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# Bad vibes

ANY BIG game hunter will tell you that just because something's gone quiet, it hasn't necessarily gone away. And things have been ominously quiet with the Physical Agents (Vibration) Directive, or PA(V)D. This is the fragment of Euro-law which, it's feared, will restrict farm machine operating hours in the UK at a time when the industry is under severe economic pressure.

Brussels makes a directive, then member states implement it. The Control of Vibration at Work Regulations (2005) is the UK's interpretation, and these new rules come into play this year.

While Silsoe's investigation covers a relatively narrow set of conditions, it takes prediction well beyond the peering-at-tealeaves stage. Here's the story so far and its likely implications for working hours.

## WHERE DID THE PA(V)D COME FROM?

The EU started down the legislative track in 1990. Two



## Vibration limits

New regulations on their way

Work commissioned by the HSE from Silsoe Research Institute puts figures on farm machinery vibration in work. As a result, we can at last glimpse the implication for driving hours. **Andrew Pearce** reports

**Bumpy ride ahead? New regulations may limit a driver's exposure to whole-body vibration.**

forms of possibly harmful vibration – hand-arm and whole-body – were included in a draft. Whether both should be is a moot point (see **Where's the Beef?**).

After some countries pointed out that no clear evidence linked whole-body vibration (WBV) to health problems, the proposals went on the back burner. But in 2000 the juggernaut started rolling again, and in 2002 the directive passed into EU law. It applies to all industry, not just to agriculture, with farming and forestry considered to be high-risk occupations.



**"Ah Bert, I've invested in some new technology to cut your vibration levels." Would that it were so simple.**

## WHEN WILL THE NEW RULES COME INTO FORCE?

On July 6 this year. Daily exposure limits won't apply to new farm/forestry machinery until 2007, and not to machinery already on farms until 2014.

For more on action/exposure values, see **Value Judgements** box on the last page.

## WHAT IS THEIR INTENTION?

To improve worker protection from risks associated with whole-body and hand-arm vibration.

## WHAT DO THE NEW RULES REQUIRE?

Employers must assess and reduce risks from exposure to vibration.

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### Continued from previous page

Assessment involves estimating workers' likely daily vibration exposure levels.

### WHAT DOES THE DIRECTIVE SAY?

It does *not* put a direct cap on working hours. Rather, it puts limits on daily exposure to hand-arm and whole-body vibration. For wheeled farm machinery only the whole-body side is significant, though ATVs may be an exception to this.

It's important to distinguish between vibration emission and an operator's daily exposure to it. WBV emission is the level of vibration a machine puts out. WBV daily exposure is the dose of vibration received by the operator; that is, the level received over a day's work.

The directive deals with daily exposure levels. Two key values apply; so, bracing yourself for more initials, take a peek at **Value Judgements**.

Keep in mind the notion of an exposure action value and an exposure limit value, as these are key to all that follows.

Everything depends on how much vibration is received and for how long. So while very high-whole body vibration emission work might reach the exposure limit value after a couple of hours or less, a lower-vibration job will take much longer to reach that ceiling, if it reaches it at all.

Spells of no (or low) vibration exposure during tea breaks, unloading, maintenance and breakdowns all extend the potential work period (Fig 1, below).



**A tractor tackles Silsoe's rough ISO track at 4-7kph. Many more assessments, with and without implements, were made on farm tracks and in the field to build a broad picture.**

### WHAT'S THE LIKELY IMPACT?

The HSE commissioned Dr Andy Scarlett's group at Silsoe Research Institute and the RMS Vibration Test Laboratory to measure vibration in modern tractors (sprung and unsprung), in self-propelled sprayers with different suspension systems and in a selection of ATVs. Vibration

was checked on industry-standard test surfaces, in controlled field conditions and subsequently on farms as machines went about their daily business, with and without implements. The team also surveyed operators' work patterns, so WBV exposure values could be figured out for different jobs.

Comparing each job's range of WBV emission levels to the directive's exposure limits shows how long work can go on, first before the action value is reached, and then before the limit value where work must stop. Note that the limit value is not regarded as a safe level of vibration exposure, but one to be avoided completely.

Table 1 on the last page sums up Silsoe's results. The bad news is that 95% of on-farm tractors surveyed exceed the exposure action value at some point in a typical eight-hour working day. What should happen then? The job can continue, but the employer will need to take measures to manage and reduce worker exposure to vibration (see **Risk management**).

On the brighter side, only about 9% of tractor operations exceeded the exposure limit value in an eight-hour shift, though this increased to about 27% as the working day lengthened. But, many field jobs won't take the driver to the exposure limit value for at least 20 hours, by which time most operators would have flaked out anyway. Self-propelled spraying comes into this category.

The kicker lies in likely exceptions to this otherwise modestly cheerful prospect. Even today's sprung tractors, cultivating

### VALUE JUDGEMENTS

The directive sets two limits for daily exposure to whole-body vibration (WBV). Vibration emission is expressed as acceleration in  $m/s^2$  (as vibration is a string of many rapid accelerations), while vibration exposure incorporates a time element.

The **action** and **limit** values are the cornerstone on which all assessments will be based – mark them well.

- The Exposure Action Value (EAV). The trigger threshold, set at  $0.5m/s^2$ . Subjectively, vibration at the action value is judged slightly-to-fairly uncomfortable (ISO 2631-1:1997). Work producing WBV levels under the action value is fine. An employee can be exposed to higher levels, but only if the employer uses a vibration management programme.
- The Exposure Limit Value (ELV) is set at  $1.15m/s^2$ . Vibration at this level is reckoned subjectively uncomfortable. The ELV is the absolute ceiling for whole-body vibration. Beyond it, work must stop or penalties will be risked. Taking effective steps at the action value should mean the ELV is not crossed.

### HOW VIBRATION RELATES TO WORK TIME

Fig 1

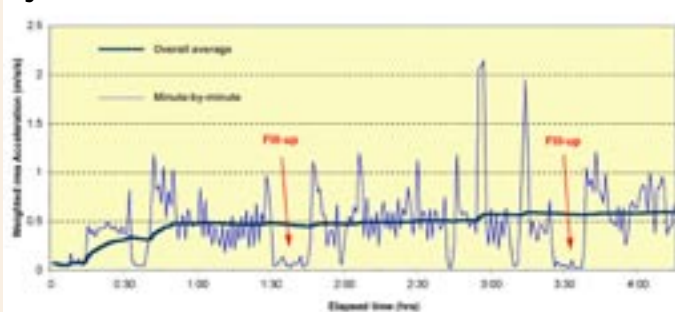
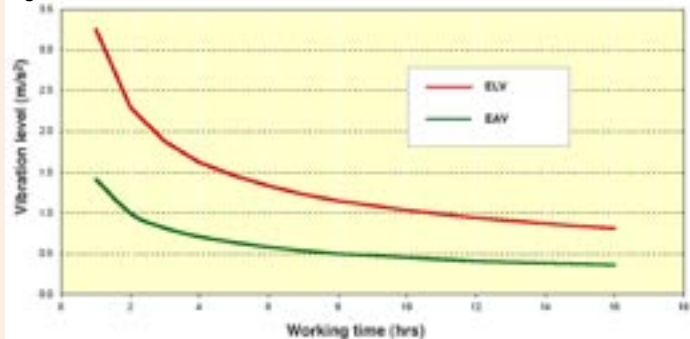


Fig 2



Here's the way that field vibration measurement is used to arrive at allowable working time. No need to be alarmed – the intention is to automate the whole lookup process through the HSE's website, which will be fine if you have internet access.

● **Fig 1:** Vibration recorded during four hours' fieldwork in a self-propelled sprayer. Minute-by-minute levels (jagged line) show rough-land peaks and spells of low/no vibration during fill-ups.

The directive works with the overall average rms (solid line), which thanks to fill-ups is  $0.5m/s^2$ .

● **Fig 2:** To find allowable working times, first check where the sprayer's  $0.5m/s^2$  average vibration meets the green action value line. It's at eight hours, so that's how long the machine could be used in those conditions before triggering risk management. If average vibration was  $1m/s^2$ , then risk management would be necessary after only two hours work. That value also goes on to meet the red limit value curve at 11 hours – which would be the maximum allowable work time in the circumstances.



From 2007 to 2014, new machines will have to conform but not existing ones.

rough land or hauling trailers, can generate enough vibration to take the operator to the limit value inside an eight-hour stint.

Unsprung and lighter, more basic tractors will do it sooner, and in both cases the timing depends on ground conditions and travel speed. And even relatively low-vibration jobs like ploughing may approach the exposure limit value towards the end of a 14 hour shift.

Once daily exposure to vibration approaches the limit value, the new rules require an operator to switch to lower-vibration equipment, use a different way of working or (ultimately) stop altogether.

ATVs are different. While it's possible to reach the action value in just over an hour's riding, a stock farm's typically intermittent ATV use makes that unlikely. Hand-arm vibration could be a bigger problem, though that too should stay under the exposure limit value in typical stock farm use. Longer-stint work like slug pelleting may be a different matter.

## MACHINERY

Silsoe's work was undertaken in 2002/03, using then-state-of-the-art machinery. Direct comparison between brands was not made or intended. Tractors were 120-170hp 4wds, weighed 5.5-7.2t, and carried the gamut of suspension types – unsuspended, full cab suspension, front axle and cab suspension, and front and rear axle suspension. Self-propelled sprayers were 2500 litre 24m boom models, with mechanical coil-spring or self-levelling air spring suspension. A range of 300-400cc ATVs were chosen from a number of manufacturers. All were driven over a 100m smooth ISO test surface at speeds between 10kph and 30kph, then the tractors were pounded across 35m of rough ISO surface at 4kph-7kph. Tractor fieldwork and transport assessment at Silsoe used a five-furrow mounted reversible for ploughing and plough transport, a mounted 1000 litre air-assist sprayer, a 12t tandem axle trailer with sprung drawbar and axles, and a 4m pigtail cultivator.

## WHERE'S THE BEEF?

The directive's stance on hand-arm vibration is based on a proven link to physical injury. Because saws, air tools, jack hammers and so on do a single job in definable circumstances, the user's exposure to vibration is fairly easy to quantify.

The resulting harm is also well documented: Vibration x time = dose, and damage relates directly to dose. The whole-body part of the directive is founded on a looser tie between vibration and ill health. There is a relationship, but not (as yet) a proven dose-response one.

Farm workers suffer back pain and/or injury. But poor driving posture is common, and even the most cab-hugging operator has to lift and twist as part of farm work.

What isn't clear is if (and how) these factors interact, and whether two or three bad jolts over a day's driving do more or less damage than a steady stream of small shocks. Nevertheless, whole-body vibration exposure is assessed through a dose approach, which is where possible working-hours limitation comes in.



Hand-arm vibration on ATVs may be a factor.

## WHO WILL POLICE THE VIBRATION AT WORK REGS?

The Health and Safety Executive. Employer action should be in proportion to the risk assessed and any action taken should be recorded. The HSE's view is very clear: The upper exposure limit is not a safe level, but a high, legally defined threshold that should never be crossed, with prosecution an option against those that do.

From an employer's perspective there's also the real possibility that a disgruntled worker will try to prove that back pain or injury resulted directly from too many hours in the seat. In either case, the best defence will be to have (and use) an effective risk management plan.

## WHAT MUST EMPLOYERS DO?

Silsoe's results suggest that most field operations will take the driver over the exposure action value inside an eight-hour shift. So from July 6, employers should assume

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**How will you know the level of whole-body vibrations your tractor is producing?**

this is the case and implement a vibration management plan (see **Risk Management**).

From 2007 the limit value applies to new kit, and then things get interesting.

To make accurate judgements you'll need to know the WBV emission of a particular machine while doing the proposed work, in your conditions. Where will this info come from?

At present Table 1 values are a good generic guide; they will be available on the HSE website ([www.hse.gov.uk/vibration](http://www.hse.gov.uk/vibration)) in simpler, operating-condition-related form and in due course as a leaflet. Estimating vibration exposure by using the website calculator and keeping records over time could be an effective counter to an employee's claim for damages.

Before mid-2007, it is likely that measurement standards will have been agreed. Machinery makers can then publish accurate, comparable vibration emission levels for their kit so buyers can make sensible choices. The generic-value approach will serve where WBV exposure lies between the action and limit values.

But where it reaches or goes over the limit value, it may be necessary to bring in a third party to measure vibration emission directly. And that's a very different ballgame.

**FUDGE FACTORS**

The directive's clear-cut exposure action/limit values imply a precision unlikely to be found in practice – look at Table 1's big ranges in vibration and working times for any given job. For example with tractors, WBV emission can vary by 40% either way depending on ground conditions, driving technique and travel speed.

This variation is much bigger than the WBV emission differences between tractor suspension types – in the scheme of things, suspension's effect is relatively small. But springing definitely lowers WBV emission and boosts subjective ride comfort, so is one way forward. Yet even then operator choice adds more complication, as the reduction



**JCB had plenty of space for vibration-measuring equipment.**

**“To make an accurate judgement you'll need to know the WBV emission of a particular machine while doing the proposed work, in your condition. Where will this info come from?”**

**RISK MANAGEMENT**

From July 6 this year, employers have a responsibility to minimise employee health risk from vibration exposure. The action value will apply from that date, then from 2007 the limit value will apply too.

Silsoe's results suggest that most common farming operations involve WBV exposure beyond the action value. Where this is likely an employer should:

- Assess the risk. Broad assessment can be made without estimating vibration exposure
- Take measures to reduce risk
- Reduce vibration exposure to a minimum
- Keep exposure below the exposure limit value (ELV)
- Provide information/training on risks from vibration exposure and ways to control it.

Practical steps could include making sure operators know the importance of correct seat adjustment/maintenance and the effect of tyre pressures; making sure that work schedules include adequate rest periods; providing vibration-reducing suspension systems, seat or handlebars where none exist; changing to machinery that emits less WBV; selecting appropriately-sized tackle to do a job; looking after farm roads; training operators to work in ways that minimise exposure and encouraging them to report regular back problems early on. Questionnaire-based health surveillance is an option still under discussion.

from effective suspension can easily be traded for faster travel.

In low vibration activities like spreading and mounted spraying, difference in suspension setups are minimal. As job severity increases, so does the difference between systems. And in the worst conditions, measurement confirms seat-of-the-pants experience: combined axle/cab setups and full axle suspension are best performers.

**FUTURE IMPERFECT**

Although it looks likely that most common arable operations will trigger risk management, only rough-ground cultivation and trailer transport generate enough bad vibes to make time-limited operation a real possibility. Ploughing and mounted spraying should be OK for at least 12 hours (not including breaks), while fully-sprung self-propelled sprayers should be able to roll for a minimum of 20 hours at a stretch.

Clearly nothing concrete can happen until vehicle WBV testing standards are developed further. This will let manufacturers publish reliable WBV values typical of farm operations for new machinery, leading to a national database. And new tackle will have to generate less WBV in a cost-effective way, so buyers can afford it and operators can work the necessary hours.

Meanwhile, the legislators and enforcers have to find a sensible operating framework for the whole business. And existing kit? The new regs don't apply to that until 2014, by which time most of today's tackle will be abroad or in the scrap yard. ■

**TABLE 1: VIBRATION AND WORKING HOURS**

Vehicle/job	Average whole body vibration at seat	Time to action value (hrs:min)	Time to limit value (hrs:min)	Average working day (hrs)	Likely to exceed value in normal working day?	
					Action value	Limit value
Self-propelled sprayer	0.53-0.69	4:12-7:7	22-24+	10.1	Yes	No
Tractor, mounted sprayer	0.36-0.78	3:17-15:26	17:23-24+	8.9	Probably	No
Tractor, ploughing	0.49-0.93	2:19-8:20	12:14-24+	8.9	Yes	Unlikely
Tractor, trailer transport	0.47-1.12	1:36-9:30	8:26-24+	8.9	Yes	Possibly
Tractor, cultivation	0.53-1.39	1:20-7:70	5:29-24+	8.9	Yes	Possibly
ATV	0.85-1.39	1:2-2:46	5:29-14.39	1-2	Possibly	Very unlikely