Sellafield | Rabble Bar

Tessella
Technology & Consulting


Aerial view of Sellafield

"Tessella impressed us with their experience in modeling, data analysis and asset condition management, as well as their unique ability to apply scientific thinking to business challenges "

Dr Carl Steele
Technology Manager
Sellafield

Tessella's pioneering approach to asset condition management boosts waste processing efficiency at Sellafield

Innovative acoustic signature monitoring of critical high-level waste processing assets aims to eliminate costly in service failure, deliver increased asset value and extend asset life by up to 50%

Business Background and Challenge

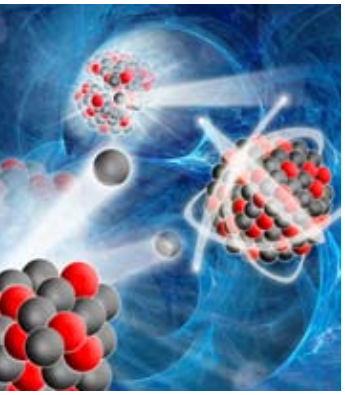
Employing 10,000 people, Sellafield Ltd. is responsible for decommissioning, reprocessing, nuclear waste management and fuel manufacturing activities at the Sellafield nuclear sites.

A critical activity undertaken by Sellafield is the Waste Vitrification Process which immobilises high-level liquid waste into a passive waste form suitable for long term storage. This process is overseen by the Nuclear Decommissioning Authority, and is heavily regulated by UK government and international rules.

Central to the Waste Vitrification Process is the production of calcine from highly active liquor. This involves feeding the liquor into a rotating tube furnace that boils off the liquid leaving the solid waste as powder. Inside each tube furnace is a loose bar (known as a rabble bar), affixed at one end, which rolls around to keep the calcine free-flowing, prevent the build-up of wall deposits and break up larger particles so they are small enough to drop through a filter at the bottom.

Dr Carl Steele, Technology Manager for the High Level Waste Plants at Sellafield, explains further, "The rabble bar is a highly stressed and vulnerable component in the process, so we were keen to find ways to maximize its operational life. Because the isolated and hostile nature of the processing environment any in service failure, due to a broken bar, is very costly and undesirable. It could mean a down-time of three or four weeks, which would literally equate to millions of pounds in lost production and replacement costs."

Dr. Steele continues, "Inspecting or replacing the bar early is a safer option, but, again, this requires a costly shut down of the line. So we started to look for ways to safely extend the life of the bar right up to the life of the calciner seal itself, which would avoid the need for intermediate maintenance or additional repairs as a result of an undetected failure."



Dr. Steele and his team decided that monitoring the condition of the bar in order to maximise its operating life would be the best approach. Instrumentation of the bar is difficult because of the hostile environment, so the team started by using accelerometers. Dr. Steele continues, “We were unable to efficiently analyse the volume of data produced, and so decided to invest in outside expertise. Tessella impressed us with their experience in modeling, data analysis and asset condition management, as well as their unique ability to apply scientific thinking to business challenges.”

The Solution

Tessella’s initial analysis of the accelerometer data prompted a simpler solution, which drew on their experience in the world of science. Why not gauge the condition of the bar from its acoustic signature by capturing audible sound using regular microphones placed outside the rotating tube?

A feasibility study was commissioned which proved that analysis of the acoustic signature was a viable route. This study involved mathematically modelling the calciner and using known acoustic properties of the alloys and the specific geometries of the components. Likely spectra were deduced and matched to spectra from an existing audio recording.

Using an existing full scale experimental vitrification test rig, Tessella developed a program of works to capture high-quality audio for the bar in different states – working, bent, fractured and broken. This data enabled Tessella to analyse the spectral data to predict when the bar is near to failure and so prompt preventative maintenance (if required) or ideally to extend the life of the bar up to the life of the calciner seal itself.

During the process, Tessella were also able to identify the potential failure of other moving components such as the furnace tube’s bearings.

With the technique proven in a test environment the next stage is to install the monitoring equipment and data analysis software in a live environment. Tessella will also work on automating and simplifying the monitoring process to provide a dashboard interface with alerts.

The Benefits

Dr. Steele adds, “I am extremely impressed by the professionalism and calibre of the Tessella team. They quickly grasped what we were trying to achieve, and their ability to apply lateral thinking and scientific expertise to our challenge provided a real breakthrough in the way we can now monitor and manage vulnerable assets in hostile environments.

“Using the asset monitoring system Tessella has developed, we hope to safely extend the life of the rabble bar right up to the life of the calciner seals – which would mean a 50% increase on our current expectation levels. If we can achieve this, then avoiding a very costly in service failure or even just an intermediate inspection and early replacement of the bar will more than cover the investment in the system – especially when it is operating across all three of our lines.

“Overall this pioneering approach to asset condition management may enable us to significantly boost the reliability and efficiency of the calciner process in our high-level waste processing plants. There may be opportunities to explore how this technique could be applied to other hostile operations across the Sellafield site.”

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