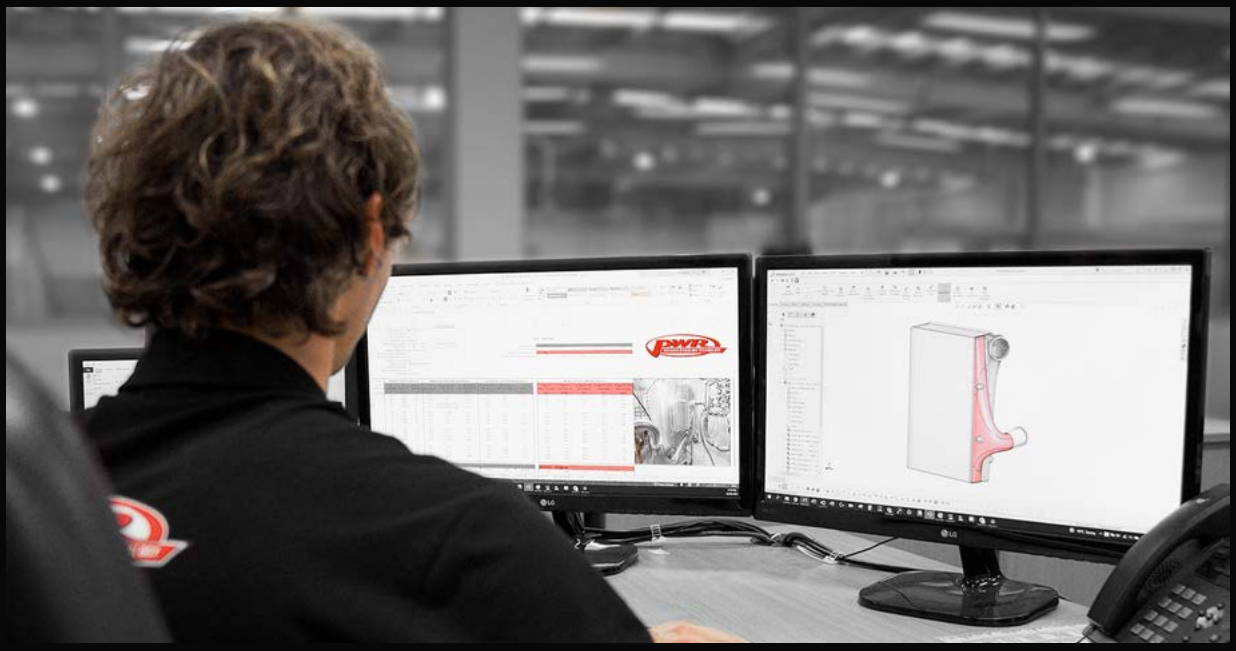
Having our own comprehensive calorific Windtunnel facility within our manufacturing and engineering facility means that we are rapidly able to build and test prototype heat exchangers to verify performance and optimise the design to engineer project solutions with confidence.

This means that PWR can be engaged from the initial phases of any project to collaboratively define heat exchanger geometries and specifications based on a library of performance data characterising the heat exchange specification, and design that complements our manufacturing capability.

In essence, PWR possesses the capability to provide turn-key cooling system solutions through an integrated engineering and design approach from prototype design, specification and simulation, through manufacture, test verification and volume production.





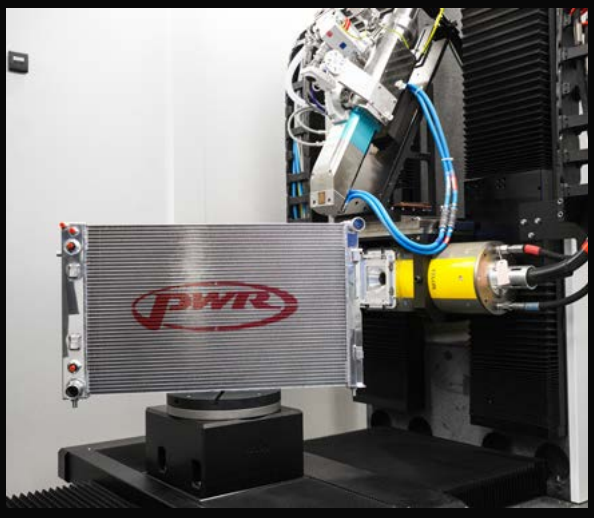


QUALITY CONTROL

PWR Computed Tomography

Weighing approximately 42 tonne, PWR's largest investment to date in a single piece of test equipment occurred with the purchase of a Yxlon FF85 CT scanner. With an inspection envelope of 1000mm height x 850mm diameter, parts as large as 2000mm height x 1500mm diameter may be interrogated layer by layer with full 360° rotation. Having up to 450 kV electrical potential, 320 W of tube power and with a focal spot size of less than 6µm, this instrument gives PWR full insight into weld penetration, inclusions and porosity, braze quality, internal product features and geometry that would otherwise be unknown without destruction. Used primarily for research & development and quality assurance, this CT scanner opens-up a multitude of potential for further product development and non-destructive testing at PWR and for external partners and research institutions.

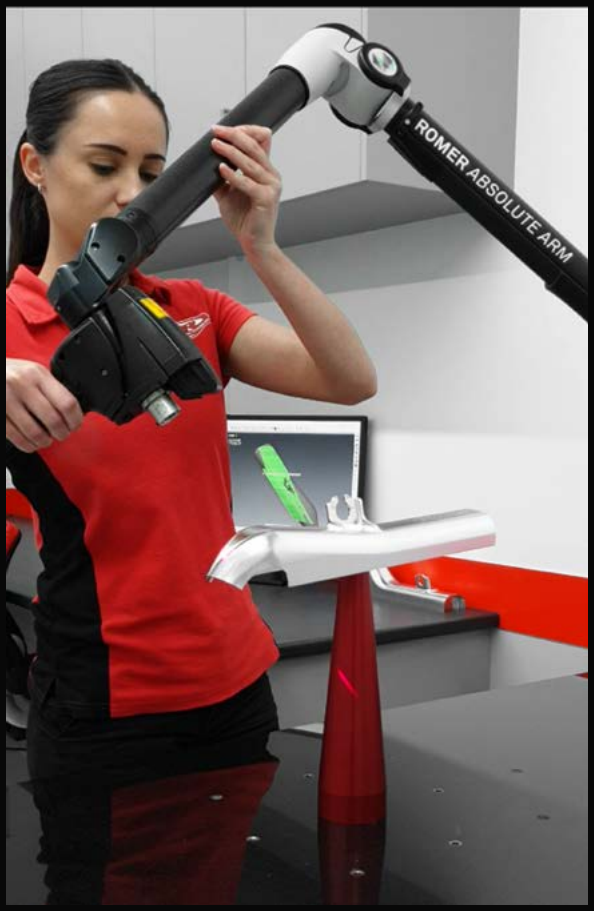
Industrial computed tomography (CT) is a highly precise, non-destructive X-Ray imaging technology. The CT scanner reconstruction produces a complete 3D representation of a component, based on a large number of 2D X-ray images. Computed Tomography allows PWR to draw conclusions on the external and internal structures without the need to physical dissect and analyse the entire component which would otherwise render it unsuitable for future use.



PWR utilises Volume Graphics VG Studio Max software which enables a seamless connection between the Yxlon FF85 data and the comprehensive analysis tools and measurement functions within the software. Some of the evaluations that can be performed include porosity/ inclusion analysis, Wall thickness analysis, Nominal/ Actual Comparison and Coordinate Measurement.

PWR Metrology Lab

PWR's Quality Engineers use the latest metrology technology in our climate controlled Metrology lab to guarantee the dimensional and geometrical accuracy of our products. PWR's metrology capabilities include a Hexagon Explorer performance 12.22.10 coordinate measuring machine (CMM) with 3D laser scanning ability paired with PC-DMIS inspection software. The CMM allows programmable autonomous inspection providing measurement results with high accuracy which plays a key role in PWR's quality assurance. The CMM has a large inspection envelope of 1200mm x 2200mm x 1000mm (X,Y, Z Axis)and is capable of maintaining tolerances down to a micron. PC-DMIS is the world's leading coordinate measurement machine software. PWR uses its powerful capabilities to measure and interrogate everything from simple prismatic parts to the most complex aerospace, defence and automotive components.



The software has the capability of importing a nominal model and comparing the measured data deviation.

The metrology lab also utilizes four Romer Absolute 7-Axis measuring arms with 3D laser scanning capability combined with Polyworks inspection software. The Romer arms provide PWR high measurement productivity and dimensional accuracy. The Romer arms are a versatile measuring instrument for PWR measuring simple and complex fixtures, components and finished products. PolyWorks Inspector is a universal 3D dimensional analysis and quality control software solution to control tool or part dimensions guide assembly building through real-time measurements, and oversee the quality of assembled products by using the Romer Absolute arms. It allows PWR's Quality Engineers to extract meaningful information from their measured 3D data, automate the inspection process when more than one piece is measured, and structure the presentation of measurement results.

MODULAR ASSEMBLY

In addition to the production of high-performance cooling systems, PWR have a proven track record in assisting our customers in platform integration. As a vertically integrated company with vast capabilities, PWR can manufacture complete sub-assemblies on behalf of the customer as a value-added process to streamline production at the final assembly plant.

PWR can manufacture and source a vast array of machined, fabricated, carbon composite and common of the shelf parts, to allow assembly of complete cooling system modules to our customers specifications.

Example 1- In the case of a radiator, this could include additional carbon composite bonded ducting and brackets, bespoke fluid line, cooling fans, thermostats, passivation and flushing processes. Allowing the customer to directly assembly the full cooling module.

Example 2. In electronics cooling applications, PWR manufacture the cooling plates through controlled atmosphere brazing (CAB) or vacuum brazing. Once complete the parts can have surface treatments such as chemical conversion and anodizing completed in house. Additional heat pipes, heat pads, quick disconnects and locating mechanisms can be assembled in our clean room build environment.

WELDING AND FABRICATION

PWR Advanced Cooling Technology's talented fabrication team are experienced in custom manufacture of bespoke aluminium heat exchanger assemblies.

Quality orientated, our welders receive product specific training and adhere to multiple welding standards while maintaining quality processes in alignment with AS9100.

The fabrication department utilises the latest technology in Miller gas tungsten arc welders (GTAW) to weld common and exotic alloys down to 0.8mm gauge. Further enhancing weld quality and repeatability, PWR offers automated welding solutions via a robotic welder.

Ensuring that the strictest dimensional requirements can be met, our welding team work closely with design and engineering to develop fixturing techniques to ensure assemblies are produced within specification. Finished parts can then be verified using our coordinate measuring machines (CMM) for dimensional accuracy.

Every article produced by PWR's fabrication team must comply with customer defined proof tests, and for ultimate interrogation, the welded assembly can be non-destructively tested (NDT) using our Computed Tomography (CT) scanner to ensure there is no inherent compromise of durability on the finished product.

Complimented by an extensive Sheetmetal, Machine Shop and Additive Manufacturing capability, our skilled fabricators are trusted globally within Motorsport, Industrial, Defence and Aerospace applications.

SIMULATION

PWR relies on simulation not only to shorten the time to market of product development but also to improve the thermohydraulic performance of each product design, a major differentiator especially in the very competitive environment of motorsport, one of the major characteristics of which being the very short development cycles.

PWR can use different simulation methodologies which have been successfully applied in Formula 1 for helping its clients finding the appropriate cooler design, bespoke to their cooling layout and performance requirements.

For the dimensioning of radiators and heat-exchangers, PWR has access to commercial and in-house 1D CFD software which is validated against PWR's own test data produced on its in-house test-rig. This provides PWR with the unfair advantage of being able to know precisely which parameters will drive the heat-exchanger performance and predict the performance accurately, not only in steady-state but also in transient conditions.

PWR has an extensive database of test data of heat-exchanger and radiators of different constructions and sizes which have been tested with different fluids. Should fluid properties differ from those available to PWR's test-rig, PWR with the help of its simulation tools, can re-process or predict the performance with the required fluids within reasonable accuracy.

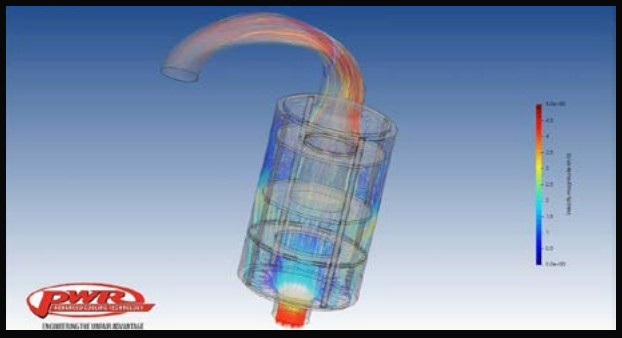
Performance predictions rely on the assumption of perfect and even flow distribution on each fluid side involved in the heat-exchange. To achieve the expected / predicted heat-transfer, reducing flow maldistribution as much as possible is paramount. In this regard, PWR reverts to full 3D Computational Fluid Dynamics (CFD) software to analyse flow distribution. From the analysis, where required, new tank geometries are designed to reduce flow maldistribution as much as possible under the different geometric and performance constraints. An interesting side effect of performing full 3D CFD analysis consists in recognizing early design features which can be a substantial contributor to the heat-exchanger pressure-drop, which would be neglected otherwise.

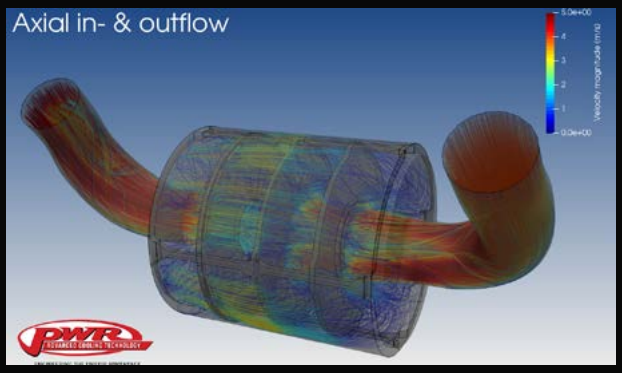
Beneath flow field analysis, 3D CFD is an invaluable engineering tool for the design and analysis of cold plates. The implementation of the flow and heat-transfer analysis (including heat-transfer from and into solids) early in the design process allows to evaluate and compare performance of different designs. In turn, flow path and gallery shapes can be optimised to maximise heat-transfer and /or reducing pressure-drop.

While PWR is currently focusing mainly on using simulation for improving their designs and products, PWR has the ability to provide additional support for internal aerodynamics involving radiators in ducted environments. Also, PWR has the capability to model the heat-exchange between multiple streams using a porous-medium approach, allowing to assess the impact of flow bypass and flow maldistribution on the heat-exchange.

In addition, the PWR simulation team strives to improve their simulation capabilities by being able to deliver predictions derived from state-of-the-art models based on the most recent scientific publications, including for instance phase-change of cryogenic fluids.

PWR are periodically increasing their in-house processing power to enable faster and more accurate analysis of increasingly complex heat-exchanger and radiator designs.





TOOLING, JIG AND FIXTURE DESIGN AND MANUFACTURE

Ensuring PWR Advanced Cooling Technology remains agile to customer demand and capable of producing finished heat exchanger assemblies with complex geometries to the finest tolerances, requires significant Tooling, Jig and Fixture design capability.

The tooling and fixtures required to produce our cutting-edge cooling solutions are developed by our experienced design team with a focus on ensuring that critical tolerances can be achieved with a high level of repeatability.

The manufacturing of tooling, jigs and fixtures is completed in house utilising our state-of-the-art CNC machining facilities so that we can ensure the quality and accuracy from the beginning of the heat exchanger manufacturing process. For more complex tooling and fixturing solutions, PWR can really flex our capabilities and rely on additive manufacturing in high temperature resins, engineering plastics and even metals.

At the completion of manufacturing, we ensure that both a repeatable and accurate result will be achieved with our tooling, jigs and fixtures by employing our meticulous quality control processes to scan and probe designs before they are utilised in manufacturing heat exchangers.

As a result of designing and manufacturing our own tooling, jigs and fixtures, PWR is poised in a unique way that allows us to react and develop solutions for complex problems in a fast-paced manner. Time and time again PWR have been able to deliver solutions where others could not by developing bespoke tooling, jigs and fixturing to achieve customers designs.

CLEANROOM ASSEMBLY

In the constant search for performance and delivering cutting edge cooling technology to our customers, PWR has built a world class clean room assembly facility.

Four isolated, temperature-controlled rooms allow PWR, independent management of complex precision assemblies for some of PWR's state of the art heat exchanger solutions. These rooms enable PWR to maintain strict manufacturing controls on detailed processes, including the management of FOD (Foreign Object Debris), to ensure our customers receive the highest quality products.

The unique layout also allows PWR to manufacture a multitude of products within the clean rooms to satisfy customer demands within a range of industries including Motorsport, aerospace, and the electronic/ battery sectors.

PWR HISTORY

In 1997, Kees with his son Paul Weel saw an opportunity to invest in a new segment of the automotive cooling market. The demand for high quality, light weight, performance aluminium cooling products was growing and Paul Weel Radiators, better known today as PWR Performance Products, was created to fulfill this need. The market was ready for a product that was measured by its performance, and backed up by a flexible manufacturing facility capable of designing and adapting configurations of coolers to custom specifications.

PWRs new headquarters in South East Queensland Australia supplies around the world. The multimillion-dollar, state of the art manufacturing plant has a controlled atmosphere brazing furnace, CNC machine shop and design department, large fabrication capabilities, CT Scanning and quality department, clean room assembly area and additive manufacturing department, all this allows PWR to lead the world in cooling research and development.

PWR provides world class cooling solutions by manufacturing high performance aluminium radiators, intercoolers and oil coolers for race cooling solutions to leading race categories and teams such as F1, NASCAR, V8 Supercars, Deutsche Tourenwagen Masters and World Rally Championship, PWR is recognised as a world leader when it comes to high performance cooling.

The flexible manufacturing approach, which sets PWR apart from its competitors, is due to every aspect of the manufacturing process being completed in its own purpose built facility.

In March 2015, PWR acquired US based C&R to strategically expand its footprint and gain further traction in the US market. Founded by Chris Paulsen in 1988

THE INSIDE STORY

For three decades the Weel family businesses have been deeply involved in manufacturing products to serve the automotive cooling industry. The PWR Performance Products brand had its start in modest surroundings back in 1987 with Kees Weel manufacturing automotive radiators in a small factory on Queensland's Gold Coast in Australia. With demand for their radiators growing, he formed the K&J Thermal Products company, and within ten years K&J Thermal Products had grown to be the leading manufacturer and supplier of automotive cooling products in Australia employing over 120 staff with offices in every major city and region of Australia.

In 1997, Kees with his son Paul Weel saw an opportunity to invest in a new segment of the automotive cooling market. The demand for high quality, light weight, performance aluminium cooling products was growing and Paul Weel Radiators, better known today as PWR Advanced Cooling Technology, was created to fulfill this need. The market was ready for a product that was measured by its performance, and backed up by a flexible manufacturing facility capable of designing and adapting configurations of coolers to custom specifications.

As PWR founder Kees Weel states "Every step of the manufacturing process is done in-house – we braze all our own cores and carry out our own fabrication. As far as I'm aware we are the only dedicated competition Radiator manufacturer who produce all aspects of our own heat exchangers, from core manufacture right through to complete assembly fabrication. This gives us flexibility of design, whilst maintaining quick turn around to our customers all over the world." As a specialist manufacturer of competition Radiators, Intercoolers and Oil Coolers for high end race and performance automotive applications, the PWR brand has fast tracked it's way to become a prominent name in top tier Motorsport, with notable successes in many categories including Formula 1, NASCAR, WRC, Dakar, Australian V8 Supercar, etc.

PWR Advanced Cooling Technology has become the technical partners of choice for leading race teams around the world.

PWR Advanced Cooling Technology is headquartered in South East Queensland Australia and supplies around the world. The multi million dollar, state of the art manufacturing plant a controlled atmosphere brazing furnace, CNC machine shop, R&D and design department, large fabrication capabilities and in-house wind tunnel that allows PWR to lead the world in cooling research and development with a dedicated focus on competition heat exchangers.

Every aspect of the manufacturing process is controlled completely within its own facility, which enables PWR to offer its global customers quick turn around and the unique opportunity to customize its products to suit their specific vehicle needs. PWR can assist individual race teams or vehicle manufacturers in the design process and selection of the most suitable core design to enhance the desired characteristics by referencing variable configuration data obtained from in-house testing.

PWR have a large range of existing heat exchange components regarding tube styles, fins, turbulators , etc, which enables the company to offer many configurations of heat exchangers. PWR have a full time wind tunnel testing division that can test core configurations in a real world environment. PWR's General Manager Engineering Matthew Bryson states, "PWR definitely has a distinct competitive advantage by having access to its own in-house wind tunnel. By varying air velocity and coolant flow rate we can provide the customer with real world results in terms of heat transfer, coolant pressure drop and airside pressure drop that is specific to customers requirements"

PWR also recognises the radiator as more than just a heat exchanger when in a race car environment. “In many formulas of racing the heat exchanger’s weight and aerodynamic characteristics have a huge impact on the performance of the vehicle”, says Matthew. PWR takes all of these factors into consideration when working with their customers in the design process. By engineering different tube styles with multiple fin styles and densities (potentially within the same core) PWR’s engineers are able to tune the performance characteristics of its heat exchangers. This allows them to maximise the downforce, drag or pressure drops to the customer’s requirements as well as providing the necessary cooling. “For example, weight and drag reduction is a significant factor in open wheel categories, but in applications such as NASCAR, building air pressure in front of the radiator can create opportunities assisting downforce,” says Bryson.

The extensive R&D program is not limited to in-house testing. PWR cooling solutions also get comprehensive on track testing with some of the worlds leading race teams, which helps validate its internal research and drives continual improvement of its products for the benefit of its technical partners and customers. Performance and reliability is critical to the success of a race team at the highest level.

The infrastructure at PWR’s world headquarters makes it possible for PWR to achieve a flexible approach to manufacturing which will inevitably maximise the worth that a customer receives from PWR Advanced Cooling Technology. Kees Weel describes when dealing with a customer “we like to point out when entering into a business relationship, that we don’t want to just sell them a radiator, we want to sell them a business relationship that means the customer can use our engineering department to purpose build exactly what they want”

PWR is not a one size fits all business model. PWR understands that different applications have different requirements and PWR work very hard to tailor make cooling solutions that will work for each individual customer. This inherent company philosophy caters for rapid prototyping and provides the adaptability that is required for a large variety of applications. PWR’s success story is rooted in the foundations of a flexible holistic approach to manufacturing, what’s so unique about the PWR brand is when we’re dealing with a customer, we give a customer a lot of different variations of how a Radiator can be built for them, which gives the customer the PWR engineering advantage.

With PWR offices in the UK and North America the PWR brand is now recognised globally as a designer, manufacturer and supplier of technically advanced high performance cooling solutions. We offer our customers a technical partnership with a passionate and enthusiastic approach, and a shared competitive determination to win

ENGINEERING THE UNFAIR ADVANTAGE

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