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A review of the effectiveness of respirators in reducing exposure to polycyclic aromatic hydrocarbons for coke oven workers

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Objectives

In 2011 recommendations for the prescription of lung cancer in coke oven workers was made. In the 1970s, helmet respirators, in this case the Airstream helmet, were introduced to the UK coke industry with the main aim of reducing exposure to polycyclic aromatic hydrocarbons (PAH) aerosols for workers on the coke oven tops.

This review aimed to identify the level of protection achieved by the Airstream helmet and when the helmets could be considered to have provided effective protection and whether the levels of protection have been maintained to the current time.

Methods

Five approaches were taken to identify review material, including searching the peer-reviewed and grey literature; searching of archive materials; using a Freedom of Information requests to government agencies; interviews with employees involved in the introduction of the Airstream helmet and acquisition of company reports.

Results

The UK companies involved in coke production took different approaches to the introduction of the Airstream helmets. Because of this, it can only be considered that effective wear occurred in the industry from 1982 onwards. The exposure measurements made by British Steel in the late 1970s suggest that the mean protection factor of the Airstream helmet was approximately 10, regardless of whether exposure was assessed as the inhalable aerosol or other measures more specific to the aerosol PAH. More recent data collected using biological monitoring has identified that average urinary levels of 1-hydroxypyrene generally correspond with the inhalation occupational exposure limit for benzene soluble material, although on occasion high urinary PAH levels have been identified, underlining the necessity to maintain close supervision of workers wearing respirators.

Conclusions

Overall we concluded that the wearing of helmet respirators has and continues to effectively control exposure to PAH for most workers on coke ovens.

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EXECUTIVE SUMMARY

In September 2011, the Industrial Injuries Advisory Council made recommendations on the prescription of lung cancer in coke oven workers. The prescription was based on research carried out within the industry over the last 40 years. In the 1970s helmet respirators, a novel method of respiratory protection, were introduced to the UK coke industry. The main aim of these respirators, in this case the Airstream helmet, was to reduce exposure to polycyclic aromatic hydrocarbons (PAH) aerosols, particularly for workers on coke oven tops. The aim of this review is to identify the likely level of protection from the use of the Airstream helmet, and powered respirators, and whether the protection has been maintained to the current time. This was assessed by identifying the jobs in the coal carbonisation industry where helmet respirators had to be used, when the helmet respirators were considered to be effectively worn, the likely reduction in exposure to PAH achieved, the overall protection from wearing powered helmet respirators and whether such protection has continued to be effective.

Five approaches were taken to identify review material including searching of the peer-reviewed and grey literature; searching archived material held by National Archives and the Coal Liabilities Unit at Iron Mountain; use of a freedom of information request to government agencies; interviews with managers and other employees involved in the introduction of the Airstream helmet and acquisition of British Steel Corporation reports relating to the period of introduction and more recent measures introduced by Tata Steel.

Review of the National Archive and Iron Mountain material identified that different approaches were taken to the introduction of the Airstream helmet by the two major companies involved in coke production in the UK at the time. However, there was consistency in the job titles identified where individuals would have been working either on the coke battery tops or sides.

A number of difficulties were encountered when trying to identify the date from which respiratory protection was likely to have been effectively worn. It was considered by those in the industry that effective protection could be obtained by wearing the Airstream helmet with the visor down 75% of the time. The approach taken by the British Steel Corporation was that wearing the Airstream helmet was always required to be worn. The reviewed material suggests that for the British Steel Corporation helmets were effectively worn from 1979, but for National Smokeless Fuels this was not until 1982. Therefore, overall it can only be assumed that the Airstream helmets were effectively worn in the industry from 1982 onwards.

The exposure measurements made by British Steel Corporation in the late 1970s suggest that the mean protection factor of the Airstream helmet was approximately 10, regardless of whether exposure was assessed as the inhalable aerosol or other measures more specific to the aerosol PAH present. The minimum protection factor achieved on any individual worker on a single day was 2. More recent data collected using biological monitoring has identified that average urinary levels of 1-hydroxypyrene generally correspond with the inhalation occupational exposure limit for BSM, suggesting effective control. On occasion, higher levels have been found on individual workers or groups of workers, which underlines the importance of continuing management supervision in ensuring the effectiveness of the respirators. Overall we concluded that the wearing of helmet respirators has and continues to provide effective control of exposure to PAH for most workers on coke ovens.

1 INTRODUCTION AND AIMS

Coke is manufactured by heating coal to between 1,000 and 1,400 °C in an oxygen deficient atmosphere to drive off the volatile components such as tar and leave a carbon residue. The process is carried out in a coke battery, which comprises many separate slot ovens into which the coal is loaded. The process lasts between 12 and 36 hours and at the end the doors on either side of the oven are opened and the hot coke is pushed into wagons (cars) before being quenched in water. Figure 1 shows the Ravenscraig coke battery displaying the narrow slot ovens.

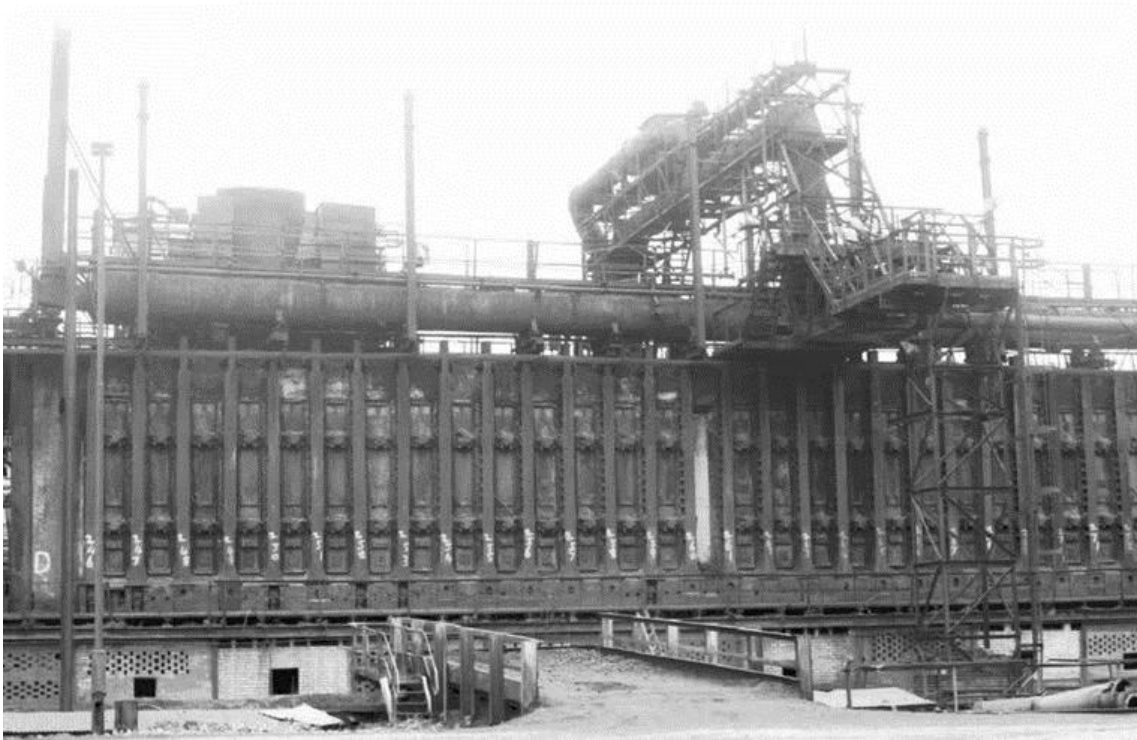


Figure 1 A Ravenscraig coke oven battery

Workers were employed to work on the top of the ovens to fill the coal into the ovens and to regulate the capture of the volatile components for transportation to a by-products plant. Those working on the oven sides were involved in opening the doors, arranging for the coke to be pushed out of the oven (using a ram car) and guiding the hot coke out of the oven. Other workers were employed elsewhere around the coke works on various tasks. Exposure to the emissions from the coking process was generally highest for oven top workers, followed by the side workers and then those working elsewhere.

In the 1970s most coke workers in Britain were employed by two companies, British Steel plc (known then as the British Steel Corporation) and Coal Products Ltd (prior to 1994 known as National Smokeless Fuels Ltd or NSF). NSF was owned by the National Coal Board. The British Steel Corporation later became part of Corus, which was then taken over by Tata Steel.

In September 2011, the Industrial Injuries Advisory Council (IIAC) recommendations on the prescription of “Lung cancer in coke oven workers” were presented to Parliament (IIAC, Department for Work and Pensions, 2011). The paper describes a review of lung cancer in coke

oven workers as a consequence of exposure to polycyclic aromatic hydrocarbons (PAH), updated since the first review in 1986 (IIAC, 2011). On the basis of more recent research cited in the document, a decision was made by IIAC to recommend that lung cancer associated with at least five years of work on a coke oven top or at least 15 years of other coke oven work should be a prescribed disease. The prescription was based on research evidence published since 1986 that identified that there was more than a doubling of risk of lung cancer after 5 years of work on the coke oven top, or more than ten years employment in general oven work resulted in more than a doubling of risk, based on the work of Hurley *et al.*, (1991) and other researchers. This recognised there are higher risks associated with being a coke oven top worker, where each year of working on an oven top was made equivalent to 3 years of being a general coke worker. The recommendation for prescription is summarised in Table 1.

Table 1: Recommendation for prescription (Industrial Injuries Advisory Council, Department for Work and Pensions, 2011)

Disease	Occupation
Lung cancer	<p>Employment wholly or mainly:</p> <p>(a) as a coke oven worker for a period in aggregate of at least 15 years</p> <p>or</p> <p>(b) as a coke oven worker employed specifically in top oven work for a period in aggregate of at least 5 years</p> <p>or</p> <p>(c) In a combination of top oven and other oven duties, such that each year in top oven work be treated as equivalent to 3 years working in other oven duties, the aggregated sum amounting to 15 years in total</p>

IIAC considered the impact of the reduction in exposures for coke oven workers due to improvements in the coke industry since the early 1970s. For example, IIAC cite the study of Romundstad *et al.*, (1998), which found a reduction in exposure to PAHs of 60% when comparing measurements made between 1977-1997 with those made in 1976 or earlier. The IIAC considered setting a cut-off date for prescription, but due to a lack of evidence in relation to reduced risk or exposure-response relationships within the industry, a decision could not be made (Industrial Injuries Advisory Council, Department for Work and Pensions, 2011). However, IIAC have agreed to revisit this question should further evidence be made available.

Although workplace maintenance is likely to have reduced exposure to PAHs for coke workers, the development of personal protective equipment (PPE) is also likely to have had an impact. One of the main developments in the industry was the introduction of the helmet respirator, which was first described in 1973 (Anonymous, 1973) as:

‘...a hood or space helmet that is being developed by the Safety in Mines Research Establishment (SMRE) of the British National Coal Board. Its design comprises a small battery powered axial fan that blows dusty air through a bag filter mounted inside the top of the helmet, and the clean filtered air passes over the wearer's face and escapes from the bottom of a flexible skirt which is designed to reduce inward leakage of unfiltered air. A pre-filter is used to remove large dust particles from the air, and this both prolongs the life of the main filter and protects the fan. The helmet incorporates a visor which can be opened to enable the wearer to eat, drink, blow his nose, etc., without having to remove the helmet.’

The design was finally described by Greenhough (1975). The helmet respirators were eventually commercialised by Racal as the Airstream helmet. They were marketed to a number of industries and were introduced into the British coal carbonisation industry from the mid-to late 1970s. The main aim in their introduction into this industry was to reduce exposure to PAH, particularly for workers on the coke oven tops.

Since the introduction of the Airstream helmet, further manufacturers have also developed powered respirators including the Cobra (MSA Designs) and the Pureflo (3M) designs. Within the report where specific powered respirators are mentioned their name will be used e.g. the Airstream helmet; with the phrase powered respirators used generically.

The effectiveness of respirators is often carried out in the laboratory and these tests may involve assessing the effectiveness of the filter element in the device, i.e. the filtration efficiency. However, when respirators are worn the overall effectiveness depends on both the effectiveness of the filter and the reliability of the seal between the face and the respirator, if this is poor then contaminant may leak into the inside of the respirator and be inhaled. Assessments of the overall protection is often measured by simultaneously sampling the contaminant in the air outside and inside the respirator and taking the ratio of these two measures, which is known as the protection factor. A protection factor of 10 would correspond to the concentration inside the respirator being a tenth of the concentration in the outside air. The effectiveness of respiratory protection can also be assessed using biological monitoring data that assesses internal body burden and therefore the actual concentration inhaled by the workers accounting for the protection afforded by the respirator.

The aim of this report is to provide an assessment of the likely level of protection that occurred after the introduction of powered respirators into the British carbonisation industry and whether this level of protection has been maintained to the current time. The review aimed to address the following:

- The jobs in the coal carbonisation industry where powered respirators were required to be used;
- The date when powered respirators were considered to be effectively worn by the majority of workers in these jobs;
- The likely reduction in exposure to PAH achieved by wearing a powered respirator;
- Evaluate the overall protection from PAH exposure from wearing powered helmet respirators;
- Assess whether powered respirators have continued to provide effective protection to the current day.

2 METHODOLOGY

Five approaches were used to identify source material for the review:

- searching the published research literature, both peer-reviewed and grey literature
- searching archived material held by National Archives and Iron Mountain
- use of a Freedom of Information Request to government agencies
- interviews with managers and other staff involved in the introduction of the helmet respirator into the UK carbonisation industry.
- acquisition of British Steel Corporation reports covering the time period of the introduction of helmet respirators and more recent measures of respiratory protection from Tata Steel.

To identify published research in this area, a search strategy including search terms and search combinations was developed. Searches were carried out on a number of databases including Medline, Highwire and Google Scholar. The search strategy is presented in Appendix A and covers the search terms used and the limits to the searches.

The second method used was to identify from National Archives, relevant documents from the UK carbonisation industry in relation to the development and adoption of powered respirators. These were supplied from National Archives or Iron Mountain. Documents including meeting minutes, memos and codes of practice and these were reviewed. The documents were screened and summary information collated into the timeline shown in Appendix B.

A Freedom of Information request was sent to the UK Health and Safety Executive (HSE) asking for information on the use of powered respirators (Airstream helmets) principally in the coke industry, but also in other industries where powered respirators are known to have been used, i.e. steel, coal, construction, welding, pharmaceutical, chemical (powder handling).

Finally interviews were carried out with individuals employed or involved with the coke industry and the implementation of Airstream helmets in the 1970s and 1980s. These included occupational hygienists who were involved in the introduction and evaluation of the Airstream helmet in the 1970s at both National Smokeless Fuels and British Steel Corporation and coke plant managers. The aim of the interviews was to obtain corroboration of the information obtained from the searches and the timeline of events. Three interviews were carried out by telephone and two interviews were carried out face-to-face. The interview was semi-structured and aimed to identify the time period in which the participant was involved with the either of the companies, feedback on the timeline of events produced by IOM and corroboration or rejection of the information identified by IOM from the historical material.

3 RESULTS

3.1 RESULTS OF THE LITERATURE SEARCHES

The search of the research databases identified 77 publications in relation to powered respirators and the Airstream helmet. These were screened as to whether they contained relevant information to inform the review. This resulted in the inclusion of 19 publications in the report. A further 11 documents were received from Tata Steel which had been published as company documents for either the British Steel Corporation or Tata Steel. Additional materials were also provided by a former employee of British Steel.

Approximately 2000 National Archive files and documents were screened during the review process. This resulted in the summary table presented in Appendix B of the timeline of events in the introduction of the helmets into the two organisations involved with coal carbonisation: British Steel Corporation and National Smokeless Fuels (NSF), which was a subsidiary of the National Coal Board (later known as British Coal). NSF was previously known as the Coal Products Division of NCB.

The FOI to HSE did not result in any usable material for the review.

3.2 THE DEVELOPMENT OF THE AIRSTREAM HELMET

The development of the Airstream Helmet was via the coal mining industry in the UK. The helmet as described previously comprised a head-shell and visor assembly with a built in fan-filter system which directed filtered air into the breathing zone of the wearer. The helmet was initially developed by the Safety in Mines Research Establishment (SMRE) for use in underground environments. Figure 2 shows a diagram of the helmet taken from Treaftis *et al.*, (1981).

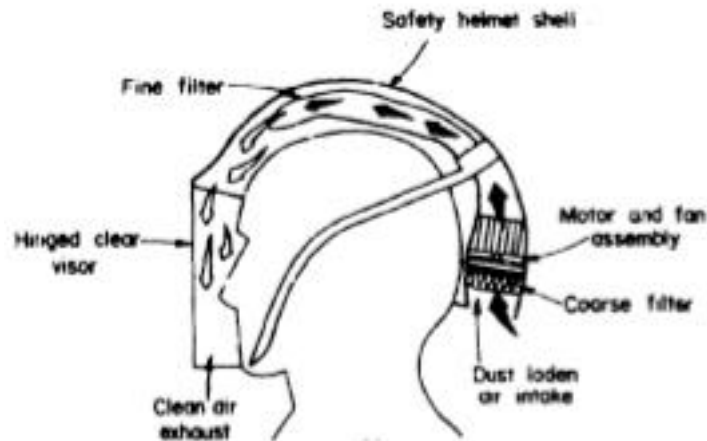


Figure 2 Schematic diagram of the Airstream helmet taken from Treaftis *et al.*, (1981)



Figure 3 Testing of a Powered Respirator

3.3 INTRODUCTION OF POWERED RESPIRATORS TO THE UK CARBONISATION INDUSTRY

The need for increased respiratory protection in the UK coal carbonisation industry was as a result of the identification of the increased risks of lung cancer from exposure to PAH produced as a result of the process (Redmond *et al.*, 1976).

In the United States, a Threshold Limit Value (TLV) of 0.2 mg/m^3 had been recommended for employees exposed to PAH, expressed as benzene soluble material or BSM (Davies *et al.*, 1986). In 1978, an HSE Guidance note (EH15.78) stipulated that this TLV should apply in the UK. As Davies *et al.* (1986) noted, the determination of BSM presented a health hazard because of the toxicity of benzene and the less toxic cyclohexane was used as an alternative solvent. From 1990 reported measurements were for cyclohexane soluble material (CSM) but are for simplicity all the measurements are described here as BSM. The percentage of collected material dissolved using the CSM method was less than with BSM, but the quantities of the more toxic PAHs were similar using both methods (Davies *et al.*, 1986).

The National Archive material allowed for the examination of papers including memos and minutes of different meetings held in both NSF and British Steel Corporation from the early 1970s. This material provides an insight into both the development of the Airstream helmet in the coke industry and how it was brought into use. A timeline of events is presented in Appendix B.

Epidemiological studies in the coke industry had been on-going through the 1960s and the potential link between lung cancer and coke oven workers in the US steel industry was recognised in the early 1970s (Lloyd, 1971). The National Archive material started in 1972, with a memo to senior staff at the Institute of Occupational Medicine (IOM), where there was

recognition that there was a risk to the health of employees and people should not work on the oven tops for more than 5 years.

At the time there were internal committees at NSF and British Steel Corporation charged with managing risks in coke ovens, but as a result of the need to develop suitable PPE, a Working Group on Environmental Control at Coking Ovens was formed with representation from both companies as well as other stakeholders include management and union representations. This group had its first meeting on the 27th of January 1975.

The Safety in Mines Research Establishment (SMRE) powered respirator was first mentioned at a meeting of NCB Coal Products Division on the 26th of January 1973. This helmet was also mentioned at a meeting of the Joint Working Party on the Environment at Carbonisation Works on the 7th of June 1974. This was followed by the successful testing of an SMRE helmet at Avenue coke works (NSF 18/07/1974). At the first meeting of the Working Group on Environmental Control at Coking Ovens, development of the new respirator carried out by SMRE and NSF was reported, but it was recognised that further work was needed to provide a reliable device (27/1/1975).

In the next reported meeting of the Joint Working Party on the Environment at Carbonisation Works in May 1975, it was reported that it was intended to form a consortium, involving the British Steel Corporation and NSF, to build a prototype helmet that would be available to test in 9 months' time. However, in November 1975, it was reported that progress on the development of the ventilated helmets had stopped and it appeared that it would be the end of 1976 before production helmets would be available to test (Working Group on Environmental Control at Coke Ovens). In February 1976, it was reported by NSF that Racal had signed an agreement to manufacture the helmets. Figure 3 presents a timeline of events in both industries from the collated material. Note that entries on the left (in black text) are general events, entries on the right above the timeline (in blue text) relate to British Steel and those on the right below the line (purple text) relate to NSF.

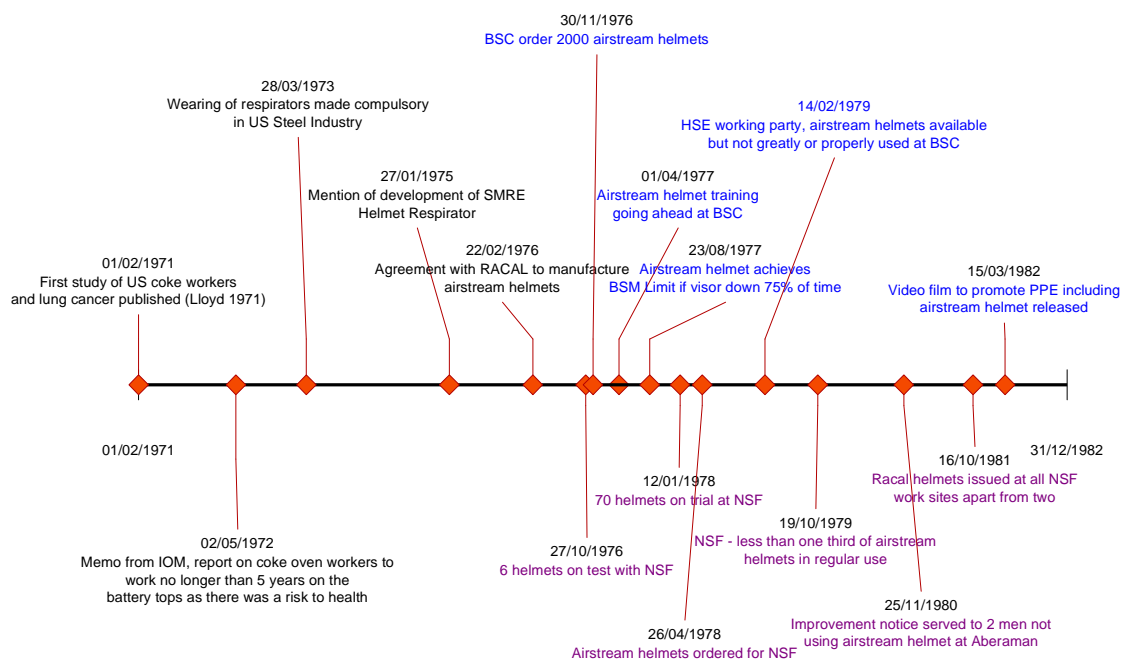


Figure 4 Timeline of events in the coke carbonisation industry

3.3.1 Introduction of the Racal Airstream Helmet at the British Steel Corporation

From 1976 the British Steel Corporation took a faster approach to the introduction of the airstream helmet. From the minutes of the Working Group on Environmental Control at Coking Ovens, it was reported that the British Steel Corporation were going to carry out user trials with the helmet (18/03/1976). Although it was suggested in June 1976 that the British Steel Corporation and NSF could have a common policy on towards Racal Amplivox, it was reported in October 1976 that the British Steel Corporation were going to order 2000 Racal Airstream helmets. The user trials also reported that the workmen found the helmets acceptable and 85% would be happy to wear it. Although there had been some problems with the design, identified by both the British Steel Corporation and NSF, it was reported that Racal would modify the helmet design to take account of their concerns. Within this document it was reported that NSF was to be supplied with 20 Airstream helmets to use throughout all the works on a trial basis.

In October 1976, the British Steel Corporation published the technical specification for Eye-Face-Head-Respiratory Protector for use on Corporation Coke Ovens. This was followed in December 1976 with the publication of two reports, "Airstream System Document 3: The Technical Specification of the Helmet" and the "Servicing Design Centre". In April 1977, at the 31st Meeting of the British Steel Corporation Joint Accident Prevention Advisory Committee, it was reported that coke oven personnel were being trained in the use of the Airstream helmet and this was going forward at works level. The approach taken by British Steel was based on operators being instructed to wear the Airstream helmet 100% of the time when at the coke ovens, and although it was known that adequate protection levels could be achieved by wearing the helmet respirator 75% of the time this was not how it was presented to employees. In May 1977, the British Steel Corporation met with HSE who were very interested in the programme set up by the company and they reported they would follow-up quickly on all sites and insist that the men wear the protection. The aim was to help management locally in getting the Airstream worn properly and regularly.

A number of problems had been identified by the corporation in July 1977 that included a lost batch and a number of helmets that had deformed due to heat exposure. They also reported difficulties in training maintenance staff. However, during October they also reported a positive result in a reduction in the number of eye injuries. At a joint meeting with NSF in December of 1977, the British Steel Corporation reported that the Airstream had been introduced at 9 works, 4 would be soon and at 5 further works no date had yet been set. They reported 2000 helmets currently in use with 85-95% of men using them. In a British Steel Corporation meeting in December 1977, a number of problems were identified with the helmet, including:

- Heat Distortion – delay in production of the snood and visor protection components at Racal
- Fan/Motor Units and Cables developing faults and not standing the heat
- Large number of cable faults, now been replaced free of charge
- Batteries – casing splitting and some defectives, being replaced free of charge
- Filters – variation in stiffness of the filters – Racal agreed to look further into this matter
- Airflow – cooling effect insufficient in some helmets. Is between 220/240 l/min but stream of air needs directing over forehead. This can be done locally
- Visor – scratching a problem but needs to pass impact test – further research being done
- Testing Equipment – sensitive and requires calibration.
- Temple seals – now produced with better adhesive

No further meeting notes were available for the British Steel Corporation until February 1979. At this meeting of the HSE Working Party on Coke Ovens it was reported that the helmets were available but not widely or properly used and more training was needed. In November 1979, at a joint meeting of the British Steel Corporation and NSF Working Party on Dust it was reported that reaction to the Airstream helmet ranged between acceptance and rejection.

In a letter from the British Steel Corporation to NSF on the 18th of March 1981, it was stated that in a joint meeting with HSE, the corporation and NSF on the 13th of January 1981 that “The HSE were anxious to ensure that the coke oven tops became a protected area with suitable protection being worn with the availability of masks for those in peripheral areas. The target date for the attainment of this was July 1981”

In summing up, “The chairman reiterated that 1 July 1981 was the hoped for commencement date for use of personal protection equipment and the time scale for the other elements would be dependent on working practices, possibly mid-1982” (Letter from the British Steel Corporation to NSF 1981). The other elements it is assumed are the setting up of maintenance facilities to ensure the continued protection of the equipment. In a further document on Working Practice (Part 11 Respiratory Protective Equipment), “RPE should be provided for those employed in places where the control of BSM concentrations within the TLV cannot be ensured. RPE should be worn at all times on the battery tops. RPE should be worn in those circumstances where concentrations of BSM are known to be above the TLV and where such concentrations can reasonably be expected to be present.”

Since the introduction of the Airstream helmet in the late 1970’s, further developments have been made in PPE and in the numbers of manufacturers involved in producing powered respirators. This included the Cobra respirator at Teesside and Port Talbot and the Pureflo at Monckton. These respirators were used as they were felt to have greater employee acceptance and better manufacturer support.

3.3.2 Introduction of the Racal Airstream Helmet at NSF

A different approach was taken to introduce the Airstream helmet to NSF. In January 1976, in the NSF and Thomas Ness¹² South Western Regional Consultative Committee, it was noted that wherever there was exposure to dust and fumes, there was a need to wear a respirator and the greatest need was on the oven tops and near the ovens. In March 1976, it was reported that 20 pre-production Racal Airstream Helmets had been ordered by the Thomas Ness/NSF Safety Committee. In October of 1976, at the Joint British Steel Corporation/NSF Working Party on Environmental Control Second Meeting, the sourcing of the helmets was mentioned again. However, in October of 1976, NSF/Thomas Ness South Western Regional Consultative Committee reported that 6 battery powered helmets were on trial at Nantgarw with two lid men, one charge car driver, one mainsman, one cokeman and one ramside doorman. It was reported that acceptance of the helmets was good but issues of filters not filtering the gas were creating a problem.

In a meeting of the Joint Working Party on the Environment at Carbonisation Works in November 1976, a later model of the helmet was demonstrated. This model could now fit 99% of heads. In January 1977, it was reported that Airstream helmets were on trial at the

¹ Thomas Ness were a subsidiary company producing tar

² Thomas Ness were a subsidiary company producing tar

Phurnacite³⁴ works and if these proved successful they would also be trialled at Codely and Cwm coke works. At the February 1977 meeting of the NSF Ltd Northern Region Consultative Committee, there was further discussion of impressions of the Airstream helmet. Comments were that despite some of the criticisms of the helmet, the operators liked them. Some of the issues identified included a lack of a chin strap, misting of the visor and lack of ability to deal with heat in the visor design. Exhaustive tests were recommended from this meeting.

In March 1977, it was reported by the NSF Environmental Control committee that there were 70 helmets available to NSF. It was also reported that the TLV standard of 0.2 mg/m³ could be achieved by the helmet if the visor was kept in the down position for 75% of the exposure time. Further issues identified included the misting of the visor and the problem of heavy rain obscuring vision through the visor. There were discussions about the need to formulate a policy as to whether the workforce would be instructed or requested to use the helmet. No firm recommendations would be made for a further nine months.

The NSF/Thomas Ness South Western Regional Consultative Committee met in April 1977. The minutes report on the use of 6 helmets at Nantgarw and that there was generally a favourable response. The helmet was now reported to be 80/90% and 70% efficient in filtering dust and BSM. Servicing was expensive and to assess this, a further 50 would be distributed at Nantgarw and as many helmets as possible made available at Phurnacite.

From a meeting of the Joint British Steel Corporation/NSF Working Party on Environmental control in April 1977, it was identified that at NSF, following initial trials in the Midlands, a further 20 helmets were allocated to other sites. It was reported that the general reaction had been good but there were criticisms on the grounds of weight, bulk, shape, inability to tilt the head backwards, smearing and scratching of the visor and audibility problems. Again it was reported that the protection levels could be achieved but the experience was that many men wore them in the up position 50% or more of the time. There were also questions raised about the intrinsic electrical safety of the helmet. The reports of men wearing the helmets with the visor raised more than 50% of the time were reiterated in the June 1977 meeting of the NSF Ltd Environmental control committee.

In October 1977, at a meeting of the NSF Ltd Cwm Coking Works and Power Station Works Consultative Committee, it was reported that the trials had proved the Airstream helmet to be successful and a member asked for them to have sufficient delivered as soon as possible. The chairman replied that it was the company's intention to obtain helmets as soon as their effectiveness was proven and time would be needed for the manufacturers to produce the numbers required. In December 1977, at the British Steel Corporation/NSF working Party on Environmental Control, it was reported that there were 70 Airstream helmets in use at NSF with a few deployed at other coking work, tar plants, pitch bays and acid plants. However, in January 1978, at the NSF Environmental Control Committee meeting it was recorded that there were problems with servicing the 70 helmets on trial.

The NSF Scientific Department in February 1978 reported that 41 Airstream helmets were in regular use and were generally well received and in demand. These had been tested with the original 6 in January 1977; a further 10 at the Phurnacite plant (5 on the ovens, 5 on

³ Phurnacite was a subsidiary company producing domestic smokeless fuel using a coal carbonisation process.

⁴ Phurnacite was a subsidiary company producing domestic smokeless fuel using a coal carbonisation process.

briquetting), 3 to oven top workers and a further 3 requests from Nantgarw and 3 at Coedely. A number of problems were identified in using the airstream helmet including concern that the cables would not withstand the work conditions, the visor not staying up, the helmets were cumbersome in small spaces (ram and guide men) and were successfully used on the coke oven tops but with the visor up. There was a perception that due to not feeling the heat as much, there was a risk of melting of the equipment. In April 1978 at the NSF and NUM Joint Working Party on the Environment at Carbonisation Works it was reported that there were 75 helmets in place and NSF were now purchasing a further 250.

The introduction and use of the helmets over the next two years within NSF was variable. In the minutes of the NSF Environmental Control Committee of May 1978, it was commented that there were 45 helmets at Nantgarw but only two were in use at any one time. It was suggested that further regular training could improve their usage. In June of that year the Northern Group reported that they were still awaiting delivery of helmets. In December of 1978, the NCB Safety Department reported that a further 50 helmets were being distributed to Nantgarw and Manvers where servicing facilities were installed. 136 were now available with 100 in regular use.

In April 1979, the NSF Environmental Control Committee reported that 300 more helmets had been purchased and a need to issue the helmets and provide servicing facilities. It was reported that the Coventry site would have 111 helmets the following month. However, these minutes also highlight that there was still a need for a policy on the use of Airstream helmets. From the NSF Directors Meeting in May 1979, it was reported that NSF had 300 helmets with 100 unused. The Inspectorate was taking the view that they would insist on the use of the helmet until conditions in the workplace improved. If this was accepted then NSF would need a further 100 helmets. The decision was an agreement to run further trials with 100 more helmets but not to purchase more.

In June 1979, the Phurnacite Works Manager's Report identified that HSE were concerned that the Airstream helmets should be available to all men to wear where warranted. In the same month the NSF Environmental Control Committee reported that they wanted to encourage people to wear the Airstream helmet before it was made a condition of service.

During the latter months of 1979, issues including the problems of tar deposits altering the fans and damaging the motors were also identified. In November that year, the use of a disposable mask (3M disposable mask) was tabled at the NSF Accountability Meeting. By December that year, NCB Coal Products had experimented with the masks and there was concern about whether a satisfactory seal to the face could be achieved. It was reported in this meeting that all Airstream helmets at Nantgarw and Aberaman were fully utilised. In the 1979/80 NCB Coal Products Safety Department Annual Review, it was identified that there was user resistance to the disposable masks due to facial discomfort in hot locations.

During February 1980, Airstream helmets were issued in the North East region after Factory Inspectorate pressure. Trialling of the 3M dust masks was also carried out at the Phurnacite works. At a meeting of the board at Phurnacite in March 1980, it was decided that the disposable masks were suitable on the briquetting works but not well received on the batteries. There were four Airstream helmets in use on the batteries. In April of 1980, the NSF Environmental Control Committee reported that the 3M masks were unacceptable on the oven tops but acceptable on the briquetting works, and HSE found the present position acceptable.

In November 1980, at a meeting of the Phurnacite Joint Safety, Health and Environment Committee, it was reported that the Factory Inspectorate wanted everyone to wear an Airstream helmet and it should be made a condition of employment. The company legal department

needed to check this and a further 80 helmets were sourced. In this same month an improvement notice was served that required all men on the Phurnacite batteries to wear respiratory protection.

The annual report from the Coke Oven National Consultative Council Safety in Coal Products (1980/1981) stated that the Airstream helmet was on issue at all works except Avenue and Smithy Wood. This was due to the time taken to provide maintenance facilities. The report also suggested that the degree to which the helmet was worn varied considerably between sites and that it had been used with the visor up on occasions. The HSE were insisting on continuous use of respiratory protection on the batteries and although the 3M mask would be acceptable, it was thought that the Airstream helmet or its equivalent was the type envisaged. Compulsion to wear protection by whatever means (prosecution or condition of service) was not seen as the most acceptable way forward. It was thought that acceptance would follow education and example and would be a topic in forthcoming training sessions in the use of protective equipment.

In April 1981, the minutes of the Joint Safety, Health and Environment Committee reported that they saw a problem in enforcing the wear of respiratory protection before HSE released their guidance notes. However, everyone at the Phurnacite site had been issued with an Airstream helmet and was now wearing them. Two individuals refused but were persuaded by the Inspectorate. At this point Airstream helmets were still not available at Smithy Wood and Avenue sites. In the minutes of the June 1981 meeting of the Aberaman Phurnacite Works Board, that two men had been cautioned for not wearing helmets.

In August 1981 a Cautionary Leaflet on Coke Ovens was sent to HSE but the source of this document is unknown. This stated that "Respiratory protection such as ventilated helmets must be worn at all times with the visors down over the face". In November of the same year, a letter was sent to NSF from HSE discussing the printing of a cautionary card and notes. This was a change in wording to "Employees are reminded that failure to wear the respiratory equipment may in certain circumstances be considered an offence under Section 7 of the Health and Safety at Work Act 1974".

In the NCB Coal Products Limited Annual Review of Safety (1981/1982), the publication of the HSE's guidelines "Reducing Operator Exposure to Fumes and Smoke from Coke Ovens" it was reported that all battery tops have now been designated areas in which respiratory protection must be worn. The Racal Airstream is available to all regular workers in these areas, while casual visitors use the disposable masks type 8800 from 3M. However, in October 1981, the helmet had still not been issued at Avenue and Smithy Wood works (Coke Oven National Consultative Committee).

In March 1992, the Coke Oven National Consultative Committee reported that a video film had been produced to promote the wearing of protective clothing, including the Airstream helmets. The minutes did report that the wearing of the helmet had been compulsory since the HSE report and the video would be shown widely.

In June 1982, NCB Coal Products Ltd Wales, Safety Health and Environment Committee reported that every person on the batteries (working or visiting) should wear PPE to the required standard. The Phurnacite workforce remained convinced of the necessity for an Airstream helmet. From the same committee in September 1982, it was reported that acceptance levels had reached 95% at the Phurnacite works for the Airstream helmet.

3.3.3 Interviews with company staff involved in introducing Airstream helmets

Interviews with 5 people involved during the implementation of Airstream helmets were carried out. These included three occupational hygienists involved in the implementation of the Airstream helmets within the British Steel Corporation and NSF and plant managers from the industry.

The interviews confirmed that different approaches were taken by the two companies. The British Steel Corporation did implement use of powered respirators throughout the company and it became a condition of service that the helmet was worn by all workers at the coke ovens (both top and side workers). However, it is unclear from the archive documents and the interviews whether NSF used the Airstream helmet across all the plants. In the Phurnacite works there certainly was evidence of usage of the Airstream by 95% of workers in 1982. Within NSF according to the archive material, there were no requirements for the Airstream helmet to be worn for the time period covered by the documents. This may have changed with the publication of the HSE report. At this point there were massive changes going on in the coal industry which resulted in the closure of NSF.

In the British Steel Corporation, the Airstream helmets were worn by all men involved in coke work. This included the top oven workers and those working at the sides of the oven. This was reported from an interview with an individual previously employed as a manager at British Steel. The approach taken by the British Steel Corporation in implementing the use of helmet respirators was also different in that employees were expected to wear the Airstream helmet respirator 100% of the time. Although the company had measurement data that indicated that there was effective protection when wearing the respirator correctly 75% of the time, this was not an approach taken in explaining use to the operators.

One further issue raised was the implementation of company responsibility for servicing of the Airstream helmets at the British Steel Corporation. Although it is not possible to identify a specific date when central servicing of the helmet respirators was achieved, this did not happen until the mid-1980s. This does bring further questions with regard to the frequency of servicing, the individual's ability to service equipment, availability of new filters and the will to carry it out. There is no documentary evidence available in relation to when central servicing of helmet respirators occurred so a date cannot be fixed.

3.4 JOBS IN THE COAL CARBONISATION INDUSTRY WHERE HELMET RESPIRATORS WERE REQUIRED TO BE USED

The command paper published in 2011 (Industrial Injuries Advisory Council 2011) identified a number of job titles in relation to prescription of lung cancer, including the following:

- Lidsman;
- Car man (chargerman);
- Valveman or tarman;
- Top oven maintenance worker.

At the British Steel Corporation, Airstream helmets were tested on:

- Ramside doorman;
- Chargerman;
- Valveman;
- Wharfman;

- Guideman;
- Heaterman;
- Tar mains man.

Tests of the Airstream helmet were carried out at NSF on individuals with similar job titles.

From the specification published by British Steel in December 1976, “the helmets are to be issued for production workers on battery tops and sides and the wharf and will include all such shift workers and day men such as tar main attendants”.

This suggests that all the job titles listed and all workers involved either on the battery tops or sides would have been expected to wear Airstream helmets.

3.5 THE DATE WHEN HELMET RESPIRATORS WERE CONSIDERED TO BE EFFECTIVELY WORN BY THE MAJORITY OF WORKERS IN THESE JOBS

During an interview with an occupational hygienist employed at British Steel from 1979-1984, a number of factors were identified in relation to effective wear. In terms of this report this would be wearing the Airstream helmet with the visor down for 75% of working time. The interviewee was employed at a period of change within the industry and was involved in a management review during 1979, which examined the human and behavioural factors in relation to the new Redcar plant. He reported that all stakeholders involved in this period wanted to reduce the occupational risks from coke ovens. At the time of his arrival, Airstream helmets were widely worn by coke oven workers. Although it was reported that at times the men wore the helmets with the visors up, when working on the coke ovens it was estimated that the visors were down 90% of the time. The visors were raised when there was a need to communicate with others on the oven tops and when away from the coke ovens, but not when individuals were at the points of highest exposure. Further data identified at British Steel Corporation identified that in 1991, after workplace observations, the visor was worn in the downwards position for 48% of the time. The additional material also highlights that compliance levels for wearing the powered respirators was 80-85% by 1996.

The interviewee also reported that maintenance of the helmets was also a potential issue. Each employee was given their own helmet and maintenance was up to the individual. There may be some concern that the helmets were not always maintained fully in relation to filter replacement. However, there is no further evidence to support this.

During an interview with an ex-NSF employee it was reported that Airstream helmets were in use throughout the 1980s and this was well policed. The interviewee reported that from him beginning work in Avenue coke works in 1982, the impression was that workers on the coke ovens had to wear the helmets. With the introduction of the Airstream helmets, after testing, it took 18 months to 2 years to become properly established. The interviewee also reported that returning to work at Cwm in 1992 that wearing the Airstream was a normal part of the work for the coke oven workers.

From the interviews and the National Archive documents, there can be no specific date given as to when employees can be considered to be effectively wearing Airstream helmets. The information collated suggests that this was earlier in British Steel when compared to NSF. However, the introduction of the Airstream helmets and the maintenance facilities took time to develop in both British Steel and NSF. The earliest point that effective wear of the Airstream helmet is reported anecdotally is 1979 for the British Steel Corporation. In reviewing the information from NSF, it was not until 1982 when workers were warned by the Factory

Inspectorate that it can be considered there was effective wearing of the helmets. At this time the wearing of respiratory protection became a condition of work within the business. However, it is still unclear how quickly respiratory protection was put in place across the different coke manufacturing plants.

What has not been covered in great detail, due to a lack of information, is the impact of behavioural issues such as the wearers' perceptions and expectations with regard to powered respirators. One point made is that the filters within the respirators remove particulate matter but not vapour and this resulted in the wearer being able to still smell "fumes" when wearing a powered respirator. This has the potential to result in the wearer perceiving that they are not being protected and will therefore not be motivated to wear the respiratory protection unless being observed. At the current time there are no data to corroborate or refute this suggestion but it is another factor that must be considered when evaluating the effectiveness of powered respirators both historically and at the current time.

3.6 THE LIKELY REDUCTION IN EXPOSURE TO PAH ACHIEVED BY WEARING A HELMET RESPIRATOR

3.6.1 Introduction

The published scientific literature was searched to identify papers that could inform the assessment of the likely reduction in exposure to PAH for coke workers wearing helmet respirators. In addition, we were provided with copies of reports from the British Steel Corporation and Tata Steel that describe tests of various helmet respirators in British coke ovens, and data from five other investigations by British Steel scientists at various coke works.

The effectiveness of respiratory protection is dependent on two main factors: the effectiveness of the filter element in removing contaminant from the air being inhaled by the wearer and the reliability of the seal between the respirator and the wearer's face in minimising ingress of contaminant that bypasses the filter. Tests of filter elements are generally carried out in a laboratory setting. They involve drawing contaminated air directly through the filter and measuring the contaminant air concentration before and after the filter element. The results from these tests are expressed in terms of filter efficiency, the ratio of the upstream to downstream concentration, as a percentage. Tests of the ingress of contaminant around the face seal may be carried out in the laboratory in simulated working conditions or combined with penetration through the filter in actual workplaces with workers wearing the respirators during their normal tasks. The contaminant concentration is generally measured inside the respirator facepiece and just outside the facepiece within the worker's "breathing zone", i.e. close to the nose and mouth. The results of these tests are most often expressed as a protection factor, where the protection factor is the ratio of the concentration outside the mask to the concentration inside the facepiece. Workplace assessments may provide a more reliable assessment of actual respirator performance than data from laboratory tests.

3.6.2 Review of the scientific literature

Early studies of the Airstream helmet mainly focussed on laboratory assessments of the device. Treafis *et al.*, (1981) from the US Bureau of Mines evaluated the filter elements from two models of Airstream helmet against coal and silica dust (the authors say the main difference between the two devices was that the AH5 helmet had a more powerful blower and a more efficient fine filter compared to the AH1 helmet). These tests showed that more than 99% of dust was filtered from the air when the device was challenged with relatively high concentrations of "total" dust, i.e. 9 to 176 mg/m³. There was little evidence of any difference in performance between the two types of respirator filter. Cecala (1981), from the US Mine Safety

and Health Administration, tested the Airstream helmet worn by a mannequin in a wind tunnel and carried out a number of tests in a mine where the helmets were worn by workers or the scientific investigators. In the laboratory, effectiveness was assessed using a tracer gas measured both inside and outside the helmet. At an air flow of 400 feet per minute or fpm (2.03 m/s) the protection factor was 10 or more, but this decreased to less than 4 at 1,600 fpm (8.13 m/s). In the mine tests, respirable dust was measured using two samplers inside the Airstream visor and a single sampler outside the helmet visor. The average protection factor was 6.2 at relatively low ventilation airflow (less than 2 m/s) but this reduced to a mean protection factor of 2 in a high airflow mine (i.e. about 8 m/s airflow). The investigators noted that there were consistently higher concentrations inside the visor on the windward side of the helmet (4.5% to 66% higher), which they attributed to air being forced between the face and the visor seal on this side of the helmet.

Parobeck *et al.*, (1989) studied the acceptability of the Airstream helmet in coalmines in the USA. They noted that the miners did not always keep the visor down in use and that there were minor issues with battery life and the filters. It is clear that with the visor lifted the helmet provides no protection to the wearer. Miners did not wear the helmet respirator when doing heavy work, e.g. shovelling, because of visor fogging.

A study of 24 smelter workers exposed to lead who had access to Airstream helmet respirators was undertaken by Ulenbelt *et al.*, (1991); refinery workers also studied did not have helmet respirators. In a statistical analysis of the data collected, 38% of the variation in lead in blood levels was attributed to the percentage of time wearing Airstream helmets, frequency of spitting, smoking and the lead in air concentration. The reduction in blood lead levels due to the Airstream respirator was statistically significant, but the data were not presented in a way that allows the effective reduction in exposure to be determined. The same group of researchers also reported on the determinants of exposure to the lead battery plant and a smelter (Meijman *et al.*, 1996). In the latter workplace the workers had Airstream helmet respirators. Use of the Airstream helmet was negatively correlated with lead in blood levels (independently of air concentration), showing that it was protective. However, it was again not possible with the data presented to assess the magnitude of the reduction in exposure.

Two published studies have focussed on the effectiveness of helmet respirators in reducing effects of airborne contaminants on the health of workers. A study by Kongerud and Rambj (1991) looked at the effect of wearing a helmet respirator in an aluminium pot room on worker lung function and respiratory symptoms. They used a randomised cross-over study design where workers wore either an Airstream helmet or a 3M disposable respirator for a 2-week period and then during a second period wore the other type of respirator. 25 male workers were enrolled, but six dropped out before the end of the study (24%). Lung function and symptoms were recorded on a daily basis. The authors concluded there was a small statistically significant improvement in peak flow when the helmet respirators were used but no corresponding change in symptoms scores. They attribute the difference to the greater comfort in wearing the helmet respirator and the likelihood that they were worn more consistently than the disposable respirators, although they had no objective data to support this contention.

Taivainen *et al.*, (1998) investigated the effect of wearing four different types of helmet respirator on lung function and respiratory symptoms of a group of 33 asthmatic agricultural workers. Subjects were monitored for three months without the respirator and for 10 months with the respirator. There was a small but statistically significant increase in morning peak expired airflow rate and daily variation of peak flow amongst atopic workers wearing the respirators, but no change in evening or mean peak flow. Wearing the helmet respirator did not affect the farmers with non-atopic asthma. The helmet respirators also reduced sputum

production but did not result in any statistically significant changes in other respiratory symptoms in the atopic patients.

Davies *et al.*, (1986) carried out a study in British coke ovens to assess the magnitude of reduction in exposure provided by these devices when used by coke oven workers, although the main focus of the paper is a general description of exposure measurements made on the plants. They found that the mean protection factors for dust were 12 on one survey and 7 on another, whilst those for BSM the corresponding mean protection factors were 15 and 7. The authors do not present information about the variability in the protective effect or any further details of how the measurements were made.

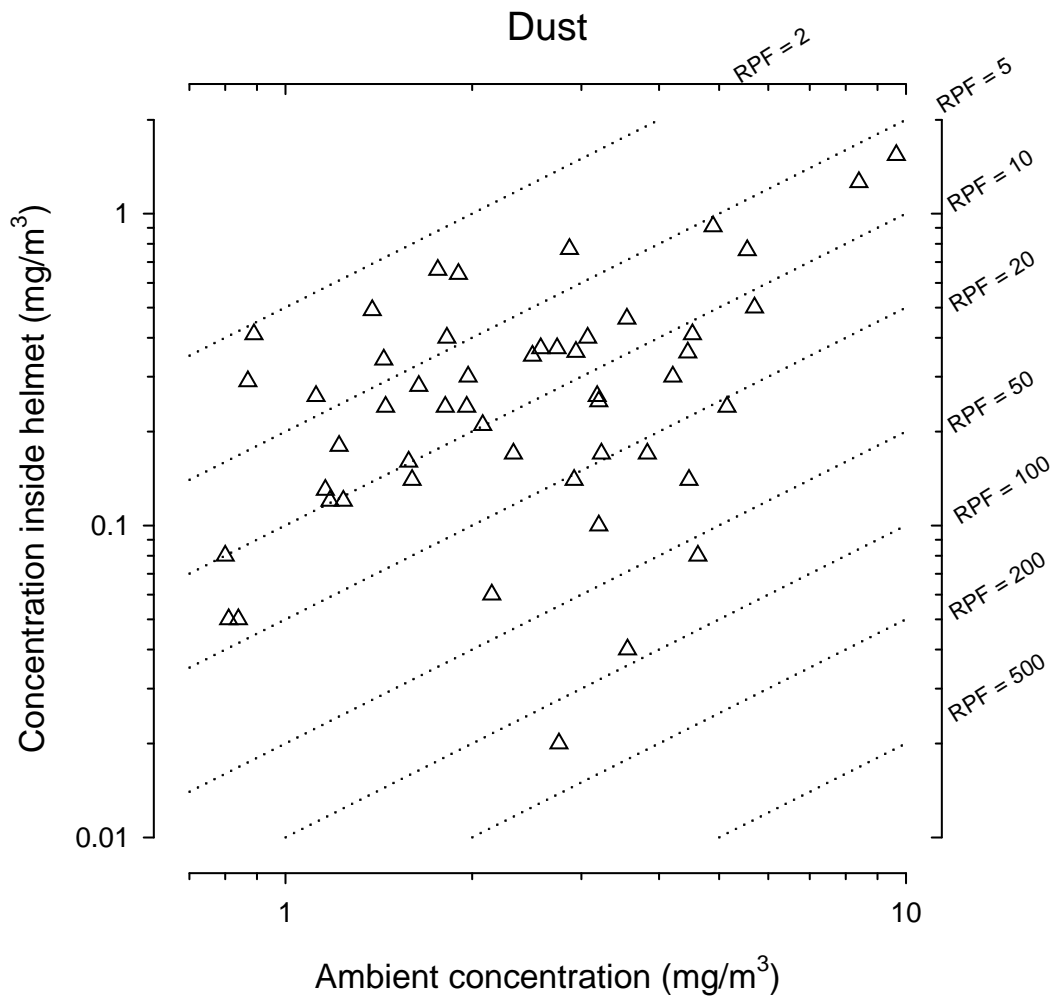
More recently, Wu *et al.*, (2002) describes a study in a coke oven to assess the protection from wearing half-mask cartridge respirators. The mean protection factor was 2.5 (range 1.1 to 9.6). However, in this study no helmet respirators were used and so we have not further described these data.

3.6.3 Measurements of exposure inside and outside Airstream respirators provided by Tata Steel

Tata Steel provided eleven technical reports describing trials on the Airstream helmet and other helmet respirators, which were carried out between 1976 and 2010. In addition, summary data sheets were provided Tata Steel for additional studies where air contaminant concentrations had been measured inside and outside Airstream helmets.

Data from measurements made inside and outside the respirator during normal work activities to assess the effectiveness of the device were abstracted for statistical analysis. There were 51 sets of measurements where dust, BSM and benzo-a-pyrene (B[a]P), which is commonly used as a marker for PAHs, had been measured over a full working shift. These were collected from five coke works from men mostly working on the oven top or sides, with a small number of measurements being obtained from the scientists undertaking the investigation. There was no information about whether the visors were always kept down or not. All of the ambient dust and BSM measurements and the in-mask dust measurements produced detectable levels. However, a proportion of the other measurements were below the limit of detection (LOD): about 4% of the ambient B[a]P; 16% of the in-mask BSM and 40% of the in-mask B[a]P values. LOD values varied depending on the sample duration.

Figure 4 compares the dust concentrations measured inside the helmet (y-axis) with the ambient dust concentration (x-axis), both expressed as mg/m³.



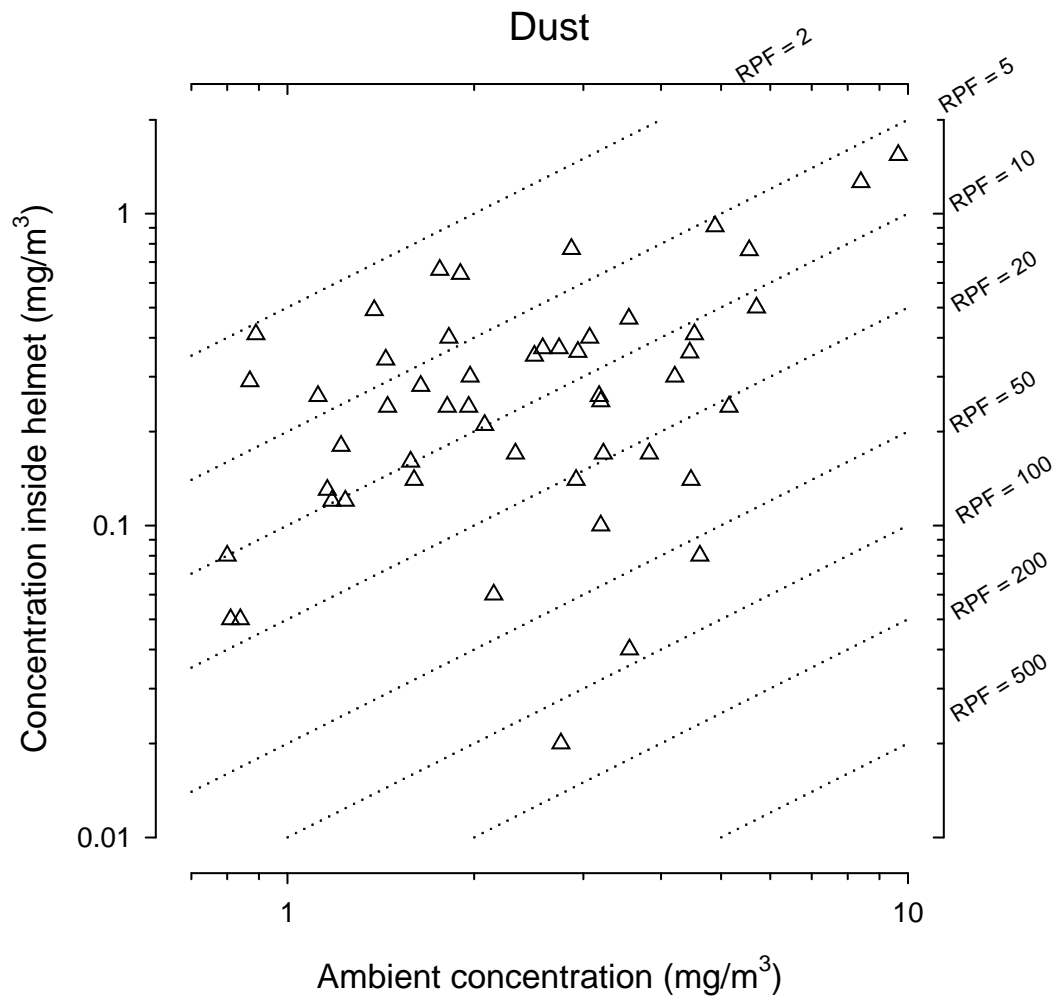


Figure 5 Scatter plot showing ambient and in-mask dust concentration measurements

Contours of respirator protection factor (RPF) are shown as dotted lines. The scatter plots show no strong relationship between ambient and in-helmet concentrations. The geometric mean protection factor is 10, with 95% confidence interval (CI) 7.8 – 12.6.

Figure 5 shows the same comparison, for measurements of BSM. Data points where one measurement was recorded as below the LOD have been replaced with a value half of the LOD, and these data are shown filled red.

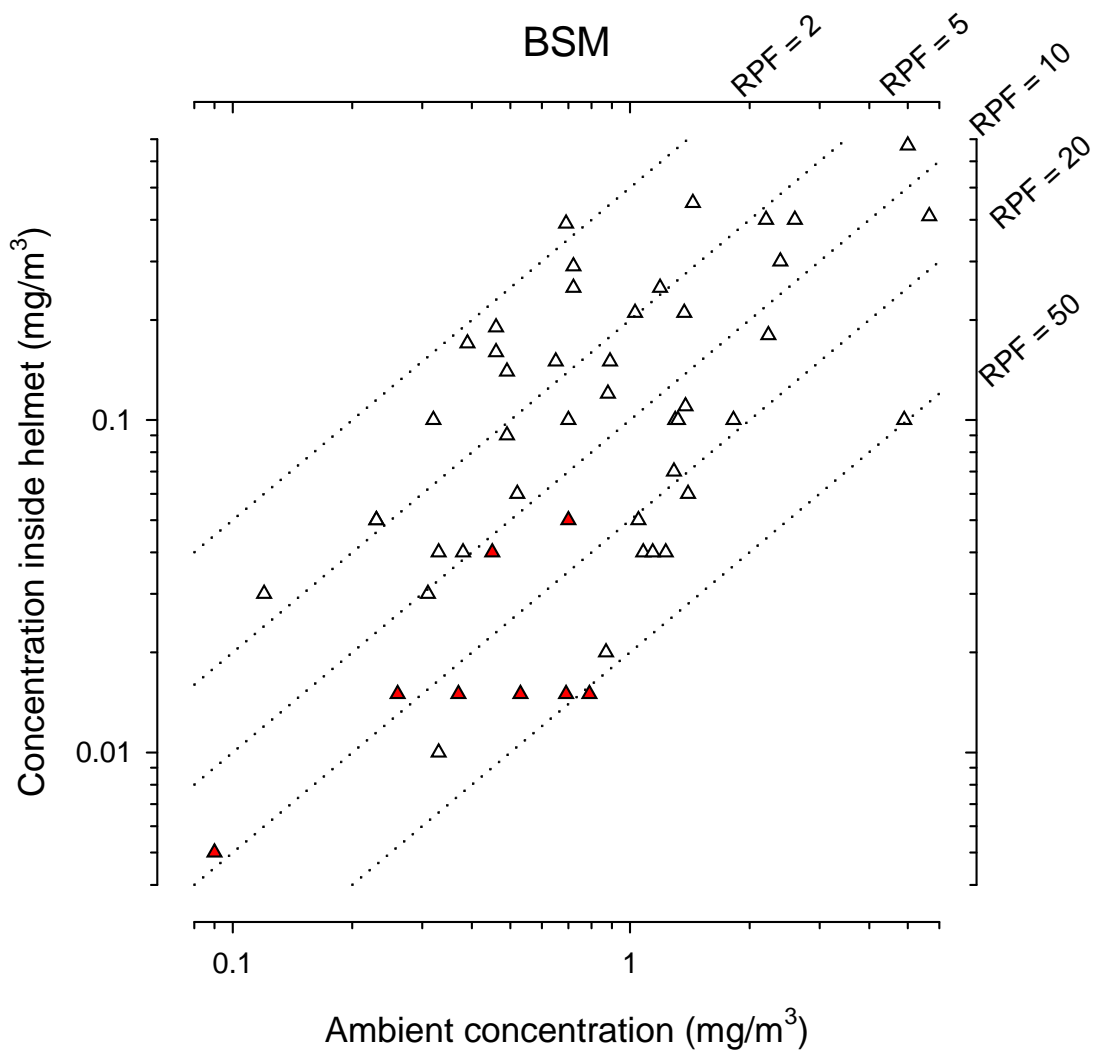


Figure 6 Scatter plot showing ambient and in-mask BSM concentration measurements

Again, the data do not suggest a strong relationship. The geometric mean protection factor is 9.6, with 95% CI 7.4 – 12.4. Omitting the red points, which may be distorting the mean, the geometric mean protection factor is reduced somewhat to 8.2, with 95% CI 6.3 – 10.7.

Figure 6 compares the B[a]P data from ambient and in-mask samples. There were more values here below the LOD compared to Figures 4 and 5. Taking all values, the geometric mean protection factor is 20.2, 95% CI 13.4 – 30.5. Omitting the red points brings this down to 11.6, 95% CI 8.3 – 16.2. Here, imputing the <LOD points has probably inflated the mean protection factor considerably and we consider that the latter protection factor excluding the non-detectable values is more reliable.

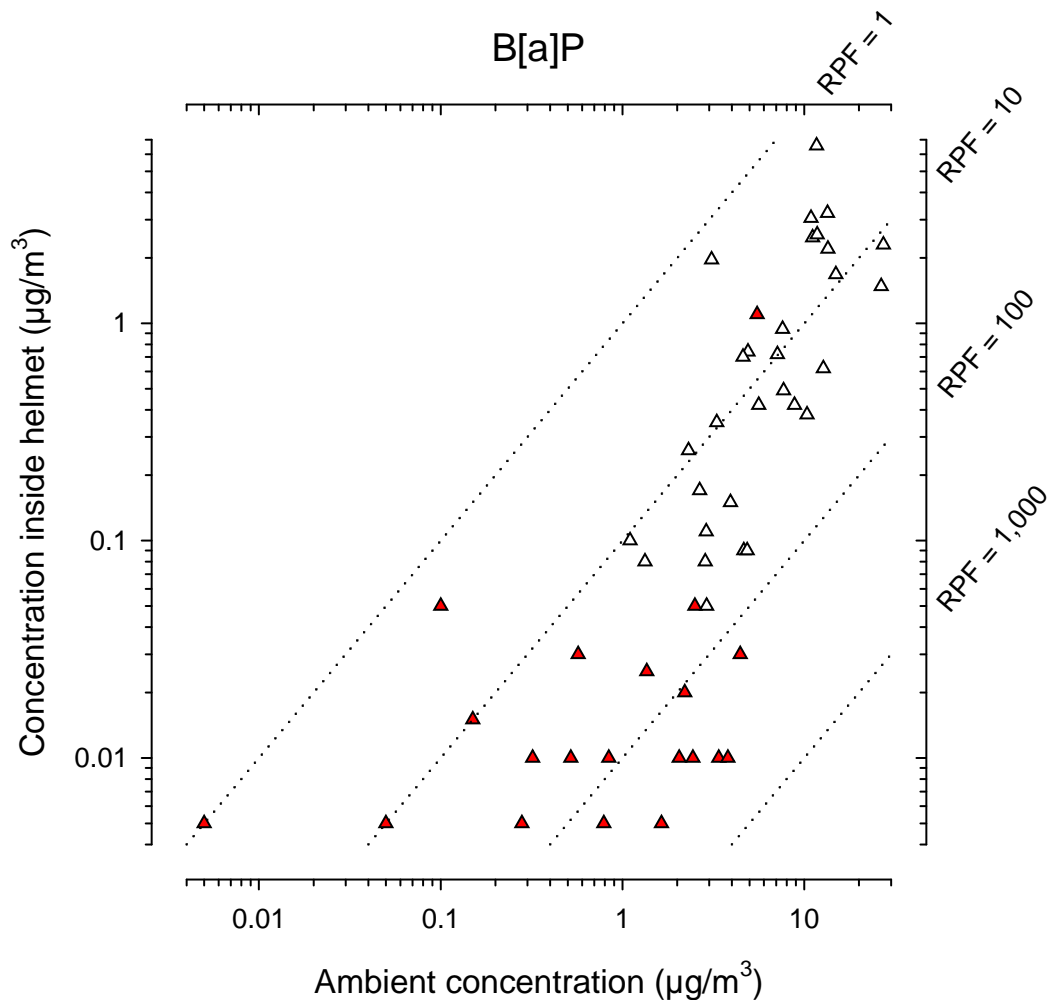


Figure 7 Scatter plot showing ambient and in-mask B[a]P concentration measurements

There is some suggestion in the graph that the protection factor is reduced at higher ambient concentrations.

There were two reports provided by Tata Steel that described small trials of the effectiveness of the Airstream helmet to reduce exposure in a powder handling task. Although this was not associated with coke ovens it is informative not only because it has relevant quantitative data but it has a unique design where for one set of the data the sampling system was set up so that the air samples were only collected when the visor was down.

There was no suggestion of a strong relationship between in-mask and ambient concentration in either investigation and there was no difference between the protection factors when the samples were only collected with the visor down. Overall the mean protection factor was 10.5, which is consistent with the data from coke ovens described above.

There was one additional report from the British Steel Corporation of an investigation of the performance of Airstream helmets in a foundry. However, we have excluded these data because the measurements made inside and outside the helmet were made with different sampling systems (a cyclone respirable dust sampler on the workers lapel and an in-line filter with a short

length of tube to sample behind the respirator visor) and these are considered to be not comparable because of the coarse nature of the airborne dust in this workplace.

3.6.4 Other relevant environmental monitoring reports provided by Tata Steel

In 1993 and 1995 the British Steel Corporation carried out investigations to assess the filtration efficiency of Airstream filter elements (and an alternative Dustmaster mask) for a range of aromatic compounds. Two types of filter were included: the conventional Airstream filter (AH1) and filters containing charcoal granules intended to adsorb volatile compounds (AH60 or Dustmaster). The filters were cut into 25mm diameter disks and these were located in filter holders with a sampling filter and sorbent tube placed in series behind. Ambient air samples were collected alongside the test rigs. The tests were carried out on the top of a coke oven. Both sets of filters and tubes were analysed for a range of aromatic compounds (in the first study there were 16 PAH plus benzene, toluene and xylene, in the second set of measurements xylene and toluene were not analysed). In the first tests ten sets of results were obtained over a five-day period while in the second tests there were eight data sets from 8 days.

The results are summarised in Table 2 as the mean percent penetration (and range) through the filter media for the 1-ring, 2-ring etc. compounds. There were large numbers of the analyses that were below the LOD, particularly for the higher molecular weight compounds (i.e. greater number of aromatic rings). In these cases the authors of the reports assumed that the penetration was <3%, which was almost certainly a considerable overestimate of the true penetration.

Table 2 Percent penetration through helmet respirator filter media for groups of aromatic compounds – mean (range)

Aromatic compounds	Study in 1993			Study in 1995	
	Airstream AH1	Charcoal AH60 Airstream	Charcoal Dust-master	Airstream AH1	Charcoal AH60 Airstream
1-ring (e.g. benzene)	49 (24-87)	0.5 (<0.1-1.3)	0.4 (<0.1-1.1)	101 (86-115)	80 (11-131)
2-ring (e.g. naphthalene)	62 (40-107)	13 (6.9-20)	11 (2.3-23)	110 (<3-122)	5.6 (1.2-8.4)
3-ring (e.g. anthracene)	59 (22-125)	3.8 (<1.5-7.8)	4.6 (<1.5-9.2)	112 (<3-176)	<3 (<3)
4-ring (e.g. pyrene)	<3 (<3 – 1.9)	<3 (<3)	<3 (<3-4.0)	<3 (<3-47)	<3 (<3)
5 & 6 ring (e.g. benzo[a]pyrene)	<3 (<3)	<3 (<3)	<3 (<3)	<3 (<3)	<3 (<3)

Note that some of the percent penetration figures are greater than 100, but this is probably because of random errors in the measurement of the concentration and the absence of any filtration effect because of the low molecular weight of the compounds, i.e. they were in vapour form.

In all cases the filter penetration for 4, 5 and 6-ring PAH compounds was <3% on average and almost all results from behind the respirator visor were not detectable. For 2 and 3-ring compounds, such as anthracene, the simple AH1 particulate filter had no clear effect but the charcoal filter media reduced the concentration of these compounds to less than 5% of the ambient levels for 3-ring compounds and less than about 15% for 2-ring compounds, on average. For benzene (toluene and xylene) the effect of the charcoal filter differed between the two trials, with less than 1% on average passing through the filter on the first occasion and 80%

passing through during the second investigation. It is unclear why there was such a large difference in the test results since the methodology was similar in both cases.

The British Steel Corporation also carried out a number of tests in 1995 to assess the acceptable duration of use of the filters in Airstream helmet respirators and other competitor equipment. Tests on the MSA Technostat filter element (used in the MSA Cobra helmet respirator) and showed that after five days the filtration of BSM decreased. As a consequence it was recommended these filters should be changed every 30 hours. Similar conclusions were arrived at for Airstream filter media.

In 1995 the MSA Cobra helmet respirator was made available as an alternative to the Airstream helmet.

In 2010 Tata Steel carried out a review of helmet respirators for use on coke ovens. The evaluation was based on the helmet providing:

- A high standard of performance (i.e. high protection factor);
- Incorporation of a charcoal filters along with a P3 aerosol filter⁵;
- Having good usability and
- Being suitable for use on coke ovens.

The company intended to choose a single device for use in all coke ovens. Four devices were assessed: Pureflo, 3M Jupiter, the Sundstrum SR 500 and 3M Versaflo.

The Sundstrum helmet respirator was recommended for use across Tata Steel oven plants because it met the initial performance criteria, was available in an intrinsically safe model, i.e. can be used in areas where there may be flammable gases present, and it had been successfully used in other coke plants owned by the company. The respirator also had a proven history of acceptable use in the coke oven environment. The authors of this report also quote a protection factor of 438 against B[a]P based on experimental tests using a mannequin to sample inside and outside the visor (presumably the mean of a number of measurements, although this is not stated).

3.6.5 Biological monitoring data provided by Tata Steel

Biological monitoring using 1-hydroxypyrene in urine as an indicator of exposure to PAH is now widely accepted. The HSE have published a Biological Monitoring Benchmark Value for exposure to PAH as measured by 1-hydroxypyrene in urine as 4 µmol/mol creatinine (Unwin *et al.*, 2006). Biological monitoring assesses exposure by all routes into the body and so these data reflect uptake by inhalation, skin contact and ingestion, e.g. hand-to-mouth contacts. Biological monitoring levels also reflect the protection offered by respirators or other personal protective equipment.

We have been provided with three reports from Corus dated 2009 summarising biological monitoring results from periodic surveys undertaken amongst coke workers on Teesside. There were data for fifty-two workers from four work areas (Charger, Pusher, Guide/Coke Car and Miscellaneous jobs, including Heater operators, Shift managers and others working around the ovens). The arithmetic average level was 3.8 µmol/mol creatinine, but the levels for Charger

⁵ Filters at least 99.95% of airborne particles according to the appropriate European standard test.

operators were much higher than for the other groups (arithmetic average 9.8 $\mu\text{mol/mol}$ creatinine) and ten of the 12 samples in this group were above the HSE Benchmark Level.

Investigation of the reasons for the high levels amongst the Charger operators revealed that by making changes to the work clothing worn (clean underwear provided by the employee and overalls provided by the company every shift), changes to the process operation and the operators wearing the helmet respirator correctly throughout the shift (visor only raised at the battery ends) resulted in exposure levels below the Biological Monitoring Benchmark Level. Clearly the implication is that dermal exposure has contributed some of the 1-hydroxypyrene in the biological monitoring samples. The author of this report concluded that it was possible to control exposures below the Benchmark Level, but “to achieve this, a whole package of control measures are required spanning clothing, respiratory protection, personal hygiene, operating procedures and personal discipline. In effect, the additional effort put into achieving these [lower] results must become the norm”.

As part of the 2010 review of helmet respirators carried out by Tata Steel, a limited amount of biological monitoring data was provided for men wearing a range of helmet respirators. The difference in level between samples collected at the end and start of the working week ranged from 0.6 to 6.6 $\mu\text{mol/mol}$ creatinine (31 measurements from nine workers wearing up to four different helmet respirators). The arithmetic average across all workers and helmet types was 2 $\mu\text{mol/mol}$ creatinine, with about 95% of measurements below the HSE Benchmark Level.

The HSE carried out a biological monitoring survey of PAH exposed workers with data for three sets of British coke oven workers (Unwin *et al.*, 2006).

Table 3 B[a]P and 1-hydroxypyrene levels for British Coke workers from Unwin *et al.*, (2006)

Site	Description	Number of measures	B[a]P ($\mu\text{g}/\text{m}^3$)		1-hydroxypyrene ($\mu\text{mol/mol}$ creatinine)	
			Mean	Range	Mean	Range
11	Coke oven	11	2.14	0.13 – 6.21	1.85	0.25 – 5.4
14	Coke oven	13	0.79	0.02 – 4.08	2.1	0.25 – 7.1
2	Coke oven (low temperature)	13	1.13	0.01 – 2.91	2.63	0.41 – 6.9

These data showed the mean 1-hydroxypyrene levels ranged from about 1.8 to 2.6 $\mu\text{mol/mol}$ creatinine, Table 3. The measurements were presumably made with workers wearing powered helmet respirators, although this is not explicitly stated in the paper.

3.6.6 Discussion of the data on the effectiveness of helmet respirators

The published scientific literature on the effectiveness of powered helmet respirators, such as the Airstream respirator, is limited and relatively uninformative. Assessments generally either measure the efficiency of the filter in removing contaminants from the air or the protection factor in real or simulated conditions. Because in most cases the contribution of filter efficiency to overall effectiveness is generally small these data are for the most part uninformative. The other major issue with respirator use is the interaction between worker behaviour and effectiveness, and in the case of the helmet respirator this is mostly related to the worker lifting the visor, which would compromise the protection offered by the device.

The most relevant published data is that of Davies *et al.*, (1986) from British coke ovens operated by British Steel Corporation. This suggests that the average protection factor of

Airstream helmets was between 7 and 15 for BSM. However, this publication contains only very limited details of the measurements made. Additional data collected in the 1970s by British Steel but not included in the Davies *et al.*, paper has been analysed in this report – it is possible that the data reported by Davies *et al.*, was a subset of the present dataset. The mean protection factor for dust was 10, for BSM 9.6 and for B[a]P, excluding the data below the detection limit, was 11.6. There was considerable variability in the protection found in these data but the lowest 95% CI was around 8 for all three measures, i.e. this is the lowest likely mean protection factor consistent with these data. Other British Steel Corporation data from powder handling are also consistent with these data.

From filter efficiency tests it is clear that including a charcoal filter element into the helmet respirator will result in a greater proportion of 2 and 3-ring PAHs being removed from the air supplied to the operator. However, this would have no effect on the air that leaks into the space behind the visor from the seal between the respirator and the wearers face. As this is an important source of contamination that is inhaled it is likely that these data overstate the effectiveness of helmet respirators with both particulate and charcoal filter elements.

There was a limited amount of biological monitoring data in the peer-reviewed literature and from reports provided to us. The data suggests that average exposures were below the 4 $\mu\text{mol/mol}$ creatinine Benchmark Level adopted by the HSE, with a proportion of measurements above this value. In the case where it was clear that best practice was not being carefully followed (i.e. the Corus report from Teesside) the levels for oven top workers could be consistently be above the Benchmark Level.

3.7 HAS EFFECTIVE PROTECTION CONTINUED TO THE CURRENT DAY?

Since the introduction of the Airstream helmets in the late 1970s, there has been continued use of protective helmet respirators, including the Airstream design. There is only limited evidence available to us to verify that these respirators have continued to be used appropriately by coke oven workers but it is our judgement that their use has been part of the accepted working procedures on coke ovens and that they have continued to be worn by the relevant work groups.

However, there were consistent reports of difficulties with the Airstream helmets. For example, in 1989 Dr Davies from British Steel Technical wrote a memo to the manager of a coke works in Teesside described the problem of “ingress of material into the helmet around the visor etc, particularly when there are crosswinds.” Racal had produced helmets with “visor shields” to improve the performance of the respirators. In 1991 a trial was undertaken at the Redcar coke works to assess the acceptability of the modified Airstream helmets compared to the original design. They found that the Airstream helmets were acceptable but that the new face seal was uncomfortable. However, they observed, “men only wear the helmet correctly for an average [of] 48% of the time that they spend on the oven battery”.

There were periodic reports in technical reports from British Steel scientists monitoring exposures on coke ovens of operators not wearing the visor of their Airstream helmet in the down position at appropriate times, e.g. inside the charger cabin (report dated 1993). In 1996 a survey of respirator use was undertaken in Teesside. This showed that visors were worn in the down position on about 85% of occasions. There were anecdotal reports of workers being found wearing helmets without batteries or where the batteries were completely discharged, i.e. they were not functioning.

In the Tata Steel report by Parris and Conroy (2010) biological monitoring data from men wearing a range of helmet respirators was compared to the benchmark value 1-hydroxypyrene – a marker for PAH exposure, published by the HSE (i.e. 4 $\mu\text{mol/mol}$ creatinine). They showed

that out of 31 measurements there were only two that exceeded the benchmark value, with the mean level across all of the measurements being 2.0 $\mu\text{mol/mol}$ creatinine. Also, the data reported by Unwin *et al.*, (2006) showed arithmetic average 1-hydroxypyrene levels for workers on three coke ovens surveyed were between 1.85 and 2.65 $\mu\text{mol/mol}$ creatinine (maximum levels were around 7 $\mu\text{mol/mol}$ creatinine). There were higher results reported in a survey in Teesside of oven top workers – average level 9.8 $\mu\text{mol/mol}$ creatinine with ten of the 12 samples above the HSE Benchmark Level.

Jongeneelen (2001) reviewed the available scientific literature on the relationship between 1-hydroxypyrene and BSM measures and concluded that for coke workers the TLV of 0.2 mg/m^3 corresponds to 2.3 $\mu\text{mol/mol}$ creatinine. This suggests that on average the protection afforded by the helmet respirators used in the British coal carbonisation industry has continued to provide control of average exposure to around the limit value expressed as BSM. However, there were a number of individual measurements in excess of 8 $\mu\text{mol/mol}$ creatinine, which is about three times the level corresponding to the exposure limit as BSM. These underline the importance of continued close supervision of the wearing of helmet respirators by management to ensure they provide the expected level of protection. The limited evidence we have suggests that this was being done in the industry.

4 DISCUSSION

From the available historical documentation and interview material it is clear that the introduction of the Airstream helmet into the coal carbonisation industry was not a straightforward process. When management in the industry recognised that there was a cancer risk from the coke emissions it was quickly decided that the only way to protect workers was to provide some form of respiratory protection. The recently invented Airstream helmet respirator seemed to provide an appropriate solution and the two main operating companies, in discussion with the HSE, decided to investigate their use on coke ovens. Helmets were being worn in some parts of the industry from around 1976.

The British Steel Corporation and NSF took a very different approach to the introduction of respiratory protection on coke ovens. British Steel moved quickly to purchase helmet respirators and to train staff in their use, whereas NSF proceeded more slowly through a number of small-scale trials. Workers on the battery tops and sides, where exposures were known to be highest, were provided with helmets and were encouraged to wear them. However, at this stage there appears to have been little enforcement of wearing in NSF. During the initial introduction there were a number of problems identified, e.g. faults in the equipment due to the high temperatures on top of the oven, scratching of visors and poor battery performance. The helmet manufacturer dealt with these problems, but these issues clearly delayed effective implementation of the respirators. It was reported in the interviews that it took up to two years to get full acceptance from workers.

The question of when “effective wearing” occurred within the industry was difficult to answer. In the context of this report we have considered this to be when the vast majority of men on the oven tops and sides (>90%) were wearing reliable Airstream helmet respirators with the visor down for at least 75% of the time. From the material available it appears that this occurred from about 1982 onwards, after action was taken by the Factory Inspectorate to enforce the use of the respirators. The available evidence from biological monitoring data and from interviews with company staff suggests that effective wearing of the Airstream helmets or other powered respirators has continued to the current time.

There is very little information in the peer-reviewed scientific literature to substantiate the effectiveness of helmet respirators in reducing exposure, either on coke ovens or in other workplaces. However, the British Steel Corporation collected data on effectiveness in the 1970s by simultaneously measuring the concentration of dust, BSM and B[a]P inside and outside the visor of Airstream helmets worn by coke oven workers. These data showed that on average the helmet respirators reduced exposure by about a factor of ten. The minimum protection provided by the Airstream helmet to a single worker on a single work shift was a reduction in exposure level by 50%.

5 CONCLUSIONS

The report aimed to answer a number of questions in relation to the effectiveness of respiratory protection in reducing exposure to PAH:

- Workers in jobs on coke oven tops and sides have been provided with Airstream helmets or their equivalent.
- It was not possible to identify an exact date when effective wearing of respiratory protection was introduced into coke ovens. However, archive materials and interviews suggest that this was around 1979 in the British Steel Corporation but not until 1982 in NSF. Overall we assume helmet respirators were being effectively worn in the industry from 1982.
- The available data from measurements made by British Steel during the late 1970s suggest that the geometric mean protection factor of the Airstream helmet was around 10 (with 95th percent confidence interval between about 7.5 and 12.5), regardless of whether it was assessed using measurements of dust, BSM or B[a]P. The minimum protection factor achieved on any individual worker on a single day was 2.
- Recent data collected by the steel industry and by the HSE using biological monitoring has identified that mean urinary levels of 1-hydroxypyrene are comparable to the level that would correspond to the inhalation occupational exposure limit for BSM. Higher levels were found on occasion, which underlines the importance of management supervision in ensuring the effectiveness of the helmet respirators and other controls. However, the information we have suggests that wearing of helmet respirators continues to effectively control average PAH exposure on coke ovens.

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APPENDIX A: SEARCH STRATEGY FOR EFFECTIVENESS OF RESPIRATORS IN COKE OVEN

Population

Coke Oven Workers
Coke Battery Workers
Coal carbonisation industry (phurnacite, coalite)

Other industries -

Steel
Coal
Construction
Welding
Pharmaceutical
Chemical (powder handling)

Intervention

Airstream Helmets
Air helmets
Helmet respirators
Powered respirators
Airstream powered helmets
Airstream safety helmets
Racal powered respirator helmets
Racal Airstream helmets
Racal air helmets
3M Airstream helmets
3M Airstream industrial helmets
3M Airstream powered helmets
3M Airstream powered respirators
Powered dust respirator helmets
Powered helmet respirators
Dust helmets
Powered Air-Purifying Respirators

Trade names: Pureflo helmets; Airstream AH6; Racal 3M Breathe Easy Shell Helmets

Comparison

Exposure measures pre and post helmet use

Outcomes

Reduction in exposure
Effective protection
Behaviour change
Wearing helmets

Combination of search terms

Primary searches

worker* AND (“coke oven” OR “coke battery” OR “coal carbonisation/carbonization” OR phurnacite OR coalite OR steel Coal OR Construction OR Welding OR Pharmaceutical OR Chemical (powder handling)) AND (“Airstream helmets OR *associated terms linked by ‘OR’*) AND (exposure OR protection OR behaviour*)

Secondary searches

respirator* AND exposure AND (PAH OR “polycyclic hydrocarbons) AND (“coke oven OR “coke battery OR “coal carbonisation/carbonization” OR phurnacite OR coalite” OR steel Coal OR Construction OR Welding OR Pharmaceutical OR Chemical (powder handling)) AND (exposure OR protection OR behaviour*)

APPENDIX B: TIMELINE OF EVENTS FROM ARCHIVE MATERIAL

Table 4 Timeline of Events in the Coke Industry

Date	Source	Summary
02/05/1972	IOM Senior Staff Meeting National Archives	Report that there was a risk to health, no oven top workers to work for more than 5 years.
11/12/1972	Memo from Dr Coleman National Archives	600 workers at risk at NCB and BSC, inquiry about the provision of helmet respirators. Martindale perceived as inadequate
26/01/1973	NCB Coal Products Division Paper by Dr Coleman National Archives	Probably a health risk of lung cancer in UK coking plants. Martindale and Siebe Gorman respirators assessed but found not suitable for oven tops. SMRE powered respirator mentioned
02/02/1973	Environmental Control Dr Morley National Archives	Men working on oven tops should be urged to wear respirators
07/03/1973	National Coal Board Coal Products Division Coking Committee National Archives	Agreed to consider the development of respirators suitable for coke oven workers. The Inspectorate had agreed that the introduction of respirators should not be regarded as an urgent matter as in the long run a better response from them would be forthcoming if an improved type of respirator could be developed.
28/03/1973	Environmental Control Committee: Use of respirators National Archives	Wearing respirators made compulsory in the USA Steel Industry
06/06/1974	Coke Oven National Consultative Committee Iron Mountain 00418127418 p127	Dr Wingfield continued by giving the general background to the masks being accepted for use by NCB. Each type of mask is submitted to the IOM where they are subjected to stringent tests of their filtration and leak properties prior to wearer acceptability trials. Each mask is manufactured to British Standard Specification. Two masks shown to the council which it was felt were currently the best. It was noted that the use of masks at present could only be recommended but that legislation would soon be passed making their use mandatory.
07/06/1974	Joint Working Party on the Environment at Carbonisation Works Iron Mountain 00413811810 p62	No clear identification of which masks SMRE were developing a dust helmet for use in mines
18/07/1974	National Smokeless Fuels Ltd Environmental Control Committee National Archives	Test of an SMRE helmet on oven top at Avenue found to be successful

Date	Source	Summary
24/07/1974	NSF Thomas Ness South Western Regional Consultative Committee Iron Mountain 00418127418 p 152	Although trials with the Pneuseal and Martindale Y masks had not been completed at all works, it appeared that there was a preference for the Pneuseal masks. However, difficulty was being experienced in obtaining supplies of the mask and filters could not be obtained for the few masks received on trial. Purchasing and stores department had advised that the delivery period quoted was 10 weeks and no information on availability of filters. Suppliers had promised to deliver 60 Pneuseal masks on 25/7. The number ordered had increased from 350 to 500.
22/10/1974	Coke Oven National Consultative Council Iron Mountain 00280671076 P 39	Some unwelcome publicity about coke ovens and carcinoma, interview with the press. This concentrated on the slow delivery of respirators to the men. Assured that was because of adequate testing of the respirators. Once the choice was made there was no delay in ordering but they had to set up servicing facilities. The impression was that most of the respirators had been delivered
10/12/1974	Letter from the Coke Oven National Consultative Council Iron Mountain 00418127418 P 124	Unwelcome press publicity on the slow delivery of the best of the respirators to coke workers. Mr Scargill said that choosing the best of the respirators on offer had necessarily taken some time but once this had been done orders had been placed and the all important servicing arrangements made with not loss of time. He would check on the latest delivery position Unclear which respirators they are referring to
27/01/1975	First Meeting of the Working Group on Environmental Control at Coking Ovens Iron Mountain Doc 0098820159 p 16	Respiratory Protective Equipment Mr Fallow spoke of a joint (SMRE/NSF) development work on new respiratory equipment where the helmet incorporated a visor, filter and fan (battery driven). Further work was needed.
08/02/1975	Memo from SMRE National Archives	Carried out testing in coal mine, workshop trials, during arc-air gouging at a steel works. Measurements made of efficiency by NSF and during arc-air gouging. Efficiencies of 90% or greater can be attained. Ergonomic assessment also carried out at Farnborough for heat.
08/04/1975	Coke Oven National Consultative Committee Iron Mountain 00418127418 p 37	Circular had been circulated from all lodges encouraging the wearing of dust masks and ear muffs by workmen
25/04/1975	NCB Mining Department Dust Respirator Approval Sub-Committee National Archives	Testing of SMRE helmets at IOM
05/05/1975	Joint Working Party on the Environment at Carbonisation Works Iron Mountain 00413811810 p21 Iron Mountain 00418127418 p 62	Necessary for a consortium including NSF, BSC and other industrialists. It was hoped in 9 months prototype models would be available to test. SMRE helmet exhibited by Mr Launder. Developed by NSF, BSC and HSE Measurements also discussed including highest counts found on the larry car and oven lids

Date	Source	Summary
01/07/1975	Joint Working Party on the Environment at Carbonisation Works Iron Mountain 00415664849 p 446	2 Respirators selected the Pnuseal and the Martindale. A demand for the SMRE helmet to be available at the next meeting Description of the sampling method used developed by NSF, BSC and HSE for personal sampling
22/07/1975	Working Group on Environmental Control at Coking Ovens Iron Mountain 0098820159 p 228	RPE Mr Fallow reported that a manufacturer had been found to make a small batch of the ventilated helmets. However there was trouble over delivery and it was thought that they would not be available for trials under 6 months.
01/10/1975	NSF Environmental Control Committee National Archives	SMRE helmet not available until the end of 1976
18/11/1975	Working Group on Environmental Control at Coke Ovens Iron Mountain 0098820159 p 233	Mr Fallow said that progress on ventilated helmets had ground to a halt. SMRE who had patent rights appeared reluctant to release the design to enable the production of prototype helmets for trial. The end of 1976 appeared to be the projected date for availability of production helmets. The Chairman undertook to investigate matters within the HSE.
05/01/1976	NSF Environmental Control Committee National Archives	No agreement with Racal until end of 1976
26/01/1976	NSF and Thomas Ness South Western Regional Consultative Committee Iron Mountain 00280671071 p 2252	Mr Fearn said that wherever there was exposure to dust and fumes there was a need to wear a respirator. Greatest need on the oven tops and around the oven Nantgarw - respirators had been issued to 20 men on request but no oven top workers wearing. Had been made compulsory for those on oven repairs. Coedely – 117 men in receipt of respirators but only one using on oven tops. Cwm 184 respirators issues but no oven top men wore on a regular basis Caerphilly – generally those needing to wear respirators were using them Phurnacite – hundreds issued and worn in areas of high discomfort These are respirators not Airstream helmets
04/02/1976	NSF and NUM Joint Working Party on the Environment at Carbonisation Works Iron Mountain 00280671071 p2286	Racal in discussion as need to have specific filters in the helmets. It would be possible to try them out and gauge the reaction of the men.
22/02/1976	NSF Environmental Control Committee Iron Mountain 00280671071 p 2286	Agreement signed by Racal to manufacture helmets

Date	Source	Summary
24/02/1976	NSF Ltd Coedely Coking Works Consultative Committee Iron Mountain 0041375764 p180	Dust Masks (Ref Min B548) 12 men were regularly using the facilities of the Face Mask Centre. The chairman had received no adverse comments regarding the cleaning of the masks but he did hope that the union would try and persuade their members to wear masks where necessary. Unclear what they mean by dust masks
02/03/1976	NSF Ltd, Thomas Ness Ltd, South Western Region Consultative Committee National Archives	Men on oven tops not generally wearing respirators due to discomfort
09/03/1976	NSF/Thomas Ness Safety Committee Meeting National Archives	20 pre-production Racal helmets ordered
18/03/1976	Working Group on Environmental Control at Coking Ovens Iron Mountain 0098820159 p 236	The Chairman stated that Racal Amplivox was now developing the SMRE hard hat helmet. It was noted that BSC would be carrying out user trials with the equipment. Mr Fallow mentioned that NSF were doing some research on the efficiency of the filtration used in the device. Mr Wood commented that the need to employ a substantial filter would have repercussions on battery life. Mr Kirk indicated that he had seen details of a less expensive Swedish device advertised and had requested further information.
30/06/1976	First Joint BSC/NSF Working Party on Environmental Control Iron Mountain 0098820159 p 249	Mr Gregory said that as an example, BSC and NSF could have a common policy on the use of respirators and regarding duration of working on oven tops by individual workmen. It was agreed that there should be a common policy towards Racal Amplivox regarding the manufacture of the latest version of the helmet. Mr Launder referred to developments aimed at controlling the temperature within the helmet since this was likely to be a source of objection by the workmen. Mr Davies said that BSC would like to have details of the NSF system of maintaining and servicing respirators at work.
05/10/1976	Joint BSC/NSF Working Party on Environmental Control Second Meeting Iron Mountain 0098820159 p 266	Dr Trevethick said that a detailed specification had been drawn up with Racal. BSC proposed to order 2000 of the final version. Workmen appeared to have taken to it very well and it appeared that around 85% of the workforce would be happy to wear it. A procedure for servicing the respirator would be drawn up. Mr Launder referred to a number of features of the design which as in BSC had not been acceptable to NSF but which Racal would modify. Arrangements had been made for NSF to be supplied initially with 20 helmets and it was proposed to use these throughout all works on a trial basis and to carry out a number of tests and measurements as on the BSC side.

Date	Source	Summary
09/10/1976	Meeting Chaired by HSE with industry groups Iron Mountain 098820159 p 240	<p>While Ori-nasal respirators with adequate filter to exclude hazardous substances were available it was known that the men found the existing equipment uncomfortable to wear and therefore did not make use of it. The ventilated hard hat helmet developed by SMRE and currently being produced by Racal Amplivox had in the various user trials conducted given certain grounds for optimism.</p> <p>Dr Trevethick gave a brief resume of the trials that BSC had conducted with the SMRE ventilated hard hat. Owing to the small number of hats available for user trials it would take until the end of the year to collect sufficient information to make a valid judgement but indications were that it was acceptable to operatives although various modifications would be required. He indicated that the helmet's retail price was £72 and the cost of annual maintenance would be £195. Mr Launder commented that NSF was not confident that the ventilated hard hat could operate effectively in the worst conditions and they were pursuing alternative methods of filtration with IOM, SMRE and the manufacturers Racal Amplivox. Mr Gregory cautioned against placing too much faith in the device.</p>
20/09/1976	Visit to Scunthorpe to see prototype Airstream Helmet Iron Mountain 0098820159 p 47	<p>Visit undertaken to see the prototype on a coke oven.</p> <p>The opportunity was taken to discuss at length and in great detail the history of the helmet from the early SMRE prototype through the various stages of modification and development to the present model on which the commercial Airstream helmet would be based.</p> <p>Among the matters discussed were the filtering power, the airflow, reliability of battery and motor, range of vision, heat resistance, noise and vibration, the protection offered by the helmet and visor. The proposed arrangements for cleaning and issue of helmets were explained.</p> <p>The Trade Union delegates were able to satisfy themselves that the Corporation has investigated the performance of the respirator and made all the improvements necessary to make the advice acceptable.</p> <p>Finally the delegates all wore the helmet and spent half an hour on the top of a coke oven. Included in this time were conversations with coke oven crew to obtain their reactions.</p> <p>The conclusion of the Trades Union delegates was that this is an excellent device which is acceptable both from the technical and wearability points of view. This report should be submitted to the JAPAC meeting on the 20th of October.</p>
11/10/1976	BSC Iron Mountain 0098820159 p 50	<p>Technical Specification for Eye-Face-Head-Respiratory Protector for use on Corporation Coke Ovens</p>

Date	Source	Summary
27/10/1976	NSF/Thomas Ness South Western Regional Consultative Committee Iron Mountain 00413811810 p 602	6 battery powered helmets on trial at Nantgarw. Two lidmen, one charge car driver, one mainsman, one cokeman, one ramside doorman. Been wearing since 14 th January 1977 inconsistent dates here! Wearing of the helmets accepted very well but issue of filters not filtering gas raised
10/11/1976	Joint Working Party on the Environment at Carbonisation Works Iron Mountain 00280671071 p 2121	Mr Cooper at meeting to demonstrate the latest model of the Racal Helmet. Racal Amplivox have now taken over this product. With adjustment could fit 99% of heads NSF would receive 30 advance models to test in December
06/12/1976	Northern Regional Consultative Committee Iron Mountain 00280671071 p 2051	Impressions of the Airstream after tests at Lambton. Liked the helmet but a few drawbacks. Will need modified as can't withstand heat. Lack of a chin strap and misting of visor. Will require exhaustive testing.
22/12/1976	British Steel Corporation Iron Mountain 0098820159 p 60	Report Airstream System Document 3 The Technical Specification of the Helmet
24/12/1976	British Steel Corporation Iron Mountain 0098820159 p 60 p 115	Report Servicing Centre Design Training Requirements Document
13/01/1977	NSF Ltd Wales Group Coedely Coking Works Consultative Committee Iron Mountain 0041375764 p116	A prototype helmet which supplied filtered air to the wearer was to be issued to six oven men at Nantgarw Coking Works for trial. Some were also being tried at the Phurnacite Works. If the trials proved promising more helmets would be acquired and issued at Cwm and Coedely.
30/11/1976	BSC/NSF Working Party on Environmental Control National Archives	BSC prepared to order 2000 helmets. It appeared that 85% of workforce would be happy wearing the helmet.
06/12/1976	NSF Ltd Northern Regional Consultative Committee Iron Mountain 0098537128 p 196	Discussion of Racal Airstream Helmet The Chairman said Head Office to supply 6 helmets to a selected Plant for trial. The Chairman said that the new helmet was an expensive item of equipment costing approximately £60. The effect of heat on the visor would need to be established. Heavy maintenance costs were also involved so it was very important to ensure that the helmet meets all necessary requirements

Date	Source	Summary
16/12/1976	NSF Ltd Cwm Coking Works Works Consultative Committee Iron Mountain 0041376941 p84	Members questioned Mr Fearn regarding the types of safety goggles available as those in present use allowed penetration of dust. Mr Fearn said that he would obtain one of each type of goggle manufactured to BSS in order to establish the most suitable. He informed the meeting that a new type of helmet was being developed incorporating a visor and battery operated filter. This would be both dust and fume free.
25/02/1977	NSF Ltd Northern Region Consultative Committee Iron Mountain Doc 0098537128 p 161	Mr Baker asked what impressions had been formed arising from the tests of the 'RACALL Air-cooled visor safety helmets. Dr Nichols reported on the findings to date of the tests at Lambton and said that in spite of criticisms the operators liked the helmets. The helmet visor will definitely require modifications in view of its inability to withstand heat in front of the ovens. Other shortcomings being the lack of a chin strap 'misting up' of the face piece etc. More tests are to be undertaken over the next three months to ascertain the maximum information, the outcome of which would be reported upon in due course. The council took note of the position and fully endorsed the policy of continuing exhaustive tests so as to ensure the correct type of helmet is obtained, particularly in view of the high cost involved.
26/01/1977	NSF and Thomas Ness South Western Regional Consultative Committee Iron Mountain 00280671071 p 2085	6 battery powered helmets with face visors on trial at Nantgarw since 14/01/1977. Been accepted well
23/03/1977	NSF Limited Environmental Control Committee National Archives	Can achieve a standard of 0.2 mg/m ³ if visor in position 75% of the time. Currently 70 helmets available at NSF. To be fully acceptable would need 1830 Filtration good by other issues include dusting up of the visor and the problem of heavy rain. Needing to formulate policy as to whether men would be asked or instructed to wear the helmet. No firm recommendations for a further 9 months
01/04/1977	BSC 31 st Meeting of the Joint Accident Prevention Advisory Committee Iron Mountain 0098820159 p 174	The coke oven training programme was going ahead. Asked if coke oven personnel were being trained in the use of the Airstream helmet and was informed that the training programmes were going forward at works level

Date	Source	Summary
19/04/1977	National Smokeless Fuels and Thomas Ness Ltd South Western Regional Consultative Committee Iron Mountain 00413811810 p 557	Mr Smith exhibited and described the Racal Airstream Helmet. In Wales Nantgarw the test company. 6 Helmets issued to oven lid, larry car, gas mains. Coke guide and ram machine since 15 th January 1977. Generally a favourable response and shown to be 80/90% and 70% efficient in filtering dust and benzene soluble material Servicing was expensive and to assess this, a further 50 would be distributed at Nantgarw. It was suggested as many helmets as possible be made available at Phurnacite.
19/04/1977	British Steel Corporation Iron Mountain 0098820159 p 131	Airstream Helmet Delivery Schedule
20/04/1977	Joint BSC/NSF Working Party on Environmental Control 3 rd Meeting Iron Mountain 0098820159 p 278	Mr Launder referred to the current situation within NSF relating to the development of the Airstream helmet. Following initial trials in the Midlands, a further 20 were allocated to the Avenue in the Midlands, Lambton in the Northern Group and Nantgarw in Wales. General reaction was good although men at the Avenue Works had returned theirs after completion of the first month's trials. Trials were continuing at the other two works. Arising from the trials a list of complaints and faults had been compiled there was no doubt that many could be eliminated. Criticisms on grounds of weight, bulk and shape. There were problems with smearing and scratching of the visor as was known and frequent replacement of these was costly. Heavy rain had caused visibility problems and the visor had to be lifted to enable men to communicate. The protection levels of 0.2 mg/m ³ could be achieved providing the visor was down 75% of the time. Experience on the trials was that many men wore them in the up position 50% or more of the time so education needed. It was proposed that NSF continue trials on an extended basis. A further problem at NSF was the intrinsic safety of the electrical parts in the Airstream helmet. However, this would reduce the use in specific areas where flame-proof equipment was required. There were also concerns of a false sense of security in relation to workmen going too close to heat sources. It was noted that proper wearing of the Airstream was crucial in order to achieve the threshold standard
28/04/1977	NSF Ltd Cwm Coking Works and Power Station Consultative Meeting Iron Mountain 0041376941 p 66	Mr J Davies reported that safety goggles tried out by operators had found to be unsatisfactory. The use of the new type clean air – positive pressure helmets was discussed. These had been tried out at some plants and Mr Davies requested that some be obtained for trial at Cwm. The chairman said that although results of trials had been encouraging, these helmets were not available in quantity yet and were very expensive. They must be considered as a long term prospect and use would be limited to certain areas of the works.

Date	Source	Summary
25/04/1977	NSF Ltd Development of the Airstream Helmet Current Position National Archives	The Racal was seen as generally acceptable but there were issues of Bulk Unable to tilt head backwards Visor distorts Audibility problems over little distance
12/05/1977	British Steel Corporation Iron Mountain 0098820159 p 135	Meeting with HSE on 21/04/1977 Progress Review on Use of Airstream Helmet The Inspectorate were very interested in the programme of using Airstream helmets as intended by BSC and they indicated that they would follow this up very quickly on all sites and would be only too willing to insist on men wearing the protection. In this, they appeared to be very co-operative and would help management locally to get the Airstream worn properly and on a regular basis.
21/06/1977	NSF Ltd Environmental Control Committee National Archives	Can only achieve 0.2 mg/m ³ if visor in down position for 75% of the time. Workmen on trials wore the visor up 50% or more of the time Problems of visibility caused by scraping of visors Problem of not using in flameproof areas.
24/06/1977	NSF Ltd Joint Working Party on the Environment at Carbonisation Works National Archives	Effectiveness. 80/90% in filtering dust 70% in filtering benzene. A further 50 helmets provided to protect all workers on the oven tops at Nantgarw 6 helmets issued to men on oven lids, larry car, gas mains, coke guide and ram machine. Found to be cumbersome and restrictive in small spaces
24/06/1977	NSF Ltd Northern Region Consultative Committee Iron Mountain 0098537128 p 171	Dr Nichols referred the Council to the paper dated 20 th June 1977 previously issued by the scientific department giving a report on the on-going tests of the Racal Safety Helmet at Lambton Coking Works. Slides were shown by Dr Nichols to illustrate the actual workings of the helmet and arrangement of the air flow system. The tests at Lambton were being conducted for the purpose of appraising the filtration efficiency together with comfort and adaptability aspects to the wearer. Dr Nichols reiterated his prior remarks that further testing of the helmet would continue as more development was needed. Dr Nichols expressed his appreciation to the Management, Union and Workmen at Lambton for their co-operation and assistance. In view of the relatively high cost of the Racal Helmet the Council supported the policy of subjecting the helmet to vigorous tests.

Date	Source	Summary
27/07/1977	NSF Ltd, Thomas Ness Ltd South Western Regional Consultative Committee Iron Mountain 00413811810 p 522	Efficiency of Airstream helmet only tested in deep mines. Four helmets tested at Nantgarw 3 on the oven tops. 42 currently in storage. At the Phurnacite works, 10 helmets currently in use; 3 battery top men, 2 quencher men, 1 pressman, a pugman and a back-end man
28/07/1977	BSC Joint Accident Prevention and Advisory Iron Mountain 0098820159 p 172	Report on progress of introduction of the Airstream Helmet A batch had developed problems and had been lost on their way back to Racal. A number had deformed due to heat Difficulties had been found in training maintenance staff
17/08/1977	National Archives	Achieved BSM threshold if visor worn down 75% of the time. Training and education of the workforce needed.
23/09/1977	NSF Scientific Department A report on the Amplivox Racal Airstream Helmet National Archives	10 helmets tested at Phurnacite. Reduction of 89% of dust in top oven workers Can maximise protection by having the visors down all the time
05/10/1977	NSF Ltd Joint Working Party on the Environment at Carbonisation Works National Archives	Problems identified with Airstream after trials of 20 Weight bulk and shape Smearing and scratching of the visor Heavy rain causes visibility problems 0.2 mg/m ³ achieved by keeping the visor down 75% of the time Education important Extended the trial at one works Proposed to offer the Airstream helmets to battery workers at NSF and would require 1830
14/10/1977	NSF Ltd Cwm Coking Works and Power Station Works Consultative Committee Iron Mountain 0041376941 p 52	Airstream helmets Mr J Davies said that the trials had proved these masks to be extremely successful and asked for delivery of sufficient masks to be made as soon as possible. The chairman replied that it was the company's intention to obtain masks as soon as their effectiveness was proved. Time would be needed for manufacturers to produce these masks on the scale required.
18/10/1977	Steelmaking National Industry Group Working Party on Coke Ovens National Archives	BSC still problems with repair and maintenance of Airstream helmets. Positive result is a reduction in eye injuries NSF started with trials of 20, TLV below limit values inside the helmet

Date	Source	Summary
02/12/1977	BSC/NSF Working Party on Environmental Control 4 th Meeting Iron Mountain 0098820159 p 293	Airstream introduced at 9 works, four more soon and 5 works no date set. 2000 currently in use, 75 in use with 85-95% of men using them NSF 70 Airstreams in use a few deployed at other coking works and tar plants, pitch bays acid plants etc. 50 in use in foundries although visor had failed the impact test. Foundry employees anxious to have them Considerable improvement at East Moors Coke Ovens after training men in using the device
07/12/1977	British Steel Corporation Iron Mountain 0098820159 p 166	Issues with the Racal Airstream Helmet Heat Distortion – delay in production of the snood and visor protection at Racal Fan/Motor Units and Cables Large number of cable faults, now been replaced free of charge Batteries – casing splitting and defectives replaced free of charge Filters – variation in stiffness of the filters – agreed to look further into this matter Airflow – cooling effect insufficient in some helmets. Is between 220/240 l/min but stream of air needs directing over forehead. This can be done locally Visor – scratching a problem but needs to pass impact test – further research being done Testing Equipment – sensitive and requires calibration. Temple seals – now produced better adhesive
22/12/1977	Report on Trials Carried out on the Racal “Airstream” Helmet Incorporating an Activated Carbon Impregnated Cloth as a Pre-Filter National Archives	Data on exposure
12/01/1978	NSF Environmental Control Committee National Archives	70 helmets on trial at Nantgarw. Problem with servicing
02/02/1978	NSF Ltd Scientific Department National Archives	41 Airstream helmets in regular use. Generally well received and in demand 15/1/1977 6 helmets issued to ram driver, valves man, larry car driver, 2 lidmen and the guide driver 30/6/1977 10 helmets to Phurnacite plant. Five on the ovens, 5 briquetting 08/1977 3 helmets introduced to oven top workers and a further 3 requested from Nantgarw 08/1977 3 helmets issued at Coedely Common issues identified are the cable and that the visor won't stay up. Found to be cumbersome in enclosed spaces (ram and guide men) Successfully used on the coke oven tops but worn with visor up Problem of not feeling the heat so risk of melting Eye protection much better

Date	Source	Summary
21/02/1978	NSF Executive Committee National Archives	Standard of the helmet now generally acceptable. Many workmen anxious to try it. Report that considerable pressure to supply the device
17/04/1978	NSF and NUM Joint Working Party on the Environment at Carbonisation Works National Archives	Had 75 helmets and now purchasing a further 250
26/04/1978	NSF Ltd Northern Group Monkton Coking Works Iron Mountain 0098547128 p 62	Airstream Helmets The Chairman said these have been placed on order by the Company and each works will be allocated approximately one dozen for trial purposes. They will be used mainly on the battery and screens and possibly the purifiers. The cleaning and servicing of this equipment will be our responsibility.
09/05/1978	NSF and NUM Joint Working Party on the Environment at Carbonisation Works National Archives	Leaks from doors and oven lids the cause of high and variable BSM levels. Also sampling and surveying away from the batteries. Airstream helmet to be used in these areas Workmen should be aware that the Airstream helmet was available if they wished to use it.
15/05/1978	NSF Environmental Control Committee National Archives	Insufficiency of servicing areas for helmets 45 at Nantgarw but only two in use at any one time Racal recommends regular visits to instil the necessity of wearing the helmet Dr Archibald suggested annual training Mr Gregory wanted to report the purchase of 250 helmets which would cover the dirtiest jobs initially at sites where room for servicing was available (Codely, C????)
02/06/1978	NSF Ltd Northern Group Monkton Coking Works Iron Mountain 0098537128 p 50	Airstream Helmets Delivery of this equipment is still awaited
23/12/1978	NCB Safety Department National Archives	A further 50 helmets delivered. Being distributed to works where servicing facilities are installed – Nantgarw and Manvers 136 made available with 100 in regular use
1978/1079	Research and Development Programmes Iron Mountain 0041255972 p 1893	The Institute will also be involved in the assessment of the SMRE dust respirator
1978/1979	Annual Review of Safety Iron Mountain 0415664850 p 106	The issue of the Racal Safety ‘Airstream’ in the development, of which the Company played a large part, has been placed under the aegis of Safety Department. Many operational problems have manifested themselves, but the helmet has proved satisfactory in some locations. Issues will be made to people at greatest risk on an extended experimental basis. This helmet is not the complete answer to dust and other environmental problems at Coal Product Works and other devices such as the ‘throw away’ mask now being tested by the IOM and the NCB will be introduced and used if considered appropriate after successful assessment trials.

Date	Source	Summary
1979/1980	Annual Review of Safety Iron Mountain 002880671071 p1951	Airstream helmet doesn't prevent all ills but it has been issued at areas of highest risk 3M throwaway mask also tested but causes problems with facial discomfort in the heat.
14/02/1979	HSE Working party on coke ovens NSF and BSC National Archives	Usage of helmets at BSC. Now available but not greatly used or properly used. More training needed
19/04/1979	NSF Environmental Control Committee National Archives	300 more helmets purchased and a need to issue and provide servicing. Propose a policy for the use of the Airstream helmets Coventry would have 111 helmets in the next month
18/05/1979	NSF Directors Meeting National Archives	NSF had 300 helmets with 100 unused. HM Inspectorate taking the view that until conditions improved they would insist on the use of the helmet. If HM views accepted they would need a further 1000 helmets Agreed to run further trials with the 100 helmets but not buy more
05/06/1979	Aberaman Phurnacite Works Manager's Report National Archives	HSE concerned that Racal helmets should be available for all men to wear where warranted
11/06/1979	NSF Environmental Control Committee National Archives	Encouraged to wear Airstream before being made a condition of service
14/08/1979	NSF Environmental Control Meeting National Archives	Problems with the fan and battons Airstream should also be available to men in screen rooms District HSE had asked for 120 helmets for Aberaman. Thought wearing the Airstream could increase other health and safety risks for men. Problems of tar deposits altering the fans and damaging the motors
24/09/1979	NSF Capital Expenditure Committee National Archives	Facilitate as soon as possible a meeting with HSE to facilitate the introduction of Airstream helmets
09/10/1979	NSF Environmental Control Committee National Archives	Less than one third of helmets issued were in regular use. 120 were to be issued at Aberaman and this on a gradual basis
09/11/1979	BSC and NSF Working Party on Dust National Archives	Reaction to Airstream helmet ranged between acceptance and rejection
13/11/1979	NSF Ltd Accountability Meeting National Archives	Requisitioned some helmets but stopped as MD wanted to talk to HSE. Disposable masks tested at Edinburgh at £1 each. These were in continuous use at BSC. These should be tried
29/11/1979	NSF Memo National Archives	Allowing men to use disposable masks at Phurnacite
19/12/1979	NCB Coal Products National Archives	Experiments with masks about to begin but doubts about whether there could be a seal. This mask complied with the asbestos regulations. All Airstream helmets at Nantgarw and Aberaman were fully utilised.

Date	Source	Summary
1979/1980	NCB Coal Products Ltd Safety Department Annual Review of Safety Iron Mountain 0041375773 p 270	As mentioned in last year's report, the Racal Safety Airstream Helmet has not proved the panacea for all ills which many anticipated it would be, although issue and use continues at locations of highest risk. Extended trials of the 3M company's throwaway mask have been undertaken and are continuing. The filtering capability of this mask equals that of the Racal helmet and makes it suitable for use at our works. However some user resistance has been found in hot locations where considerable facial discomfort due to perspiration has been reported.
30/01/1980	NCB Coal Products Ltd Joint Safety, Health and Environment Meeting National Archives	Problems with the fan in the Airstream system documented. Helmets cleaned and repaired on a daily basis at Norwood.
21/02/1980	NSF Ltd Environmental Control Committee National Archives	Helmets issued in the North East after factory inspectorate pressure so progressing. 3M dust masks also trialled at Aberaman
24/03/1980	Meeting of board at Aberaman National Archives	Disposable masks suitable on the briquetting works but not well received on the batteries. Four Airstream currently in use on the batteries
23/04/1980	NSF Ltd Environmental Control Committee National Archives	3M masks unacceptable on oven tops but ok on briquetting works. HSE found present position acceptable
07/05/1980	Aberaman Phurnacite Works National Archives	Factory inspector considered dust masks should be available for all battery men and Racal helmets if required
19/09/1980	NSF Secret National Archives	Overheating of a helmet worn by a welder
25/11/1980	Aberaman Joint Safety, Health and Environment Committee Meeting National Archives	Inspectorate wants everyone to wear Racal helmets and it should be made a condition of employment. Mr Howson to check with legal department. A further 80 helmets sourced.
25/11/1980	Meeting of the Board with the Manager of Aberaman Phurnacite Works National Archives	Improvement notice served and all men on batteries to wear RPE

Date	Source	Summary
1980/1981	Coke Oven National Consultative Council Safety in Coal Products Iron Mountain 0041375773 p155	<p>Racal Safety 'Airstream' Helmet</p> <p>This helmet is now on issue at all works except Avenue and Smithy Wood. At these works issue awaits the provision of maintenance facilities which will be completed shortly.</p> <p>While the helmet is available the degree to which it is actually worn varies considerably from place to place. It has even been seen occasionally in use with the visor raised!!</p> <p>The HSE are insisting upon continuous use of adequate respiratory protection on the batteries and although a thruway mask of the 3Ms 8800 type would be acceptable – especially for those visiting the batteries – there is no doubt that the Airstream helmet or its equivalent is the type of protection envisaged</p> <p>Pressure will undoubtedly be brought to bear by the Executive – even to the point of prosecution of the men under Section 7 of the HASWA 1974. However compulsion by whatever means (condition of service has been rejected by the workforce Trade Unions) is not the most acceptable, nor is it likely to be successful, method of ensuring the helmet's use. Its acceptance will follow education and example therefore it will be the subject of a session in the proposed programme of training in the use of protective gear.</p>
18/03/1981	Letter from BSC to NSF Iron Mountain 009862558 p30	<p>A copy of the amendments to the minutes of the last meeting with HSE on Coke Ovens. This was from a meeting with HSE, BSC and NSF on 13/1/1981</p> <p>“The HSE were anxious to ensure that the coke oven tops became a protected area with suitable protection being worn with the availability of masks for those in peripheral areas. The target date for the attainment of this was July 1981”</p> <p>In summing up, “The chairman reiterated that 1 July 1981 was the hoped for commencement date for use of personal protection equipment and the time scale for the other elements would be dependent on working practices, possibly mid-1982”</p> <p>Document on Working Practice</p> <p>Part 11 Respiratory Protective Equipment</p> <p>RPE should be provided for those employed in places where the control of BSM concentrations within the TLV cannot be ensured.</p> <p>RPE should be worn at all times on the battery tops</p> <p>RPE should be worn in those circumstances where concentrations of BSM are known to be above the TLV and where such concentrations can reasonably be expected to be present</p>
26/03/1981	Letter from HSE to NSF Iron Mountain 009862558 p27	<p>First revision on the document entitled “Notes for control of fumes and emissions from coke ovens”</p>

Date	Source	Summary
08/04/1981	Joint safety, health and environment committee meeting minutes National Archives	Saw a problem enforcing wear before the HSE released their guidance note. Everyone issued with a Racal at Aberaman now wearing. Two men refused but HMI persuaded. Helmets still not introduced at Smithy Wood and Avenue. Anticipated that helmets available before the end of 1981.
07/05/1981	Memo from Mr Wood to Mr Ineson Production Director at NSF Iron Mountain 009862558 p 21	Comments on the notes for the control of fumes and emissions for coke workers.
28/05/1981	Notes of a Meeting of the Board with the Manager of Aberaman Phurnacite Works National Archives	The Company were resisting and attempt to make the wearing of Racal helmets a condition of employment. They would most certainly encourage people to wear the equipment and there would be a Company instruction to this effect issued in due course.
07/06/1981	Aberaman Phurnacite Works Board Meeting National Archives	Two men cautioned for not wearing helmets
11/08/1981	Letter from HSE Cardiff to NSF Ltd Iron Mountain 009862558 p 20	The note as mentioned in 27/08/1981
27/08/1981	Cautionary Leaflet on Coke Ovens sent to HSE but unclear where it is from, possibly EMAS? Iron Mountain 009862558 p12	“Respiratory protection such as ventilated helmets must be worn at all times with the visors down over the face”
16/10/1981	Coke Oven National Consultative Committee Safety in Coal Products 1980/1981 Iron Mountain 00415664849 p61	While the helmet is available the degree to which it is actually worn varies considerably from place to place. It has even been seen occasionally in use with the visor raised!! The department will continue to take appropriate action where this occurs. The HSE are insisting upon continuous use of adequate respiratory protection on the batteries and although a ‘throwaway’ mask of the 3M’s 8800 type would be acceptable – especially for those visiting the batteries – there is no doubt that the Airstream helmet or its equivalent is the type of protection envisaged. Pressure will undoubtedly be brought to bear by the Executive even to the point of prosecution of the men under Section 7 of the HASWA 1974. However, compulsion by whatever means (condition of service has been rejected by the workforce trade unions) is not the most acceptable, nor is it likely to be successful, method of ensuring the helmet’s use. Its acceptance will follow education and example and therefore it will be the subject of a session in the proposed programme of training in the use of protective gear.

Date	Source	Summary
24/11/1981	Letter from HSE to NSF Ltd Iron Mountain 009862558 p 8	Change in the wording of “Failure to wear the respiratory protective equipment may in certain circumstances make the individual liable to prosecution under section 7 of the Health and Safety at Work Act 1974” to “Employees are reminded that failure to wear the respiratory equipment may in certain circumstances be considered an offence under Section 7 of the Health and Safety at Work Act 1974”. “Printing of both the Cautionary Card and the Notes is well under way and I anticipate being able to send you copies in the near future.”
1981/1982/	NCB Coal Products Limited Annual Review of Safety Iron Mountain 00280671071 P2593	Following the publication of the HSE’s guidelines for “Reducing Operator Exposure to Fumes and Smoke from Coke Ovens”, all batter tops have been designated areas in which respiratory protection must be worn. The Racal Airstream is available to all regular workers in these areas, while casual visitors use the disposable masks type 8800 from 3M.
16/10/1981	Coke Oven National Consultative Committee National Archives	Racal helmet now on issue at all works apart from Avenue and Smithy Wood. The degree to which it is worn varies from place to place and been seen with the visor in the up position.
08/01/1982	NSF 5 th Meeting of Medical Doctors National Archives	Not able to interfere if HSE decide to prosecute a workman
15/03/1982	Coke Oven National Consultative Committee Iron Mountain 00415664849 p 965	A video film to promote the use of protective clothing - and including Airstream helmets, (wearing of which had been compulsory since the HSE report) was being produced and would be shown widely
21/06/1982	NCB Coal Products Ltd Wales, Safety, Health and Environment Committee National Archives	Every person on the batteries (working or visiting) should wear PPE to the required standard Aberaman workforce remain convinced of the necessity for an Airstream helmet
20/06/1982	NCB Coal Products Ltd Wales Safety, Health and Environment Committee National Archives	Racal helmets had met with general acceptance albeit with the visors up. Further discussion of the 3M 8800 mask with breathing restrictions resulting in a lack of wearing especially on the oven tops. Possible ergonomic study at IOM
29/09/1982	NCB Coal Products Ltd Wales Safety, Health and Environment Committee National Archives	Acceptance levels of 95% at Phurnacite works for the Racal Airstream
1982/1983	NCB Coal Products Annual Review of Safety Iron Mountain 00280671071 p 2442	Acceptance of respiratory protection on oven batteries has continued to increase albeit with some reluctance by certain individuals. The inspectorate issued an individual warning to one worker in Wales

Date	Source	Summary
1982/1983	Mining Research and Development Establishment Iron Mountain Doc 009881022 p 180	<p data-bbox="994 263 1624 287">Research and Development Testing Programme 1982/1983</p> <p data-bbox="994 295 1209 319">Respirator Research</p> <p data-bbox="994 327 2016 383">A joint project to design a powered respirator helmet suitable for use in confined spaces underground has been submitted to CEC by our hygienists and ergonomists</p> <p data-bbox="994 391 2016 470">The work of the Institute on testing and appraising respirators continues. Much attention this year has been focused on the Airstream helmet and on a new generation of disposable respirators</p>

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