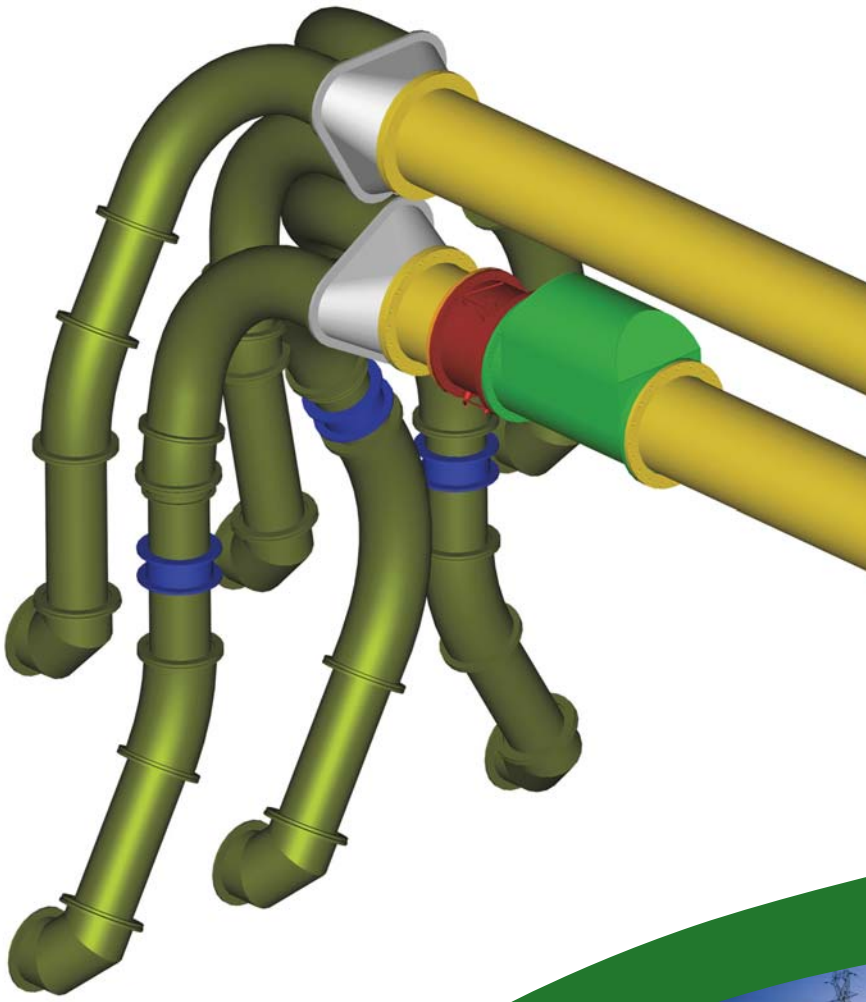
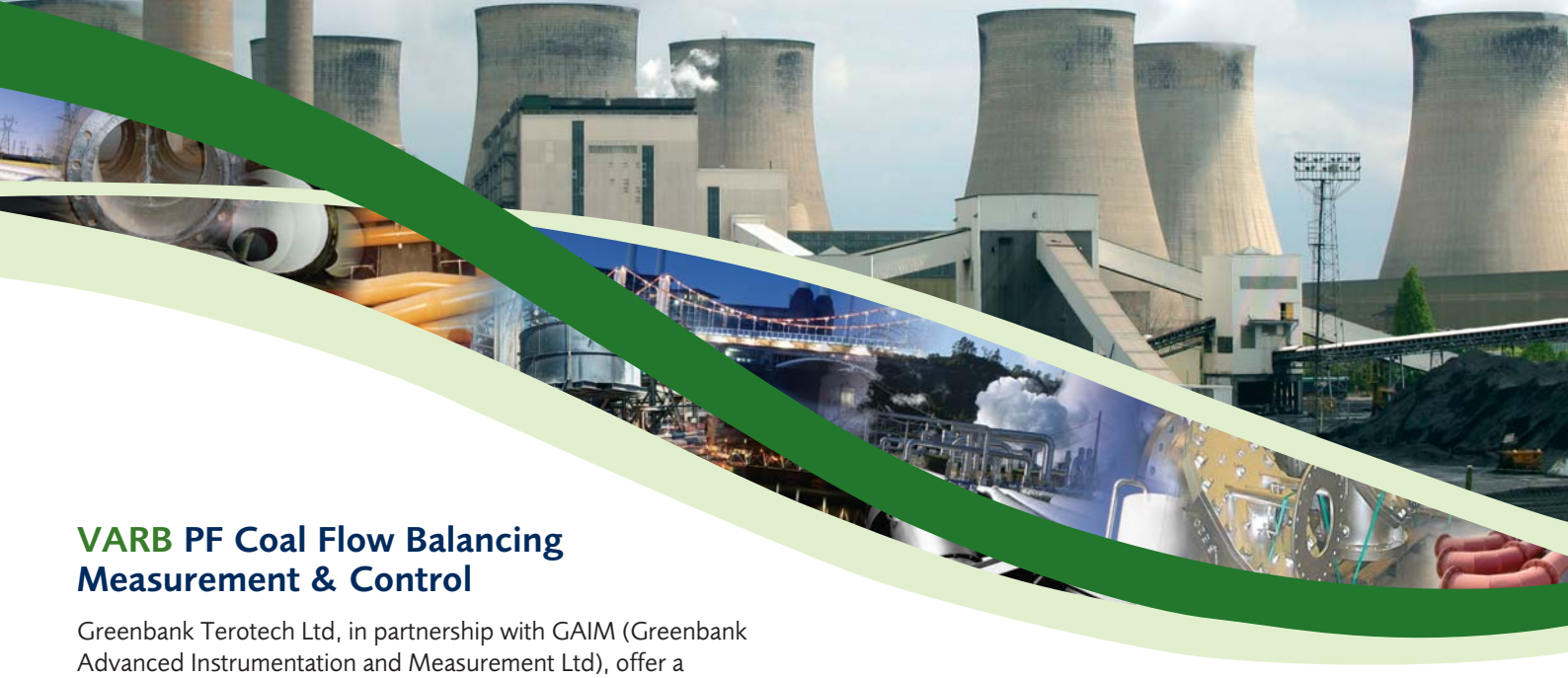
The Greenbank Group UK
Enhancing the performance of our customers plant and equipment

GREENBANK
Enhancing Performance

VARB - PF Coal Flow Balancing Measurement & Control



INVESTOR IN PEOPLE



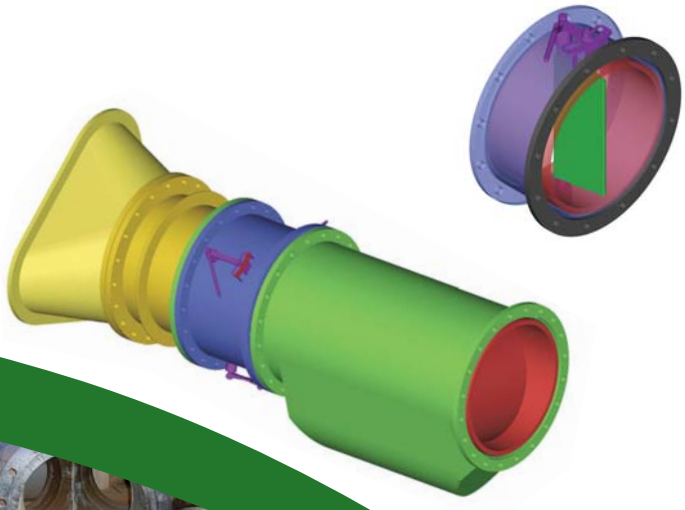
VARB PF Coal Flow Balancing Measurement & Control

Greenbank Terotech Ltd, in partnership with GAIM (Greenbank Advanced Instrumentation and Measurement Ltd), offer a revolutionary non-intrusive rope breaker for Pulverised Fuel (PF) with the unique family of VARB® PF Diffusing Systems.

As PF is conveyed from the mill classifier to the boiler burners through pulverised fuel pipework by the primary air, the resulting rope effect of the flow of material transferring disrupts the balance and efficiency of the distribution of coal as it reaches the boiler burners. The purpose of the VARB® (Variable Area Rope Breaker) is to break the PF rope

In particular where the pipes split into one or more branches, uneven distribution often leads to poor fuel to air ratio, combustion inefficiencies and accelerated erosion.

The Greenbank patented VARB® PF Diffusing System together with Greenbank s Control-Gate® technology will destroy the rope then control, balance and trim the air/fuel ratio to the desired distribution down each pipe leg.



Higher Combustion Efficiency

- Stable Combustion
- Reduced pipe erosion.
- Elimination of riffle box internals/dampers
- Subsequent reduction in pressure drop across the PF piping system.

Improved Burn

- Reduction in flame length
- Elimination of flame detachmen occurrences.

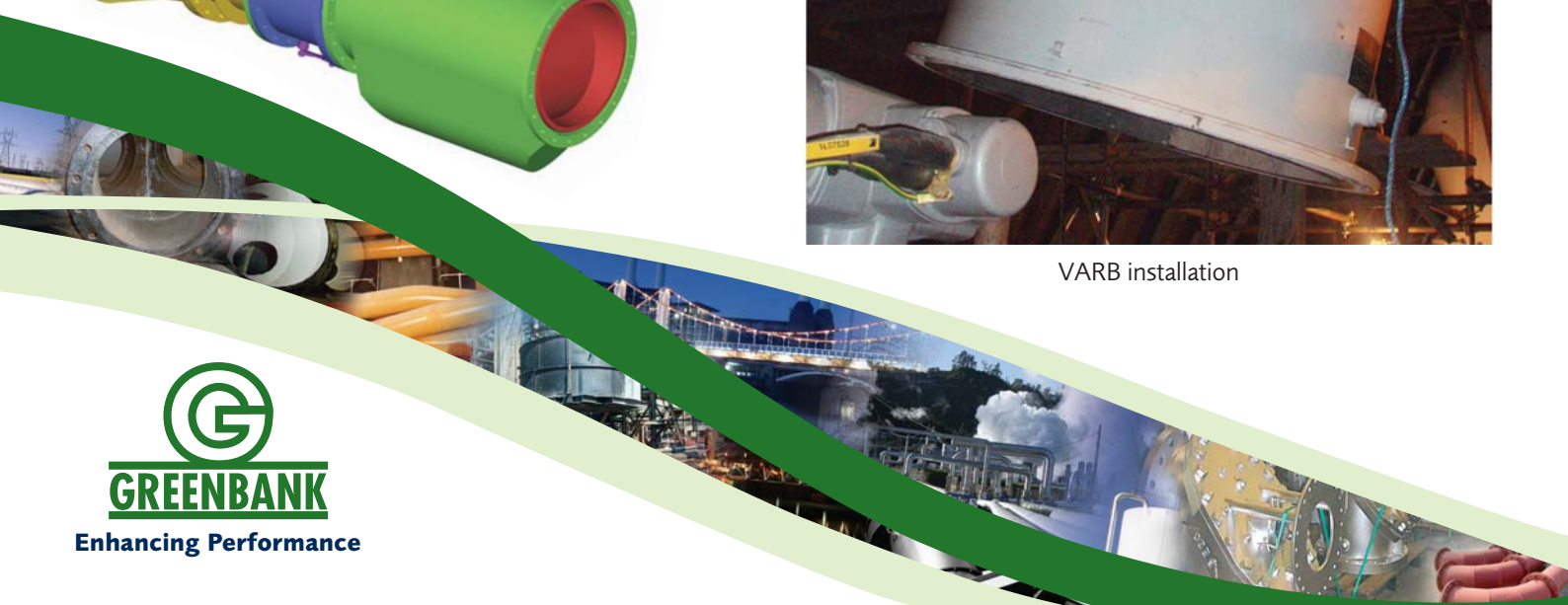
Reduced Carbon-in-Ash

- Saleable ash
- Avoidance of disposal and land fill taxes

Reduction of NOx

- A function made possible by lowering secondary air levels under stable operating conditions.

VARB installation



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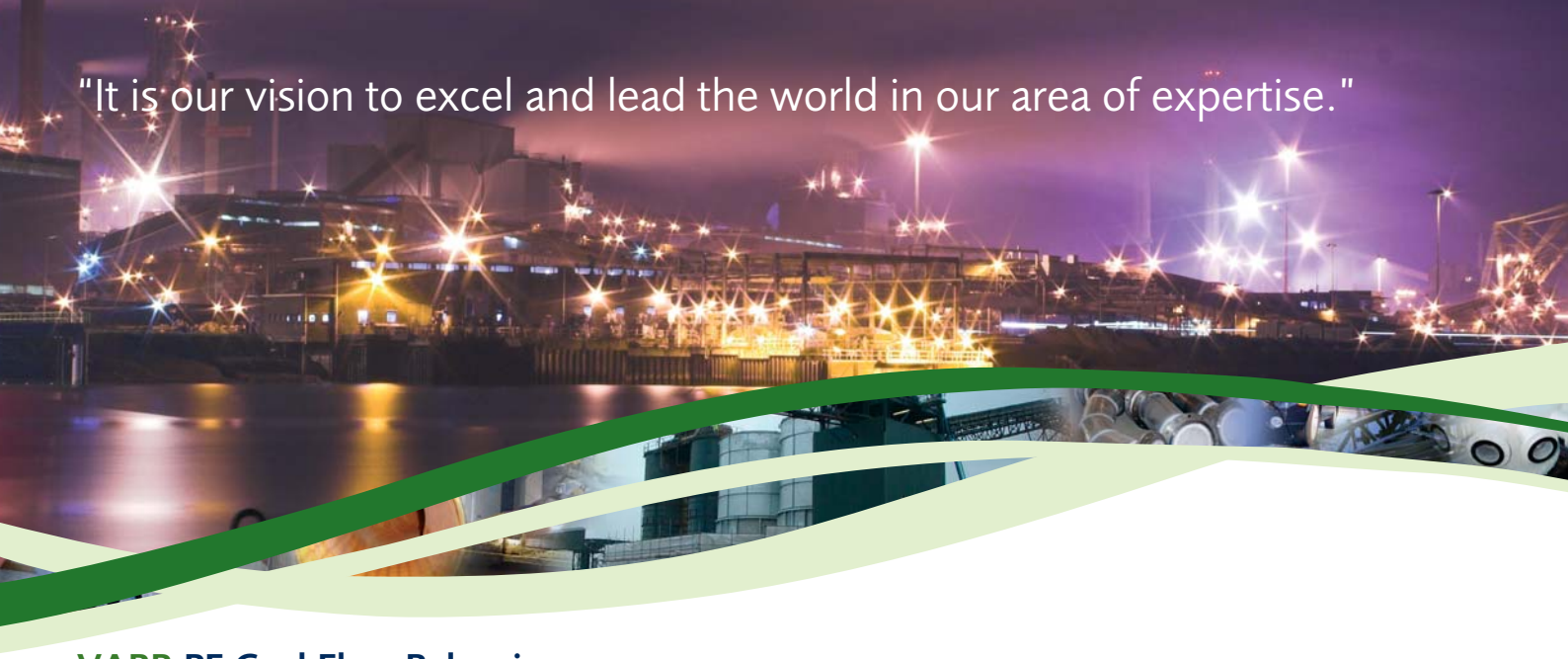


VARB PF Coal Flow Balancing Measurement & Control

The secret behind the success of the VARB® PF Diffuser is Greenbank's relationship with it's wholly owned R&D company GAIM.

GAIM (Greenbank Advanced Instrumentation and Measurement Ltd) was originally formed in collaboration with the University of Nottingham.

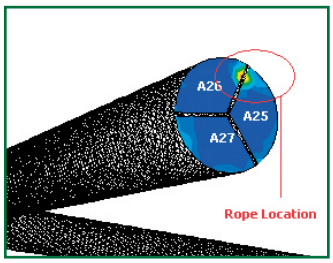
Utilising both academic and industrial expertise GAIM has developed the family of VARB® PF Diffusers.

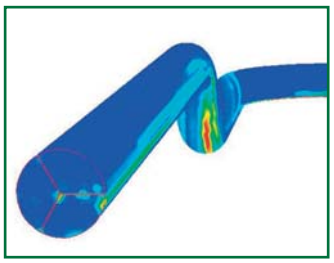
GAIM employs specialists in particulate analysis and control. Their understanding of the characteristics of particles being transported in air is second to none.

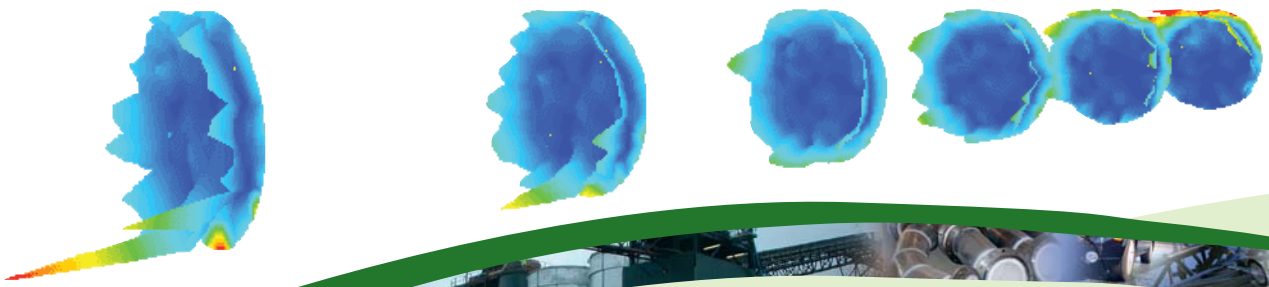
GAIM offers both CFD analysis and a 1/3rd scale test rig where concepts can be brought to life and tested prior to delivery to the customer.

The methodology rigorously applied for each and every VARB design consists of the following steps:

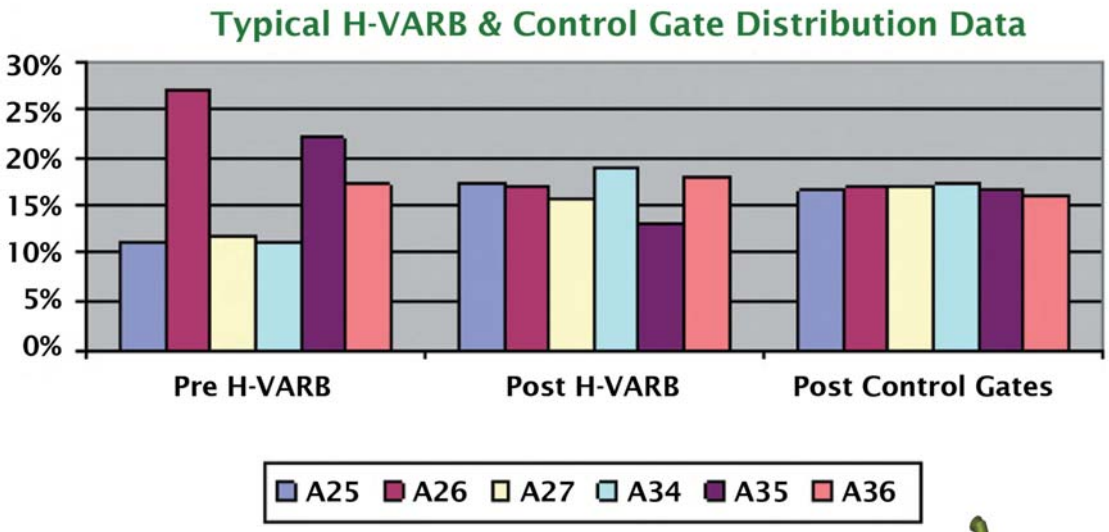
- Acquisition of customer existing PF distribution data
- Creation of a computational model (CFD) and the numerical simulation of the existing distribution.
- Prediction of the PF rope position.
- Introduction of the VARB® design within the computational model.
- Optimisation of the VARB® design and location within the numerical model.
- Verification of Rope position by survey.
- Installation and optimisation of VARB® (and Control Gate).







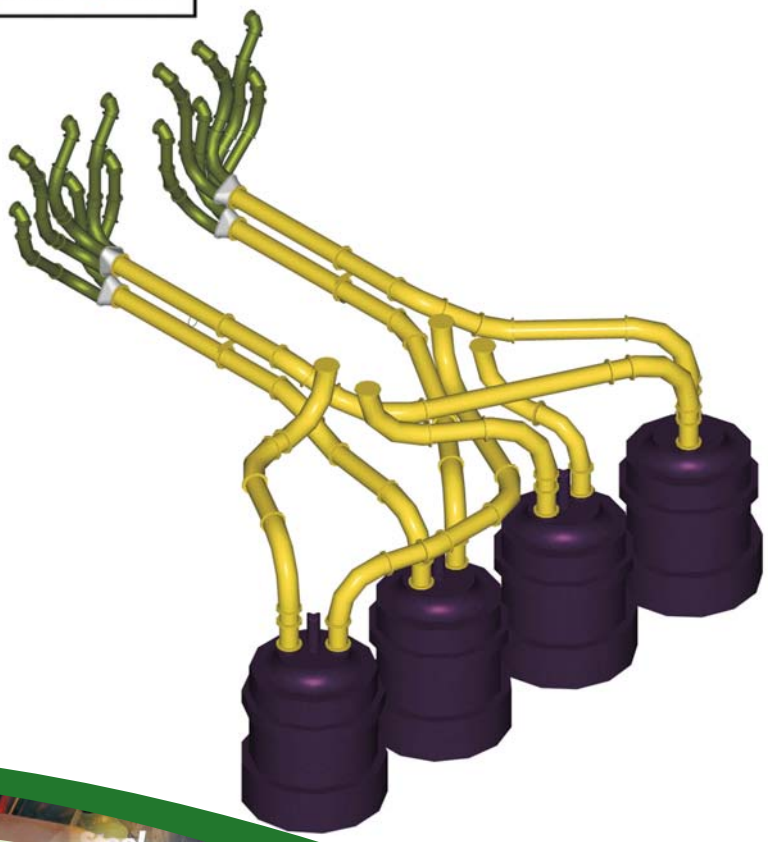
H-VARB®



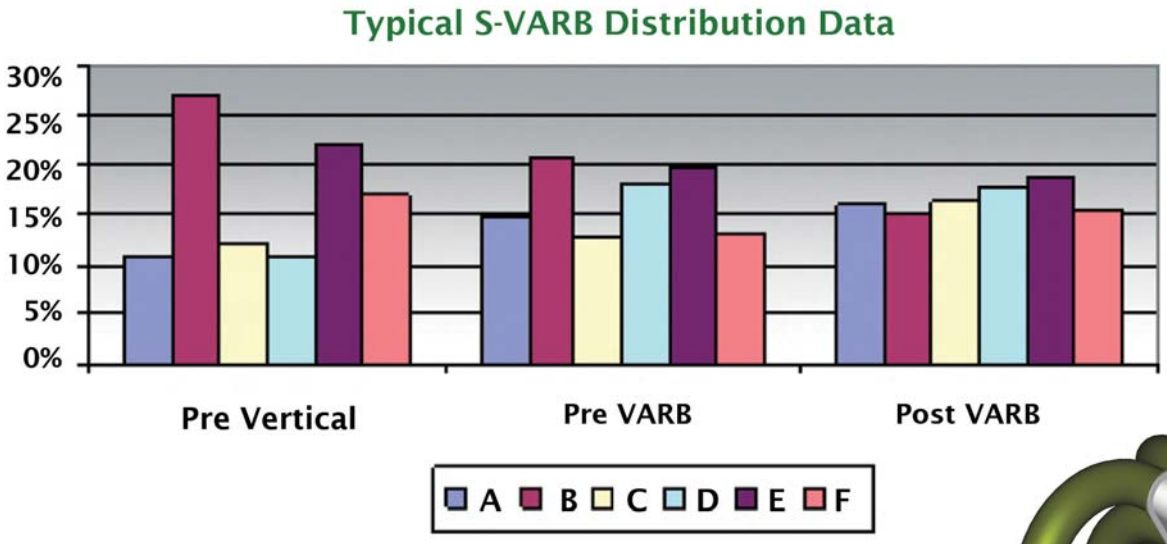
The H-VARB is the latest Generation in the VARB family. It was developed to balance the air/fuel ratio equally at bifurcations, trifurcations & multi-outlet splitters.

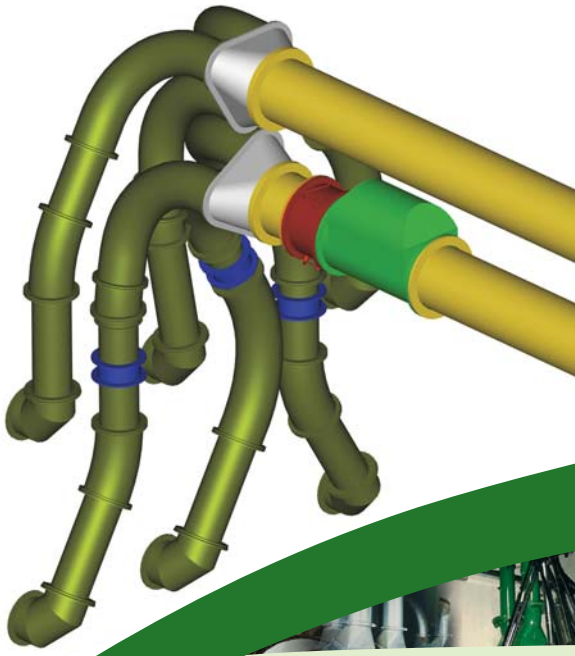
In conjunction with the Control-Gate the performance of the H-VARB is repeatable to within +/-3% of the mean distribution under different fuel /air loadings.

Since its development it has been proven to work equally well in the vertical mode.



S-VARB®

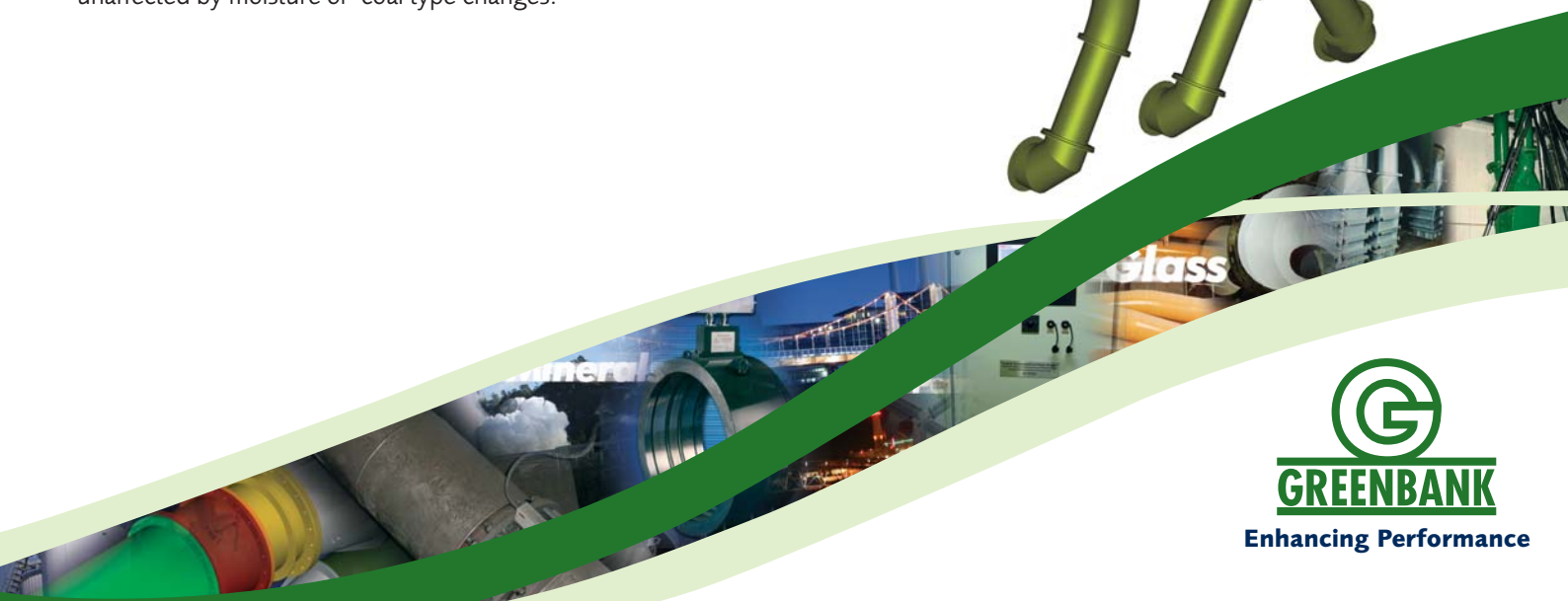




The S-VARB was the original VARB design developed to break the PF rope and produce a homogenised mixture of PF and air at the outlet in the vertical mode.

Utilising gravity it works by reducing the velocity and inducing spin such the PF particles become thoroughly mixed in the transport air before the pipe exit.

Again, the S-VARB operates under differing air/fuel ratios and is unaffected by moisture or coal type changes.



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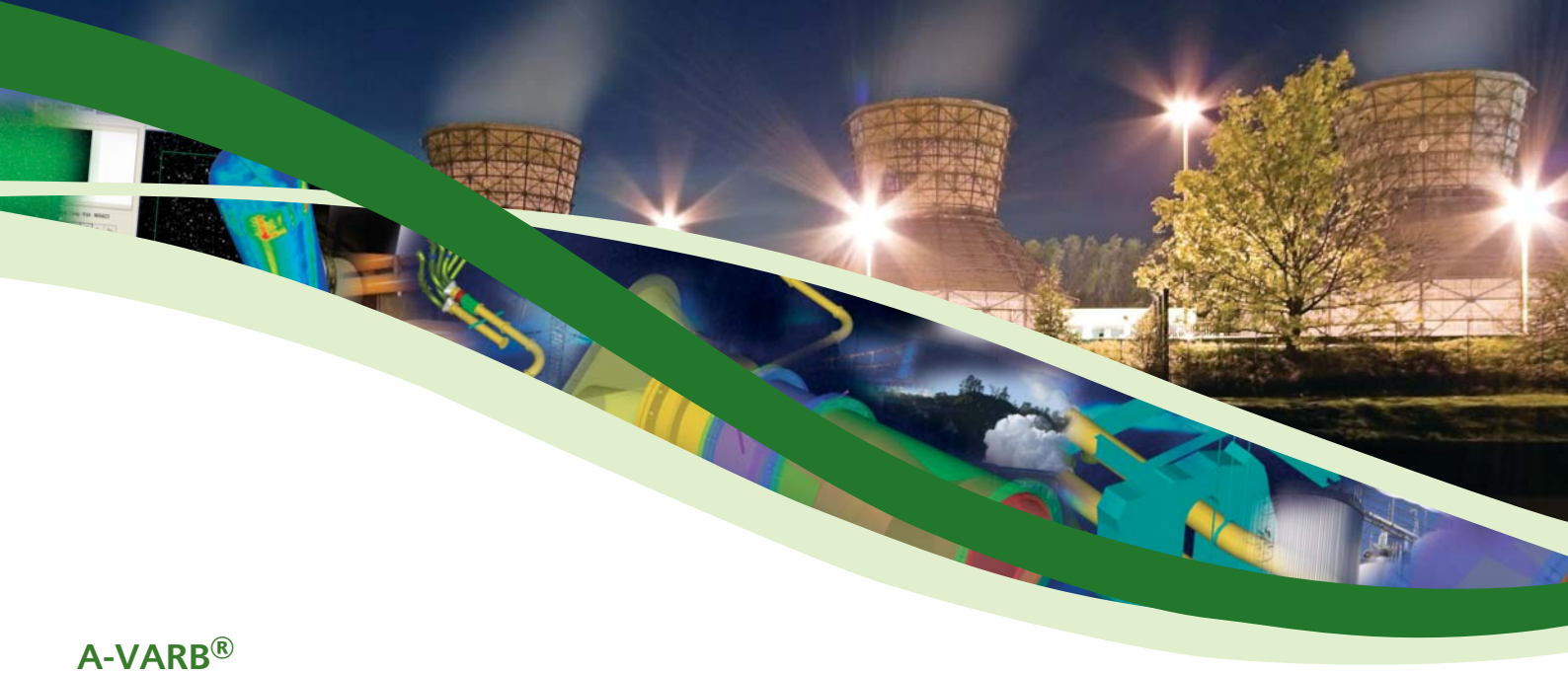
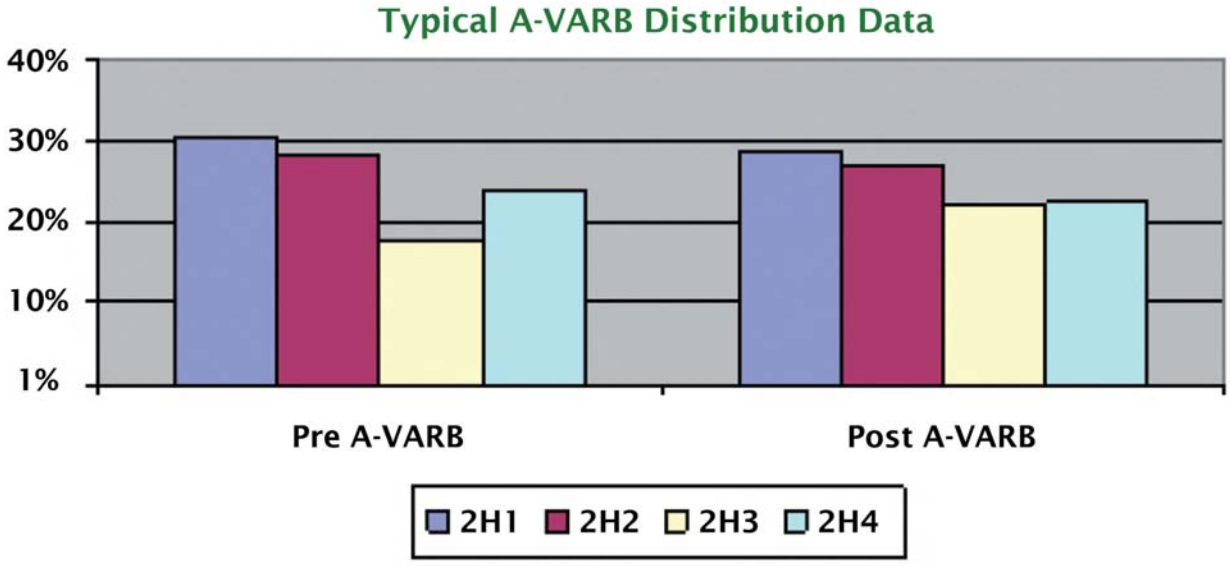
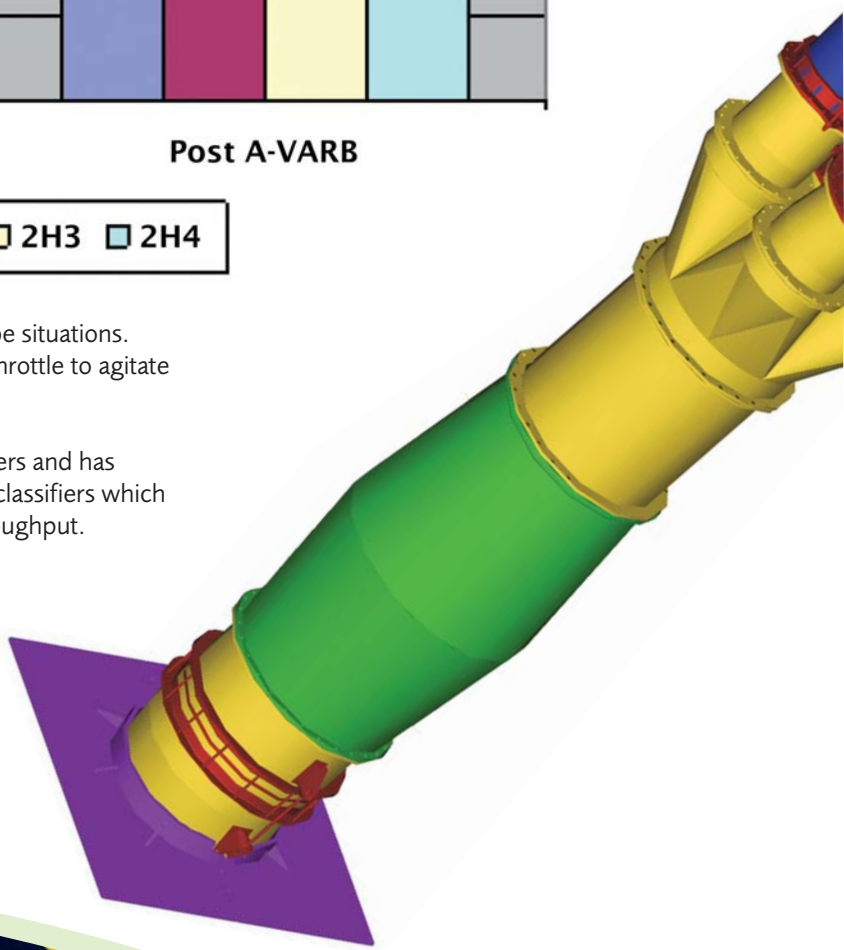


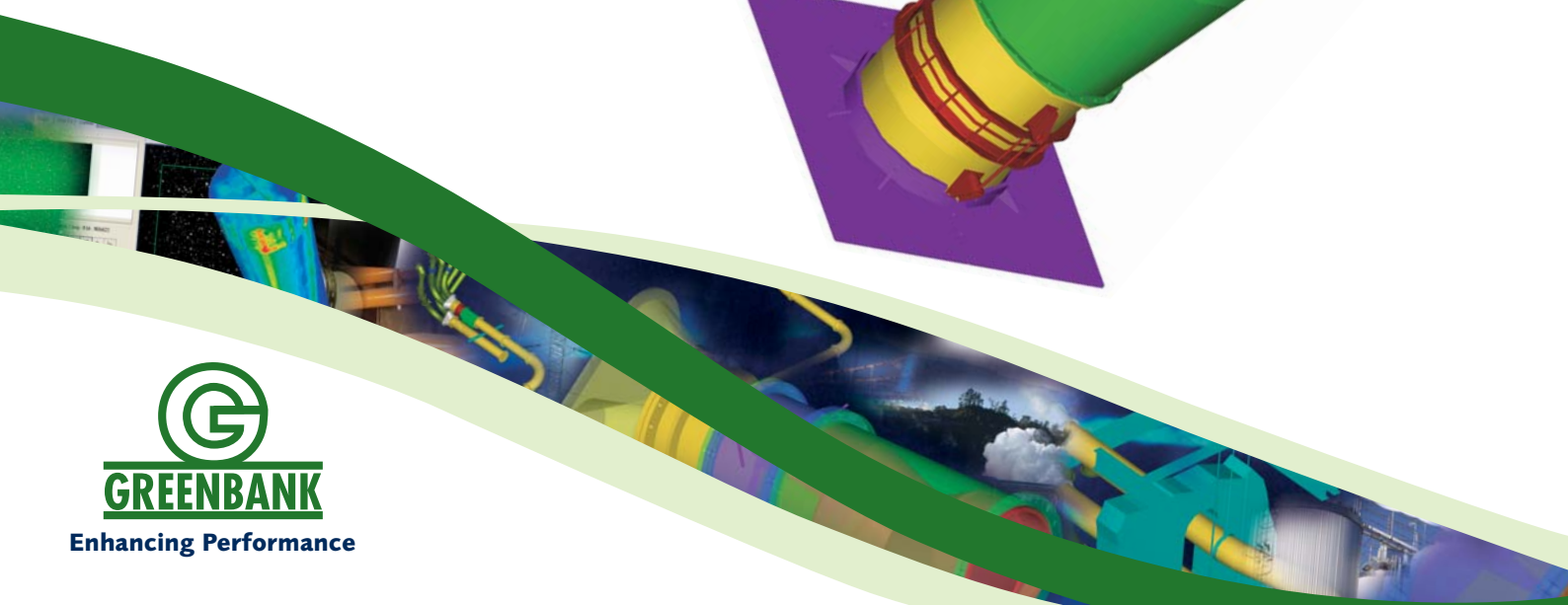
A-VARB®



The A-VARB is designed to combat particularly aggressive rope situations. Working in the same manner as the S-VARB it incorporates a throttle to agitate the rope before it is destroyed.

The A-VARB has operated successfully in front of 4-way splitters and has improved PF distribution compared with multi-outlet dynamic classifiers which were replaced with a HP static classifiers to gain increased throughput.





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Enhancing Performance

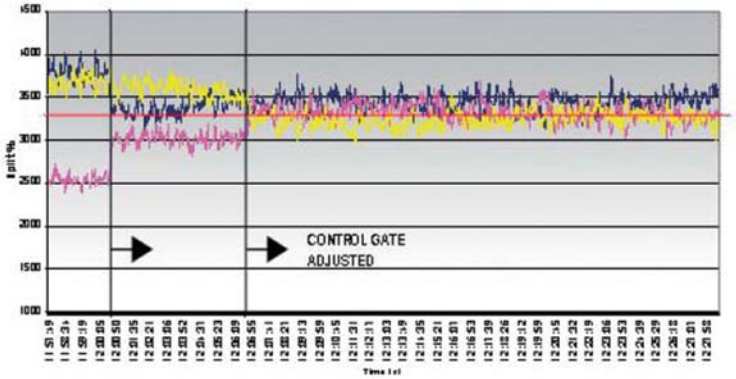
"Optimising performance"

VARB PF Coal Flow Balancing Measurement & Control

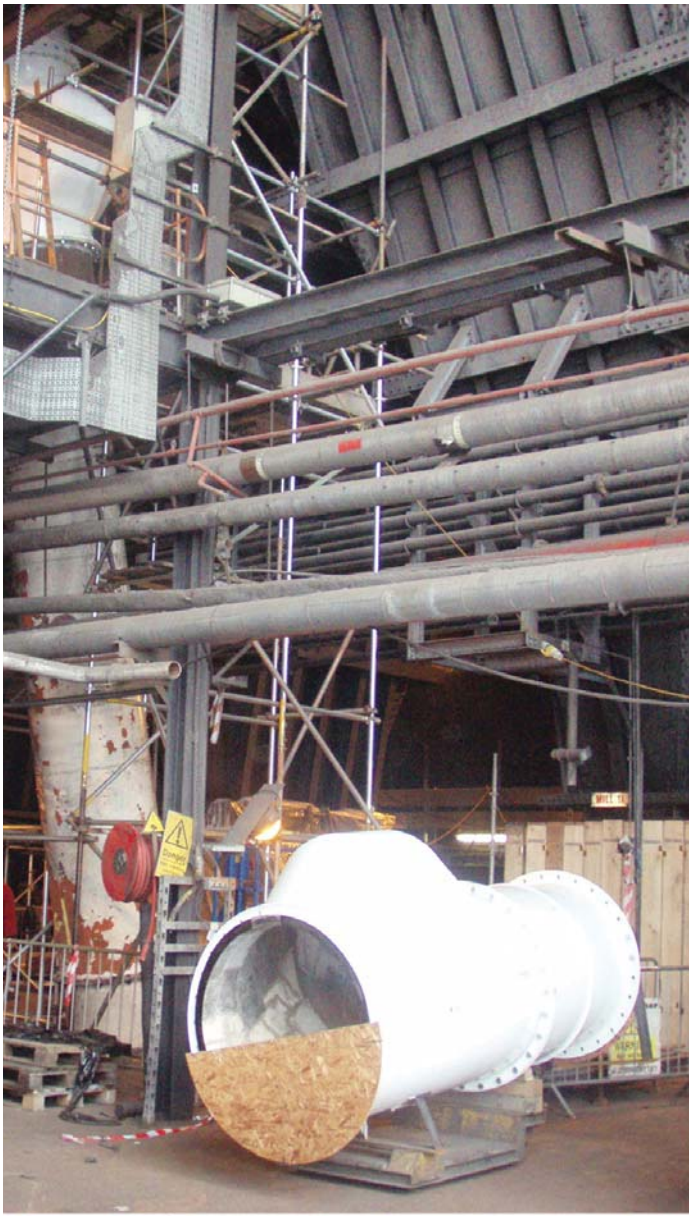
The benefits of improving poor PF distribution can be seen with a direct reduction of carbon-in-ash. Typically, poor distribution can have an exponential effect on the carbon-in-ash at individual burners. Equalising the distribution of coal to the burners lowers the carbon levels without having to make further changes to boiler controls. This can also allow the boiler operators to optimise for NOx having had their carbon levels minimised.

Having Control-Gates® fitted enables the optimisation of our VARB® technology and, in turn, the PF distribution to the boiler. The optimised position of each Control-Gate® can quickly and easily be found using a rapid on-line measurement technique such as the PfMaster® Coal Flow Monitoring System. The Control Gates are positioned directly after the VARB® and are designed to fine tune the distribution down each leg. The Control Gate is a damper which is mounted to the VARB outlet which can be utilised to trim the diffused PF into or out of the downstream pipework legs. It is cleverly designed to increase or decrease the flow of PF into any of the outlet legs without affecting the airflow or air pressure down each pipe leg.

It can be seen from the on-line data provided (below) by the PfMaster, the control-gates can be trimmed to provide optimum distribution at a splitter pipe.



Each of the three lines shows the % of the fuel mass conveyed by each leg of the trifurcator (3-way splitter) and the graph demonstrates the perfect split achieved with the H-VARB/Control Gate® combination.



VARB installation

Greenbank Boiler Enhancement Products & Technologies

G-CAM
Carbon in Ash monitor

StackMaster Laser
Stack Monitor for
mg/m³ & Particle
Size Analysis

Coal Plant Materials Handling
& Biomass plant

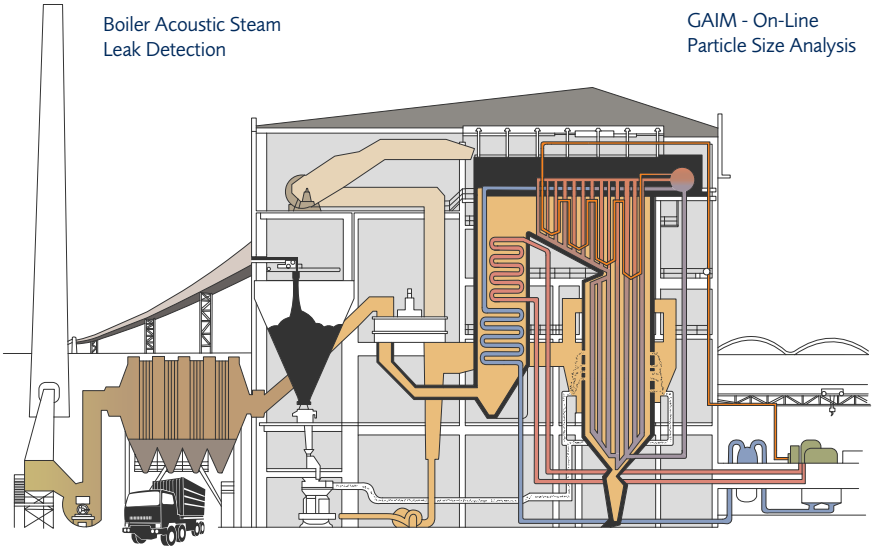
Fly Ash Pipework
& Valves

Dense Phase
Handling System

HP Classifier
Upgrades

Gravimetric Feeder and
Bunker Gate Valves

Boiler Acoustic Steam
Leak Detection



GAIM - On-Line
Particle Size Analysis

PfMaster - Monitoring Mass Flow
& Velocity of Pulverised Fuel

VARB PF Diffuser

PF Pipework
PF Non-Return Valves

PF Isolation & Control Valves
Riffles & Splitters

Furnace Bottom Ash
Pipework & Slurry Valves

VARB PF Coal Flow Balancing Measurement & Control

Higher Combustion Efficiency

Improved Burn

Reduced Carbon-in-Ash

Reduction of NOx

The Greenbank Group UK

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