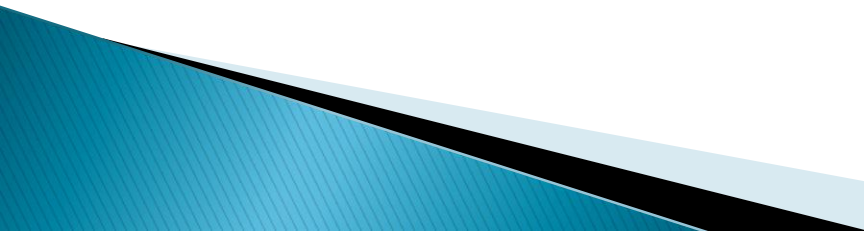


Implementation of a Vibration Risk Reduction programme at a heavy engineering manufacturing company

Julie Hills – SAIOH August 2011

Introduction

- ▶ On joining the company in January 2006 I was the first full time Occupational Hygienist ever employed.
 - ▶ Company produces wings for commercial aircraft – 4 specific variants (11 sub variants)
 - ▶ 9 departments with approximately 5000 operators required to use hand held air powered tools during their work shift – over 65000 hand tools listed on the tool register.
 - ▶ Good Health and Safety record – company holds ISO9001, 14001 and 18001 certification.
 - ▶ **EHS team:** 7 managers/ supervisory level + 19 Safety engineers, 7 Occupational health nurses & 1 consultant OHP, 1 Clinical psychologist, 1 part time Physiotherapist and 1 human factors engineer employed.
- 

The problem

- ▶ My initial Health risk assessments consistently identified vibration exposure as the highest risk factor for most operational departments:

| Task Code | | LCM04 | Task | Machining cells 1 & 2 – Assemblers trimming and fettling of machined stringers. | | | | Job Types/Exposure Groups | | | | Assemblers | | |
|-----------|------------------------------|---|------|---|-----------------------|---|--|---|---|----------------|---------|---------------------------------------|---------------------|--|
| Stress | Hazard | Exposure route & form | | Frequency dy/wk/mth/yr | Duration (mins/hours) | Existing Controls | Controls effective? | Estimated or measured Exposure Level ¹ | Control Chart Rating ² (H x E) | Meets WEL OEL? | ALARP ? | Routine Exposure monitoring required? | Health Surveillance | Action Required Y/N |
| Phys. | Noise | High level of noise emitted at the trimming and routing task. This is an intermittent job which varies depending on the number of stringers machined and requiring trimming each shift. | | Max 5 x per shift | 100 mins per shift | Ear plugs are issued but not all assemblers wear these. | Ear plugs may not offer sufficient attenuation for levels measured | Leq = 86.5 dB(A) Max = 125.9 dB(A) | 3x5 Sub | No | Yes | No | Yes | Yes RAP 2 (page 25) |
| Physical | HAVS | A router is used to trim the machined stringers. This is performed by 1 assembler per shift at cell 1 and 1 operators per shift at cell 2. | | 5 x day | Trigger time 100 mins | Anti vibration gloves used but offer minimum protection. Tool care and maintenance does not include modification for vibration reduction. | May not adequately reduce vibration effects. | | 3x5 Sub | No | No | Yes | Yes | Yes RAP 4 (page 26) |
| Ergonomic | Use of crane, lift and reach | Flexing of back required for reach and operation. Work height is to low for the type of work performed. | | daily | 12 hours | Operators are trained in correct lifting and handling techniques and are licensed to use the crane. | For handling and use of the crane. | Tol | 3x2 Tol | No | No | No | Yes | Yes RAP 5 (page 26) As per HF 0124 |

The problem

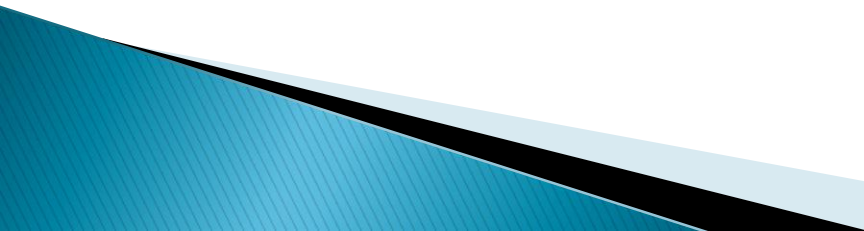
- ▶ Vibration legislation and standards were only promulgated in July 2005 in the UK
 - Exposure limits set:
 - Daily exposure limit (8 hour) = 5m/s^2 or 400 points
 - Daily exposure action level (8 hour) = 2.5m/s^2 or 100 points
- ▶ Generally poor understanding of vibration (Management, EHS team and workers) and low number of people trained in measurement and diagnosis prior to the regulations
- ▶ Vibration tended to be ignored due to lack of knowledge, training and confidence by most EHS practitioners

1st steps – Out on a limb!

- ▶ Prior to my employment a junior engineer had been tasked with a project to look at vibration risk;
- ▶ Poor management support and interest stalled the project and little progress was made.
- ▶ The good news was that 6 vibration meters were purchased and available – BUT: nobody was trained to use these.
- ▶ We managed to work out the instruments and embarked on a measurement programme for the highest risks identified in the main HRA.



Lack of understanding

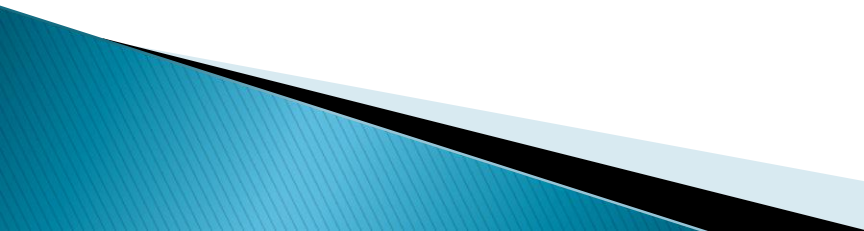
- ▶ Whilst tool data became available the size of the workplace, number of tools and work packages made it difficult to implement a structured project with our limited hands on EHS team
 - ▶ Several cases of HAVS were diagnosed by the Occupational Health Team but their lack of specialised training was also identified.
 - ▶ The Health and Safety Laboratory (HSE) were employed to train the OH nurses and selected members of the EHS team in the HAV FOM Accredited course.
- 

Year 1 – successes and outcomes

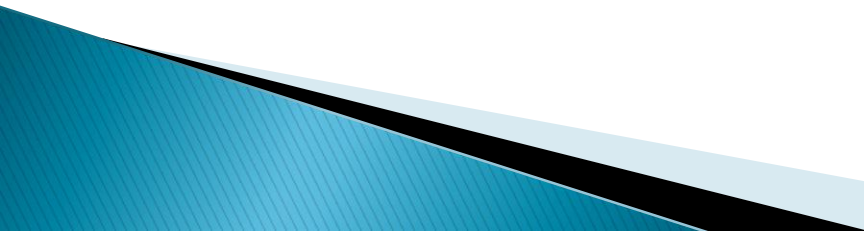
- ▶ 5 trained vibration assessors allowed rapid growth of measured data on common tools and processes and a tool measurement data base was created.
- ▶ A Process Evaluation Team (PET) was instigated where specialists from all areas (including EHS) were able to compare proposed **new** tools and select the best and safest option
- ▶ HAVS diagnosis and health checks improved dramatically and confidence grew, BUT;
 - 19 reportable HAVS cases
 - No real ability to change inherent situations at shop floor level
 - Difficulties in instigating a structured approach.



So what changed?

- ▶ HSE factory inspectorate set up a special visit to discuss the vibration situation – the 19 reportable cases had triggered concern!
 - ▶ Whilst they appreciated the work done and the size of the problem the reality was that a management supported & structured process was needed.
 - ▶ They agreed on a 3 month grace period after which they would re visit and if major improvements were not implemented legal action could be instigated .
- 

The Programme – Team building

- ▶ The Top level Manager of Engineering Services was appointed team leader and was made responsible for the project – suddenly a top down rather than bottom up drive!
 - ▶ EHS (myself, HFE & vibration assessors) advised the engineers on the scope of the problem and suggested a preferred approach – work package data requirement key issue.
 - ▶ We also developed a vibration calculation tool for data assessment
 - ▶ Production engineering agreed to allow staff to work on the project for 12 weeks (approximately 18 designated people for data identification and input)
 - ▶ An engineering graduate was tasked with project management for the duration of the programme.
- 

The Model

1. All of the production processes follow set work packages – thus every worker receives a set of instructions for his work shift as he arrives a his work station
2. These work packages describe the type and volume of work to be performed as well as tool type and size instructions
3. An example would be:

HAVS (Hand Arm Vibration Syndrome) Assessment

Can operators record the tools used during each work package that contain any vibration
(See examples list on back of sheet)

This is a requirement for a Hand Arm Vibration Assessment for Health and Safety purposes

Work Station Number 01 245. Operator Name TOM RYANES

Work Package Number 25. Operator Signature [Signature]

Operation Number 11 Date 08 10 08

| Tools and hole size | No Holes | Tools and hole size | No Holes | Tools and hole size | No Holes |
|---------------------|----------|---------------------|----------|---------------------|----------|
| 30° DRILL 3/16 NOM | 55 | | | | |
| SPACEMATIC 23/64 | 20 | | | | |
| CORCO 3/8 INS | 20 | | | | |
| CORCO 3/8 REAMER | 20 | | | | |
| 30° DRILL 1/8 DRILL | 55 | | | | |
| CORCO 3/16 NOM | 55 | | | | |
| DE BURR TOOL RUC | 110 | | | | |
| 5/16 SLICE RUMBL | 30 | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |
| | | | | | |

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The Model

4. A vibration assessment calculator was developed to allow information relating to the work package breakdown and the measured tool vibration magnitude information to be input
5. The tool then calculates the total shift/ work package exposure level for each operator.
6. Production engineers gathered the information for all work packages and input the information into the vibration calculator tool – **4925 in total**

The vibration calculator tool

1. Drop down tool list

2. Automatic insert of vibration magnitude

3. Number of holes or rivets

2. Time per hole automatically generated

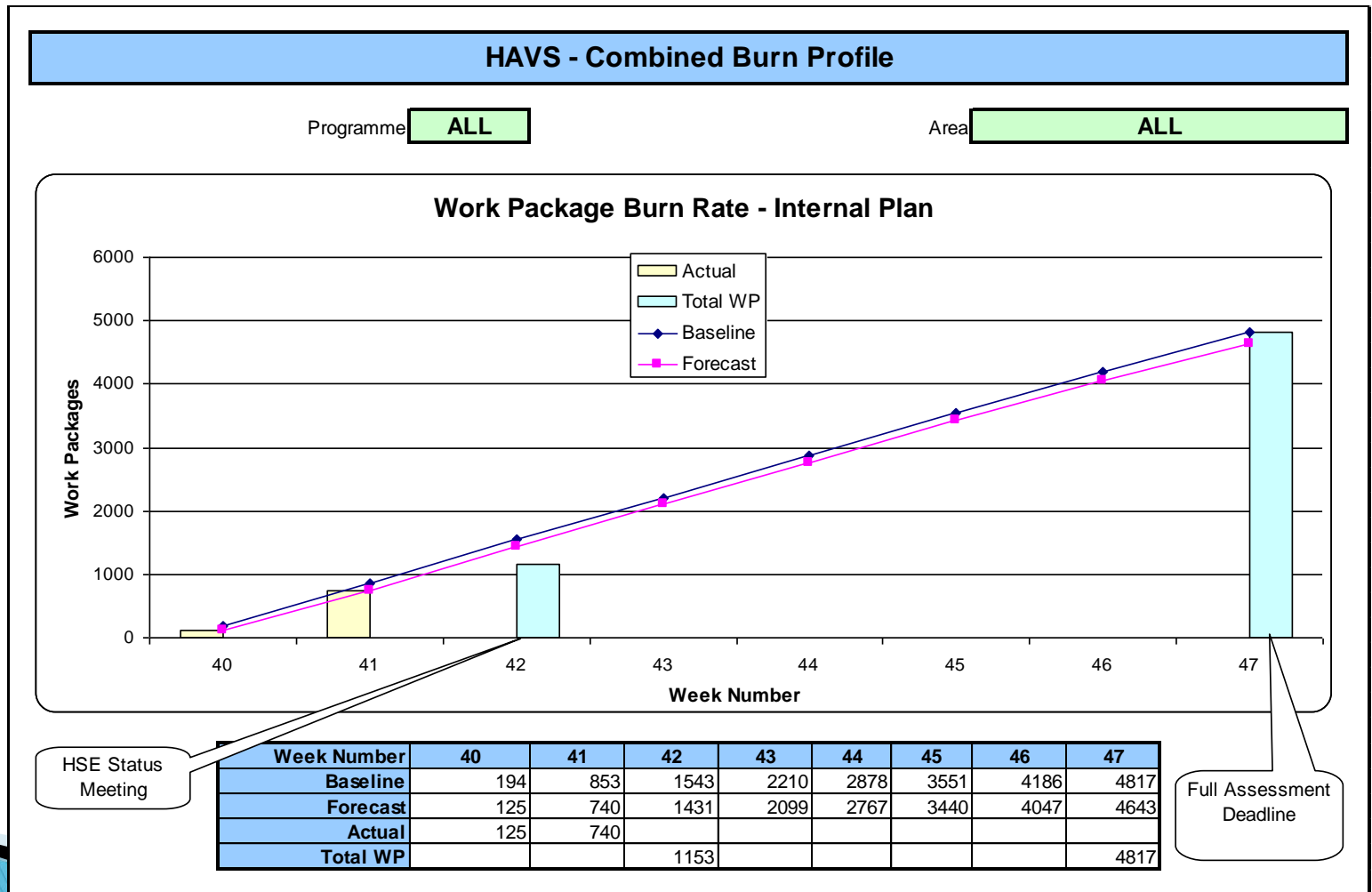
4. Identify operator involvement

| Work Package Reference | Tool Type | Identified Vibration Level | Quantity of Holes / Bolts / Units | Time in SECONDS | A | B | C | D | E | F | G | H | J | K | COMMENTS / ASSUMPTIONS |
|---------------------------------|---------------------------|----------------------------|-----------------------------------|-----------------------|-----|-----|---|---|---|---|---|---|---|---|------------------------|
| | <i>Selection Required</i> | <i>Automatic</i> | <i>Estimate</i> | <i>Semi-automatic</i> | | | | | | | | | | | |
| Keel 1.22/2.23 | Rivet Gun | 4.34 | 268 | 3 | y | y | | | | | | | | | 5/32 Snap 3X Rivet Gun |
| Keel 1.22/2.23 | Rivet Gun | 4.34 | 16 | 3 | y | y | | | | | | | | | Fit Snap 3X Rivet Gun |
| Keel 1.22/2.23 | Dolly | 6.58 | 284 | 3 | y | y | | | | | | | | | |
| Keel 1.22/2.23 | Nut Runner | 3.74 | 18 | 3 | y | y | | | | | | | | | 3/16 Bolts |
| Keel 1.22/2.23 | Nut Runner | 3.74 | 12 | 3 | y | y | | | | | | | | | 1/4 Bolts |
| Keel 1.22/2.23 | Nut Runner | 3.74 | 12 | 3 | y | y | | | | | | | | | 5/16 Bolts |
| Keel 1.23/2.24 | Rivet Gun | 4.34 | 934 | 3 | y | y | | | | | | | | | 5/32 Snap 3X Rivet Gun |
| Keel 1.23/2.24 | Dolly | 6.58 | 934 | 3 | y | y | | | | | | | | | |
| Keel 1.23/2.24 | | 0.00 | 24 | 0 | y | y | | | | | | | | | 5/32 Avdels |
| Keel 1.23/2.24 | ANGLE GRINDER | 12.00 | 24 | 10 | y | y | | | | | | | | | Grind Avdels |
| Keel 1.24/2.25 | Rivet Gun | 4.34 | 264 | 3 | y | y | | | | | | | | | 5/32 Snap 3X Rivet Gun |
| Keel 1.24/2.25 | Dolly | 6.58 | 26 | 3 | y | y | | | | | | | | | |
| Keel 1.25/2.26 | Straight Drill | 2.87 | 250 | 5 | y | y | | | | | | | | | 5/32 Drill Bit |
| Keel 1.25/2.26 | Straight Drill | 2.87 | 250 | 5 | y | y | | | | | | | | | 5/32 Cage CSK |
| Keel 1.25/2.26 | Rivet Gun | 4.34 | 250 | 3 | y | y | | | | | | | | | Fit Snap 3X Rivet Gun |
| Keel 1.25/2.26 | Rivet Gun | 4.34 | 311 | 3 | y | y | | | | | | | | | 5/32 Snap 3X Rivet Gun |
| | | 0.00 | | 0 | | | | | | | | | | | |
| RISK RATING PER EMPLOYEE | | | | | 113 | 113 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

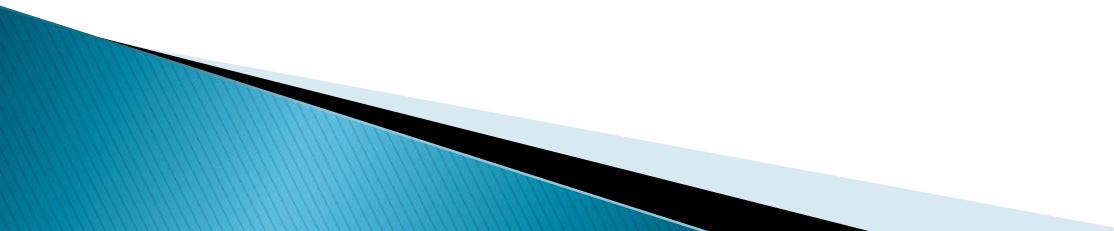
Interactive model

Trackers – timelines




- ▶ Regular feedback meetings and progress reports:



Results –

- ▶ **4925** work packages were identified and assessed in a nine week period
 - ▶ A detailed and extensive risk assessment by any standard
 - ▶ All work packages / operators exceeding the exposure limits were identified and immediate customer protection actions implemented to reduce exposures and to ensure compliance:
- 

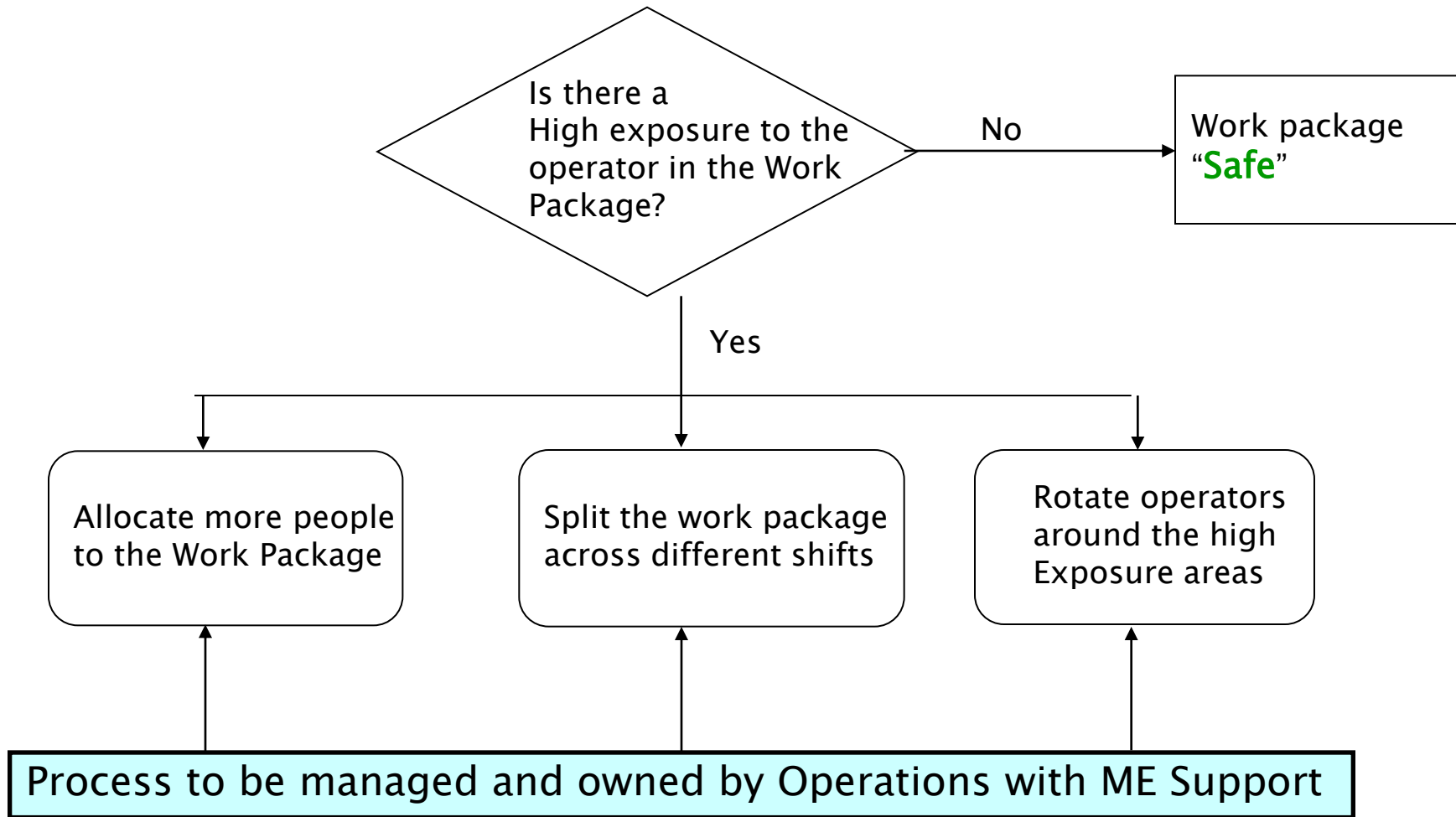
▶ The WP's results are broken down in the following manner:-

| | | | |
|--|---|----------|---|
| ▪ Above 400 | = | 0 WP's |  |
| ▪ Below 400 and above 300 | = | 1 WP's |  32 |
| ▪ Below 300 and above 200 | = | 8 WP's | |
| ▪ Below 200 and above 100 | = | 23 WP's | |
| ▪ Below 100 and above 50 & the rest | = | 128 WP's |  4893 |

Weekly meetings – corrective action feedback

| <p style="text-align: center;">Top 10 Work Packages at Risk</p> | Maximum | Area | Stage | File Name | Tab | Link | |
|--|---------|---------------|--------|----------------------------------|---------------------------------------|------|--------------------|
| | 1 | 429.89 | LCMA | MFT | Vibration WP Data - LCMA MFT.xls | LCM2 | GO |
| | 2 | 327.10 | A380 | Stage 01 - Bottom Skin | Vibration WP Data - WS 20.xls | 2 | GO |
| | 3 | 318.58 | A380 | Stage 00 - Vertical Workstations | Vibration WP Data - BS 2.xls | 1 | GO |
| | 4 | 307.66 | Hawker | Hawker FUSE - Station 4 | Vibration WP Data - Centre floors.xls | 1 | GO |
| | 5 | 289.75 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Deburr.xls | 4 | GO |
| | 6 | 289.75 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Deburr.xls | 4 | GO |
| | 7 | 280.95 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Rivet.xls | 5 | GO |
| | 8 | 280.95 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Rivet.xls | 5 | GO |
| | 9 | 271.26 | LCMA | MFT | Vibration WP Data - LCMA MFT.xls | LCM1 | GO |
| | 10 | 263.11 | Hawker | Buckley Station 1 | Vibration WP Data - Keel Drill.xls | 2 | GO |

Immediate Customer Protection



Immediate Customer Protection

Where a Work package is identified as being above 100 points and has required an Operator Protection procedure, the following action will take place: –

- Detailed assessment of Work Package.
- Understanding of manufacturing issues.
- Implement immediate short term tooling changes where reasonably practical.
- Implement long term changes where reasonably practical.
 - by either,
 - Implementing a Design change
 - Implementing a tooling change
 - Implementing a technology change

HAVS CPA Summary

Programme

ALL

WP above 100 Point Limit

44

WP able to be synthetically levelled

16

| | Synthetic level | Area | Stage | File Name | Tab | Link |
|-----------|------------------------|-------------|----------------------------------|---|-----------------------|--------------------|
| 1 | 68.51 | A380 | Stage 00 - Vertical Workstations | Vibration WP Data - BS 2.xls | 1 | GO |
| 2 | 64.69 | Hawker | Hawker WING | Vibration WP Data - Floor Tops 1.xls | 1 | GO |
| 3 | 64.69 | Hawker | Hawker WING | Vibration WP Data - Floor Tops 2.xls | 1 | GO |
| 4 | 71.52 | Hawker | Hawker WING | Vibration WP Data - Floor Btms 1.xls | 1 | GO |
| 5 | 71.46 | Hawker | Hawker WING | Vibration WP Data - Floor Btms 2.xls | 1 | GO |
| 6 | 48.57 | A380 | Stage 00 - Vertical Workstations | Vibration WP Data - BS 3.xls | 1 | GO |
| 7 | 84.94 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Rivet.xls | 3 | GO |
| 8 | 62.81 | Hawker | Hawker WING | Vibration WP Data - Centre Drill 1.xls | TOP SKIN CENTRE BADGE | GO |
| 9 | 53.96 | A340 | Site 5 | Vibration WP Data - LONG RANGE SITE 5.xls | 90 | GO |
| 10 | 82.01 | Hawker | Hawker WING | Vibration WP Data - C-Badge.xls | 1 | GO |
| 11 | 99.49 | Hawker | Hawker FUSE - Station 4 | Vibration WP Data - Centre floors.xls | 2 | GO |
| 12 | 86.99 | Hawker | Hawker FUSE - Station 2 | Vibration WP Data - Cabin Deburr.xls | 5 | GO |
| 13 | 29.00 | Hawker | Hawker WING | Vibration WP Data - REAR SPAR PORT 1.xls | REAR SPAR PORT 1 | GO |
| 14 | 29.00 | Hawker | Hawker WING | Vibration WP Data - REAR SPAR STBD 1.xls | REAR SPAR STBD 1 | GO |
| 15 | 73.13 | A380 | Stage 00 - Vertical Workstations | Vibration WP Data - TS 3.xls | 1 | GO |
| 16 | 39.31 | A380 | Stage 00 - Vertical Workstations | Vibration WP Data - TS 1.xls | 1 | GO |

On-going assessment

The Assessment of HAVS has also become a procedural requirement on the formulation and modification of Work Packages across site.

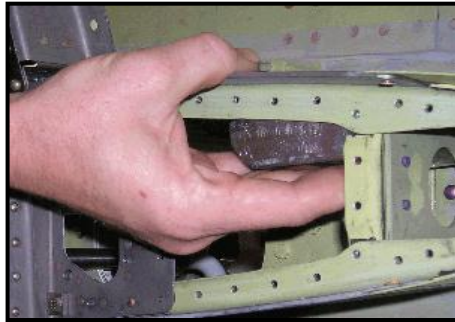
Procedure A – To require the WP compiler to have completed a HAVS assessment.

Procedure B – The process for doing the HAVS assessment exposure calculator

Long Term Customer Protection

An example of tool and process change

Old Process



Exposure: – **VERY High**

New Process



Exposure: – **Negligible**

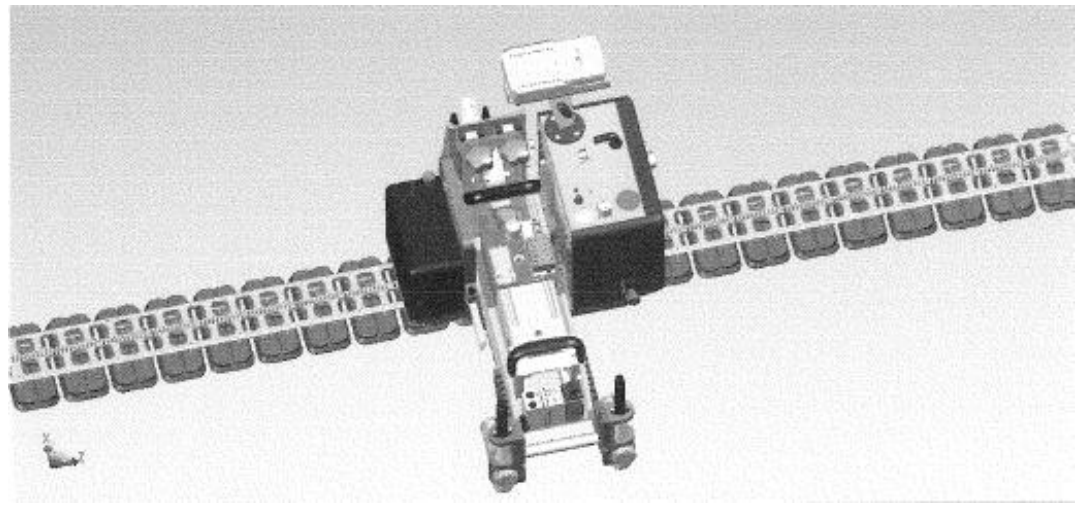
Process improvements



PNEUMATIC
DAMPENER
15% more
effective than
sprung



Long Term Customer Protection

- ▶ The aim is to reduce worker exposure by elimination of the vibration problem – automation, safer tooling etc.
- ▶ Some examples of vibration reduction measures identified and undergoing implementation included:
 - For high volume holes, an automated system is proposed. This will entirely remove the operator from the machine function.
 - Prototypes are in manufacture with introduction into production planned to start late 2009



- ▶ For large diameter holes and countersinks the operator input is now reduced to locating the machine on to a fixture.
- ▶ The remainder of the process is automated.
- ▶ 26 machines were purchased within the 12 week period!

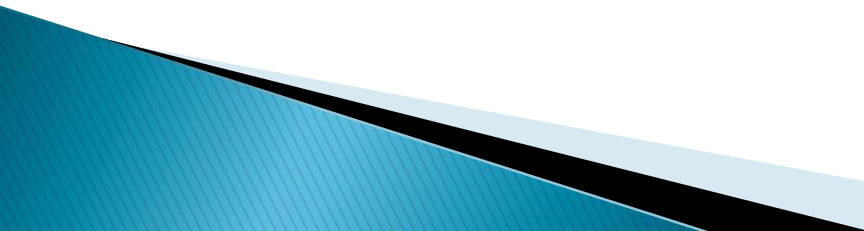
TARGET CONDITION – TAPERLOCKING PROCESS

| Reduction of Vibration | |
|---|---|
| Level of intervention: | |
| Best Practice - Elimination of exposure by process and tool modification. | |
| <p>Manual taperlocking process</p>  <p>■ Typical exposure levels:</p> | <p>Process and tool modification</p>  <p>■ No exposure: Tool locked onto jig and automatic drilling occurs. Exposure level 0</p> |
| Reduction of Risk From: | Reduction of Risk To: |
| Substantial | Trivial |

- ▶ Pistol drill has been developed so that the location is now via vacuum pads.
- ▶ The axial feed is semi-automatic.
- ▶ The machine combines 3 manual drilling operations.
- ▶ Phased implementation into main production areas



Training

- ▶ A weakness identified in the initial assessment and review was lack of training at management and worker level.
 - ▶ A DVD training course was developed to enable training to occur at all business areas over all shifts.
 - ▶ A set role out programme was implemented to ensure all workers were trained within a set time frame.
 - ▶ 1 page vibration data sheets were also developed for posting at specific work processes for worker information.
- 

Vibration

Vibration

- Introduction
- Overview
- Vibration at Airbus
- Risks associated with Vibration
- Hand Arm Vibration Syndrome
- How Airbus Protects you
- Protecting yourself from Vibration
- Quality
- Reference Information



- Play Course
- Pause Course
- Replay Course
- Exit Course

Most tooling and machinery that is operated at Airbus will generate some level of vibration.

In most cases the vibration is at a level that will not present any health risks, however, some tooling can present a significant hazard if not used within the correct health and safety guidelines.

In a later section we will look at how Airbus protects you and how you can act to protect yourself, from the harmful effects of vibration but first let's look at the operations and tools that carry various levels of risk.



Play Course

Pause Course

Replay Course

Exit Course

Vibration

Hand Arm Vibration Syndrome HAVS



- Play Course
- Pause Course
- Replay Course
- Exit Course

If left unchecked, long term exposure to vibration can cause serious health conditions that are both debilitating and irreversible. It is therefore essential that you are aware of and follow all rules for safely controlling vibration risk.

Injury sustained from bad practice or incorrect management of vibrating tooling, can severely limit your ability to operate effectively in the work place.

Ultimately, this can lead to a loss of shifts, overtime and in the worst case scenario your ability to work entirely.

At fairly low levels the vibration we experience in the workplace usually causes no more than mild annoyance and discomfort. However, if not properly controlled, vibration has the potential to cause you serious harm.

With sufficient exposure, vibration may lead to a number of debilitating conditions. The most serious of these, is known as Hand Arm Vibration Syndrome or HAVS. This permanent and irreversible condition will be covered in detail later in the course.

Project summary and conclusions

- ▶ The majority of previous HAVS work was reactive and not proactive; there was a unknown level of risk across the business due to insufficient HAVS data.
 - 4,925 Work Packages (WP's), or 100% of Production WP's have been assessed across all business areas, the findings of these results are outlined below: –
 - 33 WP's or 0.67% of WP's assessed have been found to be above the 100 Point 2010 target, of these 33 WP's the following action is on-going: –
 - 0 of these WP's are above the legislative 400 point limit, thus currently compliant with HSE legislation.
 - 29 of the 33WP's were currently within a Customer Protection Action plan.
 - The remaining 4 WP's were being reviewed.
 - 12 of the 29 WP's in a CPA have a long term Engineering change currently planned and in process.
 - The remaining 17 WP's are in the process of an investigation to find the most appropriate Engineering modification to the WP.

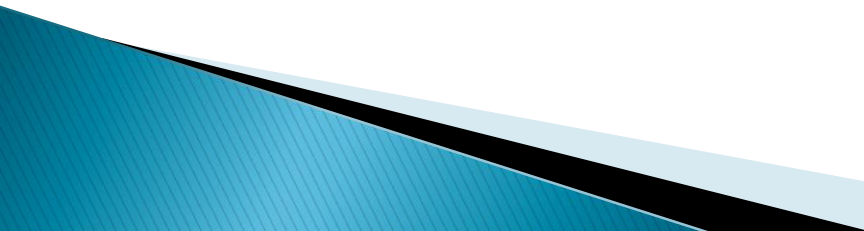
Project summary and conclusions

- ▶ Without this data there was a high risk of there being WP's above the current legislation limit of 400 points, and that these WP's were still on-going Production WP's.
 - One WP was found to be above the legislative limit of 400 points, after a realignment to the Engineering standard and control measures being implemented this WP was re-assessed as being at 136 Points.
 - Further to this, significant Capital Expenditure is being targeted towards this area to further reduce the exposure within these WP's while increasing Product Quality.
- ▶ There were limited plans for the continuous improvement of HAVS risk.
 - A full plan of continuous improvement was demonstrated, there is a demonstrated process of control of WP's, and the associated Customer Protection Action strategy will enable an incremental step reduction of exposure levels within each business area.
 - Procedures to cover HAVS compliance now integrated into current systems.
 - All new or modified WP's were 2010 HAVS compliant by Wk 1 '09.

Summary & conclusions

- ▶ There was insufficient awareness of HAVS in Production due to limited training.
 - A full training programme has been initiated across site
 - 474 Operators had successfully completed the interactive multimedia training before the follow up HSE visit
 - 100% of Operations personnel were targeted for the training module
 - A selection of Operations and Engineering Managers are also within the target population.
 - The completion date of this plan was Wk 14 '09

Acknowledgements

- ▶ The project was a success due to a dedicated team effort – special thanks to:
 - ▶ Clive Devey, Martin Bolton and the MSE team
 - ▶ Sandra Graham – Human Factors Engineer
 - ▶ Jason Tebble and Mark Richards – Occupational Hygiene Support and vibration assessors
 - ▶ Management Team – Airbus Broughton site for their dedicated support of this project
 - ▶ EHS team and safety officers for creating the drive
 - ▶ HSE Inspectorate – Wrexham office for support and guidance.
- 

Thank you

- ▶ Any Questions ?