



# Air flow analysis helps 47-year-old Brindisi blossom at low load

*The challenge at Brindisi: how to optimise the air flow to ensure clean, reliable, consistent and cost-effective coal-fired generation at reduced load.*



Figure 1. The Brindisi plant



Figure 2. Inserting the anemometer into the furnace via the oil burner carrier tube. The position of each burner is entered into the software along with the position of the measurement point

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Edipower's 4 x 320 MWe plant at Brindisi (Figure 1) dates from 1964. It originally ran on oil, but in 1979 the plant was reconfigured to co-fire coal. Two of the units are currently mothballed while the remaining two operate on coal.

In common with many other power stations throughout Europe, the plant operators at Brindisi have been working hard to meet ever more exacting emissions targets whilst simultaneously improving plant flexibility, so

that optimum performance can be maintained at a range of different power outputs.

## Low load on coal

In particular, the plant was seeking to increase its availability to the grid, by being able to generate reliably at a newly reduced load threshold.

The relationship between RJM and Edipower was established in 2006 when RJM carried out an investigative survey of the combustion performance of units 1-4 of its 160 MWe oil-fired station at San Filippo on Sicily.

The objective of the survey was to identify a range of possible measures to reduce NO<sub>x</sub> levels in the flue gases at the boiler outlet and building on the success of this project, RJM was commissioned by Edipower to carry out further studies, including the survey at Brindisi described here.

The project at Brindisi is about helping the plant run cleanly, efficiently, reliably and safely at a load level of 135 MWe (net), down from the previous minimum load level of 155 MWe net.

This low load condition can easily be met whilst firing oil or co-firing oil, however, this is not financially viable. The challenge for the plant was to achieve this new lower load firing only coal.

At Brindisi, with no flue gas desulphurisation, the plant has to burn a very low sulphur coal in order to meet its emissions targets. It is currently using 'Envirocoal', an ultra-low-sulphur coal mined by Adaro in Indonesia. This coal has a very high volatile content and is easy to burn.

In March 2010, RJM carried out a minimum load reduction study at the plant and came up

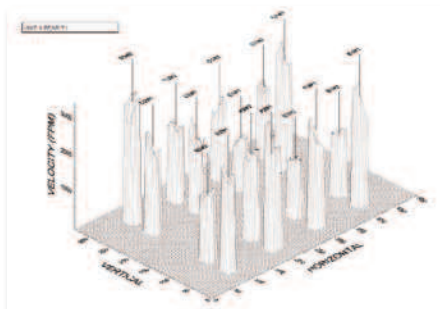
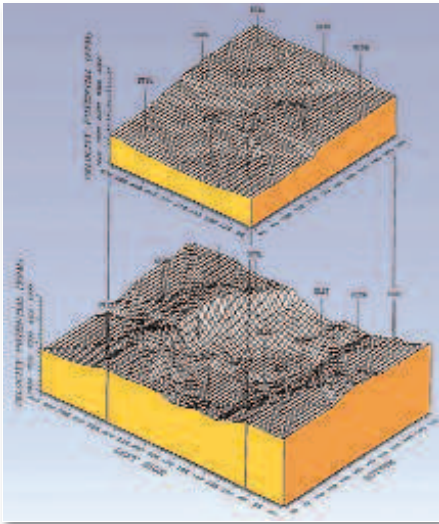


Figure 3. This chart shows in 3D the velocity cones for the rear wall of unit 4. For perfect airflow distribution all cones should be the same height, with the top of each cone flat. As can be seen, this is not the case here



**Figure 4.** Here we can see airflow distribution across the windbox with each burner identified for an easy visual analysis.

with a number of recommendations relating to operational settings. One of the key recommendations was that the plant should undertake an airflow distribution analysis (ADA), with the aim of enabling it to operate safely and efficiently at the reduced minimum load while maintaining burner and furnace stability.

**Airflow distribution analysis – a balancing act**

The rationale behind the airflow distribution analysis was that during the first study it became apparent that there was inconsistency of flame shape across the thirty Babcock & Wilcox dual cell burners, ranging from a number of long, lazy flames through to others pulled right back into the throat of the burner. We knew that if we were to get the plant running with optimal performance at low load, we needed to balance the airflow to each burner.

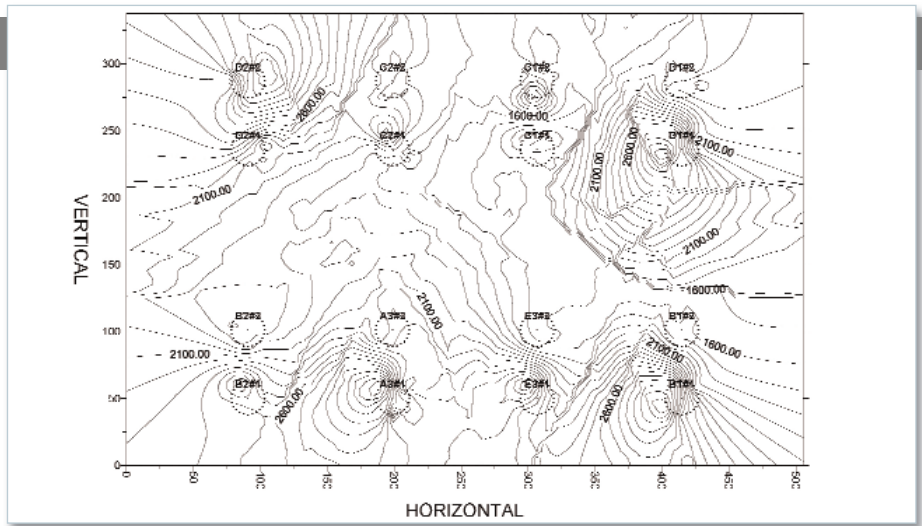
Therefore RJM returned to Brindisi to perform an airflow distribution analysis (ADA) survey in September 2010.



**Figure 6.** This image shows a flame that is pulled back into the throat (high swirl). This can lead to thermal destruction of the burner (image copyright IFRF)



**Figure 7.** This image shows a long loose flame (low swirl), which is not properly anchored and can be unstable (image copyright IFRF)



**Figure 5.** Windbox velocity topographical plot. This chart shows the baseline for rear wall of unit 4 and tells us that deviation in mass flow ranged from + 45% to - 40%, giving a range of 85% – a very high flow deviation

The process for performing an ADA survey is to run the fans at full power and insert a hot wire anemometer into the furnace via the oil burner carrier tube, which is removed for the purpose of the test (Figure 2). On all 30 burners, measurements were taken at 24 points around the circumference of each burner throat.

This data was then collected using RJM’s in-house developed software, from which a variety of 2D & 3D graphical representations can be created, giving a clear visual understanding of air flow distribution within the furnace. Figures 3, 4 and 5 show examples of such charts.

Using this type of data, we then adjusted the register door positions to balance the airflow to the burner. Caution was used in making these adjustments as changes to the amount by which the register doors were opened or closed also changed the amount of swirl, ie, the ratio of axial to tangential momentum, through the burner.

Care was taken to ensure the doors were not closed too much (creating a high swirl number and pulling the fire back into the throat), Figure 6, or too open (producing a low swirl number and a loose unstable flame), Figure 7.

At Brindisi, there is a single, “bustle” type, windbox, with air flowing around the sides of the boiler, feeding 16 burners on one wall and 14 burners on the opposite wall (Figure 8).

A particular challenge of this type of work is that determining the way air travels through a windbox is not an exact science. For example, closing a register door by 50% does

not mean that airflow to that burner is reduced by 50%. Similarly, making a single change in one area can have any number of knock-on effects on the air flow to the other burners. So, in effect, with 30 burners one is juggling with 30 variables, and they are all interlinked.

**Results**

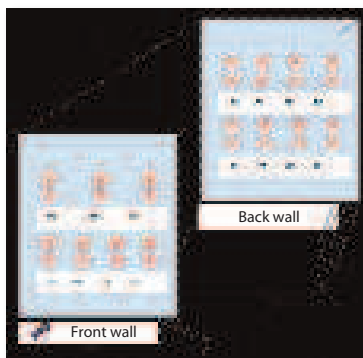
Getting the register door positions just right had the effect of dramatically improving airflow distribution across the boiler, yielding airflow distribution improvements of over 60% on unit 3.

Figure 9 shows the progressive improvement achieved in air flow distribution in successive tests.

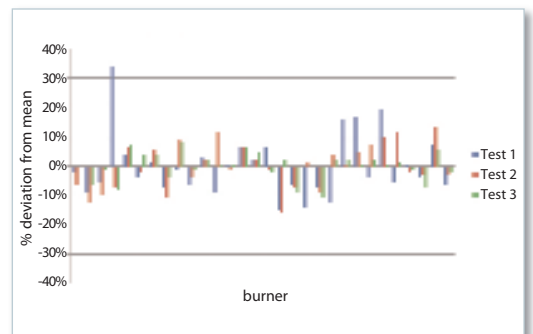
In addition to improving burner and furnace stability at minimum load, a significant reduction in carbon in ash has also been achieved, which confirms that the units are now burning their fuel more efficiently.

An additional benefit yielded by low carbon in ash is that if it can be reduced to below 7%, the ash can be sold as a valuable raw material for use in cement manufacturing (and thus become an additional revenue stream for the power plant), rather than having to be disposed of in landfill, at a cost of around 60 euros per tonne.

Commenting on the ADA project, Ing. Tonino Maglio, Plant Manager at Brindisi said, “What we wanted to achieve was reliable, safe operation at the new reduced load of 135 MWe without having to install shrouds around the register doors, which is a standard solution for addressing inconsistencies in airflow distribution. Thanks to the ADA balancing programme we have been able to improve our burner flame profiles and achieve a level of consistency which meets all our reliability, flexibility and emissions criteria – even at this new reduced load level.”



**Figure 8.** At Brindisi the windbox feeds 16 burners on one boiler wall and 14 burners on the opposite side



**Figure 9.** Baseline air flow distribution (Test 1), and improvements in subsequent tests, Test 2 and Test 3 (final). Bars above and below the line show the deviation from the mean. Each set of three bars corresponds to a burner