Conveyor belt workstation design

Contents

Introduction

This guidance is aimed at conveyor belt workstation designers and suppliers and at the employers of workers using them.

It explains how inadequately designed conveyor workstations can increase the risks of people working at them developing musculoskeletal disorders (MSDs), and the minimum action the law requires.

Background

Many industries use conveyor systems to transport raw materials and products through the stages of a process and/or to and from storage. It is often efficient to create workstations along the way.

A worker might pick parts or materials from the moving belt, or the belt might deliver a product to a buffer area next to the workstation and then stop until the person activates it again. Once a worker has completed their stage of the process, they might put the product back on the conveyor. Even employees who don't normally access a conveyor may help to clear blockages, do maintenance or fix breakdowns.

Conveyor systems can improve efficiency and help to reduce repetitive lifting and carrying, which are causes of MSDs. But unless workstations associated with conveyors are properly designed, with the tasks and the users in mind, work may be done less efficiently and workers may be at increased risk of developing MSDs.

Designing workstations so they can be used safely and comfortably (including providing seats where the work can be done sitting) and reducing the risks of MSDs are requirements of:

- the Workplace (Health, Safety and Welfare) Regulations 1992;[1]
- the Manual Handling Operations Regulations 1992.[2]

Conveyor workstations and MSD risks

Key risk factors for developing MSDs include:

- adopting awkward and uncomfortable postures (including stretching, twisting, leaning, and stooping);
- exerting large forces;
- repetitive lifting and carrying.

The risks get worse if these happen for long periods.

If the conveyor workstation design is wrong, all these MSD risk factors can be found, especially people having to adopt awkward postures to do the job.

Assessing workstations and MSD risks

Conveyor workstations should be assessed, designed, installed and maintained to fit the workers and minimise the MSD risk factors.

Key workstation risk factors

In assessing the MSD risks and designing the workstation to minimise them, take account of important circumstances including:

- the height and build of people liable to work at the conveyor(s);
- the type of operations to be performed at the workstation(s);
- what work objects are involved (including size, shape, weight, variety and amount);
- whether those operations can be done sitting.

Figure 1 Important workstation aspects to include in the assessment

Aspect covered	Potential problems
Workstation dimensions	■ Belt too high or low (making the person stoop and/or stretch) ■ Belt too wide (making the person reach too far) ■ Insufficient foot clearance under conveyor (making the person lean forwards to work) ■ Access to belt surface obstructed (eg by sills or skirts on conveyor, making the person twist or stretch awkwardly) ■ Work area not clearly visible (eg view obstructed or insufficient light, making the person lean and/or twist awkwardly to see)
How the work is organised	■ Belt moves too fast (or too slowly) for the task concerned, affecting operator comfort ■ Operator unable to stop the belt when they need a break and working when fatigued ■ Workflow disrupted by a problem somewhere else on the conveyor, unexpectedly changing the intended work pattern ■ Operators get in each others' way – all working at the same belt ■ Something on the belt goes past the operator by mistake, which they try grabbing ■ Insufficient job rotation, so the operator is loaded on one side of the body more than the other
Psychosocial factors	■ Operators don't know how to adjust seating and footrests ■ Insufficient rest and recovery time, causing fatigue ■ Pace of work too fast for an individual, who then struggles ■ Operators working perpendicular to the belt may feel 'carsick' with conveyor speeds greater than 10 metres per minute

Standing or sitting

Doing the work seated or standing affects the nature of the tasks that can be performed comfortably and the ideal working heights for individuals. Suitable seating is required whenever work can or should be done sitting,[1] so the need for seating should be identified as part of the workstation assessment.

Working while sitting helps to prevent the fatigue that can contribute to musculoskeletal injury. However, a person can exert much less strength when seated, so seated workstations should be restricted to low-force tasks, such as light assembly or picking small to medium-sized items.

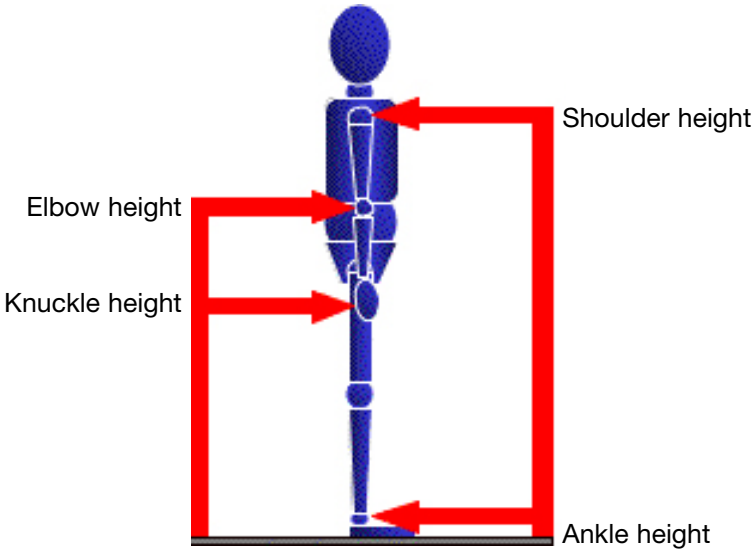
Heavier tasks performed on larger objects are easier at lower heights than are ideal for light, higher-precision tasks performed on smaller objects.

Worker stature

The best workstation dimensions for minimising MSD risks depend on the nature of the task and the height and build of the individual(s) concerned.

The actual workstation dimensions that are ideal to fit tall and short people will differ considerably. So ergonomists usually use reference points on the body instead of absolute measurements when assessing correct fit.

Figure 2 Common reference points



Assessing workstation dimensions

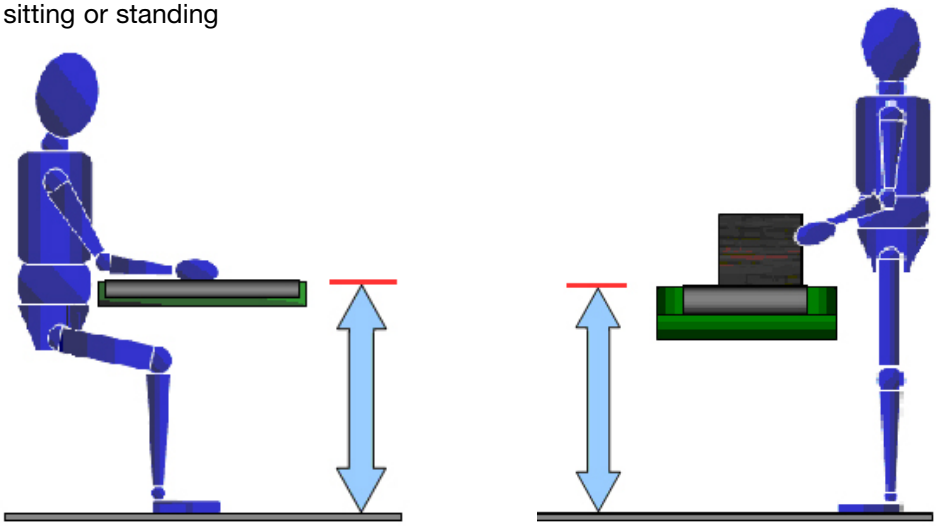
Dimensions are probably the easiest conveyor workstation aspects to assess and are likely to have the greatest impact on increasing MSD risks when wrong.

When assessing conveyor workstations, the three most important dimensions influencing comfort, efficiency and the risk of MSDs are:

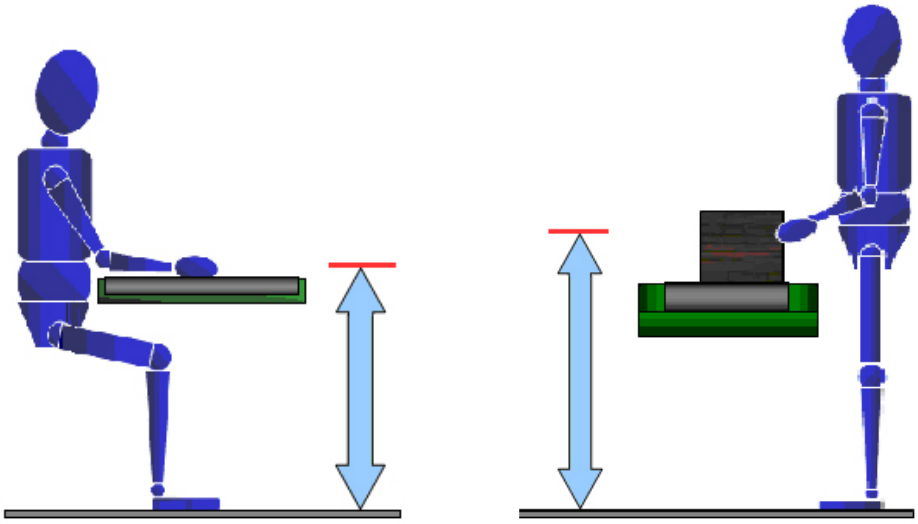
- **work surface height** – the height of the belt surface from where the person is sitting or standing;
- **working height** – the height of the person's hands when working on the item;
- **reach distance** – how far the person has to reach (forwards or sideways) from where they are sitting or standing to the object on the conveyor.

Figure 3 The most important dimensions influencing comfort, efficiency and the risk of MSDs

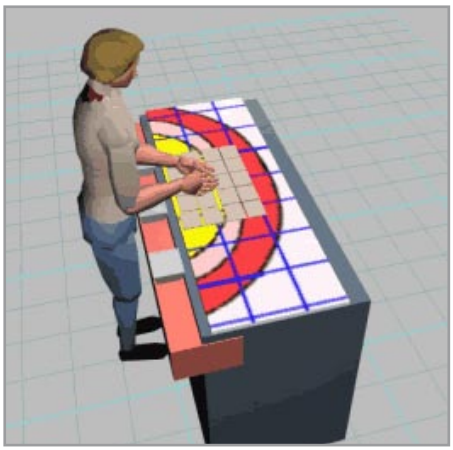
Work surface height – the height of the belt surface from where the person is sitting or standing

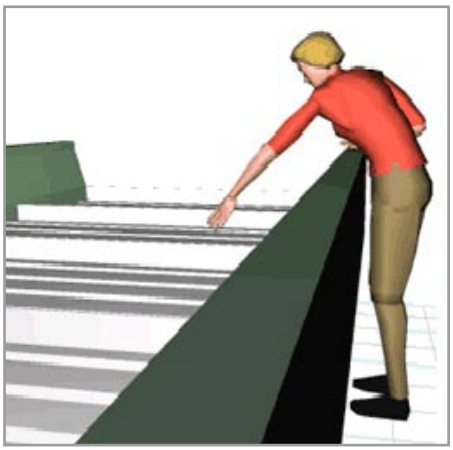


Working height – the height of the person's hands when working on the item



Reach distance – how far the person has to reach (forwards or sideways) from where they are sitting or standing to the object on the conveyor





Images courtesy of JACK software

Getting the right working height(s) and reach distance(s) to fit the people using each workstation is fundamentally important in reducing MSD risks.

Working height

Correct working height for an individual depends on:

- their stature;
- what the worker needs to be able to see and do;
- the size and weight of the work item;
- the height of the belt surface from where they are sitting or standing (work surface height).

Heavier tasks performed on larger objects are easier at lower heights than are ideal for light, higher-precision tasks performed on smaller objects.

For most standing tasks the preferred working height is below elbow height. Because seated tasks are usually lighter, the working height can be nearer elbow height. Only delicate, manipulative tasks (such as writing) need to be done above elbow height.

Also, work object size and weight often change considerably at different stages of a process:

Suitable steps should be taken to achieve and maintain the preferred working heights for all the people who will work on a conveyor belt, taking account of:

- the range of statures of the people who may work there;
- the nature of the task(s);
- size and weight of the work objects involved;
- whether seating is required.

One fixed work surface (belt) height at a workstation obviously cannot provide a working height suitable to give everyone using it effective and comfortable working postures.

Suitable methods for achieving each worker's preferred working height include:

- fixing the belt height above the floor to suit the tallest worker and, so shorter workers can achieve a comfortable working posture, supplying:
  - an operator-adjustable, variable-height working platform (or chair where the job should be done seated), or
  - a range of suitable interchangeable working platforms to stand on;
- providing operator-adjustable, variable belt height to suit the full range of worker statures (although this can present technical and other difficulties);
- providing inclined conveyors to allow workers to find spots at just the right height for them (although this can introduce problems as only a small length of the conveyor is at the right working height – the rest of the conveyor is either too high or too low).

For standing tasks where the arms need to move freely, such as belt picking, or light assembly tasks, the working height assessment should take account of the following:

- A fixed work surface height of 1075 mm from floor level[3] is generally suitable as it fits taller members of the adult working population.
- This height should be reduced if the worker has to hold their hands above elbow height while working on objects on the conveyor belt.
- Shorter conveyor operatives may require platforms up to 265 mm high to stand on to achieve a comfortable working posture.[3]
- Platforms should:
  - be stable and have enough room for operators to move their feet, not create tripping or slipping hazards;
  - have edges clearly marked;
  - have surfaces contrasting in colour with the floor they are on.

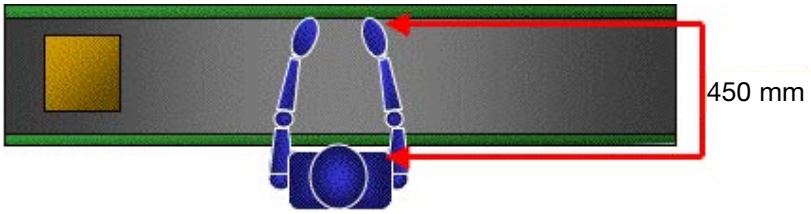
For seated tasks, which are usually lighter, the working height assessment should take the following factors into account:

- The working height can be nearer elbow height.
- A working surface height of 750 mm would allow enough space for a 30 mm thick work surface and leave 720 mm from floor level, which is enough for the legs of a large operator.[4]
- Shorter workers may need their seats raised to achieve comfortable postures.
- Shorter workers may also need to be provided with a footrest that can adjust up to 165 mm high to provide adequate foot support.[4]

Reach distance

Reaching long distances, having to keep repeating the long reach, and having to hold a forward reach posture increase the risks of MSDs. 'Zones of repetitive reaching' on the conveyor should only go up to 450 mm from the front of the operator's body.[5]

Figure 4 Reach distance



The most important factors affecting reach distance are:

- how close the worker can get to the side of the work area, mainly affected by foot and leg clearance (this is especially important where workers are seated);
- the conveyor width and where work objects are located on it;
- sills and any other obstructions at the side of the conveyor.

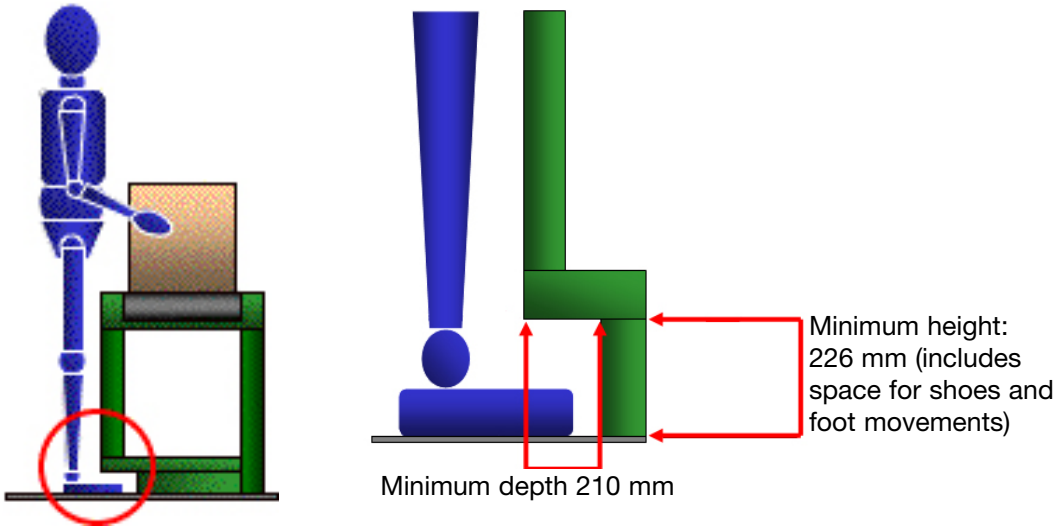
Foot and leg clearance

Operators can get closer to the objects on the belt if there is space at the base of the conveyor for their feet. This helps to prevent strain on back and neck muscles from having to lean forward while working.

At standing workstations the following foot space should be provided:[3]

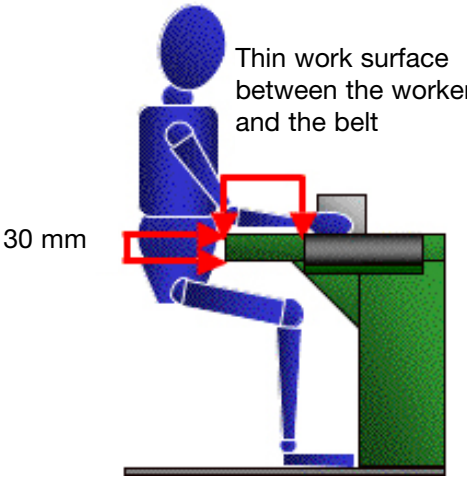
- 210 mm depth;
- 226 mm above the height of any platform.

Figure 5 Foot space for standing workstations



At seated workstations, adequate space is needed for operators to move their legs and feet around underneath the conveyor to prevent them adopting awkward forward leaning postures that put strain on their back and upper body muscles.

Figure 6 Work surface for seated workstations

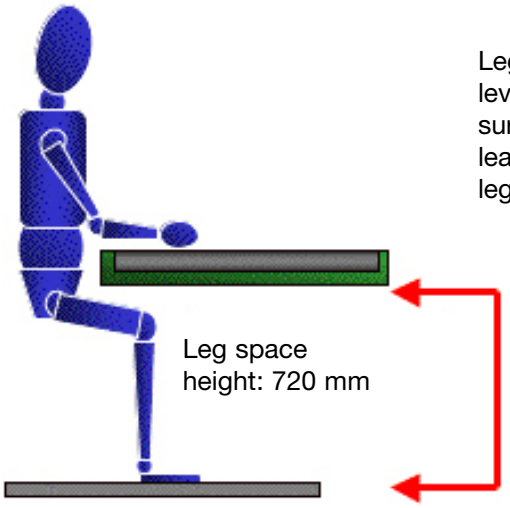


Firstly, the working surface should be as thin as possible:

- for a fixed surface, a thickness of 30 mm will often provide an acceptable compromise between space and the need for the surface to be strong enough;[4]
- for a conveyor with moving parts, slightly more would be acceptable;
- if a thicker conveyor is necessary, then a thinner fixed work surface may be put between the worker and the belt (and would create some working space for activities such as assembly tasks);
- any such fixed surface should be narrow enough for the worker to reach the belt easily.

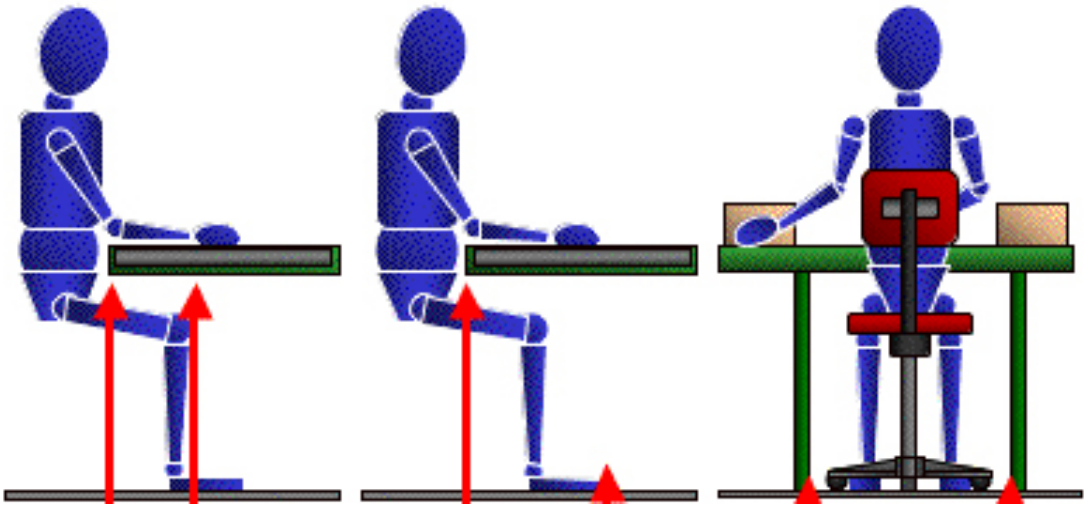
The space shown in Figure 7 should be provided so the worker's legs and feet fit comfortably beneath the work surface.

Figure 7 Sufficient leg space height for seated workstation



Leg space height of 720 mm from floor level below the underside of the work surface for seated workstations, which will leave enough space for a large operator's legs.[4]

Figure 8 Sufficient leg space width and depth for seated workstations



Leg space depth at knee height: 547 mm

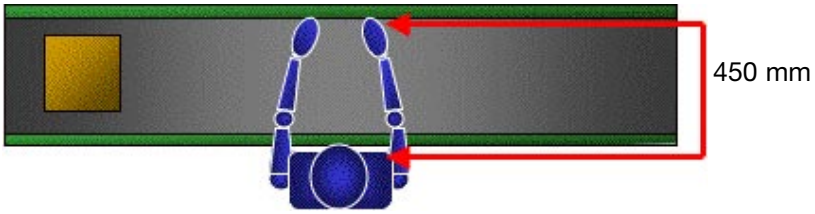
Leg space depth with movement for feet: 882 mm

Leg space width with movement for feet: 790 mm

Conveyor width

'Zones of repetitive reaching' on the conveyor should only go up to 450 mm from the front of the operator's body.[5]

Figure 9 'Zone of repetitive reaching'

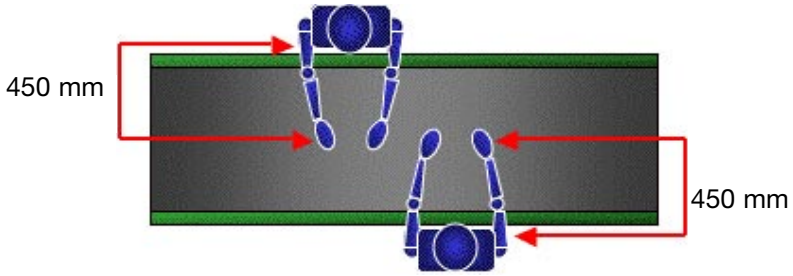


If people work from one side of a conveyor to pick many small or medium items, then the zone of repetitive reaching covers the whole conveyor width. This means the belt should not be wider than 450 mm.

If the objects on the conveyor are consistently large and take up most of the width of the conveyor, a belt wider than 450 mm may be used because the worker can still grasp the objects within the zone of repetitive reach.

Where operators work on both sides of the conveyor, as is often found in belt-picking operations, the width of the belt should allow operators on both sides to reach the middle of the conveyor within the 450 mm acceptable zone of repetitive reach. This limits the overall width of such a conveyor to 900 mm.

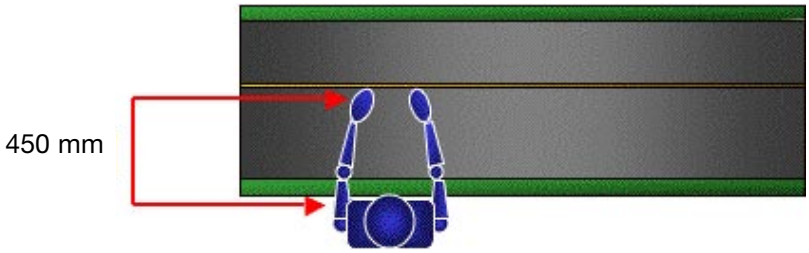
Figure 10 Where operators work on both sides of the conveyor



Fixed deflectors or deflector mechanisms can move items on the conveyor into the zone of repetitive reach when they reach a workstation.

If temporary single-sided working is required then the working area of the conveyor should be effectively limited to within 450 mm. For example, putting a removable guide down the centre of the conveyor can bring reach distances within the 450 mm guideline.

Figure 11 Reach distance for single-sided working

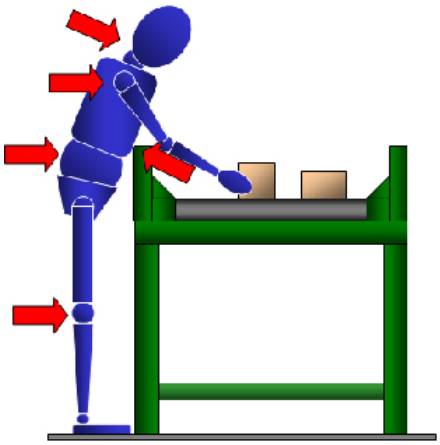


Sills, chutes, goods trays, and other features of the workstation can increase the distance between the front of the body and the conveyor belt and should be included in assessing reach distance.

Sills

Sills are put on some conveyor systems to keep material from falling off the sides of the belt. It is crucial to take these into account and reduce the reach distance to the furthest items on the conveyor accordingly. Sills can also introduce more MSD risks:

Figure 12 MSD risks caused by sills



High sills can force operators to lean further to handle objects on the belt. Working like this for an extended period puts strain on back and neck muscles that hold the trunk and head steady while the arms reach out in front of the body to grasp objects on the belt.

Leaning against the sill to support the trunk while reaching onto a conveyor can put pressure on the soft tissues at the front of the trunk. This can become uncomfortable very quickly, particularly where the conveyer edge is right-angled. Any such edges should be rounded-over to make occasional leaning more comfortable when grasping objects at the limit of operators' reach.

A strong indication that the workstation needs reassessment is if operators add padding, such as bubble wrap or rags, to the sill.

Further effective solutions include providing sill gaps or reducing sill height at workstations along the conveyor. These gaps may be closed and sills raised to prevent material falling off the conveyor when an operator is not present at the workstation.

Assessing organisational and psychosocial factors

The dimensions of the workstation are not the only factors that affect the incidence and development of MSDs. How the work is organised and psychosocial factors also have important roles and should be assessed.

Questions to consider on how the work is organised include:

- Can the operator control the belt speed?
- Can the operator stop the belt for a break?
- Are several operators all working at the same belt?
- What happens if something on the belt goes past the operator by mistake?
- How fast does the operator have to work at the belt?
- Have you allowed for rest and recovery time?
- How long does the operator perform the task for?

Other issues to consider include:

- Workers need to know how to:
  - work safely at the conveyor;
  - stop it in an emergency;
  - start it operating again;
  - adjust seating and footrests.
- The speed of the conveyor may set the pace of the work and may not be under the operator's control. Struggling to keep up can increase the risk of musculoskeletal injury through fatigue, and can be highly stressful.
- Visual effects from conveyor speeds greater than 10 metres per minute can make operators working perpendicular to the belt feel 'carsick'.
- Breakdowns somewhere may result in the workstation filling up with material. Buffer areas where surplus material can help regulate the operator's workload while the system is repaired. Extra operators can help clear a build-up of material, especially if there are spare workstations or they can access the other side of the conveyor.
- Working at conveyors can load one side of the body more than the other. Rotating between workstations on opposite sides of the conveyor will help to balance the workload on the two arms.
- A formal system of job rotation can help operators to use different groups of muscles by doing a different job away from the conveyor and give the muscles used for conveyor working a chance to rest.

HSE's publication *Upper limb disorders in the workplace* (HSG60)[5] gives more detailed information on organisational and psychosocial factors. HSE's *ART tool*[6] can also help you assess risks to the upper limbs from repetitive tasks.

References

1 *Workplace health, safety and welfare. Workplace (Health, Safety and Welfare) Regulations 1992. Approved Code of Practice* L24 HSE Books 1992 ISBN 978 0 7176 0413 5 www.hse.gov.uk/pubns/books/l24.htm

2 *Manual handling. Manual Handling Operations Regulations 1992 (as amended). Guidance on Regulations* L23 (Third edition) HSE Books 2004 ISBN 978 0 7176 2823 0 www.hse.gov.uk/pubns/books/l23.htm

3 Table 8 of BS EN ISO *14738:2008 Safety of machinery — Anthropometric requirements for the design of workstations at machinery* (ISO 14738:2002, including Cor 1:2003 and Cor 2:2005)

4 Table 5 of *BS EN ISO 14738:2008 Safety of machinery — Anthropometric requirements for the design of workstations at machinery* (ISO 14738:2002, including Cor 1:2003 and Cor 2:2005)

5 *Upper limb disorders in the workplace HSG60* (Second edition) HSE Books 2002 ISBN 978 0 7176 1978 8 www.hse.gov.uk/pubns/books/hsg60.htm

6 *Assessment of Repetitive Tasks of the upper limbs (the ART tool): Guidance for health and safety practitioners, consultants, ergonomists and large organisations* Leaflet INDG438 HSE Books 2010 www.hse.gov.uk/pubns/indg438.pdf

Further reading

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Pheasant S and Haslegrave CM (2006) *Bodyspace: Anthropometry, Ergonomics and the Design of Work CRC Press* (Third edition) ISBN 978 0 415 28520 8

Useful links

HSE website: www.hse.gov.uk

HSE's musculoskeletal disorders website: www.hse.gov.uk/msd

Further information

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