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NEWS RELEASE
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A John Brooks solution for Air New Zealand Gas Turbines…

As customers often say about projects with John Brooks Limited," It's a win/win relationship". This is certainly true of the motion control solution John Brooks Ltd supplied to rejuvenate the electron beam welding machine located at the Air New Zealand Gas Turbines' Auckland facility.

The savings were significant as the upgraded technology cost only 20% percent of the original suppliers' estimate.

There is a beam on a number of very happy faces across at Air New Zealand Gas Turbines facility at Auckland International Airport these days that has nothing to do with the glow emitted from the 'cathode ray tubes' atop the recently upgraded 30-year old, 200,000 volt, Sundstrand welding machine, which is still one of the biggest in the world.

Appropriately, the greatest radiance is centred around Ian Rowe, senior technical support engineer, components, who is a legend in the facility in his 39th year of service to Air New Zealand, having been involved in 11 engine configurations alone, on 737s, 747s, 767s, and Marine and Industrial engines – sold around the world – as part of some of the many tasks and roles he has played in ES. He has worked on Electras and even a Lancaster bomber at the museum.

"If you like you could see it as a large TV set, and the work as the screen. You have - 150,000 volts up at the top and your work is your actual anode down below. All you do is

accelerate the electrons from the filament straight through the anode inside the chamber and it hits the target just like a little dot of light that you can focus."

Complicated spiral and circular welds, to get the 'puddling effect', are all par for the course.

A quote from the original manufacturer to do a basic refurbishment was "around $500,000, with a more sophisticated higher voltage upgrade in the region of $700-800,000".

The welder allows the company to reclaim and refurbish parts which would otherwise be scrapped; require expensive replacement; or a massive replacement of a section since a single element is no longer available from a manufacturer. Companies like Rolls Royce and GE build engines to be reclaimed for the entire life of the aircraft and beyond.

Air NZ has more than 1,000,000-operating hours on the GE CF6-80C2 engines in the fleet right now. The average engine has 20,000 hours on the clock, but as Rowe points out, they are constantly performance-monitored and 'trended' all the time. The merest variation in performance, oil or fuel consumption, vibration etc sets off a series of checks and inspections. A good deal of this monitoring is linked by satellite to the ground-stations, and is continuous.
Maurice Coates, technical services manager for John Brooks Limited, providers of robotic automation and motion control, notes that with the fitting and programming of the machine control system and the motion control system, the Sundstrand could be expected to deliver another 30 years of service-plus, and with the Trio system being Windows-based, updates would be readily available.

"The machine originally had a 'very old Allen Bradley NC 7320 controller, with ASCI paper tape, driving a cubic metre of electronics' running it. All of that has been taken out and replaced by a six-pack-sized, Trio motion controller which regulates the four axes and several hundred I/Os, used to control the rest of the machine functions."

Coates programmed the new system which was provided by John Brooks, along with the Baldor servo motors and amplifiers.

The highly experienced and talented Ian Rowe personally handled the whole electrical and mechanical upgrade of the machine, bringing it up to the full operating specification.

He explains: “The entire process is dependent on a near perfect – ‘extreme’ -- vacuum. The vacuum in this chamber is so good that we measure less than one molecule of air per cubic metre of volume when it’s pulled down, a better vacuum than you could achieve in outer space.

“That way too you don’t get the oxidation or porosity in the weld, giving you the metal equivalent of ‘seamless stitching’.”

The electron welding process would fail in an inferior environment. If the electron beam struck an air molecule it would disperse the electron beam.

“You get a 50:1 aspect ration on the weld; one wide and 50 deep. If you put a metal plate about an inch above a metal block, you can actually see where the electrons went through the plate and welded the metal below it.

“Should you take something that is four inches thick, you can actually focus on it in the middle, de-focusing it at the top; and weld it two inches below the surface.”

The machine will weld copper and stainless steel together.

Rowe demonstrates two sheets of stainless steel which have been welded side-by-side to form a perfect join that is as strong as the two individual metal strips. He notes that a hand-weld in a normal atmosphere could not come anywhere close to that achieved in the machine. Welds done in the machine do not have to be heat-treated subsequently. All welds are x-rayed to ensure a perfect process.

The major applications are re-building parts and components that would never be able to be re-built with a normal welding system. 'Combustor cans' on engines have been rebuilt in the facility, along with under-carriage lug components which take the load on each landing and labyrinth V-seals, where wire is re-laid over the worn seals on engines and machined back again.

"We can chop a piece off an under-carriage lug, some two inches thick, and weld in a new section, making it just as strong as the original steel. Remember too that the lugs are where all the structural forces are concentrated and metal fatigue can take place."

As Rowe sums it all up; the electron beam welder allows Air New Zealand gas Turbines to "weld thin stuff to thick stuff; that way you have so little heat dissipation – only five percent of the energy used compared to a normal weld – meaning that you don't get any distortion, and that's what you are after in this business."

I could not have put it better myself.

HOW IT WORKS

The welder fuses metal – largely stainless steel and other metals such as copper --using a stream of electrons emitted by an electron gun which points through a gap in the chamber roof. The gun is very similar to the cathode ray tube that was a feature of the original black-and-white TV sets.
The article to be welded sits on a table. The entire carriage -- complete with the table -- moves in and out of the vacuum chamber.

The table can be articulated in four axes: X and Y movement, together with rotation, which is designated A and tilt, which is B.

The axes working in combination can move the part to be welded through any possible combination and sequence of positions. As well as that, the output of the electron beam can be attenuated or altered even as the weld is taking place. Electrical focusing elements surrounding the beam enable it to be widened or narrowed.

The beam can be focused on a specific point in space and, unlike a laser weld, that point can be inside a piece of metal, joining a rod to a block, for example.

John Brooks interfaced the new system to the original machine controls, situated in large cabinets behind the control station, which, in turn had been upgraded by the addition of a large flat screen, interfaced directly to the Trio motion controller, to provide full control of the machine.

With 200,000 volts in play and a vacuum superior to outer space, as you would expect, there is a good deal of background 'support' in the form of a three-phase rotary converter; a Leybold Heraeus blower and a vane-type vacuum pump; a molecular diffusion pump, with mineral oil at 220 degrees C, and a water cooling system working away in the background to support the machine which was mothballed in 2002.

“With the old CNC controller, the operator would have had to laboriously key-in each and every move, speeds, positions etc. We have automated that by using a TEACH function, with two joysticks which are capable of moving all the axes on the carriage (which bears the part to be welded).

“Now, when we want to set up a move, we first select a ‘recipe’ – we have up to 20 that we can select – and then ‘jog’ the table to its initial position. We can either click the TEACH button or the joystick button and it will learn the positions of all the axes at that point,” Coates explains.

The rejuvenated system has up to 100 steps for each specific ‘recipe”. Each step can have its own values for welding current, and other factors related to the welding process.

“A big bonus is that we can save each recipe, with its sequence of moves stored for use another day. It becomes a ‘standard’ weld, tagged and stored for repeat business, if you like.

“Just click on the start button and it will automatically reproduce that particular sequence again, altering the welding current and turning the weld on and off without any further intervention from the operator.

“The net result is that it is extremely quick, with the Trio system, to set up a very complex weld. What took a day in the past can now be set up in less than an hour – a huge productivity gain and a massive cost saving for Air New Zealand Gas Turbines.

The original machine, according to Coates, was built to last 100 years.

“Unfortunately, electronics just do not last that long. Being 30 years old, the original electronics, were just absolutely, totally obsolete. So, by upgrading the machine with the Trio motion controller, we have hopefully doubled the life of that side of the machine, taking it closer to its optimal century mark.”