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Research, Standards and Directives

- current research and future needs

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Research, Standards and Directives

- Review current research and future needs
- Consider implications of EC Directives and key standards work
- **Intend to discuss:-**
 - 1) Whole-body vibration on agricultural vehicles
 - 2) Agricultural tractor – trailer braking requirements
 - 3) Agricultural vehicle cab filtration



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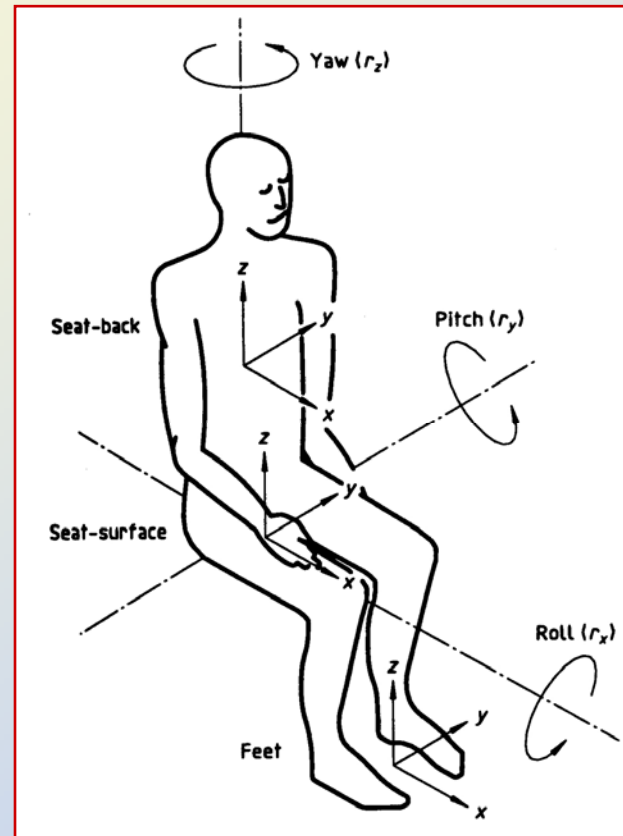
What is Whole-Body Vibration ?

- “Mechanical vibration that, when transmitted to the whole-body (when seated or standing), entails risks to worker health & safety”
- One of a number of factors linked to lower-back pain/injury, others being:-
 - Poor or constrained operator posture
 - Manual materials handling
 - Climbing to enter / exit machines
- A recognised problem upon agricultural vehicles
- Regular, long-term WBV exposure has been shown to contribute to lower-back pain, but the precise risks are not well-defined



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What is Whole-Body Vibration ?



- Vibration levels measured in 3 orthogonal axes (*at driver seat or feet*)



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What is Whole-Body Vibration ?



- Tractor WBV simulated on a test rig



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WBV Emissions vs. WBV Exposure

WBV Emission Level:-

- the magnitude of vibration emitted by a machine as a result of its normal operation
- a characteristic of a product or machine

WBV (Daily) Exposure Level :-

- the level of vibration received by a person (from a source or machine) over a period of time (a working day)
- a function of vibration magnitude and exposure duration
- the parameter used by the Physical Agents (Vibration) Directive (PA(V)D)



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Physical Agents (Vibration) Directive

Purpose:-

- To introduce measures to improve worker health & safety protection from risks associated with whole-body vibration (WBV) and hand-arm vibration (HAV)

Methodology:-

- Requires actions (on the part of the employer) to assess and reduce risks resulting from exposure to vibration
- Specifies daily vibration exposure **action** and **limit** values
- Requires employers to assess risks in the workplace – namely likely worker daily vibration exposure levels



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Requirements of the PA(V)D

Where a potential WBV exposure risk exists, employers must:-

- Reduce vibration exposure to a minimum (*an overall requirement*)
- Assess the particular risks
- Implement a programme of measures to reduce those risks
- Keep worker daily exposure below the Exposure Limit Value (ELV)
- Provide information & training to workers (*on risks of vibration exposure & means of their control*)
- Provide appropriate health surveillance when daily exposure levels reach / exceed the Exposure Action Value (EAV)



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PA(V)D Exposure Action & Limit Values

Exposure Action Value (EAV):-

- No strong evidence of health risk from exposure to WBV at or below the EAV
- If daily vibration exposure equals / exceeds the EAV:-
 - ➔ Must implement a programme of technical & organisational measures to minimise WBV exposure

Exposure Limit Value (ELV):-

- Must not be exceeded
- NOT a “safe” level of daily WBV exposure
- A high, undesirable exposure level to be avoided at all costs



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WBV on Agricultural Vehicles





‘On-Farm’ Estimated WBV Exposures

| <i>Vehicle / Activity</i> | <i>Seat overall average r.m.s. (Aeq) WBV level (m/s²)</i> | <i>Time to EAV (A(8)) (hrs:mins)</i> | <i>Time to ELV (A(8)) (hrs:mins)</i> | <i>Average Working Day (hrs)</i> | <i>Likelihood of Exceeding Value in a Normal Working Day:-</i> | |
|------------------------------------|----------------------------------------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|----------------------------------------------------------------|------------|
| | | | | | <i>EAV</i> | <i>ELV</i> |
| <i>Tractor – Spraying</i> | 0.36 – 0.78 (0.5 – 0.74) | 3:17 – 15:26 | 17:23 - >24 | 8.9 | Probably | No |
| <i>Tractor - Ploughing</i> | 0.49 – 0.93 (0.73 – 0.89) | 2:19 – 8:20 | 12:14 - >24 | 8.9 | Yes | Unlikely |
| <i>Tractor – Trailer Transport</i> | 0.47 – 1.12 (1.05 – 1.32) | 1:36 – 9:3 | 8:26 - >24 | 8.9 | Yes | Possibly |
| <i>Tractor – Cultivating</i> | 0.53 – 1.39 (1.2 – 1.49) | 1:2 – 7:7 | 5:29 - >24 | 8.9 | Yes | Possibly |

Tractor WBV data in parentheses originates from SRI ‘in-field’ measurements (performed in controlled field conditions) and encompasses all tractor suspension system designs investigated.

All other WBV data relates to ‘on-farm’ measurements and only includes suspended front axle & cab, and fully suspended

(front & rear axle) tractors



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WBV on Agricultural Vehicles





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Whole-Body Vibration in Agriculture

Findings and Action Needed

- WBV Exposure levels dependent upon:-
 - Operating surface / direction
 - Forward speed / driving technique
 - Attached equipment (implements)
 - Vehicle design / WBV reduction features (suspended seats, cabs & axles)
- The PA(V)D is NOT likely to *legally* restrict the operation of large, modern tractors during an 8-hour day, BUT:-
 - *The ELV will become a limitation if the working day lengthens significantly !!*
 - *Exposure to WBV at these higher levels is highly undesirable*
 - *Action will be required by an employer to reduce worker daily exposure immediately the EAV is exceeded*
- ‘Tractor-trailer transport’ and ‘cultivating’ operations generate WBV levels approaching / exceeding the Exposure Limit Value (ELV)
- New, standardised WBV testing methodologies for agricultural vehicles require development to permit standardised, ‘task-related’ vehicle WBV emission assessment by manufacturers
- Operator training may have an important role to play in reducing WBV exposure levels



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Ag. Tractor – Trailer Braking

- “Safe On-Road, Safe Off-Road” an efficient vehicle braking system is a major contributory factor
- Revised tractor & trailer braking standards being finalised by the EC
 - *Will be introduced via modification of EC Ag. Tractor Type Approval Directive (2003/37/EC)*
 - *Likely to become UK national legislation by ~ 2009*
- Practical requirements include:-
 - *Substantially greater trailer braking performance*
 - *Failsafe trailer brakes (upon accidental disconnection)*
 - *Trailer parking brake to be applied from tractor seat*
 - *Example trailer braking system performance assessment before sale (Type Approval)*



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Ag. Tractor – Trailer Braking



- UK max. permissible gross train weight = 24390 kg
 - Trailer max weight = 18290 kg
 - Tractor max weight therefore = 6190 kg (typical 100 – 150hp 4wd)
- Up to 75% of combination kinetic energy comes from the trailer
- Max UK road speed = 20 mph (32 km/h) – despite EC Type Approval to 40 km/h
- UK requires suspended axles and Commercial Vehicle braking performance above 20 mph



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Future Braking Requirements *- mean fully-developed deceleration*

| Speed | Vehicle | Current | Future |
|--------------------------------|----------------|----------------------------|---------------|
| <= 30 km/h | Tractor | 35% | 45% |
| | Trailer | 25% (UK) | 45% |
| > 30 km/h But <= 40 km/h | Tractor | 45% | 50% |
| | Trailer | 25% or commercial vehicle? | 50% |

- But existing spec. (25%) trailers may be used for up to 10 years following introduction of the new requirements



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Ag. Tractor – Trailer Braking



- Kinetic Energy (KE) = $\frac{1}{2} mv^2$
 - @ 32 km/h = 1
 - @ 40 km/h = 1.6
 - @ 50 km/h = 2.4
- Most UK tractors travel at 40 km/h increasing number capable of 50 km/h
- Ag. Spec (as opposed to ‘high-speed’) trailer brakes designed to operate at 32 km/h!
 - 12 tonne trailer:- Ag. Spec brakes = 300mm x 90mm
 - Commercial Spec brakes = 420mm x 180 mm
- Reflected in reduced performance & shorter service life Especially if used above 32 km/h (or 24 tons gross train weight!)



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Ag. Tractor – Trailer Braking

Action Required

To ensure acceptable levels of Workplace safety:-

- Raise user awareness of the need for:-
 - Adequate equipment specification at the time of purchase (*especially given forthcoming legislation*)
 - Regular maintenance of agricultural trailer braking systems
- Develop (alongside industry) an appropriate, simple, technically-validated methodology for in-service performance assessment of agricultural trailer & trailed equipment braking systems





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Ag. Vehicle Cab Filtration



- **Purpose:-** To make cab environment safer and more pleasant for operator
- **To remove**
 - **Particulates (dusts)**
 - **Spores**
 - **Pesticides**
- Positive air pressure within cab helps minimise contaminant ingress through holes in structure



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Ag. Vehicle Cab Filtration

Problems

- Pesticide → Active Ingredient (possibly toxic)
→ Solvent (smell !)
- Can cab filtration give same level of operator protection as Personal Protective Equipment (PPE) ?
- Difficult to assess performance of 'combined' filtration unit
- Cannot (as yet) verify effective system performance:-
 - *During manufacturer production runs*
 - *In-service*
 - *Following in-service repair*



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Ag. Vehicle Cab Filtration

Current Situation

- ASAE S525 standard no longer considered equivalent to PPE
- ISO/TC23/SC2 New Work Item, but little progress to date
- Need for focussed investigation to define system:-
 - *Design specifications*
 - *Performance criteria*
 - *Standardised test methods*