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**HEALTH AND SAFETY COMMISSION  
ADVISORY COMMITTEE ON TOXIC SUBSTANCES  
POLYCYCLIC AROMATIC HYDROCARBONS**

**A Control Approach**

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**Issue**

1. A control strategy for polycyclic aromatic hydrocarbons (PAHs).

**Timing**

2. Routine

**Recommendation**

3. That ACTS agrees the HSE's proposed control strategy as set out in paragraph 12.

**Background**

4. ACTS was due to consider the setting of a MEL for polycyclic aromatic hydrocarbons at its meeting on 13 March (ACTS/07/2003). Immediately prior to that meeting, HSE decided that it should withdraw the paper in the light of last-minute radical recalculations of the costs and benefits involved in setting a MEL at the level proposed. HSE undertook to review these findings and come back to ACTS with revised proposals.

5. Many PAHs are known carcinogens and are ubiquitous in the environment, occurring naturally in some hydrocarbon mixtures deriving from minerals, such as coal or

petroleum. They are also generated in processes involving the combustion of any organic matter, including fuels. Coal-tar pitch volatiles (CTPVs), which contain PAHs, are produced during coking, tar distillation, aluminium smelting and downstream uses of tar and pitch. These “CTPV” industries produce the highest exposures, in particular the coking process. Exposures on coke ovens are controlled by the use of respiratory protective equipment, due to the cost-prohibitive investment that would be needed to upgrade the few remaining ovens. Although these “CTPV” industries account for the highest exposures, the numbers of workers exposed are very low.

6. Beyond the “CTPV” industries, exposures occur in many and varied sectors, from rubber processing to road dressing. Many tens of thousands are exposed across these non-CTPV industries, although to levels significantly lower. Further background information is attached in Annex 1.

## Argument

7. The ACTS paper submitted to the March 2003 meeting included a lengthy Regulatory Impact Assessment (RIA), which set out the varying costs and benefits of a MEL set at 0.5, 1 or 2  $\mu\text{g.m}^{-3}$ . On the basis of these costs, HSE recommended consultation on a MEL set at 0.5  $\mu\text{g.m}^{-3}$ . Usually, it is impossible to calculate the financial benefits that might accrue from setting MELs. The best that we can normally say is that they are bound to lead to a decrease in ill-health resulting from exposure to the chemical. Exceptionally, with PAHs, we benefited from a meta-analysis on the risk of cancer from PAHs, described in more detail in paragraph 12 of Annex 1. As a result of the findings of this study, we were able to calculate the likely number of cancer deaths that might arise from a MEL set at a certain level, and thereby cost the benefits accruing from the MEL.

8. In an initial analysis, the benefits of setting a MEL at 0.5  $\mu\text{g.m}^{-3}$  were based on epidemiological assumptions that were later successfully challenged. This only became apparent after the RIA had been sent to ACTS members. As a result of a recalculation, HSE estimated that the benefits, for the majority of industries, of setting a MEL for PAHs at 0.5  $\mu\text{g.m}^{-3}$  would amount to no more than between £0.6 million and £2.8 million pounds over 25 years. These benefits were seen to be so minimal that it caused us to reconsider the best way forward.

9. Initially we considered suggesting consultation on a MEL for PAHs set at a level lower than we had previously costed, e.g. 0.2 or 0.1  $\mu\text{g.m}^{-3}$ . We anticipated that if the MEL (or eventual Workplace Exposure Limit) were set at that level, a greater number of cases of ill-health would be prevented, thereby raising the level of benefits in the cost/benefit equation. However, on further analysis, it appeared that a MEL set at a lower level would have little demonstrable effect in protecting worker health.

10. The problem can be summarised as follows:

- i) We would need to detach completely the coke oven industry. No matter what MEL is proposed, this industry could not comply without excessive costs for new control systems. Exposures are very high in this industry but are controlled on a personal basis by the wearing of respiratory protective equipment (RPE).

- ii) The remainder of the coal tar pitch volatile (CTPV) industries (tar plants, roofing etc) would experience excessive costs at a MEL set at, for example,  $0.1 \mu\text{g.m}^{-3}$ . But they employ relatively few employees so the comparable benefits would be minimal.
- iii) Most employees are employed in the industries where the exposure to PAHs is from sources other than from CTPVs. Exposure levels in these industries are already relatively low and in order for there to be any effect on workplace health, the MEL would need to be set at a very low level, even lower than  $0.1 \mu\text{g.m}^{-3}$ . Such a low MEL could not be deemed as being reasonably practicable for all the CTPV industries and especially not for coke ovens.

11. In conclusion, therefore, no MEL is likely to be appropriate for the whole of industry exposed to PAHs. It is not HSE's practice to publish MELs which are applicable to one industry and not to another. If we seek a limit that is reasonably practicable for all of industry, we make no demonstrable difference to workplace health. If we aim to protect the largest group of employees, we require a limit which is unattainable for the areas of industry with the highest exposures. We are therefore trapped by the wide range of exposures to PAHs experienced by industry. In targeting the highest exposures, we disregard the vast majority of exposures. We have the scientific knowledge to be able to define a MEL, but because of the low numbers exposed at relatively high levels and because the benefits are minimal, the MEL appears to have little benefit.

12. HSE therefore recommends that no further action be pursued to develop an occupational exposure limit for PAHs. Instead, workplace controls would be achieved by:

- a) preparation of sector-targeted workplace guidance;
- b) publication of a benchmark biological monitoring guidance value (BMGV) (see below); and
- c) inclusion of PAHs in HSE's Carcinogens programme;.

### **Establishment of biological monitoring guidance value**

13. Although no limit is being proposed for PAHs, HSE could still provide employers with a valuable tool with which to assess worker personal exposures by establishing a Biological Monitoring Guidance Value (BMGV). BMGVs have no legal status, therefore there is no need to prepare an RIA, but a BMGV will provide a target to help employers determine if the exposures received by their workers are commensurate with good occupational hygiene practices having been followed.

14. At its meeting of May 2000, WATCH agreed that it would be appropriate to establish a Benchmark BMGV for PAHs based on measurement of end-of-shift urinary 1-hydroxypyrene concentrations. A level of  $4 \mu\text{mol/mol}$  creatinine was agreed for the BMGV. This value represents the 90th percentile of measurements taken from industries deemed to have good control, including CTPV industries but excluding data from one timber impregnation site. In timber impregnation, dermal exposures are high and WATCH suggested that additional guidance on control of exposure might be useful for this industry.

15. The proposed approach of establishing a BMGV in the absence of an OEL has already been adopted for nitroglycerin (see Addendum to EH40/2002) because dermal exposure is the main route of exposure to nitroglycerin and therefore biological monitoring will provide a much more accurate assessment of worker personal exposure than airborne monitoring. In the case of PAHs, the industries which would have the greatest difficulty in complying with a MEL rely on RPE to restrict worker exposure. In this situation, airborne monitoring will not necessarily provide an accurate indication of personal exposure. In contrast, biological monitoring would accurately measure the exposures received by individual workers and would enable an employer to verify that the RPE being used is providing an adequate level of protection.

16. It is considered that by establishing the agreed BMGV, HSE would send a signal to employers about the maximum levels of exposure that they should allow their employees to receive and would avoid many of the difficulties that have been identified in relation to setting a formal MEL.

### **Consultation**

17. In preparing the Regulatory Impact Assessment for the original ACTS paper, HSE contacted a wide cross-section of industry. Relevant industries will be contacted in the preparation of any sector-related guidance.

### **Communication Plans**

18. If agreed, the BMGV would be published in the next edition of EH40 "Occupational Exposure Limits". Consideration will also be given to the publicising of the BMGV via a Press Release.

### **Evaluation Plans**

19. None.

### **Relevant Control Systems**

20. Not applicable.

### **Costs and Benefits**

21. This course of action is proposed because of the minimal benefits that would be gained by a MEL. Guidance aimed at certain industries will stress the need for them to reduce exposures as low as is reasonably practicable in line with COSHH. This may require certain companies to reconsider their existing control procedures and incur extra costs as a result. We would certainly expect the coke oven industry to look at the use and efficacy of its RPE.

### **Financial/Resource Implications for HSE**

22. Any additional costs would be met from existing resources.

### **Environmental Implications**

23. None.

### **European Implications**

24. None

### **Devolution**

25. No issues involving devolution are involved.

### **Other Implications**

26. None

### **Action**

27. HSE propose:

- a) preparation of sector-specific guidance;
- b) establishment of a benchmark biological monitoring guidance value of 4µmol/creatinine for 1-hydroxypyrene in urine;
- c) inclusion of PAHs within HSE's overall Carcinogens programme; and
- d) abandonment of the MEL proposal.

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## Background information on the setting of a MEL for PAHs

### ***Toxicology and workplace exposure***

1. PAHs are a group of hydrocarbon compounds with a structure in which 2–6 or more carbon rings are fused together. In practice, these compounds always occur together as a mixture of many components. They occur naturally in some hydrocarbon mixtures deriving from minerals, such as coal or petroleum, and they can also be generated in processes involving the combustion of any organic matter, including fuels. Because of the continuous generation of PAHs through combustion processes (including vehicle emissions), they are ubiquitous in the environment and are produced by many sectors (e.g. coking, tar distillation, aluminium smelting, foundries, rubber manufacture, petroleum refining etc). They are also produced from car engines, cooking, smoke houses and many more processes.

2. Occupational exposure to PAHs has historically been highest in those people exposed to fumes deriving from the treatment of coal to produce coke and other solid fuels, or from the use of coal-tar pitch to make graphite anodes for electrolytic extraction of aluminium from its ores. These fumes are commonly called coal-tar pitch volatiles (CTPVs). The original scope of the limit-setting work was to consider an occupational exposure limit and a sampling method for coal tar pitch volatiles (CTPVs). These CTPVs are known to be associated with an increased risk of cancer, and to contain high levels of PAHs, many of which are known carcinogens. PAHs were chosen as the preferred marker for assessment, as the previous total fume method was unreliable.

3. The industries that are encompassed by the CTPV definition are aluminium smelting, coke ovens, which destructively distil the coal to make coke (used as a fuel), tar plants that take the tar produced as a by-product and refine it to produce many products (including pitch), and downstream industries that use tar or pitch. Traditionally there were many such users, such as the roofing or road dressing industries. The use of tar and pitch has now dropped significantly, as petroleum alternatives are now favoured for roofing, road dressing and other previous uses of coal tar. These petroleum distillates have a lower PAH content by several orders of magnitude.

4. Epidemiological studies published from 1969 onwards have demonstrated excesses of cancers in some groups of workers exposed to CTPVs; the principal sites were the lungs and bladder. The information available at the time was summarised in HSE Toxicity Review No 28, published in 1993. Only a minority of the studies reported by that time included quantitative estimates of exposure to CTPVs.

### ***Occupational exposure limits***

5. There has never been an HSC-approved occupational exposure limit for CTPVs under COSHH. The earlier limit of  $0.14 \text{ mg.m}^{-3}$ , based on measurement of solvent-soluble matter, was included for guidance in Table 4 of annual editions of EH40 from 1989 to the last appearance of the Table in that form in 1993.

6. In 1992, ACTS considered the development of a MEL for CTPVs. In 1994 WATCH considered some of the scientific and technical issues and agreed:

- a) that a MEL was the appropriate type of occupational exposure limit for CTPVs;
- b) that the available methods for measuring CTPVs had serious deficiencies, and that further work on improved methods should be pursued;
- c) that industry-specific guidance for coke ovens and for aluminium smelters could be prepared by HSE;
- d) that HSE should consider further work on biological monitoring looking at 1-hydroxypyrene and at other PAHs and metabolites.

7. In 1996 and 1997, WATCH considered further aspects of sampling and analysis of airborne CTPVs and PAHs and their biological monitoring (WATCH/21/96 and WATCH/27/97). It concluded that:

- a) the only realistic basis for reliable air measurements to compare with an OEL value was determination of one or more individual PAH;
- b) information should be obtained on exposures to PAHs in industries other than those using coal tar pitch, in order to give a broader consideration of limit setting;
- c) a benchmark value for biological monitoring could be based on measurements of 1-hydroxypyrene in urine. In accordance with the agreed BMGV framework, the value would lie at the 90th percentile of data from representative workplaces with good occupational hygiene practices.

8. The highest exposures in the CTPV industries are generally found for coke oven workers. This has been recognised for many years by HSE and by the industry, and a voluntary agreement exists which stipulates that workers on coke ovens will wear respiratory protective equipment (RPE) as part of the control regime. To reduce exposures without the use of RPE would incur excessive costs and is consequently cost prohibitive. If people wear RPE, HSE deemed that there was no point including their exposures in its considerations. HSE defined three limit values, all of which were lower than what is currently achievable by coke ovens, in the knowledge that their RPE programmes would be needed to help achieve compliance. The proposed values were therefore driven by CTPV industries, excluding coke ovens.

9. Since the number of people exposed to CTPVs was falling, HSE decided to widen the scope of the project to include all exposures to PAHs. Although the highest exposures are in the CTPV industries, it was felt that a MEL, applicable to all PAH exposures was of greater value. Unfortunately the highest exposures drive the development of a MEL; therefore even with all these industries included, CTPV industries would still define the numerical value.

10. In May 2000, WATCH considered the results of a 25-site survey of inhalation exposure and biological monitoring undertaken by HSL, covering a range of different processes using coal tar pitch, oil and bitumen, and others (WATCH/21/2000). The set of PAHs measured in the air samples included 10 representative PAHs agreed by WATCH in 1996 as appropriate, plus pyrene as suggested by WATCH in 1997 (i.e. in order to relate to hydroxypyrene biological monitoring measurements). On the basis of this information, WATCH agreed that:

- a) one of the PAHs, benzo(a)pyrene (BaP) was a suitable representative marker of exposure to the full set of 10 measured PAHs of concern, for CTPV industries and for other industries; and there was little added benefit in measuring more individual PAHs;
- b) there was no requirement for a short-term limit nor for a “Sen” notation, but because PAHs are genotoxic carcinogens, and there is the likelihood that significant uptake of PAHs through the skin might occur, and in view of the concerns about cancers at different body sites, an 8-hour TWA MEL should have a “skin” notation assigned;

11. A survey, conducted last year, looked at the necessary controls to be put in place and the likely costs to be incurred by industry if firms were to comply with a MEL set at one of three different levels;  $2 \mu\text{g.m}^{-3}$ ,  $1 \mu\text{g.m}^{-3}$  and  $0.5 \mu\text{g.m}^{-3}$  8-hour TWA, measured as BaP. The old CTPV limit of  $0.14 \text{ mg.m}^{-3}$  equates to between 1 and  $2 \mu\text{g.m}^{-3}$  BaP.

The following industries/ processes were contacted:

Aluminium smelting	Iron and steel founding
Bitumen refining	Motor tyre manufacture
Carbon black manufacture	Petroleum cracking
Coal composite goods manufacture	Road dressing
Coal fired power stations	Roofing
Coke ovens	Tar distillation
Fish smokehouses	Timber impregnation

12. A meta-analysis covering all reported information to mid-2002 was commissioned by HSE from the London School of Hygiene and Tropical Medicine (LSHTM) - “Cancer Risk Following Exposure to Polynuclear Aromatic Hydrocarbons (PAHs): a Meta-Analysis”. The results of this work were discussed by WATCH in September 2002. The meta-analysis was intended to provide the best estimate of human cancer risks related to exposure to PAHs (again using BaP as a surrogate indicator of exposure), using published information from groups of workers in coal-tar related industries. The industries with highest risk per unit BaP were road dressing and chimney sweeping, and a slightly lower level of unit risk was predicted for workers in coke ovens, gas works and aluminium production. Absolute risks were higher in the latter industries, however, because of the higher exposure levels.

13. An analysis of the costs provided by industry, based on compliance with a MEL set at either  $0.5$ ,  $1$  or  $2 \mu\text{g.m}^{-3}$  for PAHs measured as BaP, in all industries, did not indicate a significant cost difference at each of these values. This is because the total costs for UK industry to comply with these values are largely centred on CTPV industries, and in particular coke ovens. Reducing exposure to any of these values would require major refurbishment of coke ovens, which would incur excessive costs. However, it has long been established that adequate control, with current technology, can only be cost-effectively achieved with the use of respiratory protective equipment. Therefore, compliance with any of these values by operators of coke ovens is reasonably practicable to achieve, with the accepted use of respiratory protective equipment programmes.

*Biological monitoring guidance value*

14. On the basis of the measured levels of 1-hydroxypyrene in the urine of workers exposed in the various industries surveyed, WATCH agreed to recommend a Benchmark Value at 4  $\mu\text{mol/mol}$  creatinine.