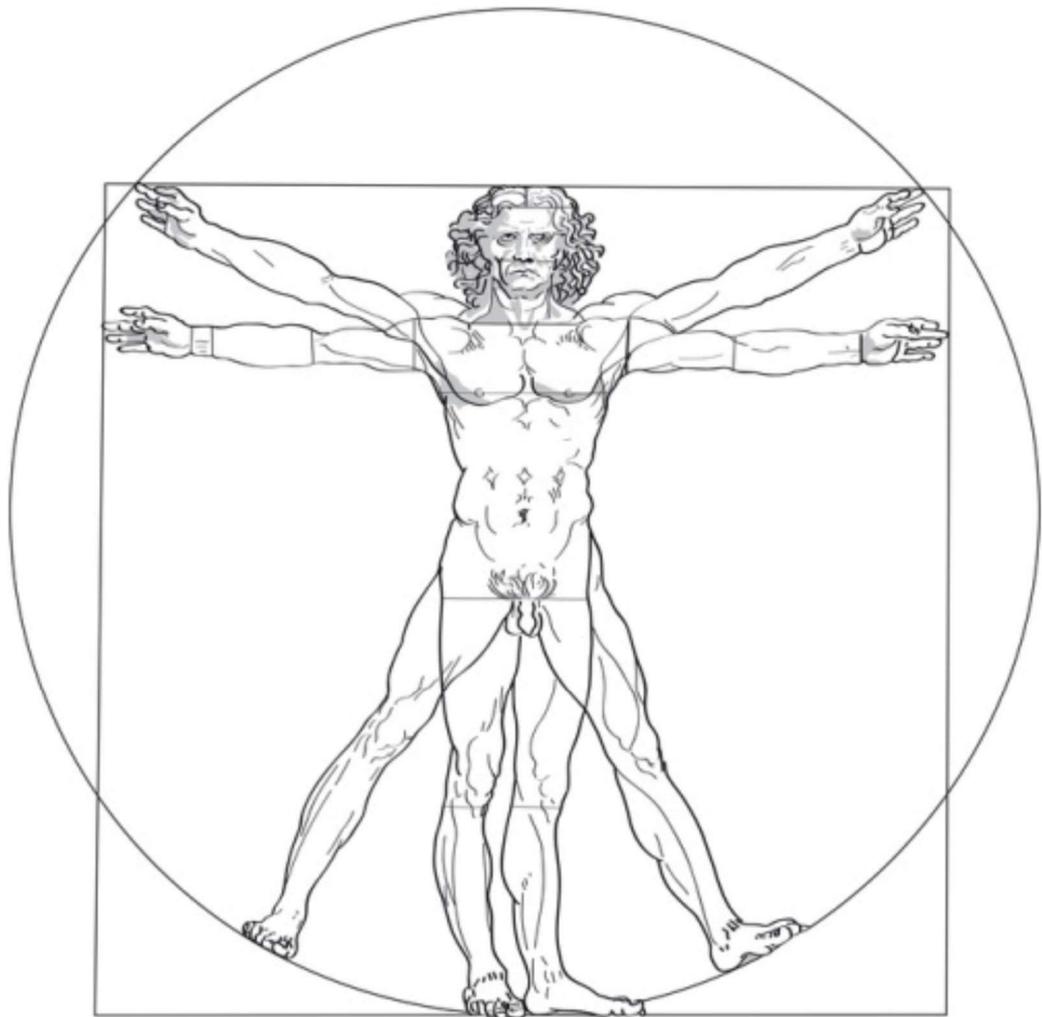


Ergonomic Requirements

Annex to IE Requirements Specification



Ergonomic Requirements
Requirements & Performance Specification

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1. Foreword/Vision

Vitesco Technologies offers attractive, ergonomically designed workplaces, where its employees

- remain healthy in the long term
- perform better because they are less tired
- do not make errors due to physical exposure and reduced concentration
- can remain consistently productive
- can be deployed regardless of their age and (gender)

This addendum to a requirements/performance specification is designed to illustrate to suppliers/manufacturers the relevance of an ergonomically designed workplace at Vitesco Technologies.

It explains ergonomic requirements, design objectives, and possible approaches for constructive consideration.

You will find additional information to each chapter of this requirements specification by using the attached link to an Internet portal of Continental:

Link

(<https://www.continental-corporation.com/en/company/for-suppliers/ergonomics-requirements>)

2. Physical Exposure

2.1 Body Posture

Definition:

Body posture is the position of the human body that results from the interaction of muscles, ligaments, and bones. Posture is mainly determined by the point at which the load is handled.

Motivation / what negative effects need to be avoided?

- Decline in performance and willingness to work
- Increased risk of errors and accidents due to fatigue
- Premature muscle tiredness due to restricted blood supply and lack of oxygen
- Increased (unproductive) expenditure of energy to maintain the incorrect posture
- Increased strain on the cardiovascular system due to undesirable hydrostatic conditions. The result of this is fluid retention in the lower extremities with formation of varicose veins and edema
- Changes to ligaments and joints (hips, knees, ankles) with deformation of feet due to long periods standing up
- Non-physiological curvature of the spine
- Pain as a result of the physical changes listed above

Important design goals:

- Selection of appropriate workplace types
- Movement zones and comfortable adjustment ranges for postures. Minimum values for workplace measurements for different body postures.
- Analysis for determination of main work posture
- Analysis of spatial layout (analysis of visibility, reach, posture)

Possible considerations during design:

- Body posture (position of the head, position of the spine, neck, shoulders, arms, etc.)
- Employees should always be able to change their posture at the workplace unassisted
- Static posture, change of load, application of force, etc.
- The suitability of a workplace for different workplace types is decided according to the general conditions. The Conti evaluation diagram “workplace type” is designed to assist in the selection of the correct workplace type.

2.2 Handling of Loads

Definition:

Manual handling means any conveyance or support of a load by human force, including the lifting, setting down, pushing, pulling, carrying or moving of a load.

Motivation / what negative effects need to be avoided?

- Overstraining, improper loading and incorrect posture cause back ache, neck ache and headaches. In the long term, this can lead to a slipped disc

Important design goals:

- The work tasks, e.g. daily duration of the activity
- The conditions under which the work is performed; conditions of the workplace and its environment
- Key indicator method for maximum load and frequencies
- Change/distribution in body posture and movement

Possible considerations during design:

- Standard values and legally prescribed limit values for lifting and carrying loads with a straight back and without aids
- Type, level and frequency of application of force
- Body posture
- Hand-arm position
- Suitable holding points (handles) must be provided

2.3 Body Movement

Definition:

The function of the "locomotory systems" is to start, perform, and monitor movements of the body, to evaluate the result of the movement, and to store the execution rules of these processes. The locomotory and sensor systems are inextricably linked with regard to their movement functions.

Motivation / what negative effects need to be avoided?

- Exposures on the musculoskeletal system (spine, intervertebral discs, hips, knees and ankles, etc.)
- Exposures on the cardiovascular system (flow of blood in the veins of the leg, high blood pressure, etc.)

Important design goals:

- Free space, safety distances
- Travel movements
- Change in movement of different muscle groups

Possible considerations during design:

- Rating of hand-arm position and movement
- Provision of sufficiently free room for movement
- Posture- and activity-specific functional dimensions adapted to the person
- Movement characteristics: rhythm of movement, precision, constancy, scope, speed, strength

2.4 Type of Work

Definition:

Energetic work is relevant when considering the ways in which human being work. This work consists of the mechanical (application of force) and locomotory (performance of movements) type of work. Use of the skeletal muscles enables us to distinguish between two basic ways in which a muscle can be used: static and dynamic.

Motivation / what negative effects need to be avoided?

- Static muscle work can lead to lack of movement, inevitable required compensatory movements become less frequent, the energy used is converted into heat rather than into mechanical energy. This reduces effectiveness when working. In addition, the muscles tire rapidly due to internal muscle pressure and the considerably restricted blood supply that results.
- This can lead to disorders of the spine relating to the intervertebral discs

Important design goals:

- The way in which the work is carried out, the workplace, and the working conditions must be designed in such a way that no preventable energetic exposures arise
- For heavy work the larger muscle groups must be used and easy work should be performed by smaller, weak muscle groups
- The muscle groups used and the chosen speed of work must be matched => relationship between contraction time and rest time

Possible considerations during design:

- Static stress on muscles and uncomfortable postures must in general be avoided
- Avoidance of unfavorable types of work, e.g. working above head height, sitting without a back rest, holding of loads, etc.

2.5 Manual Handling Operations

Definition:

The term "manual handling operations" describes activities of the hand/arm system that are constantly repeated with different amounts of force and/or increased frequency/duration. Manual handling operations arise very frequently and in many different forms. Finger grip, clasp grip, contact grip are used to perform the actions pressing, joining, holding, turning, and guiding. Typical characteristics are short, cyclically recurring fixed work content and process flows.

Motivation / what negative effects need to be avoided?

- Avoidance of musculoskeletal disorders in the hand-arm area and their economic and social effects
- Avoidance of back disorders as a result of long-term exposure due to static strain and static posture
- Avoidance of fatigue and errors due to excessive strain

Important design goals:

- Avoidance of uncomfortable joint positions
- Avoidance of static work types, requiring to maintain body posture by the need to support oneself
- Adequate space for movement without obstacles, without forced postures
- Avoidance of unnecessary joining movements through the use of threading aids or guides
- Compliance with requirements for optimum work areas taking grab distances and sight requirements into account (work zones for different activities)

Possible considerations during design:

- Use of tools and work items (rod form, grips, handles, buttons, tools) that are ergonomically well-designed and suitable for the task
- Adjustment of the level of the action forces depending on duration, frequency and dexterity

2.6 Distribution of Body Posture and Movement

Definition:

The body posture/movement ratio is an expression of the "mix" of "go", "stand", and "sit".

Motivation / what negative effects need to be avoided?

- One-sided exposures lead to tension and pain in the neck and shoulder area and in the muscles of the shoulder and back
- A lack of change in movement exacerbates lack of concentration, nervousness, and tiredness at work
- Impairment of the connective and supporting tissue, the cardiovascular system, and the nervous system

Important design goals:

- Balanced variation of the ratio between movement and static positions
- Workplaces should generally be designed in such a way as to allow both sitting and standing
- If it is not possible to switch between the two, sitting is to be preferred

Possible considerations during design:

- Match the type of workplace to the planned system of work
- Implement a standing/sitting dynamic through the use of a height-adjustable work plane and sensible distribution of work tasks (seated, standing activity and walking) => self-selected switching is supported
- Design workplaces according to the design rules for the human-technology interface

3. Environmental Conditions

3.1 Noise

Definition:

Noise is any sound that can cause hearing impairments or can lead to any other strain or risk to employees.

Motivation / what negative effects need to be avoided?

- Avoidance of damage to hearing
- Avoidance of stress due to unnecessary noise
- Avoidance of vegetative damage

Important design goals:

- Opt for low-noise design and avoid generating noise (creation, transfer, transmission)
- Define noise protection measures
- Reduce duration of noise to a minimum

Possible considerations during design:

- Determine sources of noise in the design phase
- Include adjacent work areas in the evaluation of the design
- Reduce acoustic signals to the minimum necessary
- Implement noise protection measures
- Determine equivalent continuous sound pressure level and peaks sound pressure levels (e.g. by release of compressed air)

3.2 Vibrations

Definition:

Vibrations are all mechanical oscillations transferred to the human body by objects and which can put exposures on or be a hazard to employees. A distinction is made between whole-body vibrations (transferred to the whole body) and hand-arm vibrations (transfer to a person's hand-arm system).

Motivation / what negative effects need to be avoided?

- Avoidance of muscular and skeletal disorders in the spinal column and hand-arm joints
- Avoidance of circulatory problems in the hands ("Raynaud's syndrome")

Important design goals:

- Design the workplace so that exposures from vibrations are minimized
- Avoid physical complaints, impairment and illnesses due to hand-arm or whole-body vibrations
- Avoid physical complaints, impairment and disorders caused by the long-term effects of vibrations

Possible considerations during design:

- Choose a design that makes use of decoupling and which is low-vibration

3.3 Glare / Reflection / Shadows

Definition:

Glare is a visual disturbance in the field of vision triggered by excess brightness or excessive contrast between different brightness levels. It can be caused by direct incidence of light (direct glare) or by reflections on shiny/reflective surfaces (reflected glare).

It is the interplay of light and shade that endows objects with a three-dimensional structure and provides for comfortable vision. An ideal shadow effect is produced when there is a balance between point light sources and diffuse illumination.

Motivation / what negative effects need to be avoided?

- Prevention of premature fatigue, decreasing performance, and occurrence of errors due to unfavorable lighting conditions caused by
 - **Direct glare** - it is caused by excessive brightness of light sources and window surfaces in the visual field and impairs visibility and visual comfort,
 - **Reflected glare** - which arises due to reflective surfaces, e.g. parts of machine housings, table surfaces or workpieces,
 - **Shadows with hard shadow edges**, which make it difficult to identify workpieces, tools or fields of activity.

Important design goals:

- Mixture of diffuse light (indirect light) and direct beam light sources
- Prevention of hard shadows (drop shadows)
- Even luminance values in the field of vision and the direct work area
- Non-reflective surfaces at the workplace and/or in the working environment

Possible considerations during design:

- Position of lighting, e.g. arrangement of linear lighting parallel to the window
- Appropriate incorporation of direct light sources, e.g. downlights
- Use of matt, low-reflectance surfaces
- Appropriate choice of color for balanced brightness and a balanced contrast

3.4 Thermal Radiation

Definition:

Thermal radiation is a (electromagnetic) radiation that leads to the transfer of thermal energy. It affects the experience of cold and heat at the workplace.

Motivation / what negative effects need to be avoided?

- In the case of excess thermal radiation (and therefore excess temperature) the body cannot adequately dissipate the heat, which causes core body temperature to rise
- The consequences of a raised core body temperature are increased sweating, exposures to the cardiovascular system, muscle cramps, heat exhaustion, and heat collapse

Important design goals:

- Design to minimize thermal radiation so that room temperature is as little affected as possible

Possible considerations during design:

- Heat shield (insulation)
- Option of an exhaust air connection (extraction)

3.5 Lighting

Definition:

The purpose of adequate lighting of workplaces is to enable the visual task associated with the job and to prevent health hazards and avoid accidents.

Motivation / what negative effects need to be avoided?

- Adequate and appropriate lighting helps the work task to be carried out effectively and efficiently
- It is designed to prevent accidents, to improve vision, and to prevent excessive eye exposure
- Good lighting helps promote employee performance

Important design goals:

- Use of lights that are suitable for the tasks to be performed on the production facilities
- Avoidance of glare
- Suitable surfaces at the workplace

Possible considerations during design:

- Lighting must be appropriate for the relevant visual task (e.g. warehouse work, assembly activity, test station)

4. Work Organization

4.1 Viewing Range

Definition:

Viewing range refers to the horizontal and vertical working and observation area. The range limit is the coverage and movement area of the eyes, head, and body.

Motivation / what negative effects need to be avoided?

- Decreasing concentration due to activities that require permanent focusing at different distances

Important design goals:

- The fields of vision must be kept free from technical machinery parts
- For the displays (VDUs, monitors, etc.) it must be ensured that if these are in constant use they also lie within the optimal visual field, i.e. continual movements of the head are to be avoided

Possible considerations during design:

- Appropriate design of work heights, dimensions, arrangement of control panels and devices, displays

4.2 Visual Acuity

Definition:

Visual acuity is mainly determined by the resolution of the human eye. Visual acuity is the ability of the retina to perceive two points as separate.

Motivation / what negative effects need to be avoided?

- Increased risk of errors and accidents due to excessive exposures on the eyes

Important design goals:

- All information that needs to be constantly viewed by the employee must be located within the optimum viewing range and displayed at an appropriate size and with optimum contrast
- For inspection tasks, suitable accessories must be provided, depending on the size of the structure
- Adequate illumination

Possible considerations during design:

- Suitable design/arrangement of operating and control devices, displays, labels, handles, and gripping surfaces
- Display with adequate resolution

4.3 Fine Motor Skills

Definition:

Fine motor skills are defined as targeted and finely coordinated movements and are expressed in manual dexterity.

Motivation / what negative effects need to be avoided?

- Excessive exposures of joints and muscles must be avoided
- Decline in performance and willingness to work
- Increased error and rejection rates shall be avoided

Important design goals:

- For all (machine) parts that need to be moved, optimal size must be ensured so that these can be handled easily. If this is not possible, suitable accessories must be provided

Possible considerations during design:

- Design of handles and gripping surfaces
- Provide suitable accessories
- Fit support in the positioning of devices/materials (insertion aids, beveled edges, guide pins, etc.)