

zehnder

WITH EVERY BREATH WE MAKE

Ensuring Healthy Air for Manufacturing Workers



EXECUTIVE SUMMARY

AIR POLLUTION – THE INVISIBLE THREAT

Air pollution is a health crisis and economic burden. Over 12 million residents in the UK are living with health issues that can be exacerbated by air pollution, and we lose 3 million working days a year because the UK's air pollution exceeds the World Health Organisation's recommend limits.

Air pollution is also a “levelling-up” issue. People in jobs that are not on a regular salary will lose out most when their health is affected by air pollution, which can trigger asthma attacks and non-fatal heart attacks. These jobs may also be the very jobs that are most exposed to airborne hazards in traffic jams and industrial work settings.



EXECUTIVE SUMMARY

WORKERS' HEALTH IN DANGER

With every breath, workers make the goods and food we use. They deserve every effort made to protect their health.

Employers in the manufacturing sector face the challenge of protecting the health of three million workers while activity inside their factories generates air pollutants. Airborne hazards are caused by stone work, cement, spray painting, flour and grain, animal feed, welding and metal work to name a few examples. Such hazards can cause new health issues, but are especially dangerous to the tens of thousands of manufacturing workers with preexisting conditions like asthma or heart issues.

The case for going to great lengths to tackle these airborne hazards is strong. **As well as causing serious illness to workers and the impact this has on operations, excessive airborne particles can also directly increase the costs of production, causing more production breaks for cleaning, equipment failures, product that doesn't meet quality controls and less efficient heating systems.**

Despite regulation of 500 airborne hazards by the Health and Safety Executive, there is evidence that some permitted levels of pollution cause serious health problems, pointing towards the need for lower exposure limits. The authorities would also be able to better protect employees if they collected robust data on the number of employees in the sector who have health conditions that make them especially vulnerable, and how well manufacturers minimise exposure to pollution.

Enhanced enforcement of the regulations is required to provide an executive mechanism to catch those that fail to operate within the expected standards – whether knowingly or unwittingly.

Finally, we suggest that manufacturers take a hard look at the benefits of tackling air pollution in their sites because the combined savings on production costs and employee health benefits can make

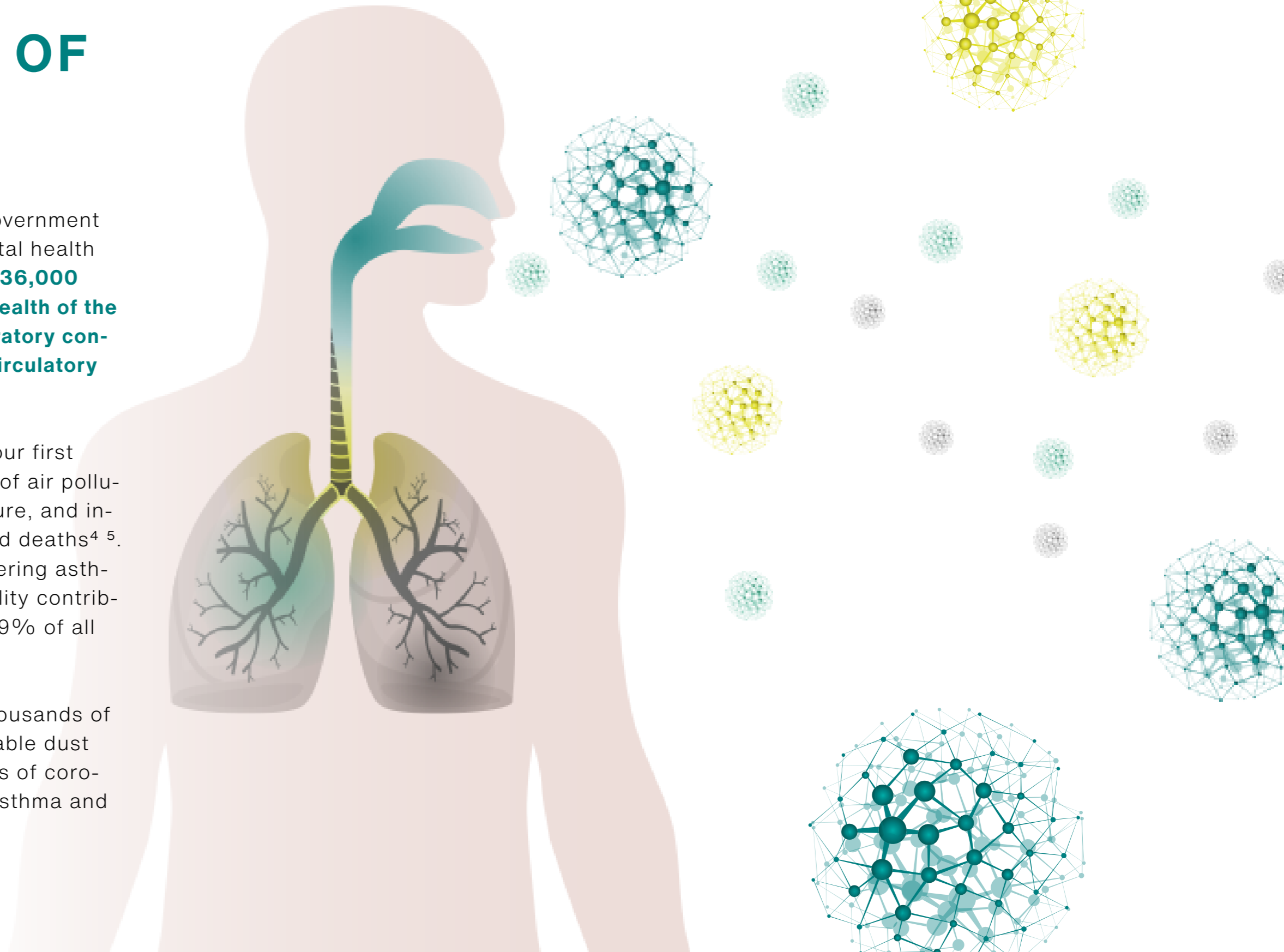
a compelling case to improve air quality beyond the regulated limits. Authorities and the government could encourage manufacturers by promoting these benefits within the industry and reviewing whether more manufacturers would act if a loan scheme provided finance to cover the upfront costs of installing measures to minimise worker exposure to airborne hazards.

1. THE HEALTH & ECONOMIC BURDEN OF AIR POLLUTION

The World Health Organisation (WHO) and the UK Government recognise that air pollution is the largest environmental health risk we face today. **Poor air quality is responsible for 36,000 deaths a year in the UK¹ and negatively impacts the health of the 12.7 million people who live with long-standing respiratory conditions² and 7.4 million people living with heart and circulatory diseases³.**


Air pollution is pervasive, impacting our health from our first breath to our last. Prolonged exposure to high levels of air pollution can damage lung function, increase blood pressure, and increase lung and heart related hospital admissions and deaths^{4 5}. Even short term exposure can be dangerous by triggering asthma attacks. Studies have estimated that poor air quality contributes towards 19% of all cardiovascular deaths and 29% of all lung cancer deaths^{6 7}.

But action will make an immediate health boon for thousands of people. A very modest one $\mu\text{g}/\text{m}^3$ reduction in respirable dust ($\text{PM}_{2.5}$) in England could prevent around 50,900 cases of coronary heart disease, 16,500 strokes, 9,300 cases of asthma and 4,200 lung cancers over an 18-year period⁸.





1.1 COVID-19 AND AIR POLLUTION



Air pollution and COVID-19 compound each other's impact. Health conditions that are caused or worsened by air pollution – such as asthma, heart disease and COPD – can also make a person more vulnerable to complications if they contract COVID-19. Emerging evidence also suggests that air pollution is contributing to the number of COVID-19 cases by making those exposed to high levels of air pollution more susceptible to catching the disease^{10 11 12}.

1.2 AIR POLLUTION AND THE ECONOMY

The impacts of air pollution are not confined to the young or old. The British Lung Foundation report that approximately one in five people in the UK have a history of asthma, COPD (Chronic Obstructive Pulmonary Disease) or another long-standing respiratory illness. 15% of adults aged 16 - 64 have been diagnosed with asthma^{13 14}, which is 6.4 million of the potential 42.3 million UK working population. The British Heart Foundation report that approximately one in nine people in the UK are living with heart and circulatory diseases, with 38% of those aged 16-64¹⁵.

Clearly, air pollution is an issue that affects the UK's workforce.

The Lancet reports 800,000 deaths globally are a consequence of poor air quality at work¹⁶. In the UK, the CBI calculates that 3 million working days currently lost to illness will be regained if air pollution is reduced to the WHO recommended levels¹⁷. The increased productivity would gain the UK economy £1.6 billion as a result, and workers would benefit through an additional £900 mil-

lion in earnings currently lost because of air pollution¹⁸.

The British Safety Council has revealed that outdoor workers it tracked in London were on average exposed to levels of air pollution above WHO guidelines, and sometimes by as much as 60%¹⁹. In another experiment, a construction worker was found to be exposed to six times more particulate matter than an office worker²⁰. A significant proportion of the UK workforce is based indoors but this does not necessarily offer protection. Pollution created outdoors ingresses into buildings, and is joined by unique sources of pollution from indoors. Pollution can also build up indoors in a way that pollution doesn't outdoors because of the natural dissipation in open air. Researchers have raised extra concerns about how different pollutants react with each other once mixed inside buildings²¹.

Air quality is a highly relevant consideration for every industry.

2. AIR POLLUTION IN MANUFACTURING

The manufacturing sector is the fourth largest employer in the UK, employing nine percent of the workforce, approximately 2.98 million people²². An employee spending their working life on the production line would spend over 10 years (93,000 hours)²³ inside these industrial buildings. The air that workers breathe in the workplace is a significant proportion of all the breaths they take.

2.1 TYPES OF HARMFUL AIR POLLUTION INHALED IN MANUFACTURING SITES

The Labour Force Survey is the largest household study of employment circumstances in the UK. From 2009 – 2011 the survey explored the causes of illness for workers who reported breathing or lung problems and found that workers cited the activities below in manufacturing settings as a cause of their illnesses²⁴.

According to the chest physician reporting scheme (THOR-SWORD) the most common causes of occupational asthma include isocyanates, flour dust, solder/colophony, wood dust and cutting oils and coolants; which are often found in manufacturing settings²⁵.

The Health and Safety Executive (HSE) regulates the exposure of workers to 500 different substances. The airborne volume of these substances are controlled by setting limits on how much of each substance can be allowed in a cubic metre of air, over a given period of time. These limits are called Workplace Exposure Limits (WELs).

To connect the worlds of air quality science and health and safety regulations, the following table provides a summary of the main categories of airborne pollutants and how they are typically referenced in each setting.

CAUSES OF ILLNESSES IN MANUFACTURING





AIR QUALITY SCIENCE



HEALTH AND SAFETY



LIMIT CONTROLS

<p>Headline term: Particulate Matter (PM)</p> <p>PM is a collection of solid and/or liquid materials of various sizes.</p> <p>Particulate matter is classified by its size, as size influences how it affects our health.³¹ Sizes are given in micrograms per cubic metre. For example PM10 is particulate matter of 10 micrometres or less in diameter. The amount of particulate matter in the air is measured in micrograms per cubic metre (written $\mu\text{g}/\text{m}^3$).</p> <p>Ultrafine Particles (UFP) are the smallest group of particles in the atmosphere, defined as particles with one dimension less than 100 nanometres in diameter³².</p> <p>One subset of particulate matter is airborne metals that are referred to in concentrations of total particulates.</p>	<p>Headline term: Dust.</p> <p>Dust is used to describe particles in the air that can be visible or microscopic. PM_{10}, $\text{PM}_{2.5}$ and ultrafine particles are all microscopic, but could still be referred to as dust, alongside visible fragments such as sawdust or flour dust. These larger dust particles are typically measured in milligrams per cubic meter (written mg/m^3).</p> <p>Smaller particles ($\text{PM}_{2.5}$) are referred to as respirable dust, while the larger PM_{10} particles are referred to as inhalable dust.</p> <p>Metal fume/dust is similarly a subset of hazardous substances.</p>	<p>PM_{10} and $\text{PM}_{2.5}$ are the size of the particulates against which the UK government has set legal limits for levels in the outdoor air.</p> <p>The HSE sets limits for exposure to dust in workplaces. There are specific Workplace Exposure Limits for some types of dust, and a ceiling limit for exposure to any type of dust.</p> <p>The HSE sets Workplace Exposure Limits for some airborne metals, such as aluminium and cadmium.</p> <p>Lead is controlled by The Control of Lead at Work Regulations 2002 (CLAW).</p>
<p>Headline term: Nitrogen oxides (NO_x) and Sulphur oxides (SO_x)</p> <p>Nitric oxide (NO) and nitrogen dioxide (NO_2) are key components of outdoor air pollution. Together they are often referred to as NO_x and are a product of combustion.</p> <p>Sulphur dioxide (SO_2) is a corrosive, acidic gas which combines with water vapour.</p>	<p>Headline term: Nitrogen oxides (NO_x) and Sulphur oxides (SO_x)</p> <p>Referred to using the same air quality science terminology.</p>	<p>NO_x and SO_x each have ambient outdoor air quality standards set by the UK Government.</p> <p>The HSE has set Workplace Exposure limits for NO_2, NO and SO_2.</p>
<p>Headline term: Volatile Organic Compounds (VOCs)</p> <p>This is a large group of organic compounds, which differ widely in their chemical composition but can display similar behaviour in the atmosphere.</p>	<p>Headline term: Solvents</p> <p>Solvents are used to dissolve or dilute other substances and materials. The risk factor of solvents is dependent on the concentration in the product, the method of use and whether multiple different solvents are present.</p>	<p>The Control of Substances Hazardous to Health (COSHH) Regulations instructs workplaces to protect against the risks from hazardous solvents.</p>

Table 1

It should also be noted that despite the separation of different pollutants here, in reality workers are exposed to a dangerous cocktail effect – which means solutions ought to be considered as a whole for the most effective protections.

2.2 THE IMPACT OF AIR POLLUTION ON MANUFACTURING WORKERS

Manufacturing has a rate of occupational asthma about five times higher than the all industries average²⁶.

However, in contrast to healthcare and education (the largest and second largest employers respectively) investigation into the impact of air pollution in the manufacturing sector is limited. Little research exists to describe the state of air quality in manufacturing as a whole. **There is no national reporting of air pollution levels in the sector, and there is no regular monitoring by an independent body.** Despite this lack of investigation into the current levels of air pollution in manufacturing settings, the impacts of air pollution on the sector's workforce is visible through health studies.

The Health and Safety Executive estimates that 15% of all COPD cases are attributable to work²⁷. The current estimate for the number of people living with COPD in the UK is 3 million which would mean **450,000 people are living with work-related lung disease just from COPD alone.** If the incidence of COPD is spread evenly across sectors, manufacturing would be responsible for 40,000 cases. But with workers in manufacturing sites exposed to pollutants that many other workers are not exposed to (for example, office workers) the incidence rate is likely to be higher.

In fact, a recent study found several manual labour jobs are associated with the highest risk for COPD²⁸. The study assessed 200,000 people's data held by the UK Bio-Bank to estimate the risk of occupational lung disease based on their role,

focused solely on COPD and not other issues such as asthma. **The rate of occupational asthma and level of risk of COPD is higher in the manufacturing sector than the UK workforce average.** If we were to apply just the average occurrence of respiratory and cardiac conditions to estimate the numbers working in manufacturing who have these illnesses, we arrive at an estimation of **121,000 with cardiovascular disease and 440,000 diagnosed with asthma** (based on the British Heart Foundation and UK Health Survey data cited earlier). Both of these conditions would be exacerbated by regular exposure to even low levels air pollution in the workplace.

The chest physician reporting scheme (THOR-SWORD) found the highest rates of annual reported cases during 2009 - 2018 were in the manufacture of food products (SIC 10), vehicles and trailers (SIC 29) and basic metals products (SIC 24). The occupations with the highest rates of annual reported cases in this same period were vehicle paint technicians and bakers and flour confectioners²⁹.

Occupational exposure to organic dust was associated with increased lung cancer risk in a study that examined the working and smoking situations for 13,300 people with cases of lung cancer³⁰.



At the end of a shift, staff would leave the facility looking like they worked on the coalface. They were covered in dust and we had to upgrade our shower and welfare facilities to meet the workers' needs. We had some employees off on recurring sick leave or experiencing occupational health issues with asthma related complaints and the mood in the workplace was grim.

- Site Production Manager, Industrial Gas Company

SEVERAL MANUFACTURING ROLES WERE AMONGST THE LIST OF THE MOST AT-RISK PROFESSIONS:

- Seafarers: 2.64 (at risk out of every 100)
- Coal mine operatives: 2.30
- Industrial cleaners: 1.96
- Domestic Cleaners: 1.43
- Roofers/tilers: 1.86
- Packers/bottlers/canners/fillers: 1.60
- Horticultural trades: 1.55
- Food/drink/tobacco process operatives: 1.46
- Floorers/wall tilers: 1.41
- Chemical/related process operatives: 1.39
- Postal workers/couriers: 1.35
- Labourers in building/woodworking trades: 1.32
- School mid-day assistants: 1.32
- Kitchen/catering assistants: 1.30

2.3 THE IMPACT OF AIR POLLUTION ON MANUFACTURING PRODUCTION

Whilst health of manufacturers is reason enough to ensure a high standard of air quality in manufacturing settings, air pollution does also affect the sector's productivity.

One detriment to productivity stems from the effect of pollution on the workforce. **Across all industries respiratory illness is responsible for 3.9 million sick days a year³¹.** If the rate of sick days in manufacturing is equal to the all-sector average, that would be over 350,000 days lost every year. Whilst figures specific to the manufacturing sector are not available, it would not be a surprise if the real figure is much higher given that manufacturing has a rate of occupational asthma about five times higher than the all industries average³². Productivity can also be affected by air pollution on a short term basis. A 2016 study in a pear packing factory found a statistically significant negative impact of PM_{2.5} on the productivity of workers inside the factory.

An increase of 10 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of PM_{2.5} reduced workers' productivity by approximately 6%³³.

Particles in the air can also affect machinery and efficiency of production lines. Clients of filtration and ventilation company Zehnder Clean Air Solutions have testified to the production problems they faced, which led to installing an air cleaning solution.

- Automotive supplier Huf found that dust made their automated equipment less efficient, which required more frequent cleaning – increasing costs – and also requiring more down time to allow for cleaning³⁴.
- Industrial, medical and special gas provider BOC similarly found that their site wasn't meeting its productivity potential due to airborne particles.
- Typhoo Tea reported that higher particulate matter in the air was associated with higher heating costs as the air did not circulate as efficiently.
- Dust can also impact product quality. Huf found that dust caused defects to paintwork, leading to quality control sometimes rejecting finished product that could not be sold.
- Logistics firm DB Schenker found that a dust film settling on the floor would increase the risk of the wheels of industrial trucks spinning, necessitating frequent manual cleaning.

WHAT PROFESSIONALS ARE SAYING



If you improve the air quality everything else works in your favour – lighting, filters in air fed mask. The investment pays off. The quality of work improves. Production goes up.

- Operations Director, JBS Fabrications



To remain competitive, we need to keep getting better and better – and improve our right-firsttime rate. Clean air is one of the ways we can do that.

- Plastics and Assembly Manager, Huf UK



A good safety manager can put together a case of the seen and unseen cost of poor occupations health and safety.

- Health and Safety Manager, Wood Product Company



Once you have the initial improvements, the high cost is out the way and it will level out over a 3 to 5-year period.

- Environment Manager, Wood Product Company

3. ASSESSMENT OF THE PROTECTIONS FOR MANUFACTURING

WE HAVE ESTABLISHED THAT

- 1 Activity in manufacturing sites causes air pollution that is harmful to health.
- 2 The health of manufacturing workers has been harmed by poor air quality.
- 3 A significant number of manufacturing workers currently have health conditions that will be worsened by being exposed to air pollution on a daily basis.

THE FACT THAT GOOD AIR QUALITY IS VITAL FOR WORKERS' HEALTH IS UNDERSTOOD WELL ENOUGH FOR THE HEALTH AND SAFETY EXECUTIVE TO HAVE SET RESTRICTIONS ON THE LEVELS OF 500 DIFFERENT POLLUTANTS IN WORKPLACES WITH SPECIFIC WORKPLACE EXPOSURE LIMITS AND THOUSANDS MORE HAZARDOUS SUBSTANCES UNDER COSHH.

BUT HOW SUFFICIENT ARE THE RESTRICTIONS, HOW SUCCESSFUL IS THE ENFORCEMENT OF AND ADHERENCE TO THOSE RESTRICTIONS, AND WHAT ARE MANUFACTURING COMPANIES DOING TO ENSURE THE BEST POSSIBLE AIR QUALITY BEYOND JUST MEETING THE HSE MAXIMUM EXPOSURE LIMITS?

3.1 SUFFICIENCY OF CURRENT AIR QUALITY STANDARDS IN MANUFACTURING

The COSHH (Control of Substances Hazardous to Health) legislation has set the operating restrictions for levels of airborne pollutants in manufacturing settings since 1998 (updated 2002). These are termed Workplace Exposure Limits (WEL). The allowable limit of pollution concentrations was last updated January 2020. The following table shows the limit values and any recent changes to those values for the most prevalent airborne pollutants in manufacturing. It also compares the limits to the World Health Organisation guidance limits and the UK's air quality targets for outdoor air pollution.

POLLUTANT	MEASURE	WHO GUIDELINES	UK OUTDOOR AIR QUALITY VALUE	MEASURE	ORIGINAL WORKPLACE LIMIT VALUE	CURRENT WORKPLACE LIMIT VALUE	DATE OF LAST CHANGE (to workplace limit value)
PM ₁₀ (inhalable dust)	24 hr mean	50 µg/m ³	50 µg/m ³ not to be exceeded more than 35 times per year	8 hr time-weighted average	15 mg/m ³ (1969)	10 mg/m ³	1984
PM _{2.5} (respirable dust)	24 hr mean	25 µg/m ³	No current target	8 hr time-weighted average	5 mg/m ³ (1980)	4 mg/m ³	1997
NO ₂	1 hour mean	200 µg/m ³	200 µg/m ³ not to be exceeded more than 18 times a year	8 hr time-weighted average	Was a new WEL in 2018	0.96 mg/m ³	2018
SO ₂	24 hr mean	20 µg/m ³	125 µg/m ³ not to be exceeded more than 3 times a year	8 hr time-weighted average	Was a new WEL in 2018	1.3 mg/m ³	2018
VOCs – note there are many VOCs, those here are selected as they are listed by the WHO	n/a	Benzene – no safe limit can be specified	16.25 µg/m ³	8 hr time-weighted average		3.25 mg/m ³	
	30-minute mean	Formaldehyde – 0.1 mg/m ³	No current target			2.5 mg/m ³	
	Annual mean	Naphthalene – 0.01 mg/m ³	No current target				
	Annual mean	Tetrachloroethylene – 0.25 mg/m ³	No current target			138 mg/m ³	

Table 2

3.1.1 EXISTING LIMITS ALLOW HARMFUL LEVELS OF AIR POLLUTION

The Health and Safety Executive identifies that there is a growing consensus in the occupational health community that exposure to all sizes of non-toxic dust at levels below the concentrations outlined in COSHH may still be a risk to the health of employees³⁷.

There is evidence to suggest that dust levels lower than the current COSHH trigger (4 mg/m³) have significant impact on worker health. Indeed, it suggests that COPD or other lung injury may occur at levels of exposure below the COSHH regulated values³⁸. Trade Unions and the Institute of Occupational Medicine have therefore been calling for lower exposure limits to be set.

Studies, conducted as long ago as the 1980s, have shown that continued, long-term exposure to respirable dust reduces lung function, above decline from ageing. Research conducted in coal mines³⁹ and PVC works⁴⁰ show that long term exposure (20 years plus) to dust levels between 2.5 and 3 mg/m³ – notably below current

COSHH trigger levels – results in decreased lung capacity⁴¹.

A third study, this time by the HSE, showed that workers who were exposed to low-toxicity dust levels of 4 mg/m³ for 40 years experienced a reduction in lung capacity equal to approximately six years loss through ageing (over and above the natural change in lung function due to ageing).⁴²

The HSE study also concluded that 12% of those workers would be twice as likely to report breathlessness than someone not working in those conditions and 7% would suffer lung function loss that left them three times as likely to report that they had to work slower than other people because of their chest. It is clear from these studies that dust levels are impacting worker's respiratory systems and as a consequence their quality of life. **Despite this evidence, dust regulations have not been updated since 2002.**

In 2011, the Health and Safety Executive's Scientific Advisory Committee on Toxic Substances (ACTS) reiterated that current exposure levels for dust are not safe⁴³. Similarly, the Institute of Occupational Medicine (IOM) has suggested that, 'until safe limits are put in place, employers should aim to keep exposure to respirable dust

below 1 mg/m³ and inhalable dust below 5 mg/m³ ⁴⁴. While the TUC recommends a standard of 1 mg/m³ for respirable dust and 2.5 mg/m³ for inhalable dusts. The current limits are 4 mg/m³ and 10 mg/m³ respectively.

All three bodies, therefore, regard 1 mg/m³ for respirable dust as a more appropriate guideline than the 4 mg/m³ COSHH trigger.

Levels of NO_x and SO_x, are allowed under the current HSE guidelines which the WHO has declared unsafe in outdoor air (see Table 2). Both pollutants were given workplace exposure limits in 2018, to ensure the UK was fully compliant with EU requirements. The WHO regards PM_{2.5} as a carcinogen, meaning that it can cause cancer. However, as the HSE don't list low-toxicity dust in the workplace exposure limits it cannot be denoted a carcinogen. If it were to be recognised as one in the workplace they must then be reduced to as low as practically possible.

COSHH

4 MG/M³

TUC

1 MG/M³ (RESPIRABLE)
2.5 MG/M³ (INHALABLE)

IOM

<1 MG/M³ (RESPIRABLE)
<5 MG/M³ (INHALABLE)



3.1.2 CALLS FOR ACTION ON THE DANGER OF AIR POLLUTION IS REACHING A TIPPING POINT

This is by no means a new subject, the TUC recommendations for lower levels were released in 2011, almost a decade ago. Unions have been seeking greater action on harmful pollutants in the workplace for years. The Choked campaign⁴⁵ calls to halve the legally permissible level of exposure to silica dust, and Unite The Union has invested significant efforts into raising awareness about the impact of diesel fumes on workers⁴⁶.

When consulted about this investigation, trade union representatives stated that they feel the clarity of the need for action on air pollution in all workplaces is clear enough. But there is an environment of deregulation, and a severe lack of data, meaning that workers in the most high-risk environments – such as manufacturing – are too often last to see protections.



Workers are the canaries in the coal mine, exposed first, exposed most, least protected.

- Hazards Campaigner

3.1.3 WE UNDERSTAND MUCH MORE ABOUT THE HEALTH IMPACT OF AIR POLLUTION NOW THAN WHEN THE EXISTING LIMITS WERE SET

The field of air quality science is fast moving, with barely a week that goes by without an academic paper shedding more light on the way that air pollution affects the human body and evidence of the mounting long-term health impacts of airborne hazards. The workplace exposure limits for particulate matter/dusts were last changed in 1997 and in 2018 for NO_x and SO_x. TUC and IOM recommendations were published

in 2011. Since just 2018, reams of new findings have been published.

With such a wealth of new insights, from the world's leading academic experts, it is vital to test the existing health protections against these new insights to determine if revisions are necessary.

2020

- Exposure to ultra-fine particles is found to increase the risk of heart attacks in a German study of 6,000 heart attacks.⁴⁷
- Prenatal exposure to air pollution is linked to cognitive difficulties as children grow up according to a multiyear study by the University of Columbia.⁴⁸
- Exposure to fine particles was associated with reduced bone mass, leading to osteoporosis in a study by the Barcelona Institute for Global Health.⁴⁹
- Mice exposed to PM_{2.5} air pollution developed prediabetic symptoms similar to mice fed a high fat diet.⁵⁰
- Collaboration between universities in Australia, Japan and the UK observes the first evidence that exposure to even very low levels of air pollution can change gene expression that are the hallmark of diseases such as cancer.⁵¹

2019

- Hundreds more people have heart attacks, strokes and asthma attacks on higher air pollution days, in the UK's 9 largest cities.⁵²
- Data from 16 countries shows that individuals who are exposed to higher levels of air pollution are more likely to experience depression or to die by suicide.⁵³
- Residents in areas with higher air pollution have higher rates of glaucoma, that can lead to blindness according to the UCL Institute of Ophthalmology and Moorfields Eye Hospital.⁵⁴
- Exposure to air pollution associated with higher levels of "bad" cholesterol and linked to obesity in young adults in a California study.⁵⁵
- World's largest study (652 cities in 24 countries and 59.6m deaths) finds that short-term exposure to air pollution, is directly linked to increases in deaths.⁵⁶

3.1.4 LACK OF UNDERSTANDING OF THE AIR POLLUTION LEVELS ACROSS MANUFACTURING SITES AND THE HEALTH DAMAGE THAT THEY CURRENTLY CAUSE CASTS DOUBT ON THE VALIDITY OF THE EXISTING LIMITS

The availability of information to assess the impact of air pollution on the health of workers in the manufacturing sector leaves many questions. We cannot be sure that the regulations are set on adequate information about the risks employees face.

The main piece of evidence referred to by the Health and Safety Executive in explaining the need to act on air pollution in workplaces is the Labour Force Survey (LFS). But this survey has significant limita-

tions that make it an insufficient tool to assess the health damage caused by workplace air pollution in the manufacturing sector.

The LFS estimates the manufacturing sector in 2019 has around **4,000 workers suffering with breathing or lung problems caused or made worse by their work (new and long-standing cases)**⁵⁷. This suggested that respiratory conditions accounted for 5% of all ill-health in the sector. The LFS is a survey completed by a representative number of workers. The first challenge with the LFS is that it only asks individuals to give information on one health condition, and so an individual with two issues – perhaps respiratory and cardiac – would not be able to report both leading to potentially significant under reporting. Secondly, they are asked to only give information about whether their current or most recent job has impacted their health, and not previous employment. Thirdly, the survey requires individuals to

identify conditions that have been caused or made worse by work. **Given that 73% of the public don't know where to go to get health information about air pollution**⁵⁸ individuals may be unaware that their conditions are linked to the air in their working environment.

Even a doctor would be hard-pressed to diagnose that a certain health condition was made worse by the quality of the air in a person's workplace, given that neither the individual nor the doctor will likely have been given accurate information about the level of pollution in the air in the workplace.

This survey is therefore an inadequate way to assess the true health impact of air pollution in workplaces.

**4,000
WORKERS**

suffering with breathing or lung problems caused or made worse by their work

**5% OF ALL ILL-
HEALTH**

in the sector are accounted to respiratory conditions

**73% OF THE
PUBLIC**

don't know where to go to get health information about air pollution

1 IN 9 PEOPLE IN THE UK

are living with heart and circulatory diseases; 38 % of those aged 16 - 64

ABOUT 121,000 INDIVIDUALS

in manufacturing suffer from a cardiovascular condition, potentially impacted by air pollution in the workplace

The most recent statistics (2019) produced by the Health and Safety Executive also don't report any manufacturing workers suffering with cardiovascular conditions caused or made worse by their work⁵⁹. However, the British Heart Foundation report that approximately **one in nine people in the UK are living with heart and circulatory diseases, with 38% of those aged 16 - 64⁶⁰**. Given the unique pollutants that are produced in manufacturing sites, it is hard to believe that the manufacturing sector doesn't have at least a rate of cardiovascular conditions equal to the national average – which would mean approximately 121,000 individuals in manufacturing with a cardiovascular condition that would be potentially impacted by air pollution in the workplace.

Finally, the most important insight that would enable the appropriate standards to be set would be regular reporting of the level of pollutants in manufacturing settings, as not currently legally required. As described throughout this document scientific studies have identified the damage that air pollution at certain levels can have on

those individuals with specific health conditions. Therefore, if information on the level of pollution in workplaces was available, we could identify how many people are exposed to these levels of air pollution, **rather than leaving it to workers to guess whether their workplace has a level of pollution that might be damaging their health.**

It is clear that the scale of the health problems caused and made worse by air pollution in the manufacturing sector are not fully understood and are potentially grossly under-reported. As a consequence of not knowing the air quality in their workplaces, those living with pre-existing respiratory and cardiac conditions remain vulnerable to hazards that they are not fully aware of.

The ideal improvement would be to **combine a thorough understanding of actual pollution levels in manufacturing sites, with sound knowledge on the health conditions that individual workers have**, whether those workers believe that health problem to be connected with their workplace or not.



3.2 EFFECTIVENESS OF ENFORCEMENT OF THE AIR QUALITY STANDARDS IN MANUFACTURING

We have understood in section 3.1 that peer-reviewed scientific studies assert that exposure to pollution even at lower levels than the current exposure limits present a serious health risk. And we understand that the knowledge of the air quality levels in manufacturing sites is poor. So, how can we be sure that there is a problem with air quality in sites if there is no data to call on?

3.2.1 ENFORCEMENT DOESN'T APPEAR TO BE FULLY EFFECTIVE AS PEOPLE ARE STILL SUFFERING FROM OCCUPATIONAL HEALTH PROBLEMS

The answer has two parts. We can be sure that there is an air quality problem in manufacturing sites because of the presence of health issues among its workforce, and from some first-hand reliable samples of data from manufacturing sites.

Epidemiological studies can isolate for a range of factors in people's health and lifestyles to determine the effect of a working sector on the health of its workforce. **A study led by Imperial College⁶¹ into the causes of cancers that led to death, found that 5.3% of the cancer deaths were attributable to the workplace** – i.e. the deaths would not have been expected given the other factors in those people's lives. This study found that "Industries and occupations with high cancer registrations include construction, metal working, personal and household services, mining, land transport, printing/publishing, retail/hotels/restaurants, public administration/defence, farming and several manufacturing sectors". It specifically identified welders as a category with high registrations of cancer, fur-

ther high registrations due to exposure to silica, inorganic mists, diesel engine exhausts, dioxins and tetrachloroethylene.

A further epidemiological study led by Imperial College⁶² found that **without intervention, cancers attributable to the workplace would remain at over 10,000 through to 2060**. A modest intervention could eliminate nearly 2,500, and stricter interventions could avoid over 8,100 cancers per year.

Finally, a 2017 study led by the Institute of Occupational Medicine⁶³ assessed the potential to avoid cancer cases by reducing exposure to a range of 25 substances. The study determined that there is a clear benefit to reducing exposure to some substances, with the strongest case for the Europe-wide introduction of exposure limit values for respirable crystalline silica, hardwood dust, hexavalent chromium and rubber fume.

**8,100 CANCERS
PER YEAR**

could be avoided with
strict interventions



Without any national record of the air pollution levels in manufacturing sites, we can still see that the impact of exposure to occupational conditions leads to increased cancer cases. But it would also be helpful to understand the level of the air pollution challenge in the manufacturing sector and so in the course of this study we asked many institutions for any sources of data that could give us a clue to the current conditions in sites.

Manufacturing businesses that see the value of good air quality have commissioned Zehnder Clean Air Solutions to provide air filtering solutions, giving Zehnder Clean Air Solutions a good sample of the air quality situation in many workplaces. A typical project begins with a monitoring phase to understand the nature and extent of any airborne hazards in the workplace. Of 188 workplaces where the air quality has been monitored by Zehnder Clean Air Solutions in recent years sites, two-thirds had levels of particulate matter – or dust – that exceeded the WHO advised limits, **and of those that exceeded the guidelines, the average was 7 times the recommended level.**

TWO-THIRDS OF MANUFACTURING WORKPLACES

exceed the WHO limits for particulate matter 7 times on average

3.2.2 THE ENFORCEMENT SYSTEM AND ITS EFFECTIVENESS AS A DETERRENT TO THOSE NOT MEETING THE WORKPLACE EXPOSURE LIMITS

Failure to meet the established workplace exposure limits is an illegal action by an employer, and may lead to fines and potential prosecution, administered by the Health and Safety Executive.

There is an inspection regime, which is severely reduced due to funding cuts, despite observing high rates of malpractice by employers when it carries out visits. The HSE and local authorities who oversee the enforcement of COSHH regulations are lacking resources to ensure compliance. A report by the Occupational Safety and Health APPG (2018)⁶⁴ revealed that the number of pro-active health and safety inspections (for any reason) by local authorities fell by 97% between 2010 and 2016. In large part this is due to budgets being cut, with no specific ring-fenced budget for workplace health and safety enforcement. The overall number of inspections and other interventions fell by 65%. However, the HSE itself reports severe issues with compliance in some sectors, including a 2015 investigation which found that over half of the 60

stonemasonry and work-surface manufacturing sites visited by the HSE were not compliant with workplace exposure limits⁶⁵.

The HSE's own enforcement statistics report Enforcement statistics in Great Britain, 2019 illustrated that the total number of prosecutions brought forward for health and safety offenses has continually reduced since 2015/16. This may reflect the simultaneous reduction in funding for the Executive – funding has reduced by 46% since 2009/10, reflecting a £100million cut and a 27% fall in Health and Safety front-line inspectors⁶⁶.

The reduction in the number of inspections combined with the falling rate of bringing prosecutions results in a weakened deterrent for unconscientious employers, which is one of the reasons that the workers union representatives are concerned about his issue of workplace exposure to hazards.

There are 150,000 union safety representatives in workplaces across the UK. These individuals are keen to play a vital role for workers in their industries. **For a responsible employer, active union safety reps are a valuable additional pair of eyes and ears, able to spot problems before they cause serious health or production issues in the workplace, and to remind colleagues of**

best practice. Where employers have not acted responsibly, reps can play a lifesaving role as perhaps the only member of the workforce with the training and position to spot and raise issues that could be harming the health of their colleagues. They also have the right to carry out safety audits during working hours. Union safety reps have identified so many missing controls on airborne hazards over the last decade that this issue is a continued area of concern.

There seems a strong case for increasing inspections to ensure compliance with workplace exposure limits given that the HSE itself has found high rates of non-compliance in some sectors and union safety reps continue to put workplace air quality towards the top of their priority list.

” You can put any regulations in, but if you don't have people checking what's going on it doesn't make a single bit of difference.

– Health and Safety Manager, Fabrications Company

3.3 EXTENT OF VOLUNTARY ACTION IN THE MANUFACTURING SECTOR TO GO BEYOND MEETING STANDARDS

The manufacturing industry is of course a very different industry to the one that was fuelled substantially by burning dirty fuels such as coal a century ago. **Protecting the health and wellbeing of manufacturing workers has become a welcome industry within an industry.**

Make UK – the champion for British manufacturing companies – has reported on the activity that companies undertake for a healthy workforce. Its 2020 report “Health, Wealth and Wellbeing for Manufacturers”⁶⁷ details that:

- 91% of employers have employees who have suffered from long-term sickness in the last year. Of that cohort, two-fifths of this absence was work related.
- Over 90% of companies which have invested in employee health and wellbeing have seen

workforce productivity increase and an improvement in workforce relations.

- Measures taken to protect health and wellbeing include flexible working and support services such as counselling.

However, it appears that the air pollution issue is poorly understood with little focus given to the importance of providing healthy air in workplaces.

In the entirety of the Make UK wellbeing report, there is no mention of the impact of air quality on employee’s health, nor of any other environmental conditions of the workplace. The importance of providing a healthy working environment with good air quality is absent from this high profile industry paper, and yet we know that even low levels of air pollution can cause significant illness and contribute to the long-term sickness of employees

which is an issue for 91% of employers.

In a previous Make UK study from 2019⁶⁸ half of manufacturing companies reported not knowing whether their risk control measures have an impact on the number of cases of respiratory ill-health within their business, while almost three-fifths (58%) reported that occupational lung disease is not applicable to their business⁶⁹. Given the level of lung disease across the population, it seems unlikely that the majority of manufacturing sites should have no likelihood of ever affecting the lungs of their workforce.

Based on this current insight from the heart of the manufacturing industry’s efforts to boost employee wellness, it appears that a focus on air quality is a missed opportunity.

HALF OF MANUFACTURING COMPANIES

do not know whether their risk control measures have an impact on the number respiratory illness cases within their business

58% OF THEM

state that occupational lung disease is not applicable to their business

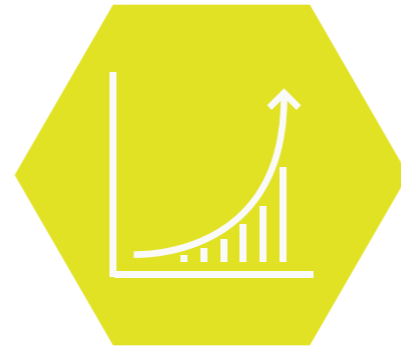
COST REDUCTIONS

Manufacturing companies may well be able to give their health and wellbeing programmes a real boost, reducing the total days lost to illness and cases of long-term sickness if they do explore and improve air quality in their sites.

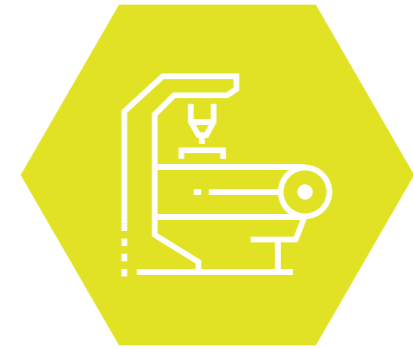
This also doesn't have to be a costly exercise given the wide range of potential benefits of reducing airborne hazards. In this report we have identified evidence that addressing airborne hazards in manufacturing sites can lead to cost reductions.



**REDUCED WORKER ABSENCE
AND LONG TERM SICKNESS**



**INCREASED SPEED OF WORKERS
AND PRODUCTIVITY**



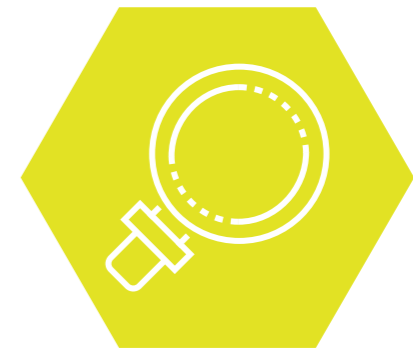
**MORE RELIABLE EQUIPMENT
WITH FEWER OUTAGES**



**FEWER PRODUCTION BREAKS
FOR CLEANING**

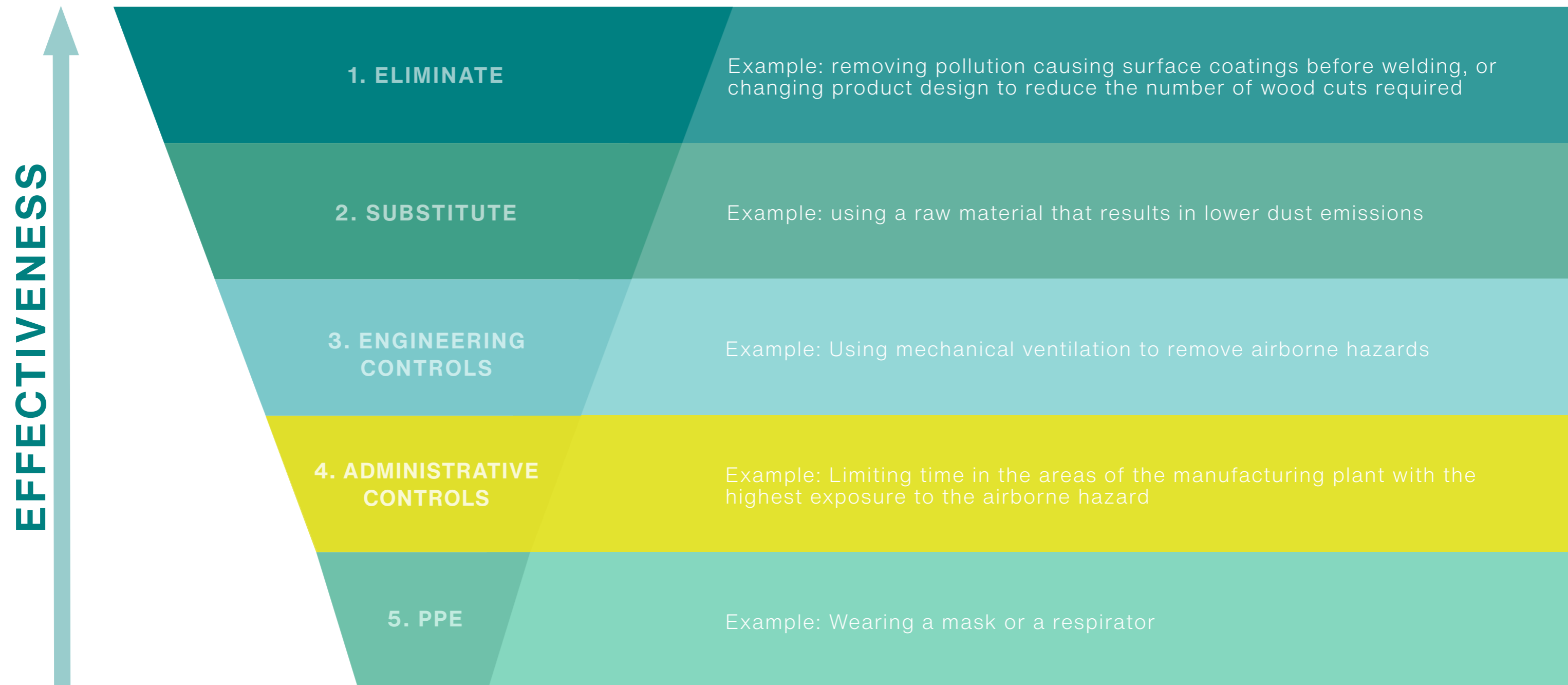


**MORE EFFICIENT HEATING AND
CIRCULATION OF AIR**



**BETTER QUALITY CONTROL AND
REDUCED REJECTION RATE OF
FINISHED PRODUCTS**

REDUCE AIR POLLUTION BY FOLLOWING THE HIERARCHY OF EXPOSURE CONTROL⁷⁰



THE BUSINESS CASE FOR ENSURING GOOD AIR QUALITY FOR WORKERS IS OVERWHELMINGLY POSITIVE.

TO CLOSE THIS ANALYSIS OF THE CASE FOR CHANGE, WE RETURN TO TWO PRODUCTIVITY STATISTICS.

Firstly, the example provided earlier of worker's productivity in a fruit packing plant⁷¹ shows the potential for UK manufacturers. Worker productivity dropped by 6% when pollution increased by 10 micrograms. The exposure limit for the same pollutant (PM_{2.5}) in UK sites is 4 milligrams – that's 4,000 micrograms. **If a change of 10 micrograms can lead to a 6% productivity swing, imagine the gains that could be had if a manufacturing site was able to decrease PM_{2.5} levels from the allowed limit of 4,000 micrograms to 2,000 micrograms.**

Finally, the potential sector wide gains can be calculated from the recent CBI assessment⁷² of the economic benefits of achieving WHO recommended air quality levels across the nation. The entire economy would benefit from fewer work absences and more productive worker years, to the tune of £1.6bn. **If the benefit is shared equally across the economy, the manufacturing sector would benefit to the tune of £240m a year.**

BUSINESSES CAN INCREASE PRODUCTIVITY BY 6%

if they reduce particulate matter by 10 micrograms

£1.6BN A YEAR

could be saved if businesses adhered to WHO's recommended air quality levels

CONCLUSIONS

This investigation has identified that:

- Workers have been, and still are exposed to unhealthy levels of airborne hazards and pollution in manufacturing workplaces
- These hazards have, and still do cause health problems for manufacturing workers
- The presence of airborne hazards also causes problems in production that hit the bottom line of manufacturing businesses
- Therefore, there is an opportunity to be grasped in minimising airborne hazards and pollution, with a business case that straddles employee health and wellbeing and lower costs of production for manufacturing businesses.

The investigation has also identified that:

- The regulation allows levels of airborne hazards and pollution that are dangerous to manufacturing workers' health.
- The way regulations are enforced is unlikely to find those not meeting the expected standards – be that intentional or unintentional on the part of the manufacturing sites
- Manufacturers are increasingly paying attention to employee wellbeing, but the quality of the air and the working environment seems to be underplayed as a foundation of good employee wellbeing.



CLEAN AIR

RECOMMENDATIONS

In response to the conclusions, we make the following recommendations for policy-makers, regulators and manufacturers themselves.

1. Regulation should lower the acceptable limits for air pollutants in the industrial workplace.

Sound evidence exists to be certain that lowering the acceptable levels of airborne hazards will significantly improve the health protections for employees in the manufacturing sector. Specifically, there is significant support for lowering the limits for inhalable and respirable dust.

2. Regulators should review the need to change exposure limits for air pollutants about which new evidence has become available since limits were last set.

In the last two years, a wealth of evidence has emerged about the impact of airborne hazards on heart attacks, strokes, asthma attacks, gene expression and cancer, diabetes, cholesterol, glaucoma, osteoporosis, cognitive function, depression, suicide and mortality rates. This new science should be used to assess whether changes should be made to limits in manufacturing workplaces – especially for on NO_x and particulate matter as the two pollutants with the most new evidence over the last two years.

3. Enforcement by regulators should be proactive with many more spot checks.

By not including random spot checks of manufacturing sites in the enforcement regime, it is highly unlikely that the regulators will identify sites that are unwittingly or intentionally exposing workers to airborne hazards above the allowed limits. Spot checks should be instated at a reasonable frequency, and undertaken in a way which uncovers the typical operations at the site. This will also enable the authorities to get a clearer picture of the actual level of pollution in the air at a wide variety of manufacturing sites, which in turn will enable authorities to inform the policy on allowable limits.

4. Establish a research programme that combines air quality monitoring in manufacturing sites with tracking of workforce health issues, resulting in a true understanding of the risks employees face.

This investigation highlighted the lack of data available on the risks faced, and the health damage caused in manufacturing workplaces. A long term monitoring programme on a representative sample of workplaces would enable the authorities to identify how many workers are exposed to air pollution that risks worsening pre-existing health conditions, and causing new ones. A fuller under-

standing of the manufacturing workforce would also enable the authorities to determine how many workers have these preexisting conditions or are developing short-latency occupational diseases in response to exposure to airborne hazards, and therefore the benefits of setting the allowable limits at a given level.

5. Manufacturers should take another look at the business case for action on air pollution, with help from the authorities.

Ensuring a healthy working environment for employees and minimising airborne hazards that can affect the operations of the factory are compelling reasons to act, with the measures to improve air quality potentially being net-positive when all benefits are recognised. But the industry is currently underplaying improving the air in the workplace for example, when it considers providing the best wellbeing for employees, based on the content of the industry's wellbeing report. We encourage individual manufacturers to take another look at the benefits it could gain by adopting measures to eliminate airborne pollution and encourage the authorities to also nudge manufacturers to look again at the benefits action on air pollution can bring.

6. Government should review the financial business case for providing loans to manufacturers to finance the up-front costs of measures that reduce airborne hazards.

The hierarchy of control identifies many ways that manufacturing sites can seek to reduce exposure to air pollution, and the long term business case for change can be financially positive when the reduction in illness, increase in productivity worker and reduction in operating costs are taken in to account. However, some measures require a capital investment that might be beyond some manufacturers. The government should explore providing a fully repayable loan that would cover the capital costs of the control measures, to be paid back over time as the manufacturers sees the financial benefits in reduced costs and increased employee productivity.



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- x 50 = 93,200hrs exposure in a working lifetime. Equivalent to 10.6 years exposure.
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