BRITISH ACOUSTICAL SOCIETY.

SPRING MEETING - 5th/7th April,1972.

University of Loughborough.

- - - - - - - - - - - - - - - - - - -

THE SILENCING MEASURES UNDERTAKEN AT LONDON TRANSPORT EXECUTIVE GREENWICH POWER STATION ON GAS TURBINE GENERATING PLANT -

BY J.S.HICKMAN AND D.F.PERCY
INDUSTRIAL ACOUSTICS CO. LTD.

1. Introduction

In 1957 the London Transport Executive carried out a re-appraisal of the future power demand for Greenwich Power Station. It was concluded that modifications to the Station should be carried out and following a feasability study it was decided to replace the existing coal fired steam turbine generating plant with gas turbine generators.

The main requirement for Greenwich Power Station is to supplement the output of the other L.T.E. Plant, Lots Road Power Station. The gas turbine plant being ideal for this type of service in that full power may be reached within two minutes from pressing the "Start Button". In this instance the button may be pressed at either Lots Road or Greenwich power station.

The scheme finally selected was a Stal-Laval installation of eight single engined gas turbine alternators, each powered by Rolls Royce Avon engines with the capability of generating up to 8 x 15 MW at an ambient temperature of 15°C.

The scheme created one major problem from the point of noise generation in that the power station is flanked on three sides by a concentrated residential area extending virtually to the boundary of the plant.

The main contract for the supply of the generator equipment, as stated above, was awarded to Stal-Laval while Industrial Acoustics Company Limited were employed as sub-contractors to accept full responsibility for noise control on the project.

Two acoustic design parameters were laid down by the L.T.E., which were:

1. A maximum noise level of NEMA 'E' should not be exceeded at a distance of 400 ft. from the power turbine hall when all eight generating sets were running.
2. Inside the main turbine hall a level of ISO NR.85

should not be exceeded when measured at a distance of 10 ft. from the outline of any unit with eight generators operating at full load.

Shown in Figure 1 is the basic layout concept for the four pairs of gas turbine generators.

In order to discuss the silencing system used by Industrial Acoustics Company Ltd., at Greenwich Power Station we shall breakdown the installation into three major components, i.e.:-

1) intake silencer system,

2) gas generator enclosure,

and 3) exhaust silencer system.

As in the case with all gas turbine installations it is essential that all air handling system pressure losses are minimised in order to achieve the required unit efficiency. The requirement specified for the intake silencer being 1.0 in. water gauge and 1.0 in. water gauge for the exhaust silencer.

Having acoustically analysed the basic installation with all eight sets in operation, thus combining the total effects of all the intake and exhaust noise contributions, the silencers were sized to meet the total system silenced noise criteria.

2. Intake Silencer System

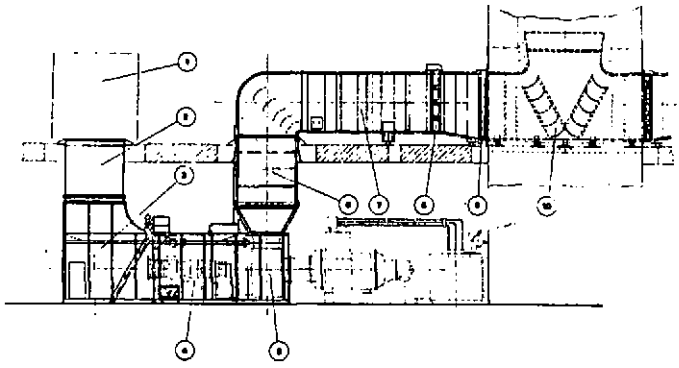
The intake silencer designed for this application was to handle a mass flow of 180 lb/sec. and had a cross-section of 12 ft. x 10 ft. and an overall length of 10 ft. The standard IAC acoustic splitter configuration consisted of 12 full and 2 half-parallel splitter panels nominally 9 in. thick and seperated by an 3 in. wide airway.

In order to minimise the pressure loss through the silencer each splitter was fitted with bull-nose leading edges and evase tails.

This splitter arrangement giving a 25% free area relationship, achieved less than the maximum permissable pressure drop characteristic.

The acoustic performance characteristics of the intake silencer, based on IAC laboratory tests and proven in service was as follows:-

Mid-Octave Frequency	63	125	250	500	1K	2K	4K	8K Hz
Dynamic Insertion Loss, dB	18	29	46	56	57	56	55	46



Longitudinal section through one gas turbine generator set showing ducting and enclosures: 1. intake air filter, 2. intake silencer, 3. intake plenum, 4. gas generator enclosure, 5. power turbine enclosure, 6. exhaust silencer, 7. exhaust ductwork, 8. high-temperature dampers, 9. expansion bellows, 10. stainless steel turning vane assembly.

The fully welded construction of the intake silencer consisted of a mild steel casing with perforated galvanised mild steel splitter noise control surfaces. The void between the splitter and perforated surfaces being packed with inert, rot proof, vermin proof, non-inflammable and non-hygroscopic mineral wool packed to a density of 3 lb/cu. ft. and wrapped in open weave cotton cloth to avoid erosion of infill into the airflow.

In order to minimise airflow distortion between the vertically mounted intake silencer and the horizontally mounted gas generator intake flare the intake plenum was equipped with a corner radius thereby easing the airflow passage.

To prevent acoustic flanking (or breakout) of unsilenced compressor noise in the intake plenum area, prior to the silencer, the plenum walls were constructed from standard IAC 4 in. thick Noishield panels of modular design. These panels are of a sandwich construction having a solid outer face and a perforated inner face separated by mineral wool, rendering the inner walls of the plenum to a semi-anechoic condition.

3. Gas Generator Enclosure

The gas generator enclosures, each 39 ft. long x 12 ft. 8 in. wide x 12 ft. 2 in. high, were also constructed from standard 4 in. thick IAC Noishield panels. The transmission loss of such a modular enclosure adequately achieved the silenced noise criteria within the main turbine halls.

Each enclosure was equipped with a silenced forced draft ventilation system designed so that no thermal trip-out could occur during the warmest ambient conditions. Additionally each enclosure was fitted with standard 4 in. thick IAC Noishield doors, one for personnel access and one double-leaf door at the front

of the intake plenum. The latter doors were considered the most effective method of removal of the gas generators during major maintainance.

4. Exhaust Silencer System

The exhaust silencer designed for this application was to handle a mass flow of 180 lb/sec. at 450°C and had a cross-section of 15 ft. x 10 ft. and an overall length of 12 ft. The standard IAC acoustic splitter configuration consisted of 5 full and 2 half-parallel splitter panels each nominally 20 in. thick separated by a 10 in. wide airway.

Again in order to minimise the pressure loss through the silencer each splitter was fitted with bull-nose leading edges and evase tails..

This splitter configuration giving a 30% free area relationship achieved less than the maximum permissable pressure drop characteristic.

The acoustic performance characteristics of the exhaust silencer were as follows and it should be noted that due allowance was made to compensate for the frequency phase shift due to elevated temperature and self-generated noise characteristics:-

Mid-Octave Frequency	63	125	250	500	1K	2K	4K	8K Hz
Dynamic Insertion Loss, dB	15	23	30	34	37	35	26	21

When designing a gas turbine exhaust silencer it is essential to ensure that the design used can withstand the thermal and vibrational cycling which occurs during start up and shut down sequencies. In this application the exhaust gas temperature during operation was in the order of 450°C.

The exhaust silencer casing was constructed from high quality plate steel to BS 4360/43A. The splitters being manufactured from 10 SWG perforated high strength corrosion resistant steel noise control surfaces. The acoustic infill was packed to a density of 7 lb/cu.ft. and wrapped in fibreglass cloth for infill erosion protection.

The transition section between the power turbine exhaust volute and the exhaust silencer was also treated acoustically to prevent acoustic breakout. While the duct between the exhaust silencer and the masonry chimney was thermally lagged to limit the external duct temperature to 50°C. Within the ductwork it was considered aerodynamically necessary to install stainless steel dynamic cascades to all bends directly after the silencer into the chimney.

Since at the entry to the chimney two separate gas generator exhaust systems met it was decided to install electrically operated dampers to prevent "windmilling" of the shut down turbine when the second of the pair was in operation.

5. Conclusion

Six of the eight sets are now installed at Greenwich Power Station and all aerodynamic and acoustic characteristics have been achieved to London Transport Executive requirements.