The problem with dust

Steve Fraser of RPS Consultants, Edinburgh, examines the new dust guidance issued for consultation in MPG11

Introduction

The mineral industry will need to conduct an assessment of PM_{10} for all types of proposed mineral processes if the recent consultation paper on MPG 11 is implemented in its present form. (Mineral Planning Guidance Note 11: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England; Consultation Paper. DETR; 19 May 2000. Annex A; *The Control and Mitigation of Dust at Mineral and Related Workings*). (See **Mineral Planning 84**, p.16.)

The deadline for consultation responses closed on 31 July and the final version is due out later this year. The draft MPG proposes that PM_{10} should be assessed for all types of surface mineral operations including opencast coal sites, quarries and landfill where the proposed development is within 1km of sensitive receptors.

This marks a change in emphasis on the importance of PM_{10} from mineral operations. Only last year DETR advised local authorities that: "*Dust emissions from quarrying and materials handling tend to be within the larger particle size fractions and correspondingly fall out of the atmosphere rapidly with increasing distance from the source. Monitoring studies completed by the first phase authorities have indicated few, if any exceedances of the proposed objective in the vicinity of quarrying activities, although the potential for problems does depend on the type of material handled. ... If there are no properties within 400m of the dust emission sources, there is no need to proceed further.*" (DETR March 1999 'Assistance With The Review And Assessment Of PM_{10} Concentrations In Relation To The Proposed EU Stage 1 Limit Values'.)

The impetus for PM_{10} assessment comes from the research lead by Dr Tanja Pless Mulloli of the University of Newcastle Department of Epidemiology, funded by DETR and DoH. (HMSO; 1999 'Do particulates from opencast coal mining impair children's respiratory health?' ISBN 0 11 322298 X.) (See **Mineral Planning 82**, p.23.) This study found that levels of PM_{10} in communities next to opencast mines were slightly higher than the control sites. The increased levels were associated with small but statistically significant health effects. The Newcastle study recommended that PM_{10} impacts from future opencast mines should be assessed where the development was within 1km of receptors.

The Committee on the Medical Effects of Air Pollutants (COMEAP) agreed with the findings of the report and concluded that the respiratory health of children living in communities close to opencast sites was very similar to that of children living in communities distant from such sites. DETR propose to impose this requirement on all surface mineral and related workings, not just opencast mining.

This precautionary approach will increase the complexity and cost of mineral applications. Modelling techniques to predict impacts from new processes are imprecise, even where this is supported by site-specific data. Even when the modelling carried out is robust and transparent, the predictions can be difficult to validate.

Baseline

Baseline monitoring can be particularly helpful where an extension is proposed to an existing operation where the data can be used to validate subsequent predictions and provide useful information on background conditions.

Monitoring for PM_{10} using a suitable method can be an expensive operation. The monitoring needs to be carried out over a long enough period to obtain representative conditions. Where the survey is around an existing site, it may be necessary to measure at two or three sites simultaneously to obtain a reliable measure of the contribution from the site. The baseline study should also record prevailing weather conditions and operational details.

Real time dust sampling using TEOM® monitors can provide useful data on short duration events that can be related to specific operations. These monitors are widely used to monitor PM_{10} throughout the UK by DETR and local Councils. The sample collected is heated to 50°C to drive off moisture. This causes loss of volatile compounds in particles. When these results are compared to samples obtained by conventional gravimetric analysis, the results in urban areas are typically 30% less. The difference between the TEOM and gravimetric sampling and analysis of mineral dusts is likely to be less than for combustion particles, but can add further to difficulties in interpretation of results.

In short baseline monitoring is expensive and can be a waste of money if the sampling strategy is not thought through. In many cases it may be sufficient to use estimates from the National Emissions Inventory. These are based on conservative estimates and can be a good alternative to baseline monitoring. The DETR factors to relate annual mean estimates to short term percentile limits are based on ambient monitoring data from predominantly urban monitoring stations which may be less relevant to conditions at many rural mineral sites. Baseline monitoring at the proposed site can help a better understanding of the site specific relationships.

In addition to national estimates, many local authorities monitor PM_{10}. Although these data are usually in urban areas, away from mineral operations, the local authority should be consulted to confirm the availability of local data.

Impact assessment

In the case of a new mineral operation the assessment will need to rely entirely on dispersion modelling. There are two parts to dispersion modelling, the source estimates and the dispersion estimates, requiring an understanding of mineral operations and atmospheric dispersion.

The robustness of dispersion modelling is dependent on the reliability of source estimates. Source estimates for opencast mining and other mineral operations are available from the United States Environmental Protection Agency. (USEPA 1995 'Compilation of Air Pollutant Emission Factors Volume 1: Stationary Point and Area Sources' AP-42 Fifth Edition, as amended).

According to AP-42, the main source of dust generation from opencast operations is from haul roads. The procedure for estimating emissions from haul roads was substantially revised in September 1998. The revised procedure (13.2.2 'Unpaved Roads'), includes a wider range of operational parameters

Left: Regular grading on internal haul roads can help reduce tyre wear, but increase the proportion of small particles on the surface, and consequently the potential for dust release.

Centre and right: The rate of emission from mineral operations can be estimated from the rate of excavation, loading, traffic on haul roads, deposit and transfer of material, wind blown dust from exposed surfaces and exhaust emissions.

including moisture content, silt content, and vehicle weight. Further allowances may be made for speed and number of vehicles.

Where possible these estimates of operational parameters should be based on locally derived estimates of silt and moisture content.

The impact assessment should detail the source inventory and the scenarios considered. The emission rate from operations, and consequently the potential impact, are mostly a function of the tonnage of overburden or material extracted, transported and processed. Estimates of source emissions can be used to justify the selection of worst case impacts to be assessed. In most cases it will be necessary to consider more than one scenario, throughout the life of the project to ensure that the worst case impacts are considered for all sensitive receptors. This type of modelling is time consuming and expensive. It is therefore always a good idea to reach agreement with the Planning Authority before proceeding too far. The emissions from certain operations are particularly sensitive to wind speed. The use of reliable local weather records can be used to compile estimates of time varying releases.

The principal factors affecting the concentration of a pollutant are:

- source characteristics including source strength, height of discharge, density, and temperature of the release. Emissions from vehicle exhausts are hot, with efflux velocity and thermal buoyancy whereas haul road dust has little momentum;
- prevailing atmospheric conditions including wind speed, direction, cloud cover, precipitation, ambient temperature and the depth of the mixing layer. Wind speed and direction and rainfall patterns can greatly influence the generation of dust around sites. It is therefore essential to use the best weather data available. It may be necessary to adjust wind speeds to take account of any difference in the elevation between the meteorological station and the proposed site; and
- topography and local surface conditions.

The modelling assumptions for dispersion and source estimates must always be clearly stated. This is essential to allow the assessment to be reviewed by interested third parties.

Health effects

One of the most important aspects of any modelling study for a surface mineral operation must therefore include the distribution of particle sizes where the potential health risk is of concern.

The Expert Panel on Air Quality Standards, (EPAQS) an independent body appointed by the UK Government, reviewed the available evidence on exposure to particles. EPAQS recommended that the rolling 24 hour average concentration of PM_{10} should not exceed 50µg/m^3 (EPAQS, 1995). In the UK this has been set as an air quality objective 90%ile of 24 hour average along with an annual mean of 40µg/m^3. Current epidemiological evidence on particles suggests that there is no safe level of exposure to particles. Compliance with the Air Quality Objectives for particles may not be sufficient to satisfy local authorities that the impacts are acceptable.

EPAQS has recently published a report on Airborne Particles (EPAQS July 2000. 'What is the Appropriate Measurement on Which to Base a Standard'.) EPAQS concluded that: "*With respect to urban, predominantly anthropogenic pollution, if the epidemiological evidence does indeed indicate a causal association between PM_{10} and ill-health, it seems likely on mechanistic grounds that the component of PM_{10} that is responsible is that fraction generated by combustion and photochemical reactions. These reside mainly, but not wholly, in the nucleation and accumulation mode particles, generally below about 2µm in diameter*".

EPAQS considers that "*Experimental evidence and theoretical considerations suggest that small particles, <1µm in diameter, may be the predominant source of the toxicity of ambient anthropogenic particles.*" (RPS Emphasis)

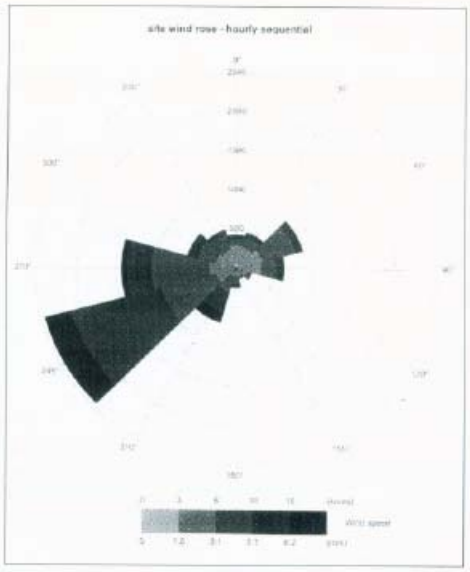
The Airborne Particles Expert Group (APEG, 1999 'Source Apportionment of Airborne Particulate Matter in the UK') has reviewed the sources of particles within the UK, including transport, industry and mineral processes including mining and quarrying. APEG reviewed the available data and concluded that most of the particulate matter emitted from mines and quarries was in the coarse range, >2.5µm. This is confirmed by the particle analysis carried out as part of the Newcastle Study which found that the majority of particles attributed to opencast mining fell within the 5 - 8µm size range.

Mitigation

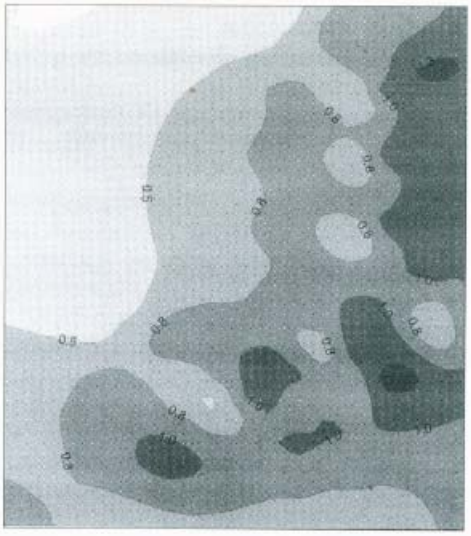
Dispersion modelling can be a useful tool to help determine the level of mitigation appropriate for a project such as the need to modify working methods; relocate sources, such as haul roads or mine support areas; or the requirements for additional dust suppression on haul roads, or grading and crushing plant. Additional measures such as water cannons and boundary sprays will help reduce emissions from the site, but it can be difficult to estimate the effectiveness of these abatement measures.

Validation

The difficult question for dispersion modellers is always how accurate are the model predictions. As for any



The newly available NWP data from the Meteorological Office can provide improved estimates of local weather conditions. The modelling assessment should consider weather over a number of years to ensure the weather records are representative of a range of conditions.



The effects of terrain can significantly affect the transport of airborne particles. The above plot (a 2.5km box) shows the ratio of predicted PM_{10} concentration with and without terrain effects. In the case above the effect of terrain was predicted to increase concentration by 30% at some locations.

modelling exercise, the study should include some indication of the error in the modelling. Where the prediction is for an extension to an existing operation, the study should model the existing operation and compare this to the measured background, if available.

In the case of a new site the credibility of the predictions will depend on comparison with measured data from other sites. Unfortunately the Newcastle Report did not examine particulate dispersion or operational conditions and is of limited use for validating predictions. There is limited published data available for levels of PM_{10} beyond the site boundary. Ideally the industry and DETR should fund a study to assess the accuracy of modelling studies.

In the absence of suitable air quality data, occupational monitoring data should be considered as a means of confirming the estimates of predicted concentrations.

Comparison of the measured occupational exposure with predicted concentrations within the site can be used to assess the validity of source estimates. This will not confirm the reliability of the dispersion modelling. In most cases where dispersion modelling studies have been considered necessary, post permission monitoring should be carried out to validate the predictions. Planning Authorities should beware of applying inflexible conditions requiring compliance with particular air quality standards as it will be impossible to determine the exact contribution from the operation due to high background concentrations.

MPG 11

As it stands the proposed requirement to assess PM_{10} would apply to all surface mineral operations within 1km of a community. While this is good news for air quality consultants and may be reasonable where large projects are required, it is difficult to see why this requirement should be applied to all mineral operations across the sector regardless of size.

Sources within the DETR recognise the shortcomings of the Newcastle study, but can't ignore COMEAP's recommendations. Hopefully the final version of the MPG, due out later this year, will provide a sensible working framework. In the meantime operators considering new schemes should use the scoping process to reach agreement on the level of assessment appropriate to their specific project.

❑ Some initial responses on MPG11 are reported on page 25.