Proceedings of the Institute of Acoustics

THE ESTABLISHMENT OF A DRIVE-BY NOISE STANDARD AT DONINGTON PARK MOTOR RACING CIRCUIT

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1. INTRODUCTION

This paper reviews development work that has been carried out at Donington Park Motor Racing Circuit over the period 1991 to January 1995 that led to the adoption by the local authority of a drive-by test as the noise control standard from April 1995.

As part of a Noise Abatement Notice served upon Two Four Sports in 1991, a Noise Standard for quiet day use was introduced. Quiet days are non-Race or non-practice days as defined in a report of a Public Inquiry in 1989(1). The Standard was a static close-proximity exhaust noise level test and is similar to the type of test widely used by motorsports authorities for checking the noise emissions of competitors' vehicles. The vehicle's engine is run at a steady speed of 5000 rpm and the L_{max} is measured at a distance of 0.5m from the end of the exhaust at an angle of 45^0 to the axis of the exhaust. The height of the noise meter is at the same height as the end of the exhaust pipe. The maximum limit of noise level for 'quiet use' was 100 dB(A).

Despite efforts to carefully control and implement the static test, there were a series of difficult incidents. Some vehicles, especially motorcycles, could pass the static test but would generate high noise emissions when on the track. This would then lead to complaints and on one occasion the circuit was threaten with legal action for breaching the Noise Abatement Notice. Equally difficult for the circuit operators were occasions when ordinary road-silenced cars, often rear engined sports cars, could not pass the static test. As it stood the static test was too unreliable for the Local Authority and unworkable for the circuit operators; all parties agreed that the situation need review and worked togather to produce an improve control standard.

As the static test was well established in motor sports, it was not put aside without careful examination but no simple reliable static test that could predict noise emission from track vehicles was found.(2) (3) (4). A sensible alternative was a drive-by test since the use of drive-by tests is universal for the regulation of type approval for road vehicle noise.

2. THE DEVELOPMENT OF A DRIVE-BY TEST

The test method used in the EC is based upon the full acceleration test specified in the International Standard ISO R362 (5). Briefly the test requires the vehicle to be driven along a specified distance at full acceleration from a constant speed in a low gear. The maximum noise level in dB(A) is taken at a distance of 7.5m either side of the test length. This test demands the use of an unobstructed flat area 50m in radius and test runs in both directions. Such a test regime would be difficult to accommodate at Donington Park, or most other racing circuits; there is no suitable test site and the time required would be excessive. What was required was a test that was simple, did not require complex calculation, was quick to administer and would effectively limit the noise reaching the surrounding villages. The last point should be the overall priority of any noise control standard.

A simple drive-by monitoring system has been in place at Thruxton Circuit for some time. This uses a monitoring point close to a designated point on the track. The noise from vehicles is taken as they pass the monitoring point. Any vehicle that is over the set limit is flagged in and not allowed back on the track until remedial work has been carried out to quieten the vehicle. This has proved to be simple to operate and provides direct control of actual noise emissions.

For such a system to be implemented at Donington Park, or any other circuit, several factors required examination

a. What is a suitable level for the drive-by test? This must be at a level that results in acceptable levels in the surrounding villages.

b. Where would be a suitable point on the circuit to site the monitoring point? This must also be related back to received levels in the villages.

c. Which noise index should be used?

d. What instrumentation would be required?

e. How will the monitoring system be managed to the benefit of both track users and local residents?

With these questions in mind a series of investigations were carried out over the 1993 and 1994 seasons. These investigations, described below, provided sufficient evidence to develop an alternative noise standard that has been accepted by the local council for the 1995 season.

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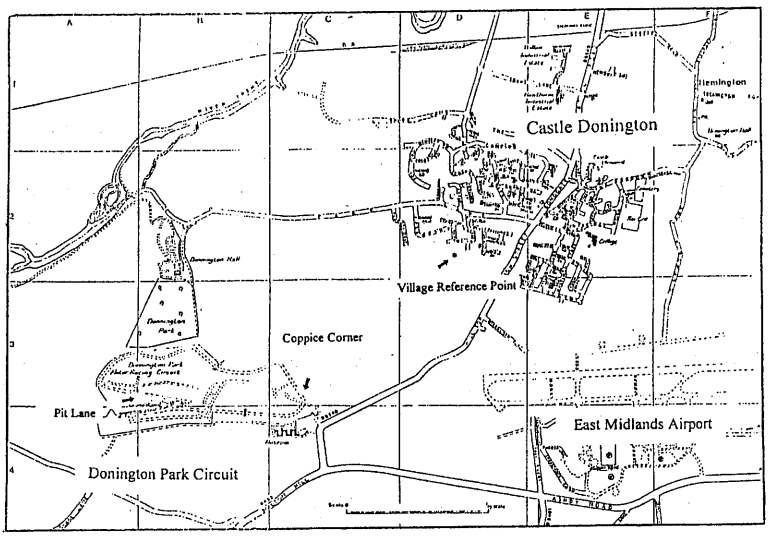

Figure 1 Location Map of Donington Park

2.1 Noise Levels in Castle Donington

As Castle Donington is the closest village to Donington Park, Fig 1 and it is downwind of the prevailing wind direction, it probably suffers the greatest noise exposure of all the surrounding villages. This is borne out by the greatest number of complaints coming from Castle Donington and was recognised in the Inspectors report of the Public Inquiry (1). For these reasons the noise impact upon Castle Donington was the subject of the work carried out, in the anticipation that any other village would be less affected by noise.

Within Castle Donington the majority of readings were taken at a site close to Shields Crescent, one of a number of roads on the side of the village closest to the track. The measurement position was at the end of a small lane between the houses on the edge of open fields.(Fig 1). This monitoring point was located as close to the track as the worst affected houses and was to some extent shielded by houses from road traffic in the village. It also had the advantage of free access

at all times. One major problem with measuring noise levels in the village is the frequent passage overhead of aircraft taking off, landing and taxiing at East Midlands Airport. This dominates noise from the track andl imits the use of continuously monitoring instrumentation. In turn, this eliminates the use of the majority of environmental assessment procedures because they would automatically include such a major source of noise as the aircraft.

Measurement of background noise levels, in the absence of vehicles on the track and noise from the airport and aircraft, were taken at different times over 1993 and 1994 by Fillery, Cherry(6) and Lefebure(4). Cherry used a direct measurement of the maximum noise level, L_{max} since he wished to compare track maxima with the maxima recorded in the village. Cherry obtained an averaged maximum of 60.5 dBA. Lefebure and Fillery used both L_{eq} and L_{90}.

The background noise levels measured at different times and seasons show little variation and are fairly consistent giving an average Leq of 40 dBA and a L_{90} of 37dBA. The Inspectors report (1) summarises measurements taken prior to 1989 (7). For these earlier measurements, the background level as indicated by L_{90} was 37dB; showing no increase over five years.

2.3 Sound Attenuation between Donington Park (Coppice Corner) and Castle Donington (Shields Crescent).

In order to establish the loudest drive-by point on the circuit, Zarebski and Cherry (3) surveyed the track emissions during testing and racing. They monitored drive-by levels at each marshal position around the track (Fig 2; lettered points) and then normalised the results to a standard reference distance from the racing line on the track. This survey showed that the loudest point on the circuit was the exit from Coppice Corner.

Knowledge of topographical and meteorological factors allow predictions of the sound attenuation to be made between two locations. There are a number of well established methods for different circumstances; for traffic noise the best known method is 'The Calculation of Road Traffic Noise' published by the Department of Transport (8). Borrowing from this method it was possible to make a simple estimate of the attenuation between Coppice Corner and Shields Crescent as 48.4 dBA.

The most direct measurement of the attenuation was carried out in May 1993. This was carried out on a warm dry day with the wind blowing from the track towards Castle Donington (SW). The noise sources were single seater cars and touring saloon cars giving noise levels in the range 95 - 104 dBA L_{max} at the Coppice Corner. Simultaneous L_{max} measurements were taken at the two sites allowing the attenuation to be determined by simple subtraction. This gave a figure

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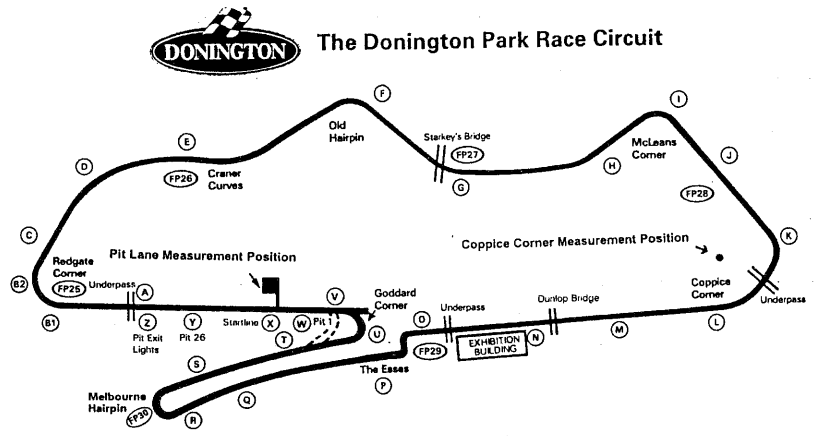

Figure 2

of 47.6 dB.+/_ 1.5dB This is lower than the predicted attenuation (48.4 dBA) and was most probably due to the wind increasing the sound traveling toward the village.

Similar values were obtained at other times. Lefebure (4) and Cherry (6) also measured at both sites but their use of time averaging rather than simultaneous measurements makes comparison difficult.

The value for the attenuation taken in the calculation of the drive-by noise standard is 46 dB. This is the measured value minus the experimental error and rounded down.

2.4 Attenuation between Coppice Corner and the Pit Lane.

The pit lane is a convenient location as it is close to the Control Box and would be the best position for on-track monitoring. Measurements at Coppice Corner would require telecommunications to relay the information back to the Control Box leading to delays and /or

unreliability. Noise monitoring instrumentation beside the pit lane could be hardwired directly into the Control Box giving an instant response.

Measurements were taken on the pit wall, close to the light stanchion. Comparing L_{max} values at the Pit Lane position with those at the Coppice Corner measurement position showed a consistent difference of 7.8 dB +/- 0.4 dB. Pit Lane values are higher because the measurement position at the pit lane is the closer to the racing line of the vehicles. Taking this value minus the error and rounding down gives a value of 7dB. A reliable correlation between the two locations means that the levels measured in the Pit Lane accurately reflect the levels at Coppice Corner.

3 A DRIVE-BY NOISE STANDARD FOR DONINGTON PARK

3.1 Introduction

Measurements over 1993 and 1994 described above have established;

a) The maximum noise levels from the circuit occur at Coppice Corner; this is the closest part of the circuit to Castle Donington village and so the most pertinent.

b) The Attenuation between the Coppice Corner measurement site and Shields Close measurement site is 46 dB when the wind is blowing from the circuit to the village i.e. the worst case. Shields Close is not the only location affected by noise in the village but it is the site closest to the circuit that offered good access without interference from traffic noise. Other sites within Castle Donington should be no worse affected by noise from the circuit.

c) The maximum levels at Coppice Corner correlate well with the levels measured at the pit lane. The levels at the pit lane are consistently 7 dB above those measured at the Coppice measurement position. This means that monitoring at the Pit Lane is feasible.

d) Experience has shown that it is reasonably easy to identify individual vehicles when measuring noise maxima.

The above points indicate that it should be possible to accurately control acceptable noise levels in the village by drive-by measurements at the track.

3.2 Acceptable Noise levels in Castle Donington

Measurements of track noise is difficult in the village due to noise from other sources. The general noise levels are low and are therefore easily affected by road traffic noise from nearby roads and more importantly by aircraft noise.

Taking attended measurements which allow the pausing out of passing aircraft noise gives an L_{eq} of 40 dB when there is no track activity. The noise climate (L_{90} - L_{10}) is low at 4.5 dB.

Setting a maximum measured level in the village as the noise standard would be difficult since non-track noise events will always out-weigh the track maxima.

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Selecting a suitable index for the acceptable level in the village on quiet days was difficult and, with the lack of well researched critria for the assessment of motor sport annoyance, a pragmatic approach was taken. On 'quiet-use' days the track activity is supposted to equate to no more than road traffic noise. From listening in the village it was apparent that the most distiguishable feature of noise from the track was the sound of individual vehicles lapping the circuit and the louder the vehicle the more apparent the nature of the activity became. Disguising the character of track noise was impossible so it was neccessary to set a level that would make it difficult to pick out the track noise peaks from the background.

L_{max} on fast response was chosen as the index because it was indicative of the projection of the track noise above the background, it was available on the existing track instrumentation and it had already been accepted by the local council in their original standard based upon the static test.

If an acceptable limit is taken as 5 dB above the general level this would give a track generated L_{max} of 45 dB in the village. Maxima of this value would not significantly increase the general L_{eq} and would be below the maxima generated by inter village sources (up to 85db) and far below aircraft generated maxima (up to 110dB). It is worth noting here that the proposal is not an increase of 5dB in the continuous noise level but that any transitory peak is within 5dB of the continuous noise level.

This suggested value is well within the disturbance criteria outlined in the findings of the Public Inquiry (1). In these findings it is clearly accepted that no disturbance does not mean no noise. Complete inaudibilty is neither reasonable nor practicable however the trials carried out so far indicates that the suggested levels would be barely audible under normal conditions in the village.

3.3 A Track Side Maximum Level

It is possible to calculate the track side maximum level working back from the criterium of 45 dB L_{max} in the village.

Maximum level in the village, L_{max}	45 dBA
Attenuation from village to Coppice	46 dBA
Difference between Coppice and Pit	07 dBA
Resulting Track Level Maximum	98dBA

This suggested level of 98dBA at the pit monitoring position does show good agreement with practice. Lefebure (4) noted that drive-by levels below 100dBA did not cause complaints.

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Trials of this standard in September and October 1994 were encouraging. A full range of different vehicles were used including standard road saloon cars, classic Formula 1 racing cars and works Superbike motorcycles. In most circumstances only vehicles in excess of 100dBA at the monitoring position could be heard in the village. This demonstrates the conservative nature of the proposed 98dBA limit.

On days when the wind was blowing from the village towards the track only cars giving over 114dB at the drive-by position could be heard in the village.

Although the test was developed specifically for Donington Park Circuit, the method outlined in Table 2 should be applicable to any location with any suitable indicator of environmental noise nuisance.

Table 2

Method for Selecting a Suitable Track Side Level		
Step 1	Choose an appropriate local environmental nuisance indicator e.g. $L_{max} = L_{eq} + 5$ or $\Delta L_{eq} < 5$ dB	L_n
Step 2	Select suitable site, A, in the affected area (worst case).	
Step 3	Determine noisiest part of the circuit, B.	
Step 4	Measure attenuation between A and B.	L_a
Step 5	Select a suitable monitoring point on the circuit, C.	
Step 6	Measure difference in measurements between points B and C,	L_c
Step 7	Monitoring position level , L_m given by $L_m = L_n + L_a + L_c$.	

4. THE NEW NOISE STANDARD

Following these successful trials and the evidence of the preceding investigations North West Leicestershire District Council accepted that the noise standard for the 1995 season would be a drive-by test with a limit of 98dBA L_{max}. This new test has been formally incorporated into a revised Noise Abatement Notice served on Two Four Sports.

4.1 Instrumentation

The drive-by level will be measured by an all weather microphone located on the pit lane wall. This microphone feeds into a Cirrus Noise Monitor 243 which is hard wired into a PC in the Race Control Box . A dedicated software program SOCAR in the PC automaticaly logs an noise event that exceeds the drive-by limit and alerts the Noise Control Officer with a visual and audible alarms. In addition an identifying blip is sent to the video recorder covering the pit lane. This provides some degree of retrospective identification; absolute indentification of vehicle by use of transponders is under development.

4.2 Operation of the Standard

Any vehicle exceeding the limit will be flagged to slow down and exit from the track. This offending vehicle will not be allowed back onto the track without remedial measures being taken to reduce the noise. The effectiveness of the remedial measures must be to the satisfaction of the track marshals. The new system will be difficult to cheat as ;

a) the identification of the vehicle creating the noise is positve (foiling the transfer of noise test stickers between vehicles).

b) the noise level is taken with the vehicle in track trim (eliminating attempts at switching exhausts and other temporary noise reduction measures).

c) drivers soft-pedaling past the test point can be easily identified and flagged off the Circuit.

d) monitoring from the Control Box with its video coverage of the Circuit allows even large numbers of vehicles of be controlled.

Doubts have been raised in some quarters as to ability of a drive-by test to control large numbers of cars on the track at any one time. This might be the case during a race but this is not the subject of this test.. Experience of carrying out hundreds of drive-by measurements in the course of these investigations has demonstrated that it is possible to log the maximum level of individual vehicles even if the vehicles are close together; the automatic system now installed makes this even simpler. Quiet-use days are not race days and therefore vehicles do not have a massed start. During a Quiet-use session on the track, vehicles will occasionally bunch together but it is quite easy to take measurements of clearly identified vehicles at the start of a session. Further, the on-line nature of the drive-by test means that the monitoring of the noise emission is constant and will detect any increase in noise emission as the vehicles warm up or get faster. Static testing can never provide direct immediate control.

Anyone using the track on a quiet day has to abide by the noise standard. This means that the command to leave the track on failing the noise test will always be enforceable and there is no reason to doubt that drivers will fail to obey in this respect.
To avoid vehicles that are too noisy taking the track in the first place only vehicle types that have previously been shown to meet the noise emission standard will be allowed use of the track on quiet days. There is now a considerable amount of data available from the measurements taken over the last two years. This forms the basis of a directory of vehicle noise emissions to pre-screen track users on quiet days.

5. SUMMARY

In summary, the static test does not consistently control noise emission from the track. This has been demonstrated repeatedly in practice. The new drive-by test is based upon careful observations at Donington Park over the last two years. Initial trials indicate that the drive-by test will prove both effective in controlling noise emissions and practical in operation. The proposed noise level for the test will ensure minimal disturbance in the village in a far more consistent manner than the current test. This in turn should reduce the possibility of reasonable complaint.

The drive-by limit of 98dB(A) L max described here is specific to Donington Park but the approach to the problem forms a proven method for similarly controlling noise from other sites.

6. REFERENCES:

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