Contents

03 Foreword
04 Science: a vital component of the regulatory craft
05 The Discovering Safety Programme
06 The HSE science and evidence cycle in action: Reducing work-related mental ill health
07 Events and achievements
13 Meet the staff
Case studies (see right)
49 References and further reading

Case studies

- Supporting small employers
  22 New good practice guidance for managing metal working fluids
  23 ‘Taking the pee’: practical means of assessing worker exposure to chemicals.
  24 Worker exposure to diacetyl in the coffee industry

- Acting together
  25 Setting fire to whisky spills: public safety in the vicinity of distilleries
  26 Scientific investigation into a gas explosion that destroyed a bungalow.
  27 Securing vehicle loads, fatal incident investigation
  28 Investigation of the Millennium Chemicals incident involving water-reactive chemicals
  29 Construction industry ‘risk profile’ interactive dashboard

- Managing risk well
  30 Summarising the evidence on the effectiveness of mental health first aid (MHFA) training in the workplace
  31 Background levels of microorganisms in public transport hubs
  32 International modelling of major hazard chlorine dispersion experiments
  33 Health and safety in the waste and recycling industry
  34 Enhancing Forestry Commission Scotland’s approach to health and safety guidance

- Sharing our success
  35 Improving safety at air displays
  36 Monitoring pesticide residues in the UK food supply
  37 Supporting effective natural disaster risk management
  38 Enhancing occupational health risk management at Heathrow Airport engineering department

- Tackling ill health
  39 Exhaled breath condensate: a novel approach to assess occupational exposure to respirable crystalline silica
  40 Supporting the HSE management standards on work-related stress
  41 Reducing weight, hand-arm vibration and noise health risk factors in the rail industry
  42 Hand-arm vibration syndrome - a referral service for high level health surveillance and training centre for doctors and nurses
  43 Wellbeing at work: The PEROSH Conference series

- Keeping pace with change
  44 Enabling the safe construction of a 100% hydrogen distribution network
  45 Health and safety implications of developments in information and communications technologies
  46 The Space Industry Act - keeping people safe
  47 Measuring and controlling potentially harmful emissions from desktop 3D printers
WELCOME TO HSE’S Science Review for 2019. Once again, we are proud to share with you some of the work that has been completed by HSE’s scientists and engineers to support our policy and regulatory activities. In addition, we have also included some case studies where we have supported other parts of Government (both in the UK and overseas) and commercial clients. In all cases, the knowledge we provide helps to reduce workplace risks and, ultimately, to protect people.

Andrew Curran at Yorkshire Water’s Health and Safety Symposium

Our focus this year is on our contribution to HSE’s regulatory activities. Critical to this area is the technical and forensic support we provide to the investigation of workplace fatalities and other serious incidents. Our scientists and engineers visit the incident site and collect a range of on-site information: laser-scans of the environment, photographs and video as well as securing any physical materials for forensic analysis back in the laboratory. The logistics for these activities can often be complex, as securing a chain of custody is critical and sometimes, for instance for major engineering failures, the evidence collected can run to many lorry loads. These investigation activities also require us to assemble inter-disciplinary teams of scientists, engineers, and analysts at very short notice to enable the contributory factors for the incident to be determined. This approach to technical problem solving is a particular strength of our technical capability, with traditional discipline boundaries not being a barrier to the investigation. Indeed, it is not uncommon for our physicians to be working with engineers, or microbiologists working with human factors specialists.

The insights provided by our inter-disciplinary approach for investigations not only support the legal process, with our specialists often acting as expert witnesses in court, but also provide knowledge which can help to safeguard people in future and support innovation to enable the safe introduction of new technologies (see HSE’s Innovation in Regulation). Indeed, our understanding of ‘failure’ at a system level is proving to be very helpful to organisations who are seeking to innovate in a range of areas including, for example, additive manufacturing (including 3-D printing), large infrastructure projects, and energy storage and supply. By sharing the lessons learned from the past through our investigation work, we can help to protect the future by designing out potential health and safety issues. We are particularly pleased that our partnership with the Lloyds Register Foundation (see p5) will help us to achieve this ambition on a global scale.

Our scientific knowledge is being used to address increasingly complex health and safety issues. This includes using our understanding of the potential risks resulting from the interface between the working environment and physical plant, and the people interacting with them. In this review, we use the example of mental ill health to illustrate how our science and evidence strategy works to translate knowledge into action. This area is of concern since one in four people in the UK will have a mental health problem at some point and our own statistics suggest that 15.4 million working days were lost in Great Britain due to work-related stress, depression or anxiety in 2017/18.

I hope that you enjoy the case studies that we have produced for this review to show how we use applied science, engineering and analysis to make a difference to the world of work. I also hope that the knowledge that we produce will continue to enable a better working world.

Professor Andrew Curran
Chief Scientific Adviser and Director of Research
Science: a vital component of the regulatory craft

OUR MISSION, AS A REGULATOR is to reduce work-related death, injury, ill health and hold people to account. Our risk-based approach to regulation, means we direct attention to those workplaces and hazards where we need to act to remove risk and prevent workers being harmed. Our scientific work, supported by regulatory and policy colleagues, is vital in enabling us to understand risks better so that we can intervene in the right way, at the right place and at the right time.

Having a robust evidence base enables us to tackle real issues causing pain and suffering in the workplace. Critically, it enables us to better understand developing issues and ways of working to ensure that we support innovation, rather than stifle it through lack of knowledge. For example, the work on the use of 3D printers in schools demonstrates HSE’s ability to engage and understand the risks to encourage safe innovation in a developing area (see p47).

Other examples in this report show just a selection of the excellent work carried out by our staff, often collaborating with others, which contributes to improving how we regulate health and safety risks proportionately and effectively.

One of HSEs key priorities is to prevent future cases of occupational lung disease by improving the management and control of hazardous substances. The case study on measuring Respirable Crystalline Silica exposure contributes to this, and to recognise developing and future issues, such as the work on diacetyl in the coffee industry (see p24 and p39). This type of scientific investigation gives our regulators good, trusted, information enabling critical decisions on the actions needed to protect workers.

The case study on publishing new guidance on the use of Metalworking Fluids (MWF) demonstrates the important contribution of collaborative science to improving regulation.

If used inappropriately exposure to MWF mist can cause serious long-term lung disease and it was recognised that users needed help to control this risk. HSE scientists and regulators worked with industry stakeholders to produce new, free, guidance which reflects changes in scientific understanding in a practical easy to use guide. As well as enabling users to better manage the risks, and as a bonus likely save money, it has assisted regulation by providing clear benchmarks for all to judge control against. An excellent example of science contributing to controlling serious health risks (see p22).

These case studies are excellent examples of how science contributes to reducing risk. Hopefully they will inspire you to think about how risk in your workplace could be improved and where further work might be needed.

Phillip White
Head of Regulation
The Discovering Safety Programme

The DISCOVERING SAFETY Programme is a large and ambitious scientific endeavour funded by The Lloyd’s Register Foundation and being jointly delivered by HSE and the University of Manchester through the Thomas Ashton Institute. The programme’s primary aim is the creation and exploitation of a global health and safety knowledge resource to support health and safety decision making around the world by using new insights from data and analytical techniques.

Every year, huge amounts of incident investigation findings and operational health and safety data are collected globally. If meaningful insights could be generated from this data and applied in local contexts and situations; through education, practical improvement initiatives and commercial tools and services, then health and safety could be substantially improved, ultimately saving lives, particularly in poorer or developing nations.

The outputs will be disseminated through an international programme of training education, and practical solutions, that will improve global health and safety performance, resulting in many lives saved, and a safer working world.

Programme Vision

Imagine a world where no one dies as a consequence of work, where industry doesn’t suffer catastrophic failure, where companies can say that no one was harmed in the making of their product and where accidents can be predicted and therefore prevented.

Objectives

To collaborate with industry, trade groups, international networks, governments, academia and other stakeholders to identify health and safety challenges and new and emerging risks where better use of health and safety data might help.

To bring together and exploit HSE and other health and safety data sources for the maximum benefit of the programme.

To develop new analytical tools and techniques for analysing health and safety data and generating insights, along with effective approaches for sharing insights across programme stakeholders.

To ensure the programme is sustainable in the longer term, including through the commercial exploitation of select outputs where feasible.

To demonstrate that the programme is achieving its goals and developing tangible benefits across the global health and safety community.

Benefits

- Reduction of incidence of injuries, non-injury accidents and cases of work-related ill health.
- Reduced financial costs of lost work time and plant downtime, better awareness of regulatory responsibilities.
- Enhanced ability to be more evidence based in how risks are managed, better tailoring of risk control measures.
- Enhanced ability to measure health and safety performance and demonstrate improvement and benefit of interventions.
- Cross fertilisation of thinking regarding best ways to control risks.
- Enhanced ability to predict when future health and safety failures might happen and therefore prevent them.
- Greater awareness of the intrinsic value of routine health and safety data.

For more information please see the Thomas Ashton Institute website and the The Lloyd’s Register Foundation website.
The HSE science and evidence cycle in action*: reducing work-related mental ill health

We catalyse engagement by others and improve performance

- Our psychologists offer training courses and consultancy on reducing work-related stress: 400 delegates have been trained on 30 courses. Our specialists contributed to developing and delivering HSE 2017 'Stress Summit', over 200 delegates.
- Our statisticians publish details on work-related stress, including infographic poster, used to make the case for improvements.
- We use knowledge shared through the PEROSH Wellbeing and Work conferences to engage with stakeholders, for instance article on the PEROSH 'Wellbeing Tree' in Safety Health Practitioner.

We protect workers and safeguard the public

- HSE's guidance 'Management Standards for Work-Related Stress' used in GB for over a decade. First published in 2004, its development included using applied research and knowledge synthesis by our psychologists and analysts. This guidance was used as the basis for 2018 Italian national guidance.

We underpin operational and policy activities

- HSE scientists and analysts develop evidence that informed development of HSE Work and Health Strategy: work-related stress made a priority.
- HSE statisticians provide annual statistics on work-related stress, depression or anxiety.
- HSE scientists provide policymakers with rapid scoping evidence on Mental Health First Aid Training (published 2018)
- HSE statisticians support policymakers in development of case studies on reducing work-related stress (three published 2018, more planned for 2019)

We anticipate new challenges through foresight and synthesis of existing evidence

- HSE's Foresight Centre identifies potential future mental ill health challenges:
  - 2019 Annual Foresight Report: occupational safety & health; and
  - 2019 Foresight Report: Information Communication Technology (ICT)
- Evidence synthesis by HSE Workplace Health Expert Committee (WHEC). Reviews published on 'work-related stress and psychological health' and 'work-associated musculoskeletal pain' which considers psychological distress and poor mental health.
- Further reviews underway on work-related stress interventions to improve health outcomes.

We provide evidence to ensure risks from work activities are effectively controlled

- Through ‘PEROSH’ Wellbeing and Work conferences, HSE scientists and physicians work with European counterparts to stimulate knowledge generation and sharing internationally.
- Our specialists publish evidence on wellbeing and work including psychosocial risk factors.

Further information

See case studies on pages 30, 40 43 and 45, and references 4-32 which include research on wider aspects of mental health and wellbeing.
Events and achievements
Events and achievements

Visitors

HSE’s Laboratory at Buxton has hosted a number of important visitors and events in 2018.

In August, HSE Board Chair Martin Temple accompanied Sara Weller, the Department of Work and Pensions’ (DWP) lead non-executive director, who was interested in finding out more about the work that takes place at HSE’s laboratory. The visit included a tour of the external test facilities, a visit to the engineering laboratory, and a session on mental health, which both Sara and Martin have a keen interest in. They were both impressed by the knowledge and enthusiasm shown by colleagues during their visit, especially in their sessions on 3D printing, as well as the forensic investigations taking place at the engineering laboratory.

In July Carl Creswell the head of the Better Regulation Executive, which leads the regulatory reform agenda across government, accompanied by Clive Fleming, HSE’s Head of Policy Profession, were welcomed to the laboratory by Professor Andrew Curran, HSE’s Chief Scientific Adviser. The visit included learning about HSE’s scientific research used to inform HSE policy and regulation to enable the safe introduction of new and emerging technologies. Carl Creswell said, ‘I wanted to say a big thank you, we were very impressed by the important work. We took away a lot of food for thought (I already talked about your work on 3D printers this morning at a cross-Government officials group on future regulation).’ (See p47 for 3D printers).

Staff from The Foresight Centre were among the HSE colleagues who met the CEO of the Medicines and Healthcare products Regulatory Agency, Dr Ian Hudson, during his visit to HSE’s laboratory. In his subsequent letter of thanks to the HSE CEO, he commented that: ‘I very much enjoyed reading your Foresight Report.’

Events

Sheffield Group

The Sheffield Group is the international network of national institutes for occupational safety and health (OSH) who share a research mission. It is chaired by Professor Andrew Curran, HSE’s Chief Scientific Adviser, and this year the annual meeting was hosted in Bonn, Germany. The Group discussed common research issues and identified opportunities for closer working in a number of key areas. In addition, a representative from OSH-Africa attended to discuss approaches to help share experiences.
PEROSH is the Partnership for European Research in Occupational Health and Safety (OSH). The partnership, whose aim is to strengthen European research, comprises 13 national European institutes affiliated to government or social insurance systems. Members have a programme of joint research projects, promote researcher exchanges, and are active in developing, sharing and disseminating new OSH knowledge. The Scientific Steering Group is chaired by Dr Mary Trainor, HSE’s Head of Science Impact and Quality, and its autumn meeting was hosted at HSE’s laboratory. The Group discussed new and emerging health and safety challenges. This included a presentation by HSE microbiologist Brian Crook talking about his work during the Ebola crisis in Sierra Leone which can be seen on a video clip.

HSE was proud to support the UK government Year of Engineering 2018. HSE helped to publicise the critical role engineers play in making sure workplaces are healthy and safe. The campaign, which ran a range of activities throughout the year, to celebrate the great work of the profession and supporting the government’s ‘Industrial Strategy’ to boost engineering across the UK. An important part of this is encouraging the next generation to join the profession and make sure they have the skills needed to thrive in a modern economy.

Professor David Fishwick, Chief Medical Adviser for HSE, has been awarded an Honorary Fellowship by the Irish Faculty of Occupational Medicine in their annual award ceremony.

Chris Keen, Occupational Hygiene Practitioners Technical Team Lead, chairs the British Occupational Hygiene Society (BOHS) ‘Breathe Freely in Construction’ campaign. She chaired and spoke at the campaign Roadshow event in December. The event had 70 delegates and attracted excellent feedback.

Bev Bishop, joint Chief Social Researcher, was invited to chair the Social Research Association (SRA) annual conference in December. This was a particularly prestigious invitation as the conference celebrated the SRA’s 40th Year.
One of the Government’s celebrations to mark 100 years of votes for some women, was a suffrage flag relay. HSE flew the suffrage flag over its Buxton laboratory on the 15th October. The event offered the opportunity to celebrate and discuss the impact women have had on science and regulation in the workplace, equality at work and increasing the numbers of women working in science and engineering. The event was attended by the local MP Ruth George, representatives from the Safety and Reliability Society and a local domestic abuse charity.

Andrew Curran, HSE’s Chief Scientific Advisor gave a keynote presentation at the Office of Product Safety and Standards international conference followed by a panel session with representatives from the Greek Ministry of Economy and Development, Food Standards Agency and Blockchain Laboratories. The conference theme was using technology to improve regulation.

Awards, honours and achievements

The value of our scientific expertise has been recognised by others who have presented HSE staff with various awards and honours.

Peter Baldwin, occupational hygiene practitioner, has been elected a Fellow of the Royal Society for Public Health for his work within HSE and also with the charity WHWB, Workplace Health Without Borders, to promote reduction in industrial disease in the UK and beyond.

Stuart Hawksworth, head of HSE’s Centre for Energy and Major Hazards, has been elected president of the International Association of Hydrogen Safety and appointed as an independent expert member of the European Hydrogen Safety Panel to provide independent advice to the European Commission’s Fuel Cell and Hydrogen Joint Undertaking. The HSE’s High Hydrogen Project, funded by The Energy Technologies Institute, was shortlisted by the Energy Institute for their 2017 Safety Award.

Peter Baldwin (right)
Keith Birkitt, engineer & materials specialist has been made a Fellow of the Institute of Materials, Minerals and Mining in recognition of his contribution to forensic engineering, in particular for his high quality incident investigation work, which has involved a number of high profile cases. Keith’s work has also contributed to a number of safety alerts and a Europe-wide ban on the sale of chain flail cutters following a fatality.

Kate Jones, Technical Team Lead Biological Monitoring has been made a member of the Editorial Board of the Annals of Work Exposures and Health and a member of the Biological Exposure Indices Committee of the US Association Advancing Occupational and Environmental Health which advances occupational and environmental health.

Garry Burdett, Technical Fellow, has been appointed as a member of the board of the new Faculty of Asbestos Assessment and Management of the British Occupational Hygiene Society (BOHS).

Professor David Fishwick, Chief Medical Adviser, has been re-elected UK secretary to the International Congress on Occupational Health (ICOH) for a 3 year term of office.

Mike Clayton, Technical Team Lead Personal Protective Equipment has been commended by Charles Tracey, Chair of CEN and ISO standards committees, ‘my sincere thanks to you personally as you were the main instigator of the standard ISO 16975 Part 3, Fit Testing Procedures which to my delight has won the ISO Annual Award for best Document’.

David Brown, microbiologist, was the co-author of the paper A Framework for the Risk Assessment and Management of Gene Drive Technology which won the Knudson Publication award from the American Biological Safety Association.

Andrew Pinder, ergonomist, is a member of the team from the Partnership for European Research in Occupational Health and Safety (PEROSH) that was awarded the prize for the best 2017 paper in the journal Applied Ergonomics: A practical guidance for assessments of sedentary behaviour at work.

Sam Bradbrook, foresight specialist, gave a keynote speech at the European HSE Management forum 3.0 in Amsterdam.
The Biological Monitoring Team had a significant presence at the 10th International Symposium on Biological Monitoring (ISBM) 2017 conference. The conference was jointly organised by Kate Jones, Technical Team Lead Biological Monitoring in her capacity as chair of the Scientific Committee of Occupational Toxicology of the International Commission on Occupational Health (ICOH), and the University of Naples. Kate gave the opening address and led the HSE team - Jackie Morten, Craig Sams, Laura Kenny and John Cocker – which presented 6 talks and 3 posters.

Amy Gyte, biohazards specialist, and Ed Robinson, workplace health specialist, have been invited to join a ‘task and finish’ group to review and re-write the NHS Standards for Cleanliness - the guidance document used by all NHS England Trusts (see Meet the staff, p15).

Phil Beards, human reliability specialist, led work on the newly published Research Report Common human factors underlying worker fatalities in the waste and recycling industry. This has been profiled on website of the Chartered Institute of Waste Management, the professional body for resource and waste management and the Cleaning Matters industry magazine. ‘This welcome report will help to focus our attention on the areas where real improvement is needed.’ Dr Colin Church, CEO, CIWM (see Meet the Staff p16 and case study p33).

Dr Steve Forman, Principal Medical Adviser, was an invited speaker at the Society of Occupational Medicine 2018 Occupational Health Conference. His talk urging organisations to review their health surveillance programmes for workers who have a high risk of developing respiratory diseases to ensure that screening is sufficient, was profiled in the ‘Occupational Health and Wellbeing’ online newsletter.(see Meet the staff, p18).

Sam Hall and Rhiannon Mogridge, exposure assessment and control specialists, were praised for their presentation at the Association for Innovation, Research and Technology Organisations Health and Safety Group meeting: ‘... the glove experience was brilliant please thank (them) for their knowledge and time’. Ray Jeffery, Health Safety and Environment Manager, Building Research Establishment.

Work by HSE’s Scientists was well represented at the British Occupational Hygiene Society (BOHS) Conference, where 12 HSE presentations were given.
Meet the staff

We employ over 850 scientists, engineers, analysts and medical staff, many hold PhDs or Masters level qualifications and Chartered status within their professional bodies. This section introduces some of our specialist staff.
GARETH AND JACK both work at HSE’s laboratory in Buxton.

Gareth joined in 2002 as Head of Health Exposures. He was previously a lecturer and worked at the Medical School in the University of Sheffield Medical School, as a tenured lecturer and post graduate tutor, leading a research team investigating virus-related respiratory diseases in children. At HSE, Gareth provides technical leadership for research into the causation and prevention of occupational disease such as the GB Occupational Cancer Burden project, asthma in bakers, and dermatitis in hairdressers. He works in partnerships with industries, trade bodies, practitioners and experts, whose aim includes identifying and challenging working practices that expose workers to substances that cause ill-health.

Recent research by Gareth and colleagues on exposure of machinists to metal-working fluids informed an industry-led good practice guide to reduce risks for skin and lung disease; the guide is used by engineering companies in GB and across Europe (see p22). Gareth is working with two Catapult Technology Centres, and their manufacturing partners, to address future manufacturing health and safety challenges by informing safe design and promoting good working practices at the technology development phase. He is currently involved in research that is informing the development by industry of a good practice guide for safe use of metal powders in additive manufacturing.

Gareth Evans (left) and Jack Mellor

Gareth thrives in interdisciplinary teams. He provided the health input for recent research led by HSE physicist Sam Hall on controlling emissions from desktop 3D printers which informed a good practice guide by CLEAPPS on safe use in schools (see p47). He also contributed to a recent evidence review led by HSE psychologist Nikki Bell on the evidence on ‘mental health first aid training’ in workplaces (see p30).

JACK JOINED HSE straight from Buxton Community School Sixth Form in 2015. As a member of the Health Scientific Support Team at HSE’s laboratory in Buxton, Jack undertakes a wide variety of activities in scientific disciplines as diverse as analytical chemistry and personal protective equipment. Jack is accredited to carry out face fit-testing of respiratory protective equipment (RPE), which he does to support operational staff across HSE who wear RPE. He particularly enjoys the analytical aspects of the work, especially practical applications in workplace exposure assessment. It is this variety of work that has given him the opportunity to decide on his future career path.

HSE is supporting Jack’s study for a BSc (Hons) degree in Chemical Science at Manchester Metropolitan University. This is a degree apprenticeship which allows students to also develop all the practical laboratory skills required to work in a chemical industry or scientific research environment. All the course students are in full-time employment within the chemical science sector. Jack says ‘I enjoy the fact that the course requires a lot of self-discipline and enables me to immediately apply the newly acquired knowledge and skills to my current work’.
Amy Gyte
Senior Health Exposures Scientist

Amy has worked in the Biohazards Team at HSE’s Buxton laboratory for four years. Amy has a PhD in molecular pharmacology. She has a background in pharmacodynamics and toxicology in an industrial setting, and worked in the pharmaceutical industry for ten years, in the development of drugs for Type II Diabetes.

Amy’s main focus is work-related lung disease and she is currently looking at respiratory ill health in hospital cleaners and in the agricultural industry. She leads research looking at the risks to farmers of exposure to toxic gases when working with animal slurries (see p39 of HSE Annual Science Review 2018).

A large proportion of her role is speaking with industry stakeholders; to understand their jobs and barriers to working healthily and safely, and working with them to develop practical control solutions.

Amy says, ‘I enjoy working in multidisciplinary teams and pulling together all of our expertise to produce robust scientific evidence and deliver practical solutions that help people to do their jobs safely and without developing ill health. I get great satisfaction from working closely with people in industry and making a real difference to working lives’.

Amy also visits schools to inspire young scientists, and promote science as a career, especially for girls, through her work in the STEM Ambassadors Programme (www.stem.org.uk).

Amy Jones
Ergonomist

Amy has worked in the Ergonomics Team at HSE’s Buxton laboratory for over 14 years. Before joining HSE she worked at Thales Underwater Systems designing user interfaces for submarine operators. Her current role involves tackling diverse ergonomic issues for example safe handling of coffins in burials and cremations, and the manual handling related risks to midwives who provide care to women using birthing pools at home and in hospital. Currently Amy is collaborating with the HSE engineering team to assess the safety of water rides at amusement parks.

Amy has helped investigate a number of incidents including some involving fairground rides and hospital and care home bed rail related fatalities. Amy has presented her work on bedrail safety at the Chartered Institute of Ergonomics and Human Factors Annual Conference and has also published in the Institute’s magazine on the difficulties of integrating human factors into the design process.

This followed on from her research into improving control panel design on mobile elevated work platforms (MEWPs) in order to reduce injuries to workers. She collaborated with manufacturers worldwide to contribute to the first global draft standard for MEWPs to consider control function consistency.

Amy says ‘I love the variety of work that I do at HSE however I confess to now being a risk adverse mum at fairground rides!’
Phil Beards
Human Factors Specialist

Phil first joined HSE in 2011, on a student placement for 6 months. He returned to HSE in 2013, as an employee and has spent the past 5 years working with the Human Factors Team at the Buxton laboratory.

Phil’s role at HSE has seen him administer the HSE Safety Climate Tool to global organisations looking to understand their safety culture; assist in the post implementation review of both Asbestos and Sharps regulations and, with the Chartered Institute for Waste Management, identify those common human factors prevalent in waste and recycling fatalities (see p33).

Phil’s recent work has seen him take on a shared research project with national retail and travel organisations within the UK, identifying the human factors associated with incidents on escalators. HSE is supporting Phil in undertaking a PhD on this work in conjunction with the University of Portsmouth.

Phil says, ‘The project has had its up and downs but the enthusiasm of the stakeholders and working with Portsmouth University is rewarding knowing the work we are doing has an impact on everyone’s daily lives.’

Jim Murphy
Statistician

Jim joined HSE in 1996 and has worked in various statistics teams. He is currently part of the Statistical Data Science and Processing Team based in Bootle and Buxton.

Alongside a data management role for the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) notifications system, Jim is responsible for a range of European and international work, involving collaboration with other UK regulators, including HSE’s liaison with the Government Statistical Service and the delivery of data to the EU Statistical Office. He is actively involved in development work for the Lloyds’ Register Foundation’s Discovering Safety Programme (see p5).

Jim says, ‘In my career I’ve worked in lots of different roles and enjoy the variety – but for me it’s the people that are most important, I’m fortunate to work with great people that are incredibly talented, across a range of disciplines: administration, policy, scientific and operational. I’m passionate about ensuring that everyone is consulted and listened to effectively, and I am active in several working groups to improve our communications, culture and identity.’
Antonia Hawker
Noise and Vibration Scientist

ANTONIA JOINED HSE in 2017, she has a degree in geophysics from University College London and an MSc by research in astrophysics from the Jodrell Bank Centre for Astrophysics at the University of Manchester.

Antonia’s research at HSE is primarily on improving technology for the assessment and control of noise and vibration hazard. This involves investigating and evaluating the risk to workers using both laboratory-based research as well as workplace site visits. Her recent work has included assessment of noise and vibration emissions from chainsaws and the evaluation and assessment of timing devices for exposure to hand-arm vibration. Companies have begun to rely on technology such as these devices in order to quantify workers exposure to hand-arm vibration. This work has recently been presented at a conference.

Antonia has also been involved with collaborative projects in the field of nanotechnology, including assessment of exposure risks to nanoparticles in fumes from lasers in the beauty and medical industries, and what control measures would protect worker and patient health.

Antonia says, ‘I enjoy the diverse nature of projects that are available to get involved with, giving me the opportunity to work with a wide range of specialists to develop my skills’.

Jaki Leaker
HM Inspector Occupational Health

JAKI JOINED HSE in 2015 working as part of a team of occupational health inspectors. Her background is in nursing, and after completing nurse training in mental health (RMN) and general nursing (RGN) she worked in the acute mental health sector both in NHS and private settings. Looking for new challenges where she could use her skills she took a trainee occupational health advisor post in the automotive industry. She provided occupational health support in a variety of settings including manufacturing, mines, quarries and warehouse/distribution, specialising in return to work interventions for workers with mental health problems. In addition to qualifications in nursing, Jaki has a degree in Specialist Community Public Health Nursing (occupational health) and an MA in psychology and social policy.

Since joining HSE she has completed HSE’s regulatory training programme and is now based in Birmingham. Her HSE work has included inspections and investigations relating to health issues which can range from respiratory and skin problems to violence and aggression. Jaki has recently been working with colleagues in looking at risks to healthcare workers in prisons from violence and aggression.

Jaki says ‘the varied nature of the work I am involved in at the HSE allows me to use my skills to look at all aspects of the impact of work on health’.
Catherine Makison Booth
Microbiologist

Catherine (Cat) is part of the Biohazards Team at HSE’s Buxton laboratory. She joined HSE in 2004 and has been involved in a wide range of projects with other specialist teams across HSE. These include training, guidance writing, environmental sample analysis, disinfection testing, fluorescence visualisation to identify the spread and cross contamination of microorganisms. HSE supported Cat to do a professional doctorate in biomedical sciences on: Survival and spread of norovirus through vomiting and toilet flushing, as part of which she invented ‘vomiting Larry’.

Recently, Cat has been seconded to the World Health Organisation (WHO), helping to revise their Laboratory Biosafety Manual (LBM). The purpose of this manual is to encourage countries to implement basic concepts in biological safety and to develop national codes of practice for the safe handling of pathogenic microorganisms. Since the third edition, technologies have and continue to evolve and with them changes in associated risks. Therefore, the fourth edition of the LBM proposes a shift in focus from a prescriptive guidance document to a risk- and evidence-based approach to biosafety. It also aims to have a technology-neutral, cost-effective approach ensuring laboratory facilities, safety equipment and work practices are proportionate and sustainable around the world. This strategy has been published.

Cat says ‘I’ve learnt that politics and international relations are a very important aspect of UN organisations like the WHO. Consequently, such a big change to the LBM requires careful writing and sensitive persuasion of many different parties. This has been one of the most challenging and perhaps one of the most important projects of my career to date. It is thanks to years of working for HSE and supportive colleagues that I have been privileged to realise this opportunity.’

Dr Steve Forman
Principal Medical Adviser – Centre for Workplace Health

After graduating from Leeds Medical School and working as a General Practitioner, Steve retrained and is now an accredited specialist and consultant in occupational medicine with experience of physical and mental illness across a wide breadth of occupational sectors.

Steve joined HSE as a Medical Adviser in 2014 and became Principal Medical Adviser in 2015. He is the lead on regulatory matters within the Centre for Workplace Health.

One of Steve’s main roles is to provide medical expertise to HSE’s investigations and support to Occupational Health Inspectors. This most commonly involves investigating where workers have been found to have high blood lead levels or may have been over-exposed to ionising radiation. He is also regularly involved in investigations undertaken by HSE’s diving inspectorate.

Steve also advises stakeholders, both internal to HSE and externally, including other government departments on occupational health issues. He provides the clinical oversight for HSE’s Approved and Appointed Doctor systems for statutory medical surveillance and fitness to work assessments.

Steve is regularly involved in training delivery at HSE and is an Honorary Lecturer at Manchester University.

Steve says, ‘I really enjoy being part of HSE. The variety of occupational health issues that we get involved in not only makes for a very interesting role, but also demonstrates the extent to which HSE can positively influence on health and safety issues. The current focus on health as part of HSE’s strategy is extremely important and plays a key role in ensuring that occupational health risks are adequately managed, irrespective of business size. The opportunity that HSE provides to work with policy, regulatory and science colleagues is one that is unique and provides excellent scope for learning and personal development.’
Ed Corbett
Principal Scientist

ED IS A PRINCIPAL scientist of human factors and occupational psychology. He re-joined HSE in 2015, returning from working in the offshore oil and gas, and maritime sectors on risk management including working with engineering teams to improve human performance in the design of plant and user interfaces.

Ed has worked extensively with organisations on organisational culture, and leadership. He has a strong interest in the learning that can be applied to organisational development by extracting lessons from research on dysfunctional organisations.

Ed works in many areas with different specialist teams including: incident investigation; work-related stress; and work-related musculoskeletal disorder. He has been involved in HSE’s guidance and tools for work-related stress since 2004, and continues to deliver training on HSE’s Management Standards, and developing high performing teams. He also works with the major hazard sectors, including reviews to help organisations reduce the likelihood of low frequency high consequence events. Recently, Ed has contributed to developing a joint HSE/NEBOSH qualification on health and safety leadership\textsuperscript{80} aligned with HSE’s Energy and Chemical, Explosives and Microbiological Hazards Divisions.

Ed says, ‘I really enjoy working in the field of leadership development. It’s incredibly rewarding when CEOs, MDs, and other senior managers adjust their business strategy based on our input. It’s also great to know that this work fits well with our mission as HSE and has an impact on those who can really instigate the changes that are needed’.

John Dale
Pesticide Assessment Manager

JOHN IS A REGULATORY specialist, team leader and assessment manager in the Pesticide Active Substance and Operational Policy Section. The Section is part of the UK’s Competent Authority (CA) for Pesticides, based in HSE’s Chemicals Regulation Division, York.

John has an agricultural science degree and previously worked as an agronomist, advising farmers on the use of pesticides, and a Regulatory Manager for a global agrochemical company.

Now at HSE, John coordinates pesticide assessments, liaising across 7 specialist discipline teams, evaluating different aspects of the active substance, to ensure the pesticide can be used safely, without unacceptable effects on the environment, and that it works!

Using his scientific expertise, he works with policy colleagues on novel issues and represents the UK’s evidence-based approach in various international fora; assessing possible new active substances or evaluating existing chemistry. This involves significant international engagement for example working closely with European Member State CAs, and the Organisation for Economic Co-operation and Development e.g. regarding the regulation of Biopesticides (pheromones, plant extracts and micro-organisms used for pest control).

John says: ‘I really enjoy the diverse nature of my role and feel fortunate to work with such a range of international experts both within HSE and externally.’
Meet the staff

Women In Engineering

HSE WAS PROUD to support the UK government Year of Engineering 2018, as part of which some of our women engineers celebrated the International Day of Women in Engineering #INWED18.

Rebecca Lisseman is a Mechanical Engineer in HSE’s Mechanical Engineering Team.

‘As a child I would design and build models from Lego; as a mechanical engineer I get to use this creativity to design and construct things for real. My natural curiosity means that I have always been interested in why things fail, at work I investigate causes of failure and help prevent accidents in the future.’

Anna Martinez is a Chemical Engineer in HSE’s Hazardous Materials and Explosives Team.

‘When I was at school I used to define ‘science subjects’ as funny and interesting. 15 years later, I can add I believe science can be found and applied everywhere, giving all of us the opportunity to interact, learn from each other and help to create an including, sustainable, safer and happier world.’

Sammantha Dennis is an Explosives Engineer in HSE’S Hazardous Materials and Explosives Team.

‘I re-trained into a science discipline and now use this in an engineering environment to test and assess explosive materials for safety, use, handling, storage and transportation to exacting standards.’

Berdine Clews is an Explosives Engineer in HSE’S Hazardous Materials and Explosives Team.

‘I’ve worked for HSE Science Division for 10 years and no day has been the same! I’m a member of the Institute of Explosives Engineers. My engineering skills allow me to test fireworks and explosives to precise standards and also use mathematical modelling to assess risks around major hazards sites across the UK.’

Ju Lynne Saw is a Chemical Engineer in HSE’s Risk and Process Safety Team.

‘Armed with a BEng and PhD in Chemical Engineering and registration with the UK Engineering Council as a chartered engineer, I am very proud of myself for having carved a challenging yet exciting career within a niche where women have historically been woefully under-represented. I am honoured to be able to play my small part in helping to protect lives and livelihoods.’
Case studies

Supporting small employers
These case studies demonstrate how we are supporting simple advice for SMEs so they know what they have to do.

Acting together
A series of case studies which demonstrate how our science and evidence is being used to promote broader ownership of health and safety in Great Britain.

Managing risk well
Our science is being used to simplify risk management and help businesses to grow: the case studies in this section show how.

Sharing our success
The case studies in this strategy theme show how our specialists are using science to promote the benefits of Great Britain’s world class health and safety system.

Tackling ill health
These case studies illustrate how our science is contributing to action to improve health outcomes.

Keeping pace with change
A selection of case studies which show how our science is being used to anticipate and tackle new health and safety challenges.
EXPOSURE TO MIST from metal working fluid (MWF) continues to be among the most commonly cited causes of cases of extrinsic allergic alveolitis and occupational asthma reported by doctors in the SWORD scheme and accounts for significant numbers of annual cases of contact dermatitis as reported by dermatologists within the EPIDERM scheme.

HSE and the United Kingdom Lubricants Association (UKLA) have developed a practical guide, for supervisors and those responsible for managing MWF, it addresses concerns about lung and skin disease in operators who are exposed to MWF either by inhalation or through direct skin contact. The guide is easy to follow and can also be used for training.

A joint HSE and UKLA advisory panel took advice from medical experts, experienced machine shop supervisors, and other industry experts. The panel looked at the reasons for concern about risks to health and set out good practice for the lifecycle of preparing, maintaining and disposing of MWFs.

The guidance identifies what monitoring checks should be undertaken for testing MWF quality, the recommended frequency of testing and how checks should be recorded. It contains links to relevant HSE guidance and industry good practice. The Guide was launched in 2018 at a stakeholder event.

‘The United Kingdom Lubricants Association’s Metalworking Fluid Product Stewardship Group are proud to have worked with our partners in the Health & Safety Executive in developing a ground-breaking guide on the best practice in the safe handling and disposal of metalworking fluids. Not only does the guide help to deliver the HSE’s strategy of improving employee’s health in the workplace but the expertise and professionalism of HSE colleagues has helped to deliver a world-first for the sector which is rightly recognised by international associations as effectively capturing best practice in the sector.’

David Wright
Director General UKLA

What were the benefits

Close collaborative working between industry experts and HSE medical and health specialists to produce new practical guidance on managing metal working fluids

The development of a life cycle guide to managing work with lubricants that has provided the industry with a benchmark for good working practices

A guide that provided advice for workshop supervisors, that can be used for training purposes, and which is equally applicable in small, medium and large machining workshops

Further information can be found on the UKLA website and The Good Practice Guide.
Many workers are potentially exposed to hazardous chemicals at work, including solvents, metals, pesticides and isocyanates. Some of these chemicals can be absorbed through the skin so just monitoring the air is not sufficient. In many cases, control measures such as ventilation and protective equipment, such as masks and gloves, are provided to reduce the risk but how do you know if everything is working as expected and that exposure levels meet with UK guidance values.

The HSE biological monitoring team have been offering an analytical service for over 30 years. The team of specialists analyse about 15,000 samples per year from over 1,000 different companies. More than 90% of requests are for samples from companies with less than 10 workers; many of these requests are from micro and small businesses, such as motor vehicle repairers using spray paint containing isocyanates. Sampling often involves simply collecting a urine sample at the end of shift and posting it to the laboratory using the provided packaging.

In 2017 more than 85% of spray-painters (>4500 samples) were compliant with the UK guidance value. Over 1000 workers were monitored for chromium in plating, aerospace and metalworking companies, with more than 95% of workers compliant with the UK guidance value.

Monitoring workers urine regularly, and taking action when higher exposures are indicated, can lead to significant reductions in exposure of workers to hazardous chemicals. For example, there has been a 25-fold reduction in 30 years in exposure to the polyurethane hardener, MbOCA. Improvement actions are often straightforward such as improved housekeeping, maintenance of ventilation and correct use of protective equipment. Managing workplace risks, particularly for SMEs needn’t be complicated or costly, this monitoring system is simple to operate, provides reassurance in working practices and focuses action where it is required to further reduce the risk of worker ill-health.

For more information see our website and Biological Monitoring Without Limits.

Funding source
Commercial Service
Worker exposure to diacetyl in the coffee industry

Worker exposures to diacetyl, a naturally occurring substance used in food flavouring and naturally occurring in coffee, may cause decreased lung function and the serious lung disease obliterative bronchiolitis. A new, lower, UK 8-hour exposure limit of 20 parts per billion (ppb) and a 15-minute limit of 100 ppb were introduced in August 2018 to better protect workers. However, most exposure measurement methods are not sensitive at the new limits. Exposure studies have looked at food and flavouring manufacturing but there is little information on coffee workers’ exposure.

HSE scientists developed a new sensitive measurement method, using well-proven sorbent tube and thermal desorption technology. This method can either be used for short term sampling, by pumping air through the samplers, or, for long term passive sampling, by allowing the air to diffuse into the sampler - a method particularly useful for personal exposure monitoring. The US National Institute for Occupational Health and Safety (NIOSH), has requested permission to include HSE’s new method in their handbook of measurement methods.

What were the benefits

HSE scientists developed a new sampling and analysis method capable of detecting parts per billion airborne concentrations of diacetyl. Levels above the new lower UK exposure limits were detected during coffee manufacture. The highest concentrations were found during grinding, and significant concentrations were detected during roasting and other activities. These findings should alert coffee manufacturers to the possibility of employee exposure to diacetyl and the need for adequate control measures to protect workers’ health.

HSE is currently in discussions with the British Coffee Association to increase awareness of these issues with their members.

For more information the HSE Research Report Validation of a monitoring method for diacetyl using sorbent tubes and thermal desorption87, and published abstracts Development of an air monitoring method for diacetyl in the workplace88 and Validation of a monitoring method for diacetyl using thermal desorption tubes and gas chromatography-mass spectrometry89.

HSE’s scientists used their new sampling method at workplaces where workers are potentially exposed to diacetyl from coffee, ranging from small cafes to large scale manufacturing and processing factories.
Setting fire to whisky spills: public safety in the vicinity of distilleries

LARGE QUANTITIES OF whisky, or similar flammable spirits, stored at major distilleries or bonded warehouses can potentially create large spills and significant pool fires. Where the quantities are high enough to bring a site under the COMAH (Control of major accident hazards) Regulations, HSE calculates the magnitude of potential fires, as part of assessing the potential risks to the public. This is used, for example, when HSE provides public safety advice to planning authorities on the risks associated with proposed new building developments in the vicinity.

HSE fire specialists found that HSE’s current fire risk calculations are based on very small scale experiments on spills covering an area of less than 0.25 m². Our specialists carried out large pool fire tests with up to 16 m² of various ethanol/water mixtures and waste whisky, which was supplied by the industry. These experiments showed that whisky fires produce conical flames with little smoke, unlike the cylindrical plume of smoke and flame from pool fires of most other major hazard sites. This results in a lower fire risk in the vicinity.

What were the benefits

The experiments by HSE’s fire specialists have demonstrated that the fire risks from whisky and similar flammable spirits are lower than for most flammable materials at major hazard sites. This new evidence is being used to develop new models of heat emission to inform HSE’s public safety planning advice and ensure there are no unnecessary restrictions on proposed new building developments.

For more information see the HSE research report Burning rates and surface emission power for large pool fires of ethanol and cask-strength whisky[^1].
AN EXPLOSION OCCURRED at a bungalow, in which the two occupants, in their mid-seventies, were buried. They were rescued by the Fire & Rescue Service. One of them was detained in hospital with a back injury and burns.

An HSE gas engineer and an image specialist sifted through the rubble to identify the cause of the explosion, collected evidence and photographed the scene. During the on-site investigation a joint between the gas supply and the boiler was found to have separated. This leak source matched the pattern of damage to the bungalow.

The evidence was taken to HSE's Buxton laboratory for examination by the gas engineer, a metallurgist and organic chemists.

Detailed metallurgical examination revealed that the pipe had been prepared for soldering, but that insufficient heat had been applied to make the joint. Other joints had been satisfactorily soldered. It was therefore suspected that the pipe had not been adequately secured allowing vibrations from the washing machine, located under the boiler, to loosen the unsoldered joint which separated and released gas to cause the explosion.

What were the benefits

HSE forensic specialists identified the likely cause of the gas explosion and gave impartial expert evidence in court during the successful prosecution of the plumber who installed the boiler.

For more information see HSE publication *Safety in the installation and use of gas systems and appliances*.
Securing vehicle loads, fatal incident investigation

A SUSSEX POLICE Forensic Collision Investigator requested technical assistance in relation to load safety to support their investigation into a fatal incident in East Sussex. A mobile generator being transported on a rigid flatbed vehicle fell from the vehicle as it travelled over a level crossing subsequently striking two pedestrians, killing one and seriously injuring the other.

HSE’s Senior Engineer, Road and Workplace Transport, examined the vehicle and the generator involved in the incident and reviewed information provided by Sussex Police:

- witness statements of the driver and passengers, and other witnesses to the incident;
- photographs from the scene
- CCTV video

Based on the information provided our engineer prepared an expert statement outlining the likely contributory factors to the incident in terms of load safety, and the relevance of these in relation to legislative requirements. As the driver was not a professional goods vehicle driver, it was important to consider whether he could have been expected to know that the load should have been secured on his vehicle. The expert statement was key to establishing the level of knowledge that could be expected of a car or van driver.

What were the benefits

Sussex Police successfully prosecuted the driver who was sentenced to four years for causing death by dangerous driving and two years for causing serious injury by dangerous driving. He was also banned from driving for seven years.

Sergeant Clare Kenward, of Sussex Police’s serious collisions investigation unit, said: ‘Just a few moments spent securing the load would have prevented this avoidable tragedy.’

Nina Day, Senior Engineer, HSE, said: ‘As this tragic case has demonstrated, load shifts can have devastating consequences.

HSE has supported the police throughout the investigation and will continue to work closely with other regulatory bodies in this area.’

For more information see the Sussex Police News report: Fencer convicted of causing death and serious injury by dangerous driving and YouTube videos Load securing: roles and responsibilities; Load security: how DVSA enforces the rules and Load security; consequences of poor load security, and the DVL guidance.
Investigation of the Millennium Chemicals incident involving water-reactive chemicals

ON 5TH MARCH 2010, a reactor vessel at the Millennium Inorganic Chemical works at Stallingborough suffered a catastrophic failure, releasing its liquid contents and creating a large dense white cloud of corrosive and toxic gas. One worker died and three were injured leaving one with irreversible lung damage. The cloud blew across the Humber closing shipping routes for several hours. After the prosecution hearing, the HSE inspector noted that, if the wind had been blowing in the opposite direction the incident ‘could also have caused a local disaster’.

HSE scientists investigated the likely scenarios that could have led to the incident.

The catastrophic rupture of the vessel occurred immediately after the changeover of a recirculation pump to a reserve pump. Given the timing of the incident relative to the changeover of the pump, it appears that titanium tetrachloride had built up, and that starting the reserve pump had restarted effective mixing/contact between this and aqueous hydrochloric acid solution, resulting in a violent chemical reaction. Our scientists designed experiments to look at the characteristics and behaviour of these two reactive chemicals.

These experiments demonstrated the formation of a spongy barrier layer (see image) which separated the two chemicals until the reserve pump restarting mixing. Their impartial expert evidence was provided for the court and proved vital to the HSE prosecution case.

What were the benefits

The experimental work by HSE scientists provided robust scientific evidence to the court that demonstrated how the violent chemical reaction had occurred. Following the prosecution, Millennium Inorganic Chemicals were fined £2.4 million under the Health and Safety at Work Act.

For more information see HSE’s press release96 and publication Chemical Incident Investigation, Millennium Inorganic Chemicals (MIC), Stallingborough UK, 201097.
Construction industry ‘risk profile’ interactive dashboard

CONSTRUCTION REMAINS a hazardous industry, with a rate of fatal injury at work that is around four times as high as the average across all industries. 38 construction workers were fatally injured at work during 2017/18.

HSE’s published statistics provide an overall picture of health and safety outcomes. These traditional statistics are based on the information reported to HSE under the RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations).

To target interventions to improve health and safety in the construction sector, more detailed information is required from the RIDDOR reports.

HSE statisticians piloted the use of novel data science and statistical manipulation techniques to allow analysis and insights from the descriptive text provided in RIDDOR reports. RIDDOR reports span a wide range of mainly physical risks, where injury or harm has been caused to a worker. A set of ‘risk categories’ were developed. Each category describes individual types of risk such as ‘fall from scaffold’ and ‘use of hand/power tools’ that give the context of incidents.

The results are displayed in a new ‘interactive dashboard’ on HSE’s website, making the data more relevant to stakeholders and those with detailed knowledge of the industry. Users can further explore the data, which includes anonymised descriptions for each incident, using individual search words.

What were the benefits

For the first time, the ‘dashboard’ on HSE’s website demonstrates the use of data science and visualisation techniques to make detailed RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations) information available and more easily used and understood by HSE and industry stakeholders. This is facilitating the use of RIDDOR incident reports to target interventions to improve health and safety in construction.

For more information see HSE’s construction dashboard98.
Summarising the evidence on the effectiveness of mental health first aid (MHFA) training in the workplace

A MENTAL HEALTH First Aid (MHFA) training programme was first developed in Australia to train the public in providing help to adults with mental ill-health problems. Subsequently MHFA training has been taken up by other countries including Great Britain. Recently there has been an increase in undertaking MHFA training in workplace settings. As the regulator for workplace health and safety, HSE wished to understand the strength of the available evidence on the effectiveness of MHFA in the workplace to improve the organisational management of mental ill-health.

HSE scientists undertook a review of published evidence that considered three research questions on the impact, influence and application of MHFA training in workplaces. The review identified that it is not possible on the basis of the published evidence to state that MHFA training is effective in the workplace setting or that it improves the organisational management of mental ill-health. There are a few published occupational studies and these have provided more consistent evidence that MHFA training raises employees’ awareness of other colleagues with mental ill-health conditions. There is no evidence that the introduction of MHFA training in workplaces has resulted in sustained actions by trainees, or that it has improved the organisational management of mental ill-health.

What were the benefits

A key priority in HSE’s Health and Work Strategy is work-related stress and related mental ill-health issues. This review by HSE scientists has provided regulatory colleagues with the knowledge that at the present time there is no evidence to state that MHFA improves organisational management of mental ill-health.

For further information see: HSE Research Report Summary of the evidence on the effectiveness of Mental Health First Aid (MHFA) training in the workplace99, which describes this review; HSE’s Health and Work Strategy100; and HSE’s information on mental health conditions, work and the workplace101.
WE CONSTANTLY INTERACT with microorganisms which are all around us, mainly through inhaling microorganisms present in highly populated public places. However, data on everyday exposure to background levels of microorganisms are limited. Knowing the background levels of microorganisms to which people are exposed on a daily basis provides a baseline against which to gauge any higher level exposures and possible health consequences.

Previous studies measuring typical background levels, and in some instances specific biological agents, have mainly used air sampling. However, this is costly and labour intensive which often limits the number of locations or study period. Also, samplers can only run for short periods which may not represent the bigger picture of typical background levels.

To address this, HSE’s microbiologists collected settled dust from railway stations and enumerated bacteria and fungi.

For this study we assumed dust settling on surfaces over one week would be representative of airborne microorganisms. We trained staff in 17 railway stations to take surface wipes on our behalf from up to three pre-determined surfaces. Samples were collected from the same surfaces weekly for 52 weeks and sent to us for analysis.

By adopting this simple, low cost sampling strategy we were able to obtain weekly data from 48 sampling locations in mainline railway stations across England and Scotland for an entire year.

What were the benefits?

Our study has generated a comprehensive database and this information will be used to provide a baseline of typical levels of bacteria and fungi in highly populated public places. This can then be used as a point of comparison to facilitate clean-up following possible contamination events.

For more information see journal publication Background levels of microorganisms in the busy urban environment of transport hubs, and a report in the press.

Funding source

Home Office
HSE IS THE STATUTORY authority in Great Britain responsible for providing public safety advice to local planning authorities on the risks associated with proposed new developments, such as housing, schools and hospitals, near major hazard sites and major accident hazard pipelines. For major hazard sites and pipelines where there is the potential for a release of toxic or flammable substances, HSE uses the computerised dispersion model DRIFT, ‘Dispersion of Releases Involving Flammables or Toxics’, to quantify the potential hazard. It is important for DRIFT to be based on sound scientific principles with robust verification and validation against experimental data to ensure that the model produces realistic predictions.

HSE mathematical modelling specialists were invited to participate in an international modellers working group, coordinated and principally funded by the US Department of Homeland Security (DHS) and Defense Threat Reduction Agency (DTRA) to help design dispersion experiments with the toxic gas chlorine and analyse the data. In 2015 and 2016, the US Army conducted these chlorine dispersion experiments – the largest ever done globally - at its Dugway test site in Utah. Known as the ‘Jack Rabbit II’ trials, these experiments included the full discharge of a 20 ton road tanker and dispersion measurements using several hundred sensors to a distance of 11 km downwind.

What were the benefits

HSE mathematical modellers participation in the international working group on the US chlorine dispersion trials has provided a unique opportunity to validate our computerised dispersion model DRIFT against the best dataset available from new scientific experimental trials. This modelling work ensures that HSE’s public safety land-use planning advice is informed by best available robust scientific evidence.

For more information see journal publication Dense gas dispersion model development and testing for the Jack Rabbit II Phase 1 Chlorine Release Experiments.
Health and safety in the waste and recycling industry

IN 2017/18 THERE were 12 fatal injuries to workers in the waste and recycling sector. In addition, each year around 5,000 workers sustain a non-fatal injury.

Improvement in the health and safety performance of the rapidly expanding waste and recycling industry is a priority for HSE. HSE specialists researched three areas in order to gain a better understanding of the issues and help the industry with solutions to reduce worker ill-health and injury.

HSE human factors specialists researched human factors associated with fatal incidents in the industry. They identified two priority areas to tackle to reduce worker fatalities; equipment factors, including design, use and maintenance, and, safety management systems. They presented options to tackle these issues and support dialogue between the industry and regulators on practical solutions.

HSE occupational health specialists reviewed the published evidence of occupational ill-health in the industry. They observed an increase in the prevalence of respiratory, gastro-intestinal and skin complaints in green waste workers. Exposure to heavy metals was a risk for workers recycling batteries, cables and fluorescent lights. They concluded that targeted health surveillance may be necessary to assess exposure to hazards and to identify occupational illnesses and their prevalence.

HSE’s ergonomists focused on improving manual handling to reduce musculoskeletal disorders. Six cases of different collection systems were investigated and recommendations were made to help the industry in identifying and implementing effective solutions to control risks during waste collection, sorting and recycling.

What were the benefits

HSE research in three health and safety priorities within the waste and recycling industry, preventing fatalities, controlling manual handling risks and preventing occupational illness, has helped identify key issues to be addressed to tackle the poor health and safety performance in this sector. The scientific evidence will help the industry to implement practical solutions to improve the health and safety of their workforce.

For further information see HSE Research Report Common human factors underlying worker fatalities in the waste and recycling industry and visit the waste and recycling section of the HSE website and HSE’s Waste Statistics in Great Britain 2018.
Enhancing Forestry Commission Scotland’s approach to health and safety guidance

THE FORESTRY INDUSTRY is one of the most dangerous sectors in which to work in the UK. Over the last five years in Great Britain six workers were killed at work in the sector, giving rise to a fatal injury rate around 10 times as high as the average across all industries. Tree site work involves significant hazards including vehicles, machine-assisted felling and chainsaws. Management of risk during such operations can be complex.

Following a safety culture assessment using HSE’s Safety Climate Tool, Forestry Commission Scotland (FCS) asked HSE specialists to assist them with acting on their survey results. The FCS wanted to use the results to enhance their operational health and safety guidance and the associated training provided.

HSE experts reviewed a sample of FCS’ operational guidance, interviewed forest operatives and managers and observed operations on a visit to a harvesting site. HSE’s three stage approach to the assessment of; operational guidance ‘on paper’, worker perceptions of forest management and observation of operations ‘in action’; provided valuable insight into understanding the key factors of behaviour and work practice that could improve the effectiveness of health and safety guidance and training.

What were the benefits?

HSE specialists identified practical recommendations designed to improve the effectiveness of FCS’ guidance, and measures they could put in place to support the guidance. The recommendations were underpinned by HSE expertise in how to influence behaviour.

Forest operatives and managers are now engaged in revising their operational guidance and training, to meet the needs identified by their staff in order to enhance safety performance.

For more information see RIDIND - RIDDOR reported fatal and non-fatal injuries in Great Britain by detailed industry and HSE’s webpages on tree work health and safety.

Funding source
Forestry Commission Scotland
Improving safety at air displays

THE AIR ACCIDENT Investigation Branch (AAIB) identified human factors issues as key contributory factors in the crash of a jet aircraft at the Shoreham Airshow in August 2015. The crash resulted in the death of 11 people and 16 people were injured. (See p49 of 2018 Annual Science Review)

Acting on the AAIB recommendations, the Civil Aviation Authority (CAA) asked HSE specialists to assist them with understanding the error paths that lead to flying display accidents, including the potential for negative transfer of behaviours, by pilots, between different types of aircraft. Negative transfer is when a learned behaviour is used in a similar setting, but with key differences that could impact performance and safety.

HSE human factors specialists carried out 3 phases of work:

- A review of relevant research theory, industry guidance and air display accident reports.
- Consultation with experts from across the display community to identify the potential for error during display flying. This included interviewing display pilots about the potential for transferring learned behaviours between different types of aircraft. Drawing out and sharing expertise from the display community was a key part of this work.
- The findings were published in a publicly available report and have been used to develop a human factors training programme for the air display community.

What were the benefits?

HSE’s research identified practical recommendations that the Civil Aviation Authority and the display community can take to improve air display safety. HSE’s report has been made publicly available enabling sharing of experience and knowledge of human factors associated with air displays. The human factors training programme, for the air display community, will be rolled out over the next three years with the aim of raising awareness of negative transfer and reducing the associated errors.

For more information see the report Human Factors in Air Displays: Transfer of Behaviours and Error Path Study, and the HSE website for Organisational culture and How to change health and safety behaviour.

Funding source
Civil Aviation Authority
PESTICIDES USED IN an incorrect way or in the wrong amounts can harm people and the environment.

On behalf of the Department for Environment, Food & Rural Affairs (Defra) and the Devolved Administrations, HSE regulates pesticide residues in food. HSE’s Chemicals Regulation Division (CRD) runs a £1.5 million programme to check that the food eaten by UK consumers (including imported food) complies with statutory pesticide Maximum Residue Levels (MRLs). MRLs are trading levels based on good agricultural practice, not safety levels. It is illegal to sell food with residues above pesticide MRLs.

CRD commissions the testing of food samples using single and multi-residue analytical methods following regulatory standards. CRD scientific input ensures the programme reflects UK diets and food production and uses efficient and relevant analytical methods.

CRD scientific specialists then assess the risk to human health of pesticide residues found in the food. Relevant results are sent to the Food Standards Agency for notification to the EU Rapid Alert System.

The Expert Committee on Pesticide Residues in Food (PRIF) advises HSE and the Devolved Administrations on the monitoring programme. PRIF reports include commentary on consumer health risks and on whether results comply with pesticide MRLs.

What were the benefits?

The programme meets EU and UK requirements to provide assurance that pesticides used in food production are used in accordance with the authorised conditions for application, protecting consumers and the environment.

For more information see the PRIF annual Report 2017.

Funding source

Defra and HSE
NATURAL HAZARDS ARE among the most significant threats to the UK. They cause property damage, disrupt infrastructure and business, and pose a danger to life, health and the environment. Many organisations are involved in natural hazard risk management including government, devolved authorities, local authorities and emergency responders. Collaboration and co-ordination is essential to support effective disaster risk management, but significant challenges arise from different organisational structures, approaches and priorities.

The Natural Hazards Partnership (NHP) is a collaboration of UK public bodies. Its aim is to provide authoritative and consistent information, research and analysis on natural hazards to government to support the development of more effective policies, communications and services for civil contingencies, governments and the responder community across the UK.

HSE specialists joined the NHP in 2012. They lead the impact and vulnerability work of the Hazard Impact Modelling group and participate in the NHP Steering and Management groups.

What were the benefits?

Participation in the Natural Hazards Partnership (NHP) enables HSE to hold a central role in a cross-government partnership that champions collaboration and shared research. This gives HSE access to a large pool of scientists across a diverse range of disciplines, enabling HSE to collaborate on more complex inter-disciplinary projects, sharing resources and expertise to improve public services.

HSE's expertise in impact and risk analysis have helped the NHP in understanding the consequences of natural hazards to society. This includes; improving national advice for severe weather by developing a novel impact forecasting model for surface water flooding, co-authorship of the Hazard Impact Framework, which underpins ongoing NHP science, promoting collaboration across disciplines, and, shaping the UK Government’s National Risk Assessment for natural hazards.

For more information see The Natural Hazards Partnership: A public-sector collaboration across the UK for natural hazard disaster risk reduction113 and the NHP website114.

Funding source
UK Government
Enhancing occupational health risk management at Heathrow Airport engineering department

THE HEATHROW AIRPORT Limited (HAL) Engineering department are responsible for essential services to maintain continued operation of Europe’s busiest airport. Delivery of these services involves a diverse range of activities which carry associated health risks. The main health hazards covered were hazardous substances, noise, vibration and manual handling. Other issues such as heat stress and solar radiation exposure were considered where relevant.

The health and safety management team of HAL contracted HSE to work alongside their teams to review the health risk management measures in place across their operations. HSE’s occupational hygienists conducted assessments in 7 business units of the airport’s engineering department. These included a review of documentation (risk assessments, safe systems of work etc), discussions with operational managers and front-line staff, and an observational assessment of work areas and facilities. Feedback was provided for each work area which highlighted situations where the current risk controls could be enhanced. These were prioritised to help formulate an action plan. In addition, the findings were grouped together to identify common themes for a site wide approach to improvement.

What were the benefits?

Our scientists provided an expert, independent review of health risks across a broad range of work activities. This enabled an action plan to be developed to enhance risk management, whilst providing assurance that in the main, a high standard was being achieved. The work also supported the sharing of good practice across the areas included in the review.

For other examples of our occupational hygienists work please see our report and papers115–117.

Funding source

Heathrow Airport Limited
Commercial Service: Health Risk Management
EXHALED BREATH CONDENSATE (EBC) A NOVEL APPROACH TO ASSESS OCCUPATIONAL EXPOSURE TO RESPIRABLE CRYSSTALLINE SILICA

EXPOSURE TO RESPIRABLE crystalline silica (RCS) can lead to a number of lung diseases including silicosis and chronic obstructive pulmonary disease. RCS has been classified as a carcinogen when inhaled and is estimated to cause over 800 lung cancer deaths per year in Great Britain. It has been estimated that over 0.5 million workers are exposed to RCS in Great Britain, with most in the construction sector as well as mining and quarrying.

Biological monitoring is a useful way of determining overall exposures to chemical substances; however, in the case of RCS, this has not been analytically feasible in conventional biological fluids such as blood or urine. A pilot study was undertaken collecting exhaled breath condensate (EBC), breathed out water vapour, from six quarry workers and six occupationally unexposed persons (controls); the samples were analysed using both single particle mass spectrometry and transmission electron microscopy. The results showed that EBC obtained from quarry workers contained silica particles of various sizes whereas these were not seen in the controls.

HSE scientists are working to solve the remaining analytical challenges so that this technique can be used in industry.

What were the benefits

This is the first study to show that exhaled breath condensate can be used to show a difference in exposure to Respirable Crystalline Silica (RCS) between workers occupationally exposed to RCS and controls who are not occupationally exposed to RCS. In the future this method could be used to provide information on exposure risks and to evaluate the effectiveness of control measures in place to protect workers’ health. These approaches ultimately could lead to earlier diagnosis and prevention of silicosis.

For more information see Journal publication Exhaled breath condensate: a novel matrix for biological monitoring to assess occupational exposure to respirable crystalline silica.118.
WORK-RELATED STRESS is the second most commonly reported cause of occupational ill health in Great Britain and is one of HSE’s 3 health priorities in its Health and Work Strategy. Over 11 million days are lost at work a year because of stress at work. The HSE Management Standards (MS) for Work Related Stress (WRS) provide a structured approach to understanding the causes of WRS, and guide employers through a risk assessment process to make improvements. HSE’s work, over 15 years, has included the training of regulatory inspectors, implementing the approach with duty holders, and providing training courses. The first Management of Stress course ran in 2003, and since then over 30 stress related training courses have trained more than 450 delegates.

We have been working to strengthen our support on managing WRS. This includes continuing to support duty holders to implement the MS, producing a new fully automated Stress Indicator Tool, and developing and delivering training courses in proactively tackling the causes of WRS. We ran a Stress Summit in 2017, incorporating presentations from stress experts, an HSE workshop highlighting top tips on running the MS process as well as case study presentations from business leaders.

We are also training a significant number of organisations in Health and Safety Leadership, placing greater emphasis on the typically silent health part of health and safety.

We recognise there is still a long way to go on workplace improvements to prevent WRS and identify it early, the HSE MS for WRS will be part of a future solution. Challenges we have observed across industry are:

- Focusing on the risk assessment process, particularly the collection of data, with little emphasis on application of interventions/controls.
- Senior leadership not fully considering organisational factors and shifting more towards fixes such as individual ‘resilience’.
- Focusing too heavily on reactive, with little consideration of preventative, measures.
- Underestimating the importance of good line management.

Organisations that have run the process have reported the following benefits:

- Reduced sickness absence, and savings in salary costs
- Signs of cultural change, including:
  - clearer communication between managers and staff;
  - greater ownership of change;
  - increased recognition of the need to encourage peer support;
  - improved communication within the organisation.

Ed Corbett says: ‘Fundamentally, managing work-related stress and providing appropriate support for mental health conditions starts with senior leadership and management showing genuine care and compassion for their employees.’

For further information on HSE’s Management Standards for Work Related Stress and associated workbook, indicator tool, and guides see What are the Management Standards available on the HSE website.

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HSE’s Psychologist Victoria Whitehouse
Reducing weight, hand-arm vibration and noise health risk factors in the rail industry

HSE scientists have worked on the debilitating ‘Hand Arm Vibration Syndrome’ (HAVs) for many years building up a body of evidence that is used in informing guidance and supporting workers. HAVs and carpal tunnel syndrome associated with vibrating tools, were responsible for 88% of all health-related Reporting of Injuries, Diseases and Disabling Occurrences Regulations (RIDDOR) in the rail industry in 2017-18.

Hand held power tools are widely used in the rail industry. The tools have 3 characteristics that present quite different health risks to the user; weight, hand-arm vibration (HAV) emission and noise emission. These can cause hearing loss, HAVs; and musculoskeletal disorders.

The rail industry would like a single tool risk rating to quickly highlight tools likely to have lower combined risks.

HSE specialists have developed a Weight, hand arm Vibration and Noise ‘WVN’ classification method, based on emission data which enables a simple comparison of machines of similar type or equivalent function.

It is important to have robust data on tools to underpin the rating scheme. It is therefore important to critically review weight, vibration and noise data before applying it to a rating scheme.

The risk of using a combined rating is that it may give a false impression of a machine being safe to use. It is therefore important to keep sight of the individual hazard information.

A possible format for presenting risk information is shown below; it includes the combined rating ‘WVN Class’ alongside data for individual hazards.

**What were the benefits?**

The new combined Weight, hand-arm Vibration and Noise (WVN) indicator could help managers and users select lower-risk machines or tools for specific tasks, enabling them to take into account the relevant risks associated with WVN emissions. This could help reduce hearing loss, HAVs and musculoskeletal disorders in industry from power tool use.

For more information see Suitability of using combined weight, hand-arm vibration and noise health risk factors in the rail industry.
The use of powered hand tools for prolonged periods of time can lead to hand-arm vibration syndrome (HAVS), a painful disabling disease of the hands affecting blood vessels, nerves and joints. Each year there are around 600-900 cases of HAVS reported to the HSE under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), and there were over 400 new industrial Injuries Disablement Benefit cases in 2017 for HAVS and carpal tunnel syndrome. By law, employers must assess and identify measures to eliminate or reduce risks from exposures to harmful vibration, and where required, to provide appropriate training and health surveillance.

HSE’s Centre for Workplace Health (CWH) has been providing a consultancy service, teaching and researching about HAVS for over 20 years. A HAVS assessment can involve a medical examination and quantitative tests of thermal and vibration perception in the hands. CWH links with the NHS in Sheffield, for specialised tests of nerve conduction and vascular imaging.

CWH runs training courses on how to diagnose, stage and manage cases of HAVS. Recent research from the centre includes publications on the value of quantitative sensory tests; the use of magnetic resonance imaging of the blood vessels in the hands and a new classification for HAVS.

What were the benefits?

HSE’s Centre for Workplace Health has over 20 years of experience in this difficult area of medical practice including research, diagnosis and training for Hand-Arm Vibration Syndrome:

› Accurate diagnosis and staging of HAVS for workers and employers
› Professional training courses for 1800 doctors and nurses.

This will lead to better and earlier workplace identification and management of these potentially disabling conditions.

Further information on the referral center and training courses can be found here and recent publications on HAVS.
Wellbeing at work: The PEROSH Conference series

WORKPLACE WELLBEING (WB) is complex involving interactions between social, physical and psychosocial elements that affect workers. Workplaces that manage it well can enjoy business gains through a more effective and engaged workforce who may also enjoy a long, healthy and productive working life, with an absence of classical work-related diseases such as respiratory problems, but also proactive prevention of work-related stress. Managed poorly, the opposite may be true.

PEROSH (the Partnership for European Research in Occupational Safety and Health) aims to strengthen occupational safety and health research in the region through collaboration. HSE has led the WB project group since its inception.

In this work, the group aims to identify common needs for not only improving well-being, but also preventing ill-health, enabling those with ill-health to stay at work, and for rehabilitating people who are not at work following ill-health or injury.

Led by HSE health specialists, the group has been successful in improving the understanding of wellbeing at work and together with experts in the field have created the Wellbeing Tree, a model illustrating the complexities of workplace WB. Topics such as physical activity at work, job satisfaction, work-life balance and good jobs have been published and presented by the group and shared at a conference series that sees its 5th event in Paris in 2019.

What were the benefits

The outputs of the Workplace Wellbeing Group are varied and aimed at diverse audiences. For example, we have developed advice, guidance sheets and case studies for workplaces, as well as developed peer reviewed articles and wellbeing models for a more scientific audience.

HSE health specialists are contributing to organising the Wellbeing at Work conferences which provide a high-profile platform for a global community to share research, form collaborations and lay foundations for the future through the young researcher initiative. They also offer opportunities to interact with duty holders and develop practical tools and solutions to wellbeing issues in the workplace leading to improved worker mental health.

Over the last decade the conference series has facilitated international research links and have demonstrated a move from understanding the precursors of wellbeing to practical workplace interventions.

For more information see PEROSH and wellbeing at work125, Physical exercise and sedentary behaviours, good practice check list126, a short video about PEROSH127 and the 2019 Paris conference - Wellbeing at Work in a Changing World128.

The PEROSH Wellbeing Group
Enabling the safe construction of a 100% hydrogen distribution network

INTRODUCING THE ‘hydrogen economy’ is an important step towards reducing the CO₂ emissions that contribute to climate change. As part of the decarbonisation of the UK gas network the Scottish Gas Network (SGN) aims to determine the technical and economic viability of constructing the first 100% hydrogen gas delivery network. SGN plan to construct a pilot scale gas network to demonstrate the safe, secure and reliable distribution of 100% hydrogen in the gas grid.

As part of the scientific evidence base in support of this pilot, HSE specialists have been commissioned to provide evidence on the suitability of polyethylene pipes, fitting and jointing techniques, including determining the performance criteria and integrity of the polyethylene system when used with 100% hydrogen.

HSE major hazards specialists are working in partnership with Radius Systems to design, test, evaluate and specify safety systems for a polyethylene pipe and jointed pipe longevity test. This test is equivalent to those performed as standard for current methane gas pipelines. Due to the additional considerations of the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), a new pipe testing facility is currently under construction at Radius Systems.

On another part of the project HSE’s explosive atmospheres specialists have also developed and built a facility at HSE’s laboratory, Buxton, to test excess control valves with 100% hydrogen. These valves are usually used on natural gas networks to cut gas flow in the event of pipe failure.

What were the benefits?

The output from this work will provide robust scientific evidence to Scottish Gas Network (SGN) to use in their Safety Management System for the proposed 100% hydrogen trial. The use of 100% hydrogen in the gas network has huge potential to support the challenge of de-carbonising energy in the UK.

For more information see Scottish Gas Networks, innovation projects, H100129.

Funding source
Scottish Gas Network
Health and safety implications of developments in information and communications technologies

Developments in Information and Communications Technologies (ITC) have the potential to fundamentally change: the tools and equipment used at work; how work is managed and organised; employment status, hierarchies and relationships; the characteristics of the workforce; and the skills workers will need, where and how they obtain them. Whilst this can provide opportunities to reduce or better manage some existing health and safety risks it can also create several new sources of work-related stress.

The European Agency for Safety and Health at Work (EU-OSHA) commissioned the HSE Foresight Centre to produce scenarios of the future for decision-makers to use when considering how to manage the risks and uncertainties associated with the impact of ICT developments on the nature of work.

Futures scenarios are narratives that set out what alternative futures might be like, created by assessing how trends and drivers of change might influence the present to create different possible futures.

The HSE Foresight Centre, working with SAMI consulting, used horizon scanning to identify key trends and drivers of change, relevant to ICT developments. These were used to develop four scenarios which were called Evolution, Transformation, Exploitation and Fragmentation. This involved consulting experts from different fields via telephone interviews, web-surveys and workshops. The scenarios were peer-reviewed before being tested in a workshop with policy-makers and technical experts.

Each scenario presents different challenges and opportunities for occupational health and safety. For instance psychosocial and organisational factors become increasingly important and there are new challenges for managing work-related stress, for instance as a result of the use of wearable devices in the workplace.

The findings were explored by HSE policymakers at a session in their 2018 conference.

For more information see the European Agency for Safety and Health at Work, Foresight on new and emerging occupational safety and health risks associated with digitalisation by 2025, Foresight of new and emerging occupational safety and health risks associated with information and communications technologies, European Agency for Safety and Health at Work, Foresight on new and emerging OSH risks associated with information and communication technologies by 2025, Seminar Report and UK Government Office for Science, Futures Toolkit: tools for strategic futures for policy-makers and analysts.

What were the benefits?

Futures and horizon scanning exercises are not intended to predict the future, but to challenge us to review our assumptions and to consider the potential impact of future developments on our strategies and plans. EU-OSHA anticipates that these scenarios will assist decision-makers to minimise any potential future new and emerging health and safety risks, whilst realising potential benefits of developments in information and communications technologies.

Funding source

European Agency for Safety and Health at Work
The UK has a thriving space industry, with a significant proportion of the world’s satellites developed and built in the UK. The Space Industry Act 2018 provides the framework for the development of commercial spaceports to enable spacecraft launches from the UK. Whilst this will provide further growth opportunities for the UK industry, the primary aim of the Act is to ensure that launches are carried out safely and do not pose an unacceptable risk to the public.

The UK Space Agency and Civil Aviation Authority (CAA) asked HSE risk assessment specialists to help them understand how to keep people safe from spaceport and launch activities. HSE specialists analysed the health and safety risks from space industry activities and identified ways to assess and manage these risks. This assisted other government departments in the development of legislation.

This work included HSE specialists:

- developing quantitative risk assessment techniques to assess any potential risks to the public from a spaceport and launch activities to inform the siting of a spaceport.
- helping wider government develop the regulatory framework to ensure that the industry risks are being reduced as low as reasonably practicable.
- developing a competency framework for new regulatory inspectors within the UK Space Agency by sharing best practice and learning from HSE’s regulatory experience.

What were the benefits?

The work of HSE specialists supported the development of The Space Industry Act 2018, which received Royal Assent in March 2018. The Act sets the foundations for commercial space activity in the UK, and the government is seeking to enable launch from the early 2020s. HSE specialists are involved in ongoing work to help the government understand how space industry risks can be managed.

For more information see UKSA pages on the UK government website.
Measuring and controlling potentially harmful emissions from desktop 3D printers

LOWER COST DESKTOP 3-Dimensional printers are becoming widely used in businesses and schools to build 3D objects. As the printers are not generally enclosed there are concerns regarding the exposure to potentially harmful fume and particle emissions, and potential health endpoints, when filament material is deposited through a heated nozzle. A scientific evidence base is being developed internationally, with HSE forming a working group of experienced individuals from the education sector, 3D printer manufacturing and HSE scientific and regulatory colleagues to share knowledge and experience.

HSE carried out laboratory research to a) measure particulate and volatile emissions, and b) investigate the effectiveness of potential exposure controls.

The research found that the heated filaments emitted small particles and vapours containing hazardous substances. It is not known if in real-use conditions the concentrations of the substances released from these printers are sufficient to cause harm if breathed in. The research identified that exposures are significantly reduced by: (1) setting a lower printer nozzle temperature; (2) using a filament with a lower emission rate; (3) placing the printer in an enclosing hood fitted with an extraction fan and particulate filter and (4) maintaining a hood ‘clearance time’ of about 20 minutes.

What were the benefits

The HSE scientific research into emissions from desktop 3D printers helped inform the new good practice guide published by CLEAPSS (the advisory service supporting science and technology teaching for a consortium of local authorities and their schools) on the health and safety risks of using 3D printers in schools.

For further information see the CLEAPSS good practice guide and HSE’s Research Report.

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For a full list of details from previous years see http://www.hse.gov.uk/resources/publications. HSE also commissions reports from researchers in other institutes, for a full list of research reports published by HSE see http://www.hse.gov.uk/research/rhtm/index.htm

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Our scientists, engineers, physicians and analysts use their extensive expertise, knowledge and capability to make a positive impact on the working world. This review uses case studies to describe the contribution their work makes to helping Great Britain work well.