GTB®

CASE STUDY

DIDCOT 'A' POWER STATION – CLEAN DRAIN FLASH VESSEL SILENCERS

Didcot A Power Station is a dual-fuel (coal and gas fired) power station located in the civil parish of Sutton Courtenay, next to the town of Didcot in Oxfordshire (formerly in Berkshire). Construction commenced in 1964 in the face of local opposition from the village of Sutton Courtenay and the station commenced generating in September 1970. Didcot A has four generating units, each rated at 500MWe, giving the station a total generating capacity of 2000MWe.

From its commencement of operation, Didcot A had been a source of controversy in respect of environmental issues involving noise and pollution. In 1993 noise level measurements were carried out at Sutton Courtenay cricket ground in response to complaints from local residents. Early morning venting of the steam drains during the raising of steam at the plant produced sound readings in excess of 90dB. The problem was exacerbated by the fact that Didcot A was being used as a "peaking" station rather than for base-load generation, meaning that the same procedure of venting the steam drains also occurred during the late afternoon in advance of supplying the increased demand upon the grid during the early evening. "Double-shifting" in this manner exposed weaknesses in systems designed for intermittent operation. One such system comprised the steam drain vent silencers, and, in particular, the packing material within.

During their operation, steam vent silencers endure extreme conditions. The rapid passage of superheated "dry" steam at a temperature in excess of 500'C is preceded by a slug of "wet" steam into silencers which may be close to or below freezing point at their rooftop locations. With intermittent operation being the considered norm for steam vent silencers, commercial constraint may result in the absorptive packing material being specified on the basis of cost rather than durability. The double-shifting operation at Didcot A was fundamental in hastening the loss of absorptive packing, resulting in the high far field noise levels measured during the raising of steam.

When the problem came to the attention of the Company, it became apparent that the steam drain vent silencers had been previously re-packed with rock wool material during planned annual outages. However, as the outages were rotational across the four generating units, the rate of deterioration meant that the steam-raising procedure would always produce excessive noise due to two or three of the four silencers being depleted of packing material at any one time. It was evident that a different infill material would be required if each silencer was to remain effective over the intervening period between scheduled outages.

It was proposed that each silencer be re-packed with A-glass RGS, to the following specification: -

A-GLASS ACOUSTIC PACKING FIBRE - 4003RGS

DESCRIPTION

A high diameter continuous monofilament glass fibre with high chemical resistance and high physical durability. The material has excellent acoustic properties at low/mid frequencies, is stable in arduous environments and does not accelerate corrosion of metallic components.

CHEMICAL COMPOSITION

Silicon oxide	*SiO_2*	*72.5%*
Aluminium oxide	*Al_2O_3*	*1.4%*
Iron oxide	*Fe_2O_3*	*0.1%*
Calcium oxide	*CaO*	*9.2%*
Magnesium oxide	*MgO*	*3.2%*
Sodium oxide	*Na_2O*	*13.2%*
Potassium oxide	*K_2O*	*0.4%*

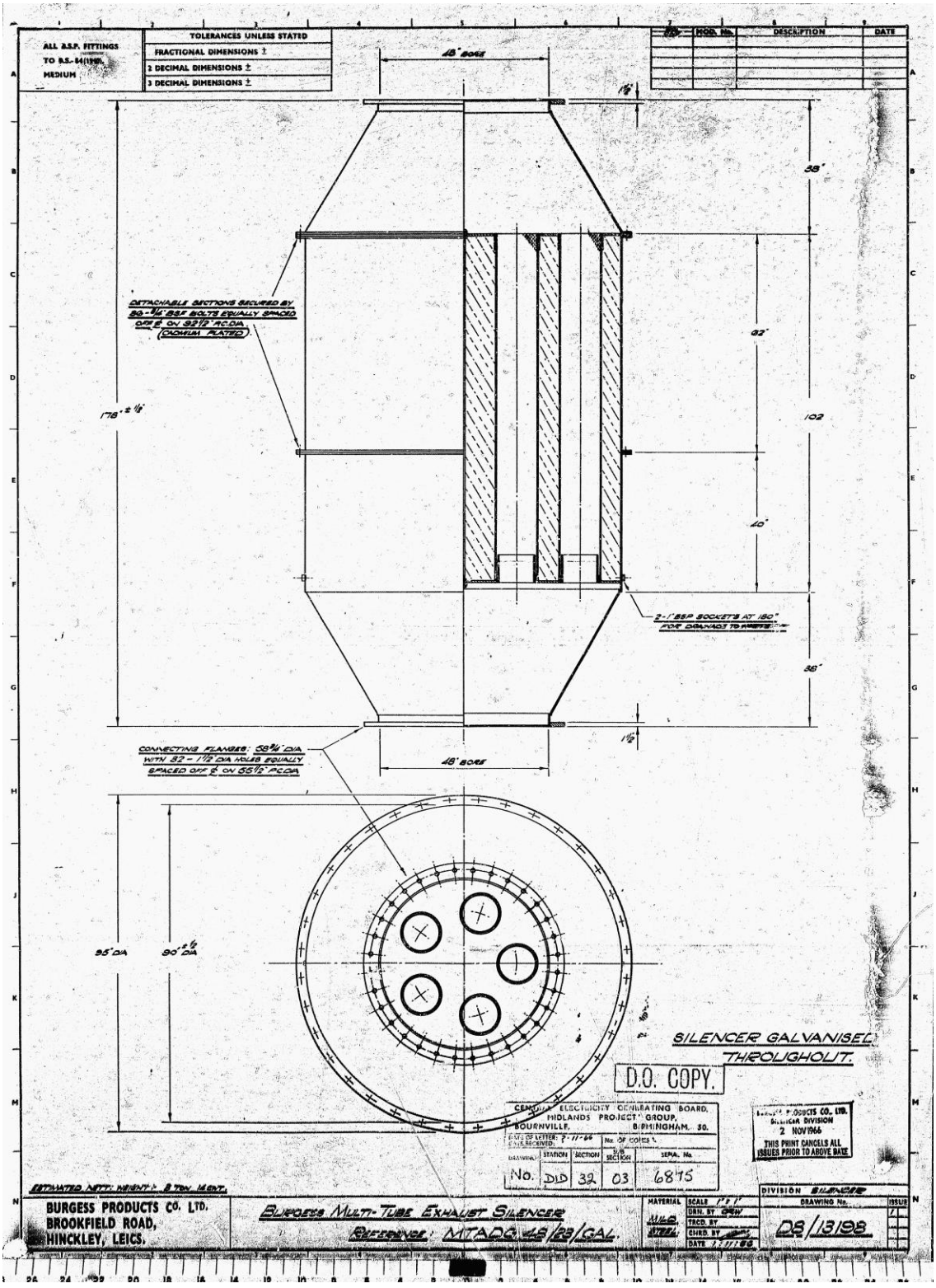
PHYSICAL CHARACTERISTICS

Filament Diameter:	*22-30 micron*
Filament Length:	*Produced as continuous monofilament*
Maximum Working Temperature:	*575ºC.*

The silencers are of the multiple vertical tube design, with the space between the tubes being packed with the absorptive material, at a recommended density of 130kg/m3. At this density, the airflow resistivity through the packing was calculated at circa 10,500mks Rayls/m, a value which would produce effective noise attenuation in the low and mid frequency bands for this design of silencer.

Subsequent to being re-packed with the 4003RGS material, far-field noise measurements remained within acceptable limits and this material remained the specified packing material until 2002.

The construction and internal arrangement for each of the Clean Drain Flash Vessel Silencers is shown overleaf.



In 2002 an analysis of routine water condensate samples taken from the clean steam drain indicated slightly raised silicate concentrations. It was deduced that the source of the silicate was erosion of the pitted surface of the A-glass packing within the silencers, the result of repeated scouring of the glass fibre twice daily by superheated steam.

Further to the above, a recommendation was made to the effect that the A-glass packing fibre should be replaced with fibrous stainless steel material, to the following specification: -

4010SGF 434 FIBROUS STAINLESS STEEL

DESCRIPTION

A long-strand, fibrous stainless steel to AISI 434 specification supplied in coil format at width 100mm (4"). This material is capable of withstanding severe thermal shock and vibration. It is resistant to corrosion with good thermal-soak and acoustic characteristics. Suitable for use in many types of very hot silencing applications including gas turbine exhausts with high gas flow-rates (where the material can be used to advantage to retain other unbonded fibrous materials) and in high velocity compressor bleed-air and steam vent silencing applications.

CHEMICAL COMPOSITION

Carbon	*C*	*0.07%max*
Silicon	*Si*	*1.00%max*
Manganese	*Mn*	*1.00%max*
Sulphur	*S*	*0.045%max*
Phosphorous	*P*	*0.045%max*
Chromium	*Cr*	*16-18%*
Nickel	*Ni*	*0.4%max*
Molybdenum	*Mo*	*0.9-1.2%*
Iron	*Fe*	*Residual*

PHYSICAL CHARACTERISTICS

Typical Filament Diameter Distribution:

Diameter	*<35um*	*35-65um*	*>65um*
Contribution	*10%*	*80%*	*10%*

Mean Filament Length: *150mm*

Installed Airflow Resistivity (ambient)

At 130kg/m3 (8.1pcf)	*600mks rayls/m*
At 185kg/m3 (11.5pcf)	*1400mks rayls/m*

Thermal and Volumetric Stability:

Results of Static Test (50kg/m2 (10psf) applied load):

Packing Density	*130kg/m3 (8.1pcf)*	*140kg/m3 (8.75pcf)*	*160kg/m (10pcf)*	*180kg/m3 (11.5pcf)*
U Stability Temp.	*750'C (1380'F)*	*775'C (1425'F)*	*775'C (1425'F)*	*775'C (1425'F)*

Uncompressed Density	*100kg/m3 (6.25pcf)*
Uncompressed Thickness	*8mm (0.3")*
Packing Density Range	*120kg/m3 - 200kg/m3*
Max. Working Temperature	*775'C (1425'F)*
Commencement of sintering	*800'C (1470'F)*

Note on Thermal/Acoustic Performance:
In certain silencing applications, the robustness of the material and its low flow resistivity properties can be used to advantage. For example, in the case of compressor bleed air silencing, the material can be packed at high density into an appropriately designed silencing element and the gas expanded from the issuing orifice through the fibrous metal matrix without incurring significant back pressure from the silencing element itself.

By the end of 2006, all four Clean Drain Flash Vessel Silencers had been packed with the stainless steel fibre. The service life of the infill is expected to double that of the A-glass packing. Bearing in mind that the A-glass outlasted its rock wool predecessor by a factor of 4, the benefit of matching the material to the application is clearly illustrated.

Footnotes: -

(i) Didcot A, having opted out of the Large Combustion Plants Directive, is currently scheduled for closure by end December 2015. However, the possibility of modernisation to enable super-clean combustion could result in a reprieve for the power station.

(ii) The success of the 4010SGF fibrous stainless steel material as a steam drain silencer packing option at Didcot A led to the same material being supplied to Littlebrook D Power Station in Kent in 2008. Littlebrook D has also opted out of LCPD and is currently scheduled to close by end December 2015. As with Didcot A, the option for modernisation and a consequential reprieve remains open.