GTB®

CASE STUDY

USAF REFURBISHMENT PROGRAMME FOR T9 / T10 TEST FACILITIES

The T9 /T10 refurbishment programme presented the Company with the opportunity to provide Exhaust System Attenuation Kits (ESAK's) to the United States Air Force.

Working in partnership with metalwork fabricators Vital Link Incorporated, initial discussions took place in summer 2001. In early 2002, the design proposal for a high performance, high durability infill system was accepted by USAF procurement for installation into both a T9 and a T10 facility at the Spangdahlem AFB in Germany. The T9 facility is an engine test cell, whilst the T10 is a hush house, thus enabling installed engine testing to be carried out. The two types share a common augmenter tube but differ in the design of the exit stage.

Following completion of refurbishment, a sound measurement survey was carried out on each of the two facilities in order to establish achieved performance levels.

T9 Re-commissioning

The lead T9 facility was surveyed and re-commissioned on 30 October 2002, when this photograph was taken. Points to note include:

1) The elevated ground level applicable to the arc of measurement around the exhaust exit section, so the noise readings were effectively taken at the same level as the exhaust outlet.
2) The low cloud at the time of measurement, which acted as a noise reflector.

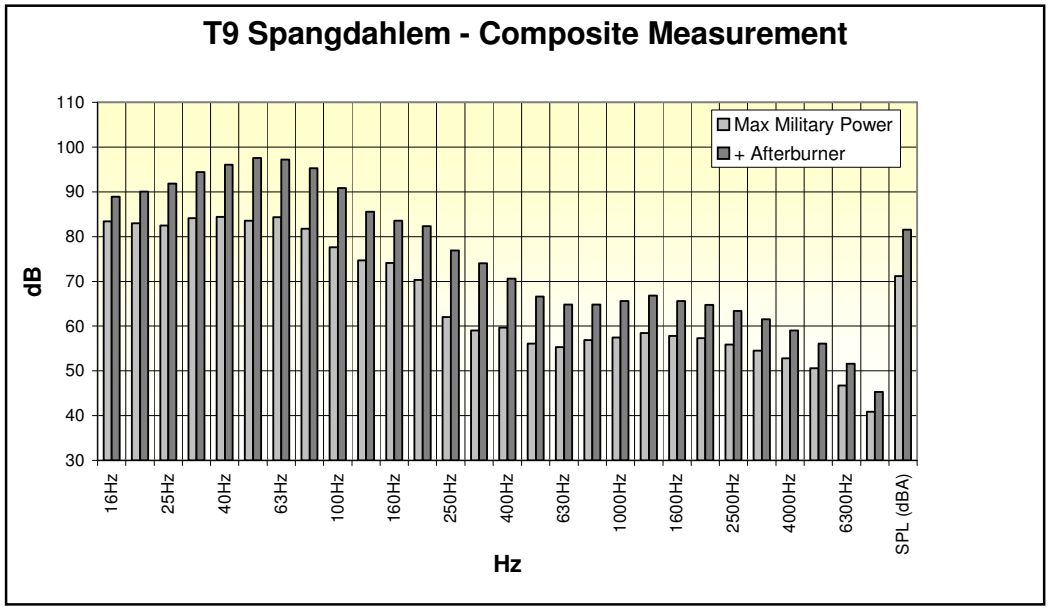
The noise signature was recorded with a GE F200 series engine on the test stand. Without quoting precise thrust figures, it should be noted that these engines, as tested, develop significantly more power (and inevitably more noise) than the P&W F100 series engines used originally in T9 test cells.

Using a B&K Investigator sound analyser, acoustic measurements were taken at 100m distance within a 180deg arc, centred at the rear of the exhaust exit section and extending equally to each side. Eight measurement sets were recorded, comprising the sound pressure level values (SPL dBA) and 1/3rd centre octave frequency spectra over the range 16Hz - 8000Hz, firstly with the

engine running at military power (maximum “dry” rating) and subsequently in afterburning configuration. The respective data sets were averaged to obtain the following composite measurement data: -

Climatic conditions: Ambient temperature: 9’C. Wind 5 Knots. Cloud-cover: 8/8 (low cloud).

Recorded SPL (GE F200 max military power): 71.2dBA Original SPL (P&W F100): 73.4dBA
Recorded SPL (GE F200 + afterburner): 81.6dBA Original SPL (P&W F100): 83.2dBA



This T9 facility at Spangdahlem represented the first installation to be refurbished using the 700-05 Combination infill system.

T10 Re-commissioning

The lead T10 facility was surveyed and re-commissioned on 30 October 2002, when this photograph was taken. Points to note include:

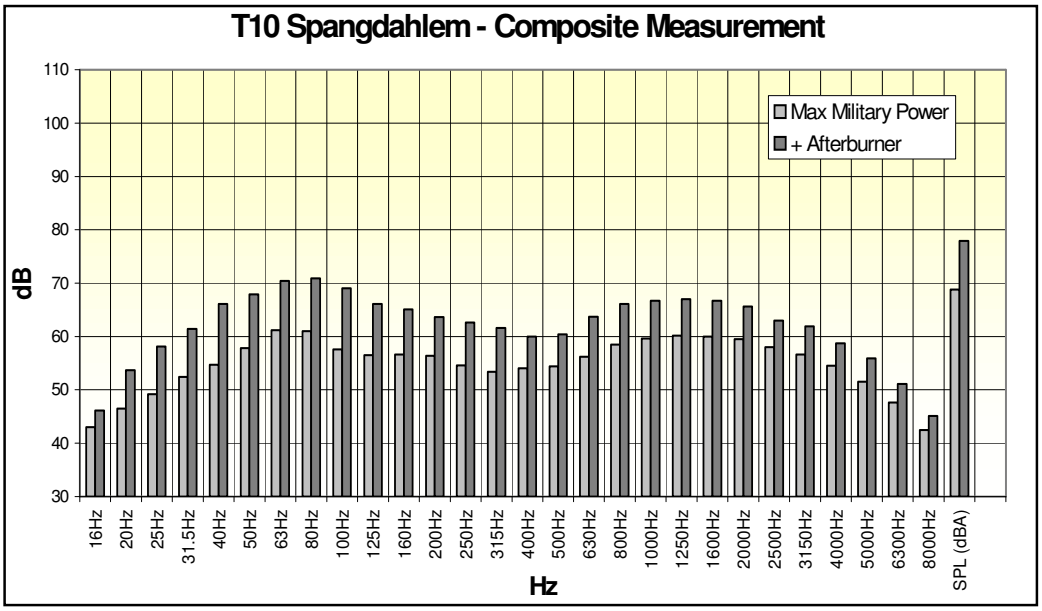
1) The level ground surrounding the site was in contrast to the location of the T9 test cell previously surveyed.
2) The clear sky meant no reflective properties.

Using a B&K Investigator sound analyser, multiple acoustic measurements were taken at circa 100m distance within a 180deg arc, centred at the rear of the exhaust exit section and extending equally to each side. Each measurement set comprised the sound pressure level value (SPL dBA) and the 1/3rd centre octave frequency spectrum over the range 16Hz - 8000Hz, with separate data sets being recorded for military power (maximum "dry" rating) and afterburning configuration (+ afterburner). The respective data sets were subsequently averaged to obtain the following composite measurement results:

It should be noted that the noise signature was recorded with a GE F200 series engine on the test stand. It should be noted that current series GE engines develop significantly more power (and inevitably more noise) than the P&W F100 series engines that were originally operated in T10 hush houses.

Climatic conditions: Ambient temp: Minus 7'C. Wind: 1 Knot. Cloud-cover: 0.

Recorded SPL (GE F200 max military power): 68.8dBa Original (P&W F100) SPL: 71.4dBA
Recorded SPL (GE F200 + afterburner): 77.9dBA Original (P&W F100) SPL: 80.2dBA



ASSESSMENT OT THE DATA

Assessment of the Noise Measurement Data showed that the refurbished test facilities exhibited improved noise attenuation when compared with the original SPL values obtained when the installations were first commissioned. This was especially significant as the P&W F100 engines originally used in the F16 aircraft developed produced significantly less noise than the current GE F200 engines.

The noise signatures for the T9 and T10 installations were practically identical in the mid to high frequency range (630–8000Hz). However, the noise signature obtained from the T10 hush house indicated a significant reduction in low frequency noise emissions (16–400Hz) when compared with the data obtained from the adjacent T9 test cell. The reasons for this can be attributed to the following:

a) The similarity in the noise signatures for the T9 and T10 facilities in the mid/high frequency range provided an indication of consistency of performance from the respective refurbished exhaust systems.

b) The operational location of the T10 test stand gains significant advantage from effective acoustic absorption characteristics within the larger hush house environment. This contrasts with the constrained test cell environment within the T9 facility, where reflected noise and adverse secondary air intake geometry are negative factors.

c) The T10 noise signature data was collected in clear air with zero cloud-cover reflection, whilst the T9 data was subjected to low level cloud reflection.

The T9 and T10 facilities at Spangdahlem represented the “first of type” to be refurbished using the 700-05 Combination ESAK. The respective noise measurement surveys confirmed that the upgrading of the exhaust gas path to a high standard enabled significant reduction in recorded sound pressure levels (SPL), both at maximum military power and with the afterburner.

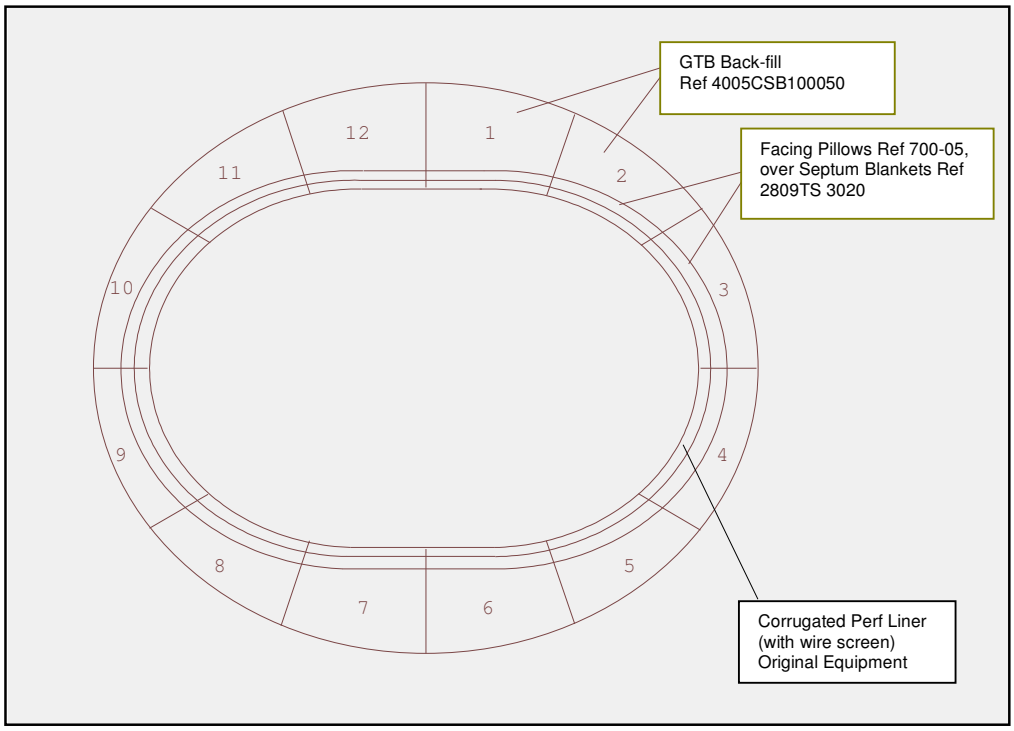
APPROVAL BY THE USAF

Following the signing-off and acceptance of the re-commissioned T9 and T10 test facilities at Spangdahlem, the 700-05 Combination infill system was specified by USAF to be used in the on-going T9 / T10 refurbishment programme.

In the period 2003 – 2009, T9 and T10 installations have been refurbished by VLI at an average rate of 10-12 per year, with the 700-05 Combination ESAK being supplied by the Company into all these installations. Recent inspections of the earlier refurbishments have indicated no significant increase in noise emissions and no need for remedial action or repair after circa 8 years of operation.

APPENDIX

THE 700-05 COMBINATION ESAK (KIT) SYSTEM



The augmenter tube comprises an ob-round construction, being internally oval and externally cylindrical, thus creating cavities of non-uniform depths (see section above).

ESAK 700-05 components are as follows: -

GTB® Basalt Blanket 4005CSB10050 – Fan-folded into the back of the cavities as back-fill, with the number of layers being calculated according to the volume of each cavity.

Woven E- Glass Fabric 2809TS Septum Blanket – Laid over the basalt blanket and turned in around the edges of the cavities, forming an effective seal against fibre migration from the basalt blanket beneath.

Type 700-05 Facing Pillows – Packed into each cavity, over the septum blanket, and capable of sustaining very high service temperatures and gas velocities. The tailored pillow modules become positively located behind the corrugated perforated liner and wire mesh screen.