Overview of research and practices in relation to new monitoring systems for improving worker safety and health

EUOSHA/2021/OP/F/SE/0152

Case-study: Reactec

Company name:

Reactec

Country:

UK

Company description:

Founded in 2001, Reactec is an Edinburgh-based SME active in the field of occupational health and safety risk prevention. Reactec employs approximately 40 employees, who are broadly distributed into three departments: product engineering, operations support, and sales and marketing. The company specialises in providing smart digital solutions for Hand-Arm Vibration Syndrome (HAVS) through different smart digital systems employing an array of technologies. Its flagship system, HAVWEAR, provides a fully automated exposure management support system for over 140,000 UK workers.

Company size and other company characteristics:

Reactec

☐ Micro (fewer than 10 ppl + annual turnover/balance sheet < EUR 2 million)

☒ Small (fewer than 50 ppl + annual turnover/balance sheet < EUR 10 million)

☐ Medium (fewer than 250 ppl + annual turnover < EUR 50 million or balance sheet < EUR 43 million)

☐ Large (bigger than medium)

Description of the new OSH monitoring system and examples of use cases:

What is Hand-Arm Vibration Syndrome (HAVS)?

Hand-Arm Vibration Syndrome (HAVS) is the medical term for damage that may occur to the fingers, hands and arms as a result of working with vibrating tools or machinery. HAVS can be caused by operating hand-held power tools, such as road breakers, and hand-guided equipment, such as compactor plates, or by holding materials being processed by machines such as linishers. According to a study[1] conducted by the European Agency for Safety and Health at Work (EU-OSHA), **one in three European workers is exposed to vibrations at work**. The study also found that the prevalence of HAVS varied widely across different sectors, with the highest prevalence in construction, mining, and manufacturing.

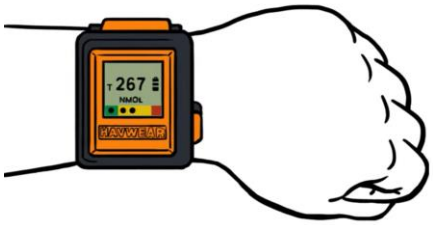
HAVS can have a variety of symptoms, including numbness, tingling, and pain in the fingers, hands, and arms. It can also cause reduced grip strength and dexterity, which can affect a worker's ability to perform tasks requiring fine motor skills. In severe cases, HAVS can lead to permanent damage to the hands and arms, including tissue damage, nerve damage, and musculoskeletal disorders. The best-known HAVS form is the vibration white finger (VWF), which can be triggered by cold or wet weather and can cause severe pain in the affected fingers. The figure on the right illustrates a poster used by Reactec to raise awareness of HAVS among workers and potential clients.

[1] For more information, see: https://osha.europa.eu/en/publications/report-workplace-exposure-vibration-europe-expert-review

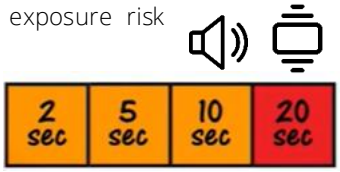
What is HAVWEAR about?

HAVWEAR is a wearable device that is worn on the wrist of workers and detects their exposure to hand-arm vibration (HAV) in real-time. In doing so, HAVWEAR can prevent hand-arm vibration syndrome (HAVS)[2] by identifying when exposure levels are becoming excessive.

How does HAVWEAR look like?



HAVWEAR provides workers with real-time information regarding their exposure by calculating and displaying their exposure risk assessment. It also shows the initials of the wearers and the current tool in use e.g., 'drill.' Exposure thresholds are indicated through a black circle appearing in each colour segment (green, yellow and red) serving as alerts to the wearer for incremental increases in exposure. To estimate the HAV exposure risk, HAVWEAR relies on the UK's HSE exposure point system.[3]



Sound and vibration alerts inform the worker of potential risks, with these alerts increasing in line with vibration levels. For example, when workers are exposed to vibration levels exceeding the acceptable thresholds, e.g. in the 'red zone', they receive sound and vibration alerts lasting for 20 seconds (see image above).

How does HAVWEAR work?

After collecting HAVWEAR, workers simply attach it to the tag of the tools they are using during their shift. Then, at the end of their shift, they place it on a docking station, where it will charge and upload the data to the Reactec Analytics Platform. Using this platform, OSH managers can access online reports, identify exposure levels and find suitable solutions to address potential risks. These steps are set out in Figure 1 below.

Figure 1 Five simple steps to use HAVWEAR

Collect	Protect	Connect	Return	Manage
				
Workers use their Operator ID card to unclip the HAVWEAR watch from a docking station	HAVWEAR is placed into a wrist strap and fitted snugly onto the wrist	HAVWEAR is then connected with the tool tag by pressing and releasing a button.	At the end of a shift return the HAVWEAR to a dock station to recharge and transmit data.	Employers and workers have access to online reports on individual and overall HAV exposure and the source of risk.

[2] HAVS is a condition that can affect workers who extensively use hand-held power tools, such as grinders, drills, and sanders, which produce vibration. HAVS can cause permanent damage to nerves, blood vessels, and joints in the hands and arms, leading to pain, tingling, and reduced dexterity.

[3] For more information, see: https://www.hse.gov.uk/vibration/hav/readyreckoner.htm

To prevent HAVS, in addition to using smart digital systems, it is advisable to use appropriate tools and equipment, take regular breaks, and practice good hand hygiene.

HAVWEAR: From 2008 to the present day

Reactec developed the first version of HAVWEAR in 2008 to gather data on individual users' exposure to vibration.

In 2014, the company automated the gathering and analysis of HAVS exposure by using mobile phone networks to transmit data and releasing a web based portal to analyse the data. Two years later, in 2016, Reactec made its monitoring technology wearable by developing a wristwatch, the so-called HAVWEAR. This collects, calculates, and transmits health, safety and environment (HSE) data on HAV risk exposure using Tool Exposure Points (TEP) and Sensed Exposure Points (SEP). This is possible through sophisticated **sensor and software technology.** An independent assessment by the Institute of Occupational Medicine (IOM)[4] concluded that the HAVWEAR sensed vibration magnitude data were able to inform suitable and sufficient risk assessments. The assessment has also shown that traditional assessments methods such as TEP can often fail to capture exposure. Differently from TEP, SEP assessment picks up previously unidentified exposure risks.

Tool Exposure Points (TEP) assessment is based on a static vibration magnitude programmed into a tool tag and duration of tool usage. This is the *standard measure*.

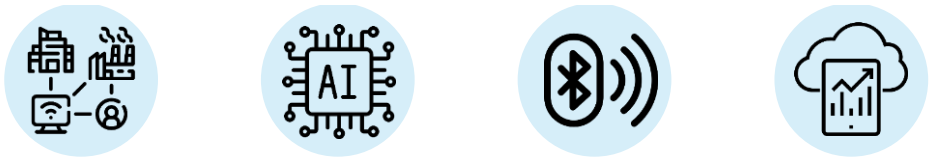
Sensed Exposure Points (SEP) assessment is based on a real-time determination of vibration magnitude during all use of the tool, which if assessed to be representative, will comply with the regulations and HSE guidance. Rather than simply taking the typical measure as set by the standards, it reflects the *real use by a real person*.

But how is this done? This is all possible due to the software at 'the heart of Reactec's ecosystem'[5], i.e., Reactec Analytics. This provides insights into the vibration level each worker experiences, with data readily accessed in a clear format, thus allowing individual risk to be understood before exposure compounds and irreversible damage has been done. After converting the vibration into HSE data, Reactec Analytics notifies the worker if the vibration level gets close to the acceptable threshold.

HAVWEAR provides constant monitoring through **automated reporting**, including individual daily exposure and tool usage reports, highlighting areas of risk and suggesting prevention strategies. The reports are available 24/7, are GDPR compliant, and can be accessed remotely ('Zero Paperwork'). HSE specialists or designated managers can use their laptops or an app on their smartphones to **monitor exposure levels** in real-time and intervene, if necessary. This facilitates early intervention and can thus inform companies' constant risk reduction plans. By displaying these indicators in reports, Reactec helps to ensure that all parties take responsibility for workers' welfare. Employers and OSH managers are encouraged to become more proactive and engaged, actively communicating with workers regarding their exposure levels and proposing measures to improve their safety, e.g. better shift scheduling.

HAVWEAR employs several other technologies, as shown in Figure 2 below, which also shows how these technologies are used to effectively monitor and reduce workers' exposure to HAV.

Figure 2 Technologies employed by HAVWEAR[6]



[4] https://www.reactec.com/workplace-risks/evidence/an-independent-report-by-the-iom/
[5] https://www.reactec.com/products/reactec-analytics/
[6] Icons made by Freepik from flaticon.com

Internet of things	Artificial Intelligence	Bluetooth	Cloud-based analytics
IoT transfers vibration data from the wearable to the cloud	Artificial Intelligence analyses the data received to produce reports.	Bluetooth is key to transferring data and enabling real-time assessment of risks.	Cloud-based software is used for reporting and managing users, tools and plants.

Technical Performance

HAVWEAR has an internal lithium-ion polymer rechargeable battery that takes 3 hours to fully charge and 70 minutes to reach 75% charge. The battery can last up to 48 hours with Bluetooth disabled and 36 hours with Bluetooth enabled for live data. The battery can undergo 1000 full charging cycles and can be stored for a maximum of 6 months when fully charged in a cool, dry place away from direct sunlight. Finally, the docking station archives and transmits data to the Reactec Analytics platform and charges up to 15 HAVWEAR monitors.

Recent developments in the system

Based on HAVWEAR, Reactec has introduced R-Link®, a third-generation workplace wearable that can protect workers from multiple industrial risks on a single device. The R-Link® watch can:

- Keep workers safe with **proximity warnings** to moving vehicles or equipment;
- Gain real insight of **exposure to vibration** and readily show compliance with limits on vibration exposure;
- Create **exclusion zones**, based on workers' credentials, i.e. where workers are permitted to move around the workplace, based on tasks they are carrying out;
- Send alerts and track **lone workers;**
- Track employee **movements and activity** levels.

The latest version of HAVWEAR (R-Link® watch), together with Reactec Analytics, offers an improved view of employees' environments and improves operational efficiency and safety. For example, the R-Link® watch assists in mitigating the effects of HAV exposure, identifying hazardous proximity and near misses in restricted areas, and sending immediate alerts to workers exceeding exposure limits. This information is gathered through Reactec Analytics and is used to minimise risk and establish a secure workplace. Finally, in addition to the technologies employed by HAVWEAR, R-Link® has the latest ultrawideband[7] technology to detect dangerous proximity.

Table 1 R-Link® key benefits and features

Benefits	Features
Provides personal monitoring experience	Personalised exposure threshold display & multi haptic alerts[8]

[7] Ultra-wide band is a short-range wireless communication that has been identified as one of few technologies that were likely to perform well enough for HAVWEAR's purposes. From the interview with Setsuo Maeda, Reactec's HAV expert.

[8] Haptic alerts refer to the use of tactile sensations or vibrations to convey information or notifications to a user.

Supports employee behavioural change	Employees are alerted even if colour blind or wearing hearing protection
Automatically transmits exposure data online	Real-time exposure points calculation & display
Sends automatic manager alerts and KPIs from the Reactec Analytics	33-minute R-Link re-charge

Examples of HAVWEAR use cases

HAVWEAR helps employers to protect their workers from the harmful effects of HAVS by providing real-time monitoring and risk assessment, allowing for better management of exposure levels to prevent the development of this debilitating condition. As **Figure 3** illustrates, **HAVWEAR can be widely used in several sectors** including construction, public utilities, heavy engineering manufacturing, grounds maintenance, shipbuilding, mines, industrial cleaning vehicle repair, and many others. The figure also shows the **equipment and task-related risks that HAVWEAR can prevent.**

Figure 3. Potential applications of HAVWEAR in different sectors

Construction

Equipment-related risks

Breakers

Grinders

Task-related risks

Drilling

Blasting

Shipbuilding & Repair

Equipment-related risks

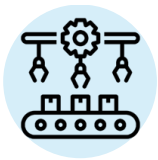
Jackhammers

Chipping hammers

Task-related risks

Drilling

Shovelling and digging



Industrial manufacturing

Equipment-related risks

Sanders

Pedestal grinders

Task-related risks

Operating sanders

Shovelling and digging

Mining

Equipment-related risks

Bolting machines

Breakers

Task-related risks

Drilling

Heavy machinery

Industrial cleaning

Equipment-related risks

Pressure washers

Floor scrubbers

Task-related risks

Manufacturing concrete products

Equipment-related risks

Chipping hammers

Concrete breakers

Task-related risks

Roads and railways maintenance

Equipment-related risks

Compactors

Breakers

Task-related risks

Motor vehicle repair

Equipment-related risks

Impact wrenches

Polishers

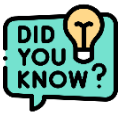
Task-related risks

Using pressure washers	Drilling	Drilling	Using polishers
Using floor scrubbers	Clearing concrete	Blasting	Operating sanders

Information on designing and developing the new OSH monitoring system

EU Directive and HAVWEAR

As a start-up business, Reactec began designing HAVS monitoring systems in 2005, following the UK adoption of EU legislation on exposure of workers to vibration (Directive 2002/44/EC). The Directive aimed at ensuring the health and safety of each worker and at creating a minimum basis of protection for all EU workers through the early detection of adverse health effects that arise - or may arise - from exposure to mechanical vibration in various industrial sectors, including construction, manufacturing, and public services. The Directive distinguishes between **vibration affecting the hand-arm system** and **vibration being transmitted to the whole body** and defines exposure limit values for both types of vibration based on an eight-hour reference period. According to this Directive, **the employer has an obligation to assess and measure the levels of exposure to mechanical vibration** based on technical specifications provided in the Directive's annex and must take into account working practices, equipment, and unusual working conditions. The risk assessment must be regularly updated, and based on the results, the employer must take measures to reduce risks at the source.



Want to learn more about HAVWEAR's results? Then check out this peer-reviewed paper here. A summary of the results is also available in the Annex of this case study.

- If threshold values are exceeded, an action plan must be implemented to prevent exposure from exceeding the exposure limit values, which may include adequate technical and/or organisational measures to reduce exposure to mechanical vibration.
- If the exposure limit values are exceeded, immediate action must be taken to reduce exposure below the limit. Employers must also provide workers who are exposed to risks from vibration at work with the necessary information and training.

According to the Directive, 'risk assessment should involve vibration magnitude probably experienced during tool use.' At the time the legislation was formulated, it was acknowledged that some uncertainty would be present. Nonetheless, the current technology for measuring vibration is more advanced than previously. For this reason, HAVWEAR considers two significant points of measurement, TEP and SEP.

Challenges and opportunities

While the Directive has been in effect since 2002, challenges in adopting smart digital systems to monitor vibration still exist. On the **workers' side**, these challenges include fears that precise risk measurement would allow employers to make employees work close to the acceptable thresholds. On the **employers' side** and in particular in the case of SMEs, these challenges include difficulties in changing 'paper practices' to digital processes, due to **costs** and **lack of skills** within their workforce. However, both parties also see opportunities, such as **improving OSH monitoring, upskilling workers, and saving time in risk assessments and compliance.** In addition, opportunities include obtaining real-time insight into an increasing number of risks at the workplace.

Table 2 Challenges and opportunities related to the development / implementation of HAVS

Challenges	Opportunities
Fast-moving technology	Potential to improve HAVS monitoring

Complicated legislation (e.g. ISO standards)	Possibility to up-skill the workforce
Shift from paper to digital monitoring	Possibility to save time in OSH procedures

In addition to these opportunities, when COVID-19 hit, Reactec integrated SAFE-DISTANCE into HAVWEAR's watches to detect the distance between two workers, nudging them to stay at a safe distance. Developed in response to the challenges posed by COVID-19, SAFE-DISTANCE is a stand-alone upgrade of the Reactec ecosystem. Therefore, if there is no need to monitor HAV exposure, Reactec can also configure only SAFE-DISTANCE without the features needed to detect HAV exposure.

Experiences of adoption from the client's perspective

Clients' participation and involvement in the design and development of smart digital systems for OSH are **key elements in ensuring effective implementation**. HAVWEAR is no exception. However, since the device and the software of the system are off-the-shelf, clients' participation is particularly relevant in the implementation of the system.

Clients' involvement does not appear to link with a specific sector or its size, but rather is related to the individual enterprise and how it broadly considers health and safety issues. The person responsible for the implementation and monitoring of HAVWEAR is typically an HSE specialist or a safety manager, although this varies across companies based on their organisational structure and size.

Workers can be suspicious about how their employers might be using the data created by smart digital systems. To resolve any misconceptions, HAVWEAR clients have been talking to workers and trade unions. **Clear and transparent communication on the purpose and use of the system** has been cited as one of the main enabling conditions that can win workers' trust. In other words, when workers know that the smart digital system is exclusively about health and safety and not about performance monitoring, they are generally positive about incorporating it into their daily work.

During the implementation phase, Reactec provides several training opportunities on how to set up the system and interpret the data. Some clients decided to start with a trial in one site before rolling it out across all their sites. Annex 3 summarises feedback and experiences from a number of these clients.

A client's perspective: Solus Arc

Solus Arc is a large vehicle repair company operating 21 sites throughout the UK and successfully repairing approximately 35,000 vehicles annually. The company uses Reactec's smart digital systems to monitor the safety and health of its workers who are exposed to vibration.

Solus Arc chose Reactec primarily because it offers continuous monitoring rather than sample-based monitoring, even though this is not mandated by UK legislation. In addition to the individual monitoring, Simon Kirwin, HSE Manager at Solus Arc highlighted that having access to a dedicated portal with real-time data and individual reports on users' exposure to vibration was key when deciding on implementing HAVWEAR across Solus Arc sites.

Before introducing HAVWEAR, Solus Arc monitored HAV exposure ex-ante, through setting plant-wide threshold levels based on a sample from a single plant. However, this sample did not take into account variables that can affect individual

HAV exposure, from the pressure the user exerts to the tool, to the different performance of the tools across sites. For example, an experienced worker might exercise less pressure on the tool than a worker with less experience.

HAVWEAR implementation at Solus Arc

After piloting HAVWEAR, Solus Arc took the decision to scale it up. As a result, the company now monitors vibration exposure on real-time across all of its sites, as well as identifies risks that would have otherwise gone unnoticed. For example, the company's HSE manager became aware that cutting a van side panel with a compressed air saw was causing vibrations exceeding the acceptable thresholds. **To respond to these risks, the company is training workers, managing their shifts as well as looking into equipment upgrades.**

Using the system, however, also came with some challenges. For example, people can forget to tag on and off the system. In addition, as Reactec now uses the R-Link hardware instead of its HAVWEAR, migrating to the platform involves some additional costs.

"HAVWEAR helps us to identify risks that would have otherwise gone unnoticed and take action."

Simon Kirwin, HSE Manager at Solus Arc

Experiences of implementation from the designer/developer perspective

This section presents the main factors that facilitate or limit HAVWEAR implementation.

Factors facilitating implementation

HAVWEAR is adopted by companies of different sizes, from small organisations, i.e., companies of 10 to 20 people, up to multinationals with thousands of employees. However, its uptake is higher in bigger companies that might have more budget, awareness, organised structure of OSH management and are more prone to compliance checks.[9]

There are transversal success factors for the implementation of HAVWEAR:

- ✓ easy to use
- ✓ not intrusive
- ✓ easy to deploy and maintain
- ✓ trial and training opportunities

"Reactec provided plenty of training on how to set the system up and interpret the data. We also had a trial on one site and then we rolled it out to all the sites."

Simon Kirwin, HSE Manager at Solus Arc

Factors hindering implementation

The main barrier to the implementation of HAVWEAR appears to be the capacity of clients' IT infrastructure to manage and store the data. To address this barrier, Reactec now transfers all data to the cloud. Another significant barrier is that, as with any other smart digital system that has a monitoring function, doubts or resistance can also arise on the part of the workforce. Concerns are often linked to a fear that HAVWEAR can share data on workers' productivity or location with managers. However, as noted earlier, **clear and transparent communication on the purpose and use of the system** can be helpful in addressing these issues. Once workers know that the systems are focused on safety, they are generally positive about using them.

[9] Interview with Reactec's Sales Director

Research conducted for this case study

This research was conducted in the first two quarters of 2023. Our interviewees shared public and private material for the purpose of this case study. In total, we conducted five interviews. We would like to thank the following persons for their active participation in the case study: Jacqui McLaughlin (Reactec CEO), Leif Anderson (Reactec CTO), Sam Thomas (Sales Director at Reactec), Setsuo Maeda (Chief Scientific Liaison at Reactec) and Simon Kirwin (HSE Manager at Solus Arc).

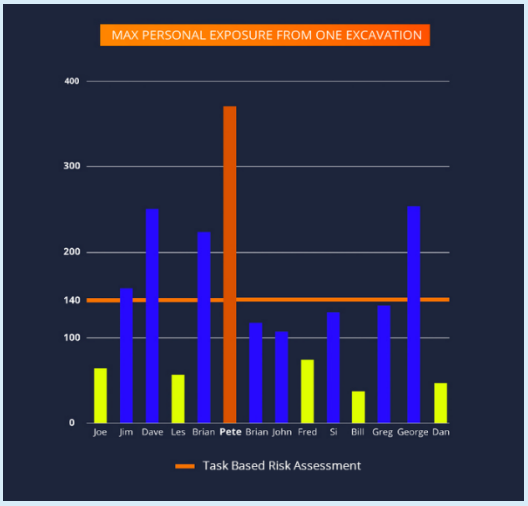
ANNEXES

In recent years, Reactec has provided several case studies and external assessments of HAVWEAR.

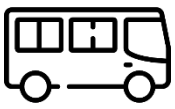
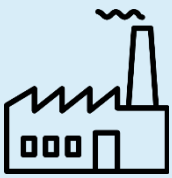
Annex 1: Peer-reviewed publication on HAVWEAR

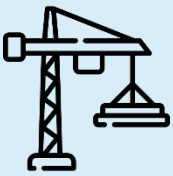
Title	Determination of hand-transmitted vibration risk on the human
Authors	*S. Maeda, M.D. Taylor, L.C. Anderson and J. McLaughlin*
Journal	*International Journal of Industrial Ergonomics*
Purpose	The purpose of this paper is to examine the effectiveness of the proposed consideration for hand-transmitted vibration measurement on humans. The Reactec wearable device utilised for this study is HAVWEAR-001.
Results	The study measured the temporary threshold shift in the fingertip vibrotactile perception threshold before and after exposing subjects to hand-transmitted vibration using a handheld tool. The proposed vibration measurement on the subject was found to be proportional to increasing temporary threshold shift in the fingertip vibrotactile perception threshold whereas the conventional vibration measurement on the tool showed a relatively constant vibration level. The results showed that data acquired on the human using a wrist-worn wearable device, with the proposed methodology, can predict exposure risk with enough accuracy (Maeda et.al., 2019). The principle of using hand-transmitted vibration as an indicator of HAVS health risk is valid and can address limitations identified with tool emission data.
Conclusion	The study concludes that the proposed methodology can capture the effects of transmission and tool interaction specific to the individual operator which directly affects the risk faced and is not captured with tool emission data. The assessment of vibration transmitted to the tool operator using the proposed methodology is positively correlated with the human subject's response to vibration.
Suggestions	The paper suggests that greater consideration should be given to the proposed wearable devices methodology as a practical workplace solution to vibration monitoring, and further research is required to fully understand the response of structures within the hand and arm to mechanical vibration.

Annex 2: HAVWEAR Vibration risks assessment

The study conducted at a utility company aimed to effectively assess vibration risk using our HAVWEAR wearable. The study involved 2- and 3-person teams digging identically sized holes in the same type of road using the same tool. Based on the average time, vibration levels, and work-sharing rules, the predicted task risk assessment was 140 points. However, the graph reveals the actual maximum risk faced by each individual, with 'Pete' being exposed to significantly higher risk compared to his colleagues. This study shows that the variability in tool condition, operator skill, and different work-sharing arrangements can have high levels of variability. Therefore, individual monitoring is key to having reliable results on workers' exposure to vibration.	 Source: Reactec

Annex 3: Feedback from clients

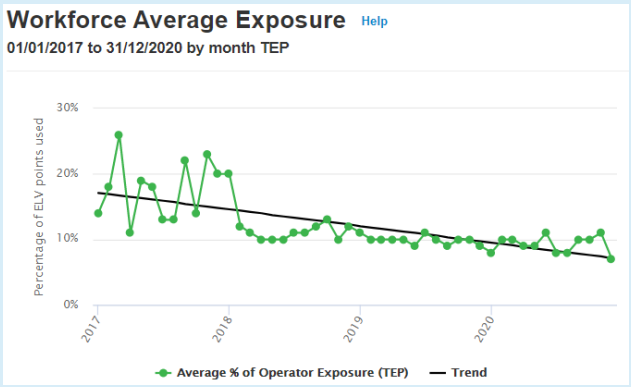
Company	Sector	Feedback
Morgan Sindall	*Construction* 	**Morgan Sindall** has recognised the lack of operator awareness regarding Hand Arm Vibration (HAV) risks and the unreliability of paper-based monitoring systems. They have introduced the Reactec Analytics Platform, which incorporates HAVWEAR and HAVMETER to collect accurate and consistent data about vibration exposure. Morgan Sindall introduced Reactec's OSH monitoring systems to ensure the safety of employees and subcontractors thereby reducing HAV-related claims or HSE improvement notices. According to this client feedback, Reactec provided a secure system that tracks each operator's exposure and can be used as reliable evidence to protect both the company and the client in the event of a dispute.
Brighton & Hove Bus & Coach Company	*Transport* 	**Brighton & Hove Bus & Coach Company**, a top 3 UK bus company, used tool diaries to manage HAV risk but found them inaccurate and time-consuming. To address this issue, the company adopted the Reactec Analytics Platform, which includes the HAVWEAR and online exposure reports. The platform provided greater insight and accuracy into tool usage and exposure risk by accurately calculating exposure risk from the wearer's tool trigger time and pre-defined tool vibration. It also sensed unexpected exposure levels and identified tools outputting higher vibration than anticipated. According to Tim Witham, Health & Safety, Environmental Manager at Brighton & Hove Bus & Coach Company, the system has exceeded their expectations, allowing them to confidently manage the perceived and actual risk of HAV exposure to their staff.
Siemens Energy Industrial Turbomachinery Limited (SEITL)	*Manufacturing* 	**Siemens Energy Industrial Turbomachinery Limited** (SEITL) has adopted Reactec's HAVWEAR solution to monitor its workers' exposure levels to vibration. The company had relied on two primary sources of information for vibration exposure levels: vibration testing carried out during the servicing of power tools; and manufacturer guidelines on reported "vibration values". However, over time, SEITL realised that these methods were not sufficient to meaningfully identify its workers' actual exposure levels. Reactec's solutions provided insights into the experience of a single worker, with data readily accessed in a clear format, allowing individual risk to be understood before exposure compounds and irreversible damage has been done. SEITL has also

		been using HAVWEAR to run trials on equipment to understand the differences measured between left-handed and right-handed users, reviewing what tools are being used and the processes they are following at that time. The insight provided by Reactec Analytics has been essential in SEITL's focus on employee health and safety, with reporting available to Health and Safety teams, operations managers, and senior management.
Sir Robert McAlpine	*Road maintenance* 	**Sir Robert McAlpine**, which has been delivering a Design, Build, Finance & Operate (DBFO) contract for the A19 Trunk Road Network for 20 years, employs over 80 onsite workers who are exposed to vibration from various power tools. To protect workers from hand-arm vibration risks, the company used to conduct multiple assessments to understand the levels of exposure from different work environments and power tools. However, with the deployment of the Reactec Analytics Platform, the DBFO can now monitor an individual's actual exposure to vibration in real time. HAVWEAR provides tangible information through online analytics reports, allowing the company to refine control measures and reduce exposure to vibration. The system also allows the company to monitor work patterns and implement changes, such as encouraging the rotation of tools every six weeks to create a more balanced tool usage programme. The HAVWEAR can also sense the wearers' vibration exposure during actual tool use, enabling unexpected levels of exposure to be checked and future training of operators to take place by assessing their technique. Overall, since deploying the Reactec Analytics Platform a few months ago, Sir Robert McAlpine has already seen a drop in exposure.
Keltbray	*Construction* 	**Keltbray** is a leading construction engineering specialist. To address the risks of its several activities in the construction sector, Keltbray adopted the combination of Reactec's HAVWEAR and cloud-based analytics to actively prevent health risks for their employees. As reported by Paul Deacy, Operations Director, Keltbray will replace 500 HAVWEAR currently used with the new R-Link wearable. In the upcoming year, the device will receive automatic upgrades remotely, introducing a range of new features, such as geofencing capabilities, support for lone workers, employee communication, evacuation and mustering assistance, and tracking of upper arm musculoskeletal disorders. Once everyone is familiar with the new device, Keltbray will begin evaluating the functionality for proximity provided by SAFE-DISTANCE[10].

Annex 4: User case study - J Murphy & Sons Ltd

J Murphy & Sons Ltd	
Summary	J Murphy & Sons Ltd were a pioneer in the adoption of Reactec's HAVWEAR with intuitive analytics, to advance their efforts to manage HAV exposure within their employees. The leadership of Murphy chose to invest in the Reactec system as they saw the potential for the technology to not only comply with regulatory requirements but to help prevent risk of HAVS among their employees . J Murphy & Sons Ltd are now able to evidence a 61% reduction in the average daily exposure of their employees from the launch in 2017 and average daily exposure to HAV across their employees of only 27 HSE points. 1,435 Murphy employees have benefited from J Murphy & Sons Ltd management having a clear understanding of the risk of developing HAVS in their everyday work.
Problem	• HAVS is preventable. However, once the damage is done it is not reversible. According to the HSE, nearly 2 million people are at risk of HAVS.

[10] Interview to Keltbray operations director. Available at: https://www.bimplus.co.uk/keltbray-supports-reactec-wearable-device-to-boost-hs/

	• HAVS can lead to the inability to do work, while exposure to cold weather conditions can trigger painful attacks of finger blanching. HAVS can impact operational productivity, employee confidence, result in compensation claims for industrial disease, as well as reduce business productivity. • Traditional methods of assessment and paper records were not considered to be fit for purpose, with significant errors in self-assessment of task times and major inefficiencies and inaccessible data from manual records. • Even with all the right training, it is hard to know how closely individuals follow HAV control measures. Individuals taking more risk than asked could be damaging their health, and unchecked exposure damages organisations if this leads to litigation. • Immediate and long-term gains require a shift towards prevention rather than simply compliance.
Solution	J Murphy & Sons Ltd wanted to be able to measure what is happening, to be able to tailor controls faster, engineer out risk and actively protect their workers' health in the workplace. After extensive evaluations, J Murphy & Sons Ltd chose to deploy Reactec's wrist worn HAVWEAR. Deploying monitors to initially a few hundred employees in 2017, Murphy expanded HAVWEAR more widely in 2018 meaning that 1,435 employees have benefited from the system.
Evidence	The evidence of these efforts shows a 61% reduction in average employee exposure and a workforce average exposure controlled consistently to less than 30 HSE exposure points. 
Conclusion	Providing employees with real-time feedback on their exposure levels effected a direct administrative control vastly superior to previous paper records and heightened employee awareness of exposure to HAV as a tangible workplace risk. The Reactec Analytics and ease of access to all duty holders gave J Murphy & Sons Ltd leadership the ability to seek out better tools and better workplace practices to proactively engineer out HAV exposure as a workplace risk.

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