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THE ENVIRONMENTAL NOISE IMPACT OF A LARGE QUARRY EXTENSION

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1. INTRODUCTION

In Somerset there are 250 current peat extraction permissions covering a total area of 3,500 acres. There are 17 active hard rock quarries producing limestone, basalt, sand and gravel. There are also 8 building stone quarries and 8 dormant quarries. The most intensively quarried area in Britain is in the East Mendips. From this area, roughly 4 by 2 miles, 9 quarries, including one of the largest in Europe, produce a total annual output of 15 million tons of stone.

This paper deals with quarry noise and planning matters generally but with reference to a specific application for an extension.

2. PLANNING AND QUARRY NOISE

Current planning applications are made under the Town and Country Planning Act 1971 [1]. However, existing permissions may date back as far as 1945. In May 1986 the provisions of the Town and Country Planning (Minerals) Act 1981 came into force [2]. The provisions of this Act are explained in DOE Circular 11/86 [3]. The Act places a duty on mineral planning authorities to periodically review all their minerals sites (including dormant sites worked within a 5 year period prior to the review). The purpose of the review is to ensure that conditions are consistent with current minerals planning practice. The Act enables mineral planning authorities to impose conditions on the continued use of land for mineral working.

On 27 June 1985 the Council of the European Communities issued a Directive (85/337/EEC) on the assessment of the effects of certain public and private projects on the environment [4]. In response to this the British Government introduced the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 [5]. These Regulations require that for certain types of scheduled development the developer must submit an "environmental statement" which the planning authority must consider before they can grant planning permission. This statement (sometimes known as an environmental impact asessment or AIE) should contain information which includes likely significant effects of the development, direct and indirect, on the environment and on human beings. Opencast mineral extraction is a Schedule 2 type development which means that the requirement for an environmental statement is at the discretion of the planning authority or, in the case of a dispute, the Secretary of State. Whether mineral workings require an EIA will depend on the location, the scale and type of the activities proposed.

Advice on conditions for minerals permissions is given in the DOE Minerals planning guidance note MPG2 [6]. This Note includes sections on noise and blasting and states some of the factors which have a bearing on noise levels. It mentions the use of The Control of Pollution Act 1974 [7] by local

authorities or individuals to control noise amounting to a nuisance but advocates preference for control to be exercised from the outset by the use of planning conditions. DOE Circular 10/73 Planning and Noise [8] is stated as containing the principles and criteria by which Secretaries of State will be guided in taking planning decisions. The Note recommends, among other things, that conditions should be imposed limiting levels of noise, ground vibration and overpressure. Limits to be specified at the site boundary or outside key nearby buildings. Other possible planning conditions are also mentioned.

It should be borne in mind that any conditions imposed should satisfy the tests for planning conditions set out in DOE Circular 1/85 [9]. That is, they must be: necessary, relevant to planning, relevant to the development permitted, enforceable, precise and reasonable in all other respects.

DOE Circular 10/73 states that where by reference to BS 4142 [10] the noise from a proposed development "is likely to give rise to complaint" it will hardly ever be right to give permission. But the Circular also states: "There will however be times when it is appropriate - or even desirable in order to meet other planning objectives - to allow some form of industrial or similar development near houses etc. Minerals have sometimes to be worked although there are houses nearby..... The need then is to take every precaution to ensure that noise emitted by the development in question does not on the whole make the area a less pleasant place in which to live."

The above paragraph from 10/73 may appear to indicate that minerals working applications should not be refused on grounds of noise. However, Gloucester County Council refused permission for sand and gravel extraction at Twyning near Tewksbury. Reporting on the subsequent Appeal Inquiry (October 1987) the Inspector said that despite the fact that the plant was mobile and the working would be limited to 10 years he considered that noise assessment should be made according to BS 4142 [10]. He decided that BS 5228 [11] was not applicable because it does not rate noise for complaint potential. In his view the predicted increase of 14 to 20 dB(A) above background might give rise to complaints and would make the area a less pleasant place in which to live. He recommended upholding the Council's refusal.

Given the above legislative framework and precedent it is considered that conditions limiting environmental noise can be imposed on new or existing mineral working permissions and that BS 4142 can be a valid method of assessing the impact of noise. This philosophy was put into practice recently when Somerset County Council considered an application for an extension at Torr Works Quarry in the East Mendips.

3. ENVIRONMENTAL NOISE ASSESSMENT

The application site and existing quarry are shown on the plan in Figure 1. The village of Downhead is closest to the proposed development with some houses quite near the edge of the proposed extension, the nearest being 90 m from the edge of the proposed quarry face. The main A 361 road is 2 km south of Downhead and there are 5 other quarries within about 3.5 km of the village. The only other major industrial activity in the area is agriculture.

3.1 Monitoring technique

Occasional noise surveys in this area have been conducted since 1985. These were done in response to sporadic noise complaints and a previous planning application at Torr Works.

Ideally many days of continuous noise level recording are required at several sites with constant attendance of the acoustician at each site making notes of all the relevant facts. Such time consuming procedures are not practical. A reasonable compromise is a series of surveys at a range of sites covering the relevant time periods combined with long term monitoring at one or more sites. In this exercise the 'mobile' surveys were mainly conducted in the night time period. Short period (i.e. 5 to 10 minutes) measurements were made at seven locations and L90, Leq and Lmax levels were recorded. In some cases FFT analyses were made in order to identify tonal components. Detailed observations about audible noises were made including their characteristics, their apparent direction and the subjective impressions gained. Notes were also made of the weather conditions including wind speed and direction, temperature and cloud cover.

Long term monitoring (several days at a time spread over many months) was conducted at three locations but concentrated on one of these. Levels were recorded using an environmental noise analyser programmed to compute hourly statistics. Results from such monitoring can indicate daily patterns of noise levels, long term trends if any, and the effects of weather conditions.

3.2 Analysis of results

Some of the general problems of assessing noise in rural areas have been discussed before [12]. In this case the existence of a number of potential noise sources and the very wide range of measured background levels pose special problems. Many locations can be subjected to noise from more than one quarry, some of which operate 24 hours per day. The major source is usually the nearest quarry but if that one stops operations noise levels are likely to be governed by one or more of the others. The only period when they are all closed is Christmas to New Year. Measurements made in Downhead at the end of December 1988 showed the L90 (1 hr) falling to 18 dB(A) during the night. The average L90 (1 hr) for the night (2200 - 0700) was 20 dB(A). The value of 18 dB(A) may be an exceptional low but on other occasions night time L90 (1 hr) levels as low as 22 dB(A) have been recorded. Night time L90 (1 hr) levels have been as high as 41 dB(A) when Torr Works was assumed not to be operating and 51 dB(A) during a period when it was operating. The problem is distilling from all the data a value for the background that is meaningful, reasonable and useful.

Since it was apparent that meteorological conditions had the greatest influence on the variations in background levels, further computer analysis was made using the recorded weather data available. Data from 332 hours of recording at one site were transferred to a database. Logical fields were added to indicate whether the quarry was working and whether winds were unfavourable (from the direction of the quarry) or favourable. Although the assumptions made were rather crude and somewhat arbitrary the results (shown in table 1) were interesting. The night time (considered to be the most

critical) results for all wind directions averaged were only 2 dB(A) higher for working periods than non-working. During working periods the average L90 was 10 db(A) higher in unfavourable winds than in favourable. In unfavourable winds the average L90 and Leq were 8 dB(A) higher for working periods than non-working.

3.3 Noise Criterion

From comments made by complainants it was clear that levels below 35dB(A) Leq at night were unlikely to cause annoyance. Levels of 45 dB(A) Leq or over did give rise to adverse comment. The unfavourable weather conditions have tended to occur mainly between October and April. East winds are associated with stable spells of high pressure so tend to persist for days. Since noise was not generally a problem in westerly winds it is considered that the average levels recorded during unfavourable conditions when the quarry was not working would constitute a reasonable background despite the possibility of influence from distant quarries. The value of 35 dB(A) was therefore adopted as the background level and a planning condition limiting noise between 2000 and 0600 to 40 dB(A) Leq (1 hr) at the nearest residential property in Downhead was attached. The day time limit was set at 47 dB(A) Leq(1 hr).

4. THE NOISE SOURCES

Noise is produced at almost every stage in the extraction process. To the distant listener the sounds merge into a general rumble of machinery and moving stone with occasional vehicle engines and mechanical clankings being audible. As well as dry stone many quarries make secondary products such as coated stone, asphalt, concrete, concrete blocks, lime and limestone powder. The major noise sources are listed below.

Operation	Noise source(s)
overburden stripping embankment construction	excavators, dumpers, dozers or graders
shot hole preparation	mobile drilling rig
blasting	(ground vibration and air overpressure)
ripping	hydraulic chisel
fragmenting	"
face working	loaders, dumpers or conveyors
crushing and grading	primary, secondary and tertiary crushers and screens, conveyors
stockpile movement	loaders, dumpers, conveyors
loading	hoppers, conveyors
transport	heavy road vehicles, or railway trains
stone coating	burners, fans, conveyors
lime or concrete products	kilns, burners, fans, conveyors
concrete blocks	mould vibrator
limestone powder	mills

In addition to the major sources large quarries will usually have many other vehicles such as smaller dumpers, tractors, tankers, sweepers etc. and auxilliary machinery such as pumps, generators and compressors.

5. CALCULATIONS AND PREDICTIONS

Predicting the noise generated from such a complex of machinery is a difficult task. Wentang and Attenborough have reported that for earth moving machinery the sound power level correlates well with the mechanical power [13]. However, a major source of noise in stone moving operations is the impact of stone on metal and stationary noise measurement methods such as BS 6812 [14] will not reflect the activity level of an operation. BS 5228 [11] contains a lot of data on machine noise levels but it is not always clear whether the activities described exactly match those you want to consider and often a wide range of levels is given for the same plant with the same weight and power rating.

It is preferable to calculate sound power levels from measurments on existing plant if possible and by measuring at suitable distances the equivalent sound power for a whole process can be determined. No changes to the plant were proposed at Torr Works. The main effect of the development would be the movement of face operations towards the village with the removal of intervening ground. Consultants for the applicant measured sound power levels of plant items and used a mathematical propagation model to predict current and future levels at several locations in the village. The predicted current level (for neutral atmosphere) was 37 dB(A) near the location where the measurements in table 1 were taken. This discrepancy between the measured and predicted levels indicates either very large effects due to weather conditions or a deficiency in the model used. In any case, since current levels often exceed the new planning limit it is clear that noise control measures are required.

6. NOISE CONTROL

A scheme of noise control measures was proposed by the applicant. The application already included a 10 m high environmental bank along the western edge and northwest corner of the site. As well as visual screening it was intended that this bank should provide a noise barrier to replace the loss of the barrier effect of the current quarry face when is it removed. Other noise control measures included attenuating drilling rigs and loaders by fitting radiator fan attenuators, side and belly plates and improved exhaust silencers. Remedial measures proposed for the screening plant included replacing the metal screens with rubber ones, lining transfer shutes with rubber, replacing anti-vibration mounts in the building and improving the external cladding of the building. Mobile or temporary noise screen were proposed for the ripping and drilling operations on the top levels.

In design considerations for new plant the general common sense rules of noise control apply. Noise should be reduced at source as far as possible. Static plant should be contained in well sound-proofed buildings. Enclosed conveyors are preferable. Rubber linings should be use to reduce the noise from stone on metal. Rubber bodied dump trucks are available. Plant should be sited as far away as possible from noise sensitive premises and should be well shielded. Access roads should be designed carefully and transport schedules planned to reduce the effects of vehicle noise to a minimum.

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7. GROUND VIBRATION AND AIR OVERPRESSURE

Local experience has shown that the threshold for complaints about ground vibration from blasting is around 1.5 mm/sec ppv (as measured near the house foundation). Fear of structural damage seems to be a common concern (cracks in the plaster are always pointed out). BS 6472 'Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)' [15] provides a method of establishing vibration levels below which 'adverse comments or complaints are rare'. For impulsive events human response is not so well understood and the 'trade off' between number of events per day, their magnitudes and durations is not well established. The calculation for one event per day gives a 'satisfactory' level range of 8.6 to 12.9 mm/sec ppv. BS 6472 is currently being revised and unless the new Standard gives clearer advice it is likely that setting vibration conditions will continue to be somewhat arbitrary. UK Local Authorities set planning limits between 2.5 and 12 mm/sec. The Somerset County Council Planning Department imposes limits of 9 mm/sec (as measured at the nearest residence).

This limit becomes more difficult to achieve as the quarry face moves close to houses but it can be done by careful blast design. Good blast design together with down-the-hole detonation and the elimination of surface detonation cord can also help to reduce the air blast.

Table 1

Analysis of the noise related to working periods and wind directions.
The non working period has been taken as 1200 on Saturday to 0600 on Monday.
Winds from the NE round to S are classed as unfavourable, other winds as favourable. Average noise levels in dB(A)

Period	working	winds	L90	Leq	(hours)
N	n	all	34	38	(34)
N	y	all	36	40	(92)
N	y	u	43	46	(26)
N	y	f	33	37	(66)
N	n	u	35	38	(17)
N	n	f	34	39	(17)
E	n	all	30	36	(12)
E	y	all	35	42	(30)
E	y	u	40	44	(6)
E	y	f	34	41	(24)
E	n	u	30	34	(6)
E	n	f	29	37	(6)
D	n	all	34	43	(39)
D	y	all	38	46	(125)
D	y	u	42	48	(22)
D	y	f	37	45	(103)
D	n	u	33	41	(20)
D	n	f	36	45	(19)

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REFERENCES

[1] Town and Country Planning Act 1971

[2] Town and Country Planning (Minerals) Act 1981

[3] Circular 11/86 Town and Country Planning (Minerals) Act 1981 Department of the Environment April 1986

[4] EEC Directive 85/337/EEC (OJ No.L175, 5.7.85, p.40) on the assessment of the effects of certain public and private projects on the environment. 27 June 1985

[5] The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 Statutory Instruments no. 1199 15 July 1988

[6] Minerals planning guidance note MPG2 Applications, permissions and conditions. Department of the Environment 1988

[7] The Control of Pollution Act 1974 Part III s(58), s(59)

[8] Circular 10/73 Planning and noise. Department of the Environment 1973

[9] Circular 1/85 The use of conditions in planning permissions. Department of the Environment 1985

[10] British Standard BS 4141:1967 Method of rating industrial noies affecting mixed residential and industrial areas. British Standards Institution

[11] British Standard BS 5228:Part 1:1984 Noise control on construction and open sites. Part 1. Code of practice for basic information and procedures for noise control. British Standards Institution

[12] Manning C J The assessment of environmental noise impact from industrial activities in rural areas. Proc. IOA Vol 9: part 3 (1987) 287 - 294

[13] Kentang R and Attenborough K The prediction of noise from construction sites. Proc. IOA Vol 11:Part 5 (1989) 323 - 330

[14] British Standard BS 6812:Part 1:1987 Airborne noise emmitted by earth-moving machinery. Part 1. Method of measurement of exterior noise in a stationary test condition. British Standards Institution.

[15] British Standard BS 6472:1984 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz). British Standards Institution.

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Figure 1

The application site showing existing quarry and proposed extension.