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# Not your average weld

## Steve Hudson, The Lincoln Electric Company, Australia, talks about the challenges of welding on the Colongra gas pipeline project in Australia.

Jemena's Colongra Gas Pipeline project, located on the Central Coast of New South Wales, Australia, has been designed to supply new gas turbines being installed at Munmorah Power Station. These turbines will enable Delta Energy to meet peak electricity demands quickly and efficiently, while significantly reducing greenhouse gas emissions compared to coal-fired energy generation. Unlike coal-fired electricity generation that can take days to commission extra power to meet increased demand, gas

Figure 1. The high-strength X70 grade pipe with thick 24 and 30 mm walls specified for the Colongra Pipeline needed to be welded with stringent quality control to be able to cycle through pressure variations, and hence temperature variations, that would occur on a daily basis.

Figure 2. TOFD (Time of Flight Defraction) ultrasonic testing was used as the inspection method. This has a much higher defect detectability rate than radiography.


Figure 3. The Colongra Pipeline loops back on itself to increase the length of the pipeline by 3 km, and hence storage capacity, but also added to the precision welding requirements.

turbine generation is comparatively responsive, taking just hours.

In re-thinking methods of generating greener, cleaner more responsive electricity production, the X70 grade Colongra Gas Pipeline also demanded a re-think on welding solutions to meet the unique challenges it presented. Like the advantages of gas turbine electricity generation, the result has been a project delivered efficiently and on time.

The Colongra Pipeline not only acts as a carriage way for the gas, but essentially it is also a storage facility. The 800 sections of 42 in. diameter pipe, extending nearly 9 km, slowly takes in gas from the Sydney/Newcastle line over a 24 hour period and compresses it to deliver adequate supply to the gas turbines to be used over a six hour period of peak demand.

## A unique case

Definitely unique to Australia and possibly the world, the dual purpose of the pipeline created equally unique welding issues for the infrastructure project as it needs to cycle through a wide range of pressure conditions, and consequently temperature variations, on a regular basis. “Any welding flaws could grow due to fatigue (with the regular pressure changes),” said Andrew O’Neill, Engineering Manager for the Colongra Pipeline. “The welding needs to meet the demanding fatigue requirements.”

The high-strength X70 grade pipe with thick 24 and 30 mm walls (compared to the standard 10 mm of most pipelines in Australia) specified for the project needed to be welded with exceptionally stringent quality control, meeting ANSI Class 900 requirements. “This project was very different in terms of welding requirements. We knew that a traditional pipeline welding solution (stove pipe welding) was not going to be viable on the Colongra Pipeline,” said Paul Grace, Jemena’s Welding Engineer.

“With traditional methods and the pipe composition and wall thickness there would have been a high level risk of cracking. It had to be low hydrogen and the weld toe profile needed to suit the onerous fatigue requirements. We needed to find a very different solution,” continued Grace.

Figure 4. Once the sections of pipe were laid with precision, the hut is placed over each weld section, the truck with generator and STT®/Power Wave® machines moved into position and connected all done within a 20 minute time frame.


Figure 5. The Lincoln Electric® Power Wave® 455M machines completed the STT® root runs using a semi-automatic process, followed with G70M semi-automatic hot pass before fillout.

The pipe is also unique in that it loops back on itself to increase the length of the pipeline by 3 km, and hence storage capacity. Jemena had a specialised pipe bending machine built in the US for the project and this looping of the pipe added to the precision welding requirements.

## The necessity of tests and trial periods

An extensive testing period to develop a welding solution for the unique pipeline was instigated, by Jemena and Diona P/L, the organisation engaged by Jemena to construct the 42 in. pipeline. The key criteria in the testing of equipment and consumables were: the production of high integrity/sound welds that meet stricter quality than standard pipeline projects; developing a process that had a good production rate/day; a solution that was efficient in the size of product – not large equipment that got in the way all the time; and equipment that could stand the challenge of working in the field.

Extensive trials were conducted with controlled wave form processes, including STT®. Other processes included FCAW Gas Shielded, STT® and SAW, and MMAW low hydrogen to develop the best solution. "We evaluated several welding equipment waveform technologies as part of this project. Lincoln Electric's semi-auto/STT® with mechanised flux-cored welding was selected due to the consistency of the weld quality," said Grace. "The productivity was also good considering the thickness of the pipe being welded and the stringent defect assessment criteria."

## Benefits of using a semi-automatic process

All STT® root runs were completed using a semi-automatic process, followed with G70M semi-automatic hot pass before fillout. The Lincoln Electric STT® or Surface Tension Transfer® process ultilises sophisticated software to precisely control the current throughout the welding cycle instantaneously.

"While there are some greater logistics requirements in using this process, the productivity rewards are great," said Hugh Daly, Project Manager for Diona P/L, Jemena's construction contractor.

Darren Barrington, one of welding contractors working on the Jemena project said, "On this job, we were doing two joints a day comfortably." The dual wire feeder capabilities of the Power Wave®/STT® power source also enabled efficient switching between processes.

"For this project it is was extremely important to have good toughness of the weld joints," Grace noted "and the Lincoln Electric G70M had good strength matching with Charpy Impact Testing delivering toughness averages of 100J at -10°. Such good toughness assisted with stress analysis and improved allowable discontinuity size."

"The G70M is a beautiful wire to run – it washes in nicely – solidifies nicely - no undercut," said Barrington. "I had not done much with wire before, but I am definitely a convert now. The flux-cored wire also carried quite a bit more metal making fill-out quicker."

The repair rate on this project has been good, according to Grace, "Given the extremely stringent

defect acceptance criteria and the challenges. The defect rate has been low – lower than anticipated especially when you consider the TOFD Ultrasonic testing that was used."

"Unlike typical pipe welding projects where welds are inspected by radiography, because of the stringent fatigue/stress analysis for this project, TOFD (Time of Flight Defraction) Ultrasonic testing was used as the inspection methods. This has a much higher defect detectability rate than radiography."


Figure 6. The dual wire feeder capabilities of the Lincoln Electric® Power Wave®/STT® power source also enabled efficient switching between processes.

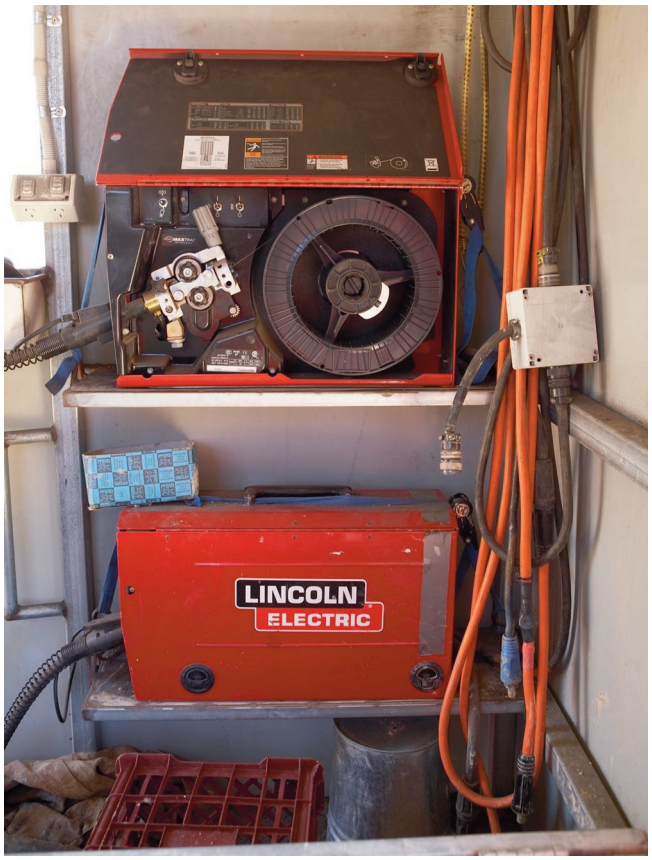


Figure 7. The solidly constructed welding huts, rather than tent like structures, features the Lincoln Electric wire feeders, guns, etc. permanently mounted on the wall, enabling quick and efficient set up.

## Efficiency is the key to productivity

Phenomenal efficiency in welding station set up and placement by Jemena's contractor, Diona, in readiness for the welding operators, has been a key to the productivity. The solidly constructed weld hut, rather than tent like structures, features the Lincoln Electric wire feeders, guns etc permanently mounted on the wall. Once the sections of pipe were laid with precision, the hut is placed over each weld section, the truck with generator and STT®/Power Wave® machines moved into position and connected – all done within a 20 minute time frame.

"The efficiency is extremely high and the project was delivered quicker than expected," said Daly. "I don't think there is any way we could improve on how this project has proceeded. A lot of money was invested early on researching welding methods and I am certain that we picked the most efficient method available."

"We also had the issue that all this was very new to all of us - welding operators, inspectors, contractors," said Grace. "At the start it was a steep learning curve for all involved."

There was not a lot of experience in STT® for field pipeline construction in this country and it was found that the majority of welding done with STT® is roly poly welding where the pipe spins – this field work was totally different where you could not rotate the pipe. The biggest challenge was welding in 12 and 6 o'clock position.

Lincoln Electric provided technical support and some initial training at their Padstow manufacturing site.

"There were a couple of tricks to learn (the 12 and 6 o'clock positions)," said welding contractor Darren Barrington, "but once you get use to this process it is user-friendly. Now I would pick the STT/flux-cored process any day of the week. It is going to be the way of the future for large diameter, heavy wall pipe." Darren Barrington also said that the Lincoln Electric STT® Power Wave® machines performed well in the field.

This project has been unique. Paul Grace added, "While the diameter of the pipe is reasonably common in Europe and North America, the fatigue factor is not. To our knowledge, it has not been done before and it is an important step in developing greener power generation."

Strict ecological guidelines have been followed keeping environmental impact of the Colongra Pipeline to an absolute minimum. Top soil preservation, erosion/sedimentation control and seed gathering in the immediate locality to rehabilitate the areas above the underground pipe, will ensure the area is back to its natural state as quickly as possible ensuring the quest for low-carbon-emission, cleaner electricity production does not sacrifice the local environment. WP

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