18. MODULE

Anthropometric design of the workstation

- Introduction
- Data
- Adaptation to worker
- Report and recommendations

INTRODUCTION

Scope of application. The module *anthropometric design of the workstation* provides the user with recommendations for the design of the workplace, both general recommendations and adapted to the anthropometric measurements of the worker.

Contents. The module studies the characteristics of the workstation and the tasks performed in order to establish the main physical requirements of such workstation (main working posture, visual and precision requirements, force and handling demands, possibility of changing the working height). Optionally, you can measure the worker, which allows you to obtain recommendations for a customized adaptation of the workstation. The result of the module is a report that includes the **recommendations for the design of the workstation, both general and adapted to the worker**.

Source. This module, developed by the IBV, is based on the standard EN ISO 14738 on *Safety of machinery. Anthropometric requirements for the design of workstations at machinery*. This standard establishes principles to obtain dimensions from anthropometric measurements and apply them to the design of workstations associated with non-mobile machinery.

DATA

Activate the *Design* view from the *Views* menu o from the associated button on the toolbar (Figure 1).

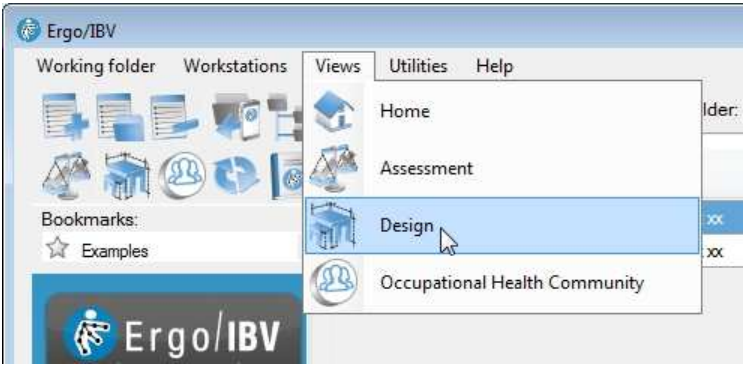


Figure 1. Access to the Design view

Once you have accessed the *Design* view, select the *New workstation* command on the toolbar (Figure 2) or from the menu *Workstations*.

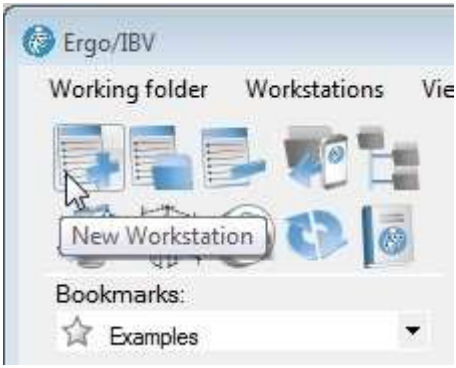


Figure 2. Open new workstation

You will access the main window of this module (Figure 3), where the data are entered.

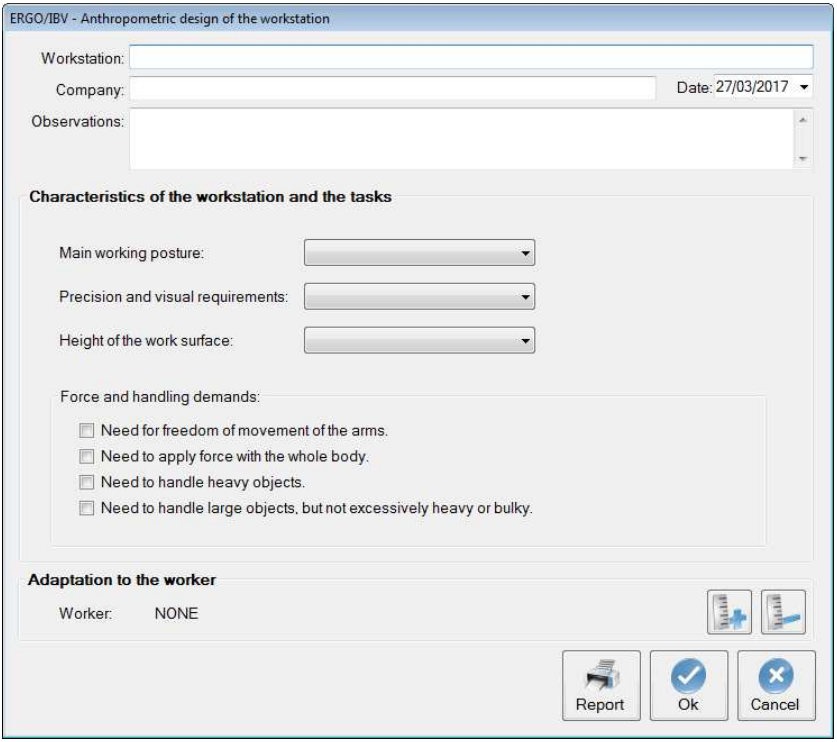


Figure 3. Design – Main window

Identification. As in other modules, the name of the workstation and the company, the design date and the relevant observations are entered in the header.

Characteristics of the workstation and the tasks. After entering the general data of the workstation, certain requirements, demands and characteristics must be specified:

1. *Main working posture*
2. *Visual and precision requirements*
3. *Height of the work surface*
4. *Strength and handling demands*

All the items in each section should be reviewed, and the applicable boxes checked. In the first three sections (main working posture, visual and precision requirements and height of the work surface) you are required to choose an option from the drop-down menu, whereas in the fourth section you only have to check the relevant items.

The contents of each sections are detailed below.

Main working posture

- ☐ Standing position
- ☐ Sitting position
- ☐ Supported standing position
- ☐ Raised sitting position

Visual and precision requirements

- ☐ High
- ☐ Medium
- ☐ Low

Visual and precision requirements are considered to be:

High	When the visual task requirements demand a very good vision of what is being done; the object or task should be close to the worker's eyes so as to help visual acuity (e.g. jewelry tasks, microelectronics, examining fabrics, etc.). Precision requirements will be high when accuracy, dexterity and/or hand coordination are required when performing manual tasks. In these cases, it may be advisable to provide forearm support for the worker. Precision tasks are usually associated with high visual requirements.
Medium	When visual and/or precision and coordination hand requirements demand medium accuracy and dexterity, that is, neither high nor low.
Low	When visual requirements are not significant; the worker can stop looking at the task (e.g. goods handling). The precision and/or coordination requirements are low when the worker does not need to be particularly careful or accurate when performing the manual tasks.

Height of the work surface

- ☐ Adjustable or adaptable
- ☐ Not adjustable or adaptable

Force and handling demands

- ☐ Need for freedom of movement of the arms.
- ☐ Need to apply force with the whole body.
- ☐ Need to handle heavy objects.
- ☐ Need to handle large objects, but not excessively heavy or bulky.

After entering the data that characterize the workstation and the tasks, you can obtain a report with general recommendations for the design of the workstation [see section "*Report and Recommendations*" in this chapter]. Optionally, these design recommendations can be adapted to a worker from the *Adaptation to worker* section in the main window.

ADAPTATION TO WORKER

Once the workstation data have been entered, you can optionally enter the anthropometric data of the worker of the workstation being analyzed.

In order to incorporate the measurements, access the option *Adapt to worker* (Figure 4).

Figure 4. Accessing Adapt to worker

If you want to delete a worker that has already been created, use the option circled in the image (Figure 5).

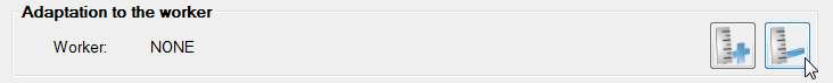


Figure 5. Deleting a worker

Pressing *Adapt to worker* opens the main window of *Anthropometric characteristics of the worker*, where all the data must be entered.

Worker data. The worker's name (code or identifier), worker's gender, date of birth, date when the measurements were taken, person who performed the measurements, and the relevant comments are entered in the header.

There are two tabs under the identification data:

1. *Preparation*
2. *Measurements*

Preparation

This tab provides 3 screens with some instructions to be considered when taking body measurements regarding the clothes that the subject should wear, the measuring instruments to be used, and other auxiliary material required for the measurement.

Clothing

Clothing. During the measurement, the person must be naked or wearing minimal clothing, uncovered and barefoot. It is advisable to wear tight clothing, but such clothing must not alter the original form of the body so that measurements are accurate.

Hair. In order to facilitate the measurements with the anthropometer, the person should keep the hair off the face and neck: therefore, it is advisable to wear the hair tied up on the crown of the head.

Footware. When the height is measured with respect to the floor, the person must be barefoot or wearing socks that are not too thick.

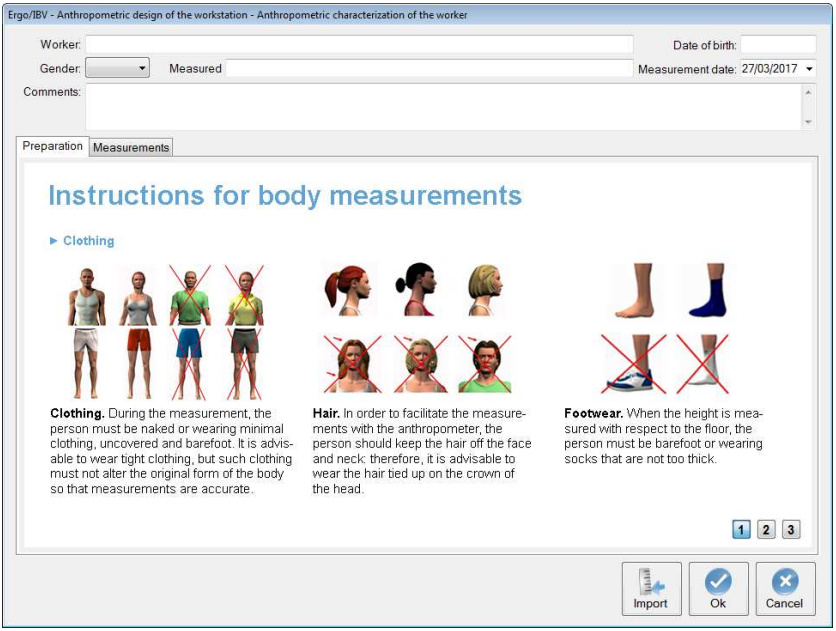


Figure 6. Screen showing how to prepare the clothing

Instruments

Anthropometer. Specialized instrument for measuring linear distances between points on the body or from a typical reference surface such as the floor or a seat platform. The measuring scale should be made of a rigid or slightly flexible material so that the minimum distance between two points is

measured. In order to make sure that the points that define each measurement are identified, the anthropometer has two rigid arms perpendicular to the measuring scale; one of them is fixed and the other one slides along the measuring scale.

Symmetrical body measurements. Symmetrical body measurements can be taken on either side of the body. We must document on which side of the body the measurement is taken or agree to measure always on the right side of the body.

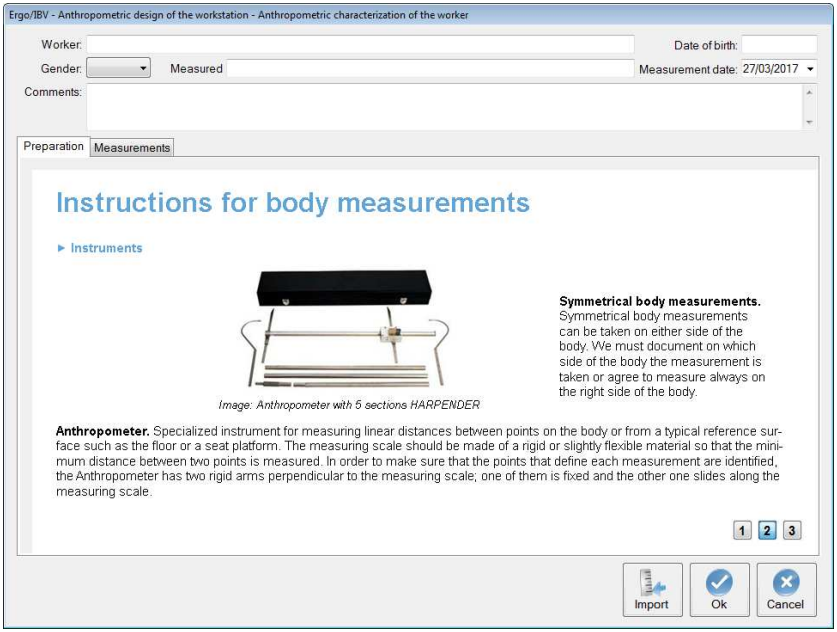


Figure 7. Screen showing how to prepare the instruments

Auxiliary material

Stool with no back support and with adjustable height (the seat surface must be flat, horizontal and not compressible).

Hand cylinder. Cylindrical element whose diameter can be grasped inside a fist. The recommended diameter is 20mm.

Measuring block. Rigid block of 200mm side length used to determine the maximum projection of a person who is sitting.

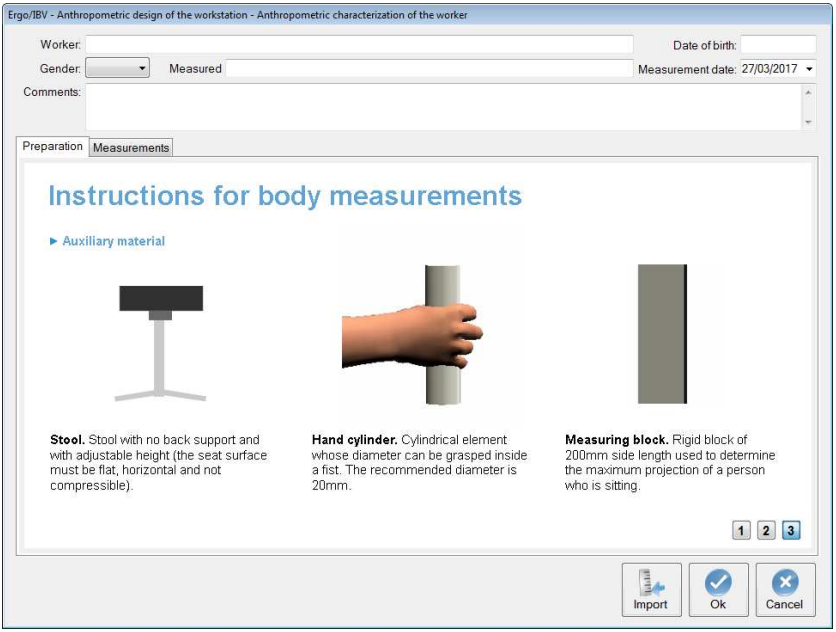


Figure 8. Screen showing how to prepare the auxiliary material

Measurements

The worker's measurements are entered in this tab following the criteria recommended for each measurement (Figure 9). You can access the instructions for each measurement (Figure 10) by clicking the button next to each measurement.

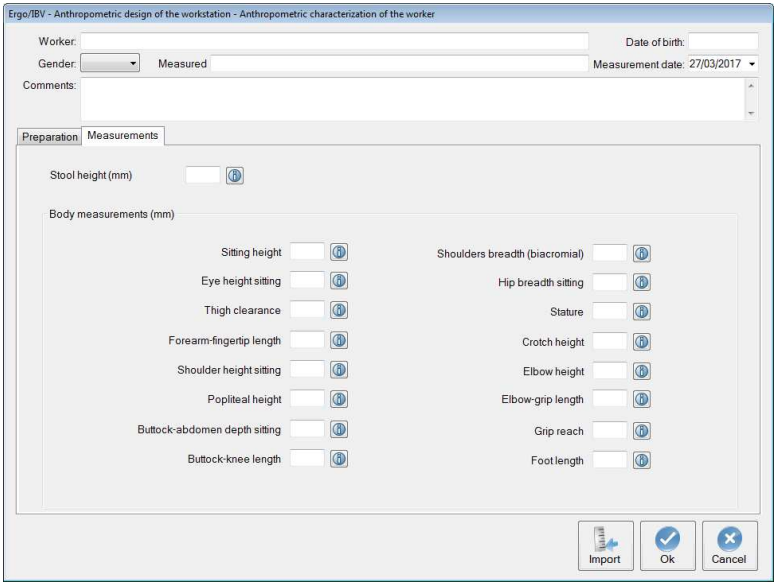


Figure 9. Screen to enter the worker's measurements

Figure 10. Screen providing help on how to take the Height sitting measurement

The measurements can be entered in the application both from the *measurements* tab (Figure 9) and the measurement help screen of the relevant body dimension (Figure 10). The *Next* and *Previous* buttons allow you to navigate through the all the help screens for taking body measurements without having to return to the *measurements* tab.

It is important to note that all the data must be entered in millimeters (mm.); otherwise, the dimensional recommendations will not be correct.

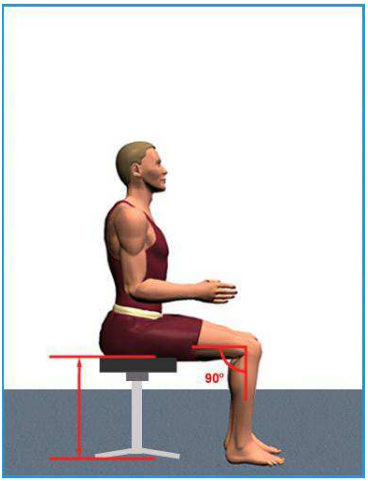
The module includes the following measurements:

Stool height

Position of the chair

It is advisable to use a stool with adjustable height. In order to adjust it correctly, ask the person to sit down and then check that:

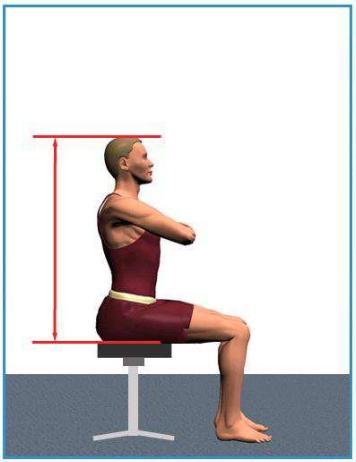
- The thighs are in the horizontal position.
- The legs are in the vertical position, at a 90º angle with respect to the thighs.
- The feet are resting on the floor.



Once the height of the chair has been adjusted, measure the distance from the seat to the floor.

Note: The height of the stool has to be slightly below the popliteal fossa of the person (back of knee).

Sitting height



Description

Vertical distance from a horizontal sitting surface to the highest point of the head, excluding the hair.

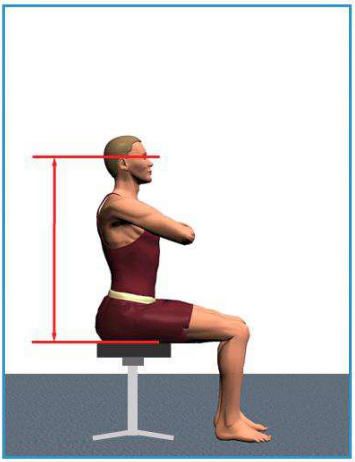
Worker's position

The person sits fully erect, feet together. In order to achieve a good head position, the subject is asked to look ahead at a point placed far at eye level without raising the chin excessively.

Necessary instruments

Stool and anthropometer.

Eye height sitting



Description

Vertical distance from a horizontal sitting surface to the outer corner of the eye.

Worker's position

The person sits fully erect with thighs fully supported and lower legs hanging freely. In order to achieve a good head position, the subject is asked to look ahead at a point placed far at eye level.

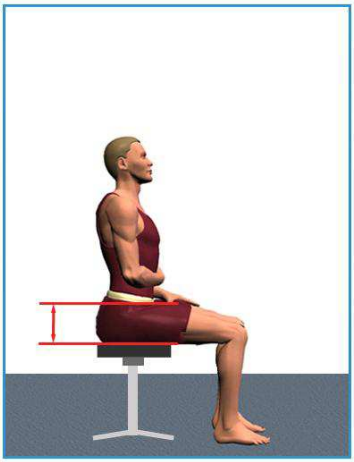
Necessary instruments

Stool and anthropometer.

Thigh clearance

Description

Vertical distance from the sitting surface to the highest point of the thigh.



Worker's position

The person erect with knees bent at right angles, supporting the feet flat on the floor.

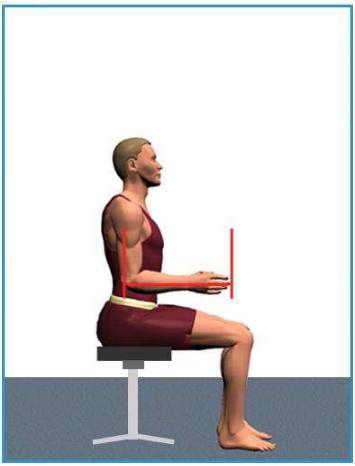
Necessary instruments

Stool and anthropometer.

Forearm-fingertip length

Description

Horizontal distance from the back of the upper arm (at the elbow) to the fingertips, with elbow bent at right angle.



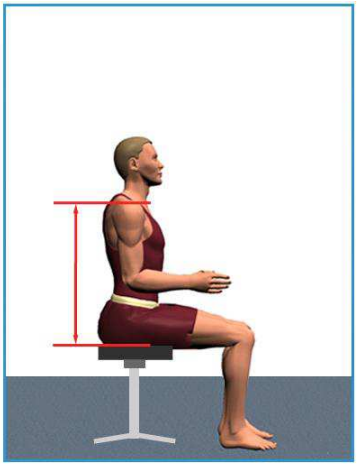
Worker's position

The person sits erect, with the arm hanging downwards, the forearm horizontal, and the hand outstretched with the fingers together.

Necessary instruments

Anthropometer.

Shoulder height sitting



Description

Vertical distance from a horizontal sitting surface to the acromion.

Worker's position

The person sits fully erect with thighs fully supported and lower legs hanging freely. Shoulders relaxed and arms hanging freely.

Necessary instruments

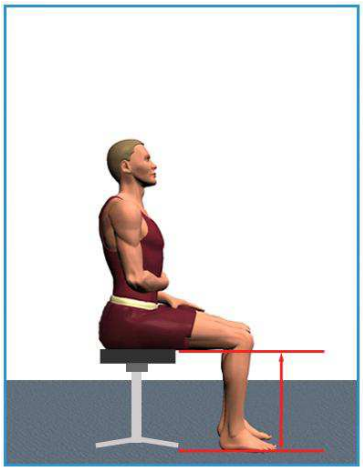
Stool and anthropometer.

Popliteal height

Description

Vertical distance from the supporting surface of the feet to the lower surface of the thigh immediately behind the knee, which is bent at a right angle.

Worker's position

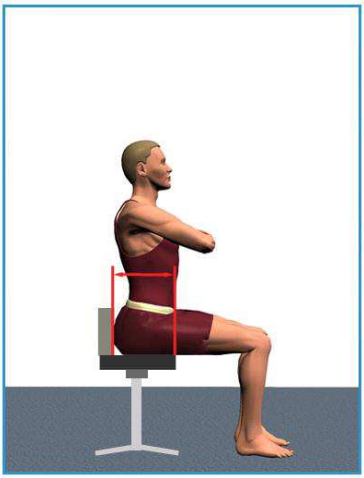


The person keeps the thigh horizontal and the leg bent at a right angle during the measurement. This is achieved by adjusting the height of the stool until the thigh is horizontal and then aligning the ankle with the knee along the same vertical line. The subject can also stand with the foot on a platform raised above the ground, provided that perpendicularity between the leg segments is maintained. The movable arm of the measuring instrument gently presses down on the relaxed biceps femoris muscle tendon.

Necessary instruments

Stool and anthropometer.

Buttock-abdomen depth sitting



Description

Maximum thickness of the projection of the belly, measured between the maximum anterior protrusion of the abdomen and the maximum posterior protrusion of the buttock.

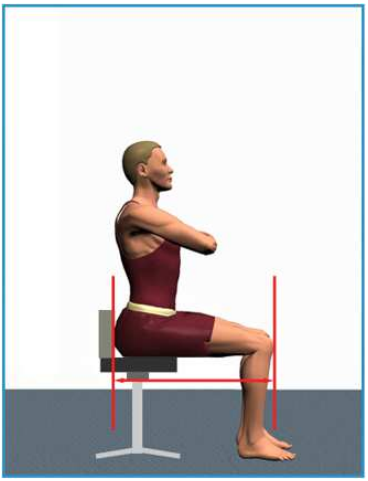
Worker's position

The person sits fully erect with thighs fully supported and lower legs hanging freely, with rearmost point of the buttocks touching the surface of a vertical panel. Distance is measured from the vertical panel to the maximum anterior protusion of the abdomen.

Necessary instruments

Stool, measuring block, anthropometer.

Buttock-knee length



Description

Horizontal distance from the anterior point of the kneecap to the foremost point of the buttocks.

Worker's position

The person sits fully erect with thighs fully supported and lower legs hanging freely. The measuring block is placed in contact with the body in the posterior part of the buttocks. Distance is measured from the measuring block to the foremost point of the knee-cap.

Necessary instruments

Anthropometer, measuring block, stool.

Shoulders breadth

Description

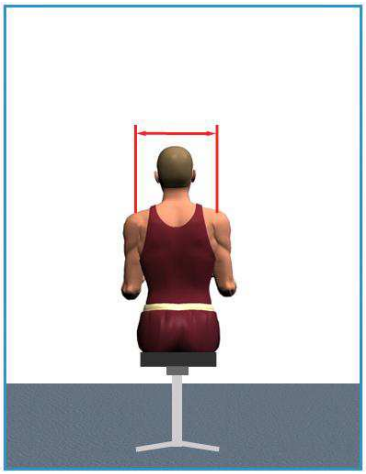
Distance along a straight line from acromion to acromion.

Worker's position

The person sits or stands fully erect with shoulder relaxed.

Necessary instruments

Anthropometer, stool (optional).



Hip breadth sitting

Description

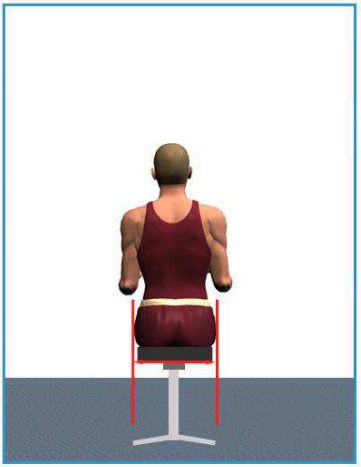
Breadth of the body measured across the widest portion of the hips.

Worker's position

The subject sits with the thighs fully resting on the seat, both legs hanging free with the knees together. Measurement is taken without pressing into the flesh of the hips.

Necessary instruments

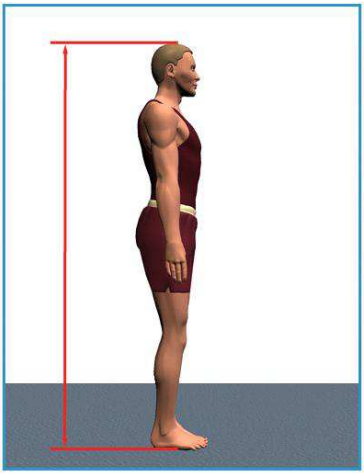
Anthropometer, stool.



Stature (body's height)

Description

Vertical distance from the floor to the highest point of the head, excluding the hair.



Worker's position

The person stands fully erect with the feet together. In order to achieve a good head position, the subject is asked to look ahead at a point placed far at eye level without raising the chin excessively.

Necessary instruments

Anthropometer.

Crotch height

Description

Vertical distance from the floor to the lower part of the pubis.

Worker's position

The person stands with the legs slightly apart. Ask the subject to hold the fixed arm of the measuring instrument against the inner surface of the thigh so that, when pushed upwards, it gently presses the pubic bone. Then the subject closes the legs and stays fully upright during the measurement while the technician moves the movable arm of the anthropometer down to the floor.

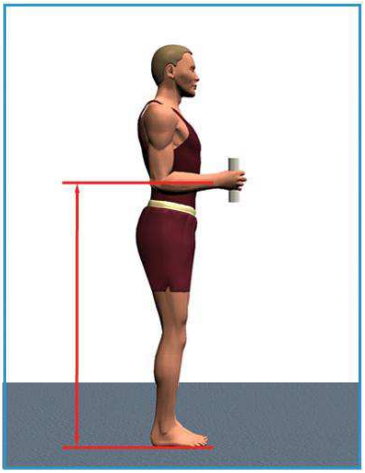
Necessary instruments

Anthropometer.

Elbow height

Description

Vertical distance from the floor to the lowest bone point of the elbow bent.



Worker's position

The person stands fully erect with the feet together. Upper arm hangs freely downwards, with forearm flexed at right angles to it.

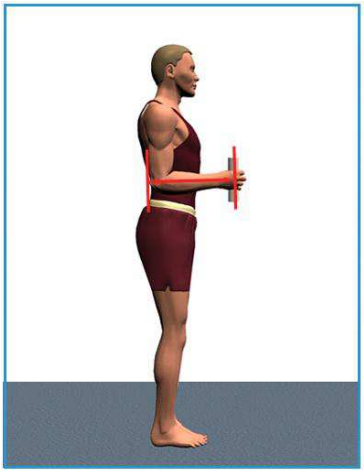
Necessary instruments

Anthropometer.

Elbow-grip length

Description

Horizontal distance of the upper arm (at the elbow) to grip axis, with elbow bent at right angles.



Worker's position

The person can sit or stand upright with the arm hanging free and the elbow bent at a right angle so that the forearm is in a horizontal position. The hand grasps the cylinder with the axis of the fist in a vertical position.

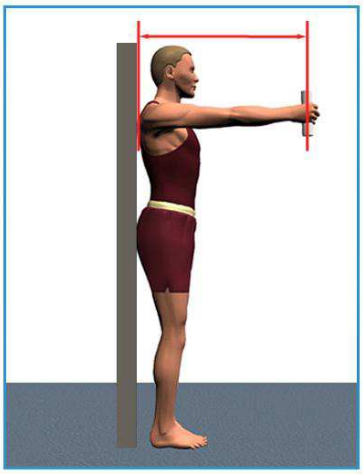
Necessary instruments

Anthropometer, straight hand cylinder.

Grip reach

Description

Horizontal distance from a vertical surface to the grip axis of the hand while the subject is leaning back against the vertical surface.



Worker's position

The person stands fully erect leaning the back and the buttocks firmly against the vertical surface. The arm fully extended horizontally and forwards, without moving the scapular area away from the vertical surface. The hand grasps the cylinder with the axis of the fist in a vertical position.

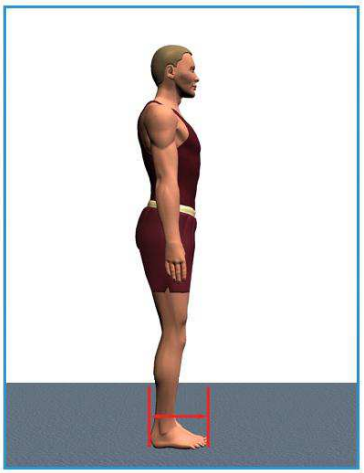
Necessary instruments

Anthropometer, straight hand cylinder.

Foot length

Description

Maximum distance from the rear of the heel to the tip of the longest toe (first or second) measured parallel to the longitudinal axis of the foot.



Worker's position

The person stands with weight equally distributed on both feet.

Necessary instruments

Antropómetro.

The instructions provided in this module are based on the standard EN ISO 7250-1:2010 Basic human body measurements for technological design - Part 1: Body measurement definitions and landmarks

When *all* the worker's measurements have been entered following the instructions previously provided, press the *OK* option (Figure 11).

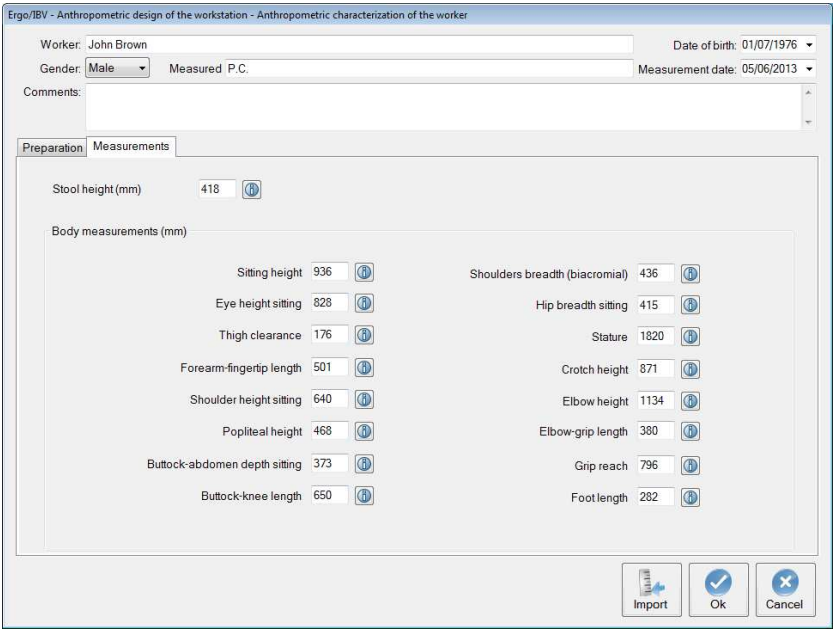


Figure 11. Worker's data entered

It is also possible to **import** the data of a worker who was already measured in a different workstation. To do this, click the *Import* button in the menu below, search for the folder where the file containing the worker's data is, and select the worker from the list (Figure 12).

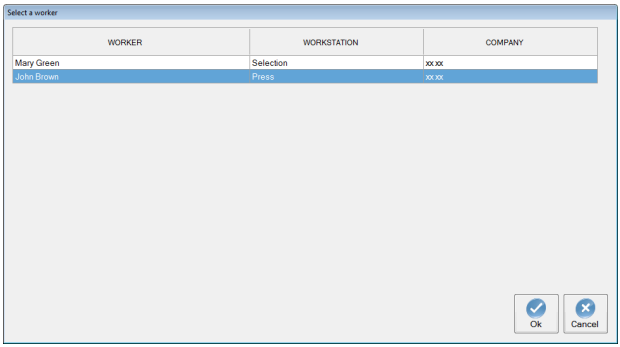


Figure 12. List of workers in the selected folder

After entering the anthropometric data of the worker, you can obtain from the main screen of the module a report with design recommendations for the workstation, both general and adapted to the worker.

Data protection. You can restrict access to the data recorded in the system by activating the data protection module, which restricts access to the design view by requesting a user authentication password [see chapter *"Annex 4: Data Protection"*].

REPORT AND RECOMMENDATIONS

Once you have entered the information, access the *task report* window by pressing the *Report* button at the bottom of the main window. This report contains the following information:

- **Identification**. It includes general data (location where the task is saved, date, workstation, company and observations) (Figure 13).

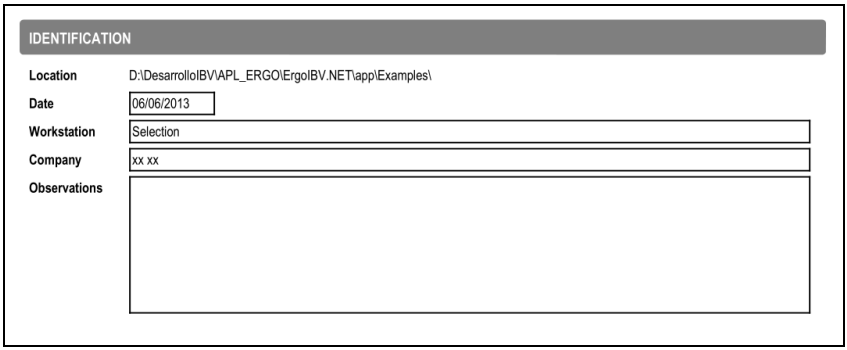
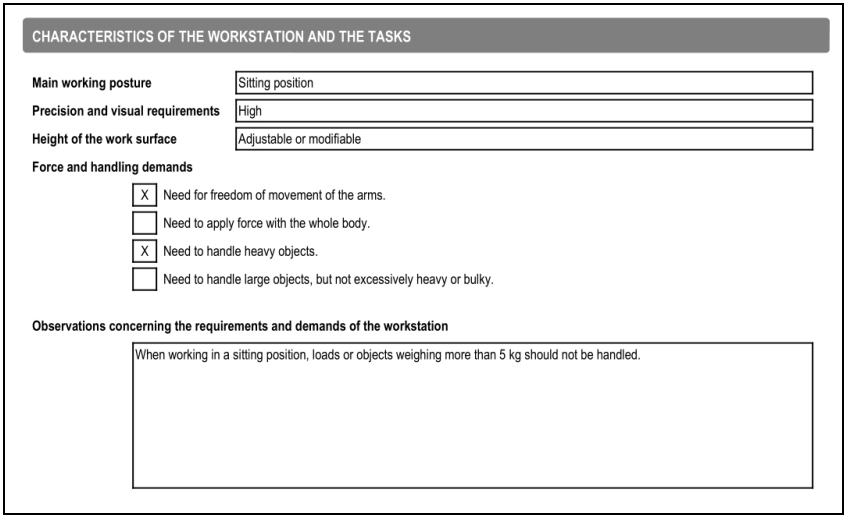


Figure 13. Identification

- **Characteristics of the workstation and the tasks**. It shows the items that were checked in each section of the checklist (Figure 14). This section also includes a number of observations concerning potential incompatibilities between the requirements and the demands of the workstation that have been specified.


CHARACTERISTICS OF THE WORKSTATION AND THE TASKS

Main working posture: Sitting position

Precision and visual requirements: High

Height of the work surface: Adjustable or modifiable

Force and handling demands

[X] Need for freedom of movement of the arms.

[ ] Need to apply force with the whole body.

[X] Need to handle heavy objects.

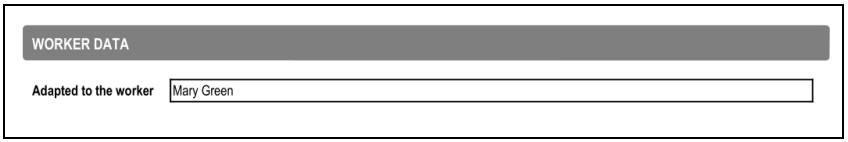
[ ] Need to handle large objects, but not excessively heavy or bulky.

Observations concerning the requirements and demands of the workstation

When working in a sitting position, loads or objects weighing more than 5 kg should not be handled.

Figure 14. Characteristics of the workstation and the tasks

- **Worker's data.** These data identify the *Worker* (Figure 15) if you chose to adapt the workstation. If no worker was measured or specified, it will show *NONE*.


WORKER DATA

Adapted to the worker: Mary Green

Figure 15. Worker's data

- **Design recommendations for the workstation** (Figure 16). This section of the report shows a number of design recommendations for the workstation, which will depend on the selection made in the characteristics of the workstation. These recommendations concern:

    - Working height.
    - Space requirements for the legs and feet.
    - Recommended reach area for the legs.
    - Space requirements for seat access.
    - Field of vison

The design recommendations are illustrated with pictures where a letter indicates the dimension involved (Figure 16). Moreover, the table below the explanatory text shows the recommended values for the main dimensions of the workstation. These dimensions are based on the standard EN ISO 14738 on the *Safety of machinery. Anthropometric requirements for the design of workstations at machinery*.

The recommended values are presented in four types of columns, which may vary depending on the type of recommendation. The columns "Minimum adjustment", "Maximum adjustment" and "Not adjustable" provide the values established based on the European population, whereas the "Custom adjustment" column includes the values based on the body dimensions of the worker.

Ergo/IBV
Ergonomic risk assessment

Anthropometric design of the workstation

IBV

DESIGN RECOMMENDATIONS FOR THE WORKSTATION

WORKING HEIGHT

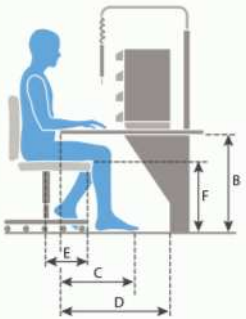
For tasks requiring high visual and/or manual precision and coordination, where the height of the work surface is adjustable, a working height above the elbow (**A**) is advisable (e.g., between the elbow height and the elbow height plus 100 mm). The adjustable height of the work surface can adapt to the body dimensions of workers, changes in posture, the different sizes of the objects that are handled and specific force demands; this height must be easy to adjust.

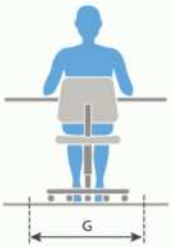
The following table shows the recommended dimensions:

	Custom adjustment	Minimum adjustment	Maximum adjustment
A - Working height	Between 651 and 751	507	891

Units: mm

SPACE REQUIREMENTS FOR LEGS AND FEET





It is essential to provide the minimum necessary space for workers to position their legs properly when sitting, and to encourage leg mobility. If the necessary space is not guaranteed, postural problems associated with incorrect posture may appear.

The following table shows the recommended dimensions to position legs when working in the sitting position:

	Custom adjustment	Minimum adjustment	Maximum adjustment	Not adjustable
B - Height of leg space	594	495	820	
C - Depth of leg space at knee height	350			547
D - Depth of leg space for feet	653			882
E - Space for leg movement under the seat	253			285
F - Seat height	449	370	535	
G - Width of leg space	714			790

Units: mm

Figure 16. Design recommendations for the workstation