



# Study & ergonomic improvements in the manufacture of incandescent bridges for electric detonators

## **UEE Initiation Systems**



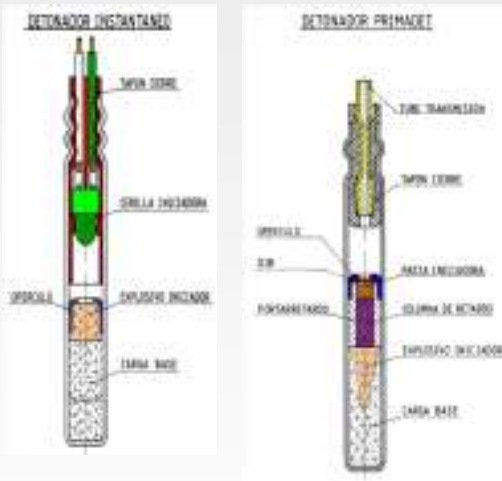
# The UEE Group. Leaders in the sector.



Located in a privileged natural environment, the Galdácano explosives' factory houses various sections of the UEE Group's different Business Units.

The Initiation Systems unit is leader in the manufacture of detonators, cord, fuses and boosters.

It has a workforce of over two hundred people.



# The UEE Group. Leaders in Prevention.

## Corporate Policy on the REDUCTION AND MANAGEMENT OF OCCUPATIONAL RISKS

The UEE Group is committed to providing all of our employees, contractors and visitors with a safe place and system of work. As UEE we are aware of the unique characteristics of our industry and the risks involved in the delivery of diversified employee services. To ensure that the Health, Safety and Well being of our employees and contractors remains our highest priority, a list of key basic principles has been produced. These principles constitute the UEE CORPORATE POLICY ON THE REDUCTION AND MANAGEMENT OF OCCUPATIONAL RISKS. These principles are to be cited as guidelines in all decisions made with the Company and are to be communicated to, and elicited by every employee, contractor or visitor acting under the direction of UEE:



- 1 All accidents and injuries are avoidable.
- 2 The development of preventive actions is a Management Function, and, in each, all executives and managers must take an active role in exercising leadership in the application of preventive actions within their areas of responsibility.

3 The protection of the Health, Safety and Welfare of any person (or person's) who may be affected in the course of UEE conducting its business is a core principle of our business development.



4 As a fundamental preventive action we provide all our employees with adequate training relating to the risks associated with our processes, raw materials and products manufactured. This training includes detailed instruction regarding preventive measures required to minimize such risks. Consulting with relevant competent authorities as such risks deserves the same definition.

5 We commit ourselves to continuous improvement in the use of our resources and the progressive reduction and management of occupational risks typical of our business activity.

6 We regularly inform our customers on the characteristics and risks of our products, giving advice on their transport, storage and appropriate use.

7 We believe that when carrying out their activities, contractors and sub-contractors should adopt the same level of risk reduction, or elimination practices as those specified in the Company operating procedures or standards.



8 Risk assessment techniques are used to adequately evaluate the occupational risks involved in all new projects and developments; risks treatment strategies are implemented, where required.

9 In all our locations, we observe compliance with all relevant statutes and laws, in addition to strict compliance with our Company Safety Management System including all Company standards, procedures and directives relating to the Management of Occupational Risks.

10 We ensure that these principles of Occupational Risk Reduction and Management are known by all employees and are applied in all our industrial and commercial activities.

Note: The Corporate Policy on the Reduction and Management of Occupational Risks will be revised at least every 2 years.

Our concern for Industrial Health & Safety is reflected in the leadership of management, and is detailed in the wording of the Prevention Policy and the Corporate Manual and Procedures.





# Background of the post

In 1997, there were two cases of illnesses caused by osteotendinitis of the carpal canal, in workers who normally carry out their work in the post making incandescent bridges for electric detonators.

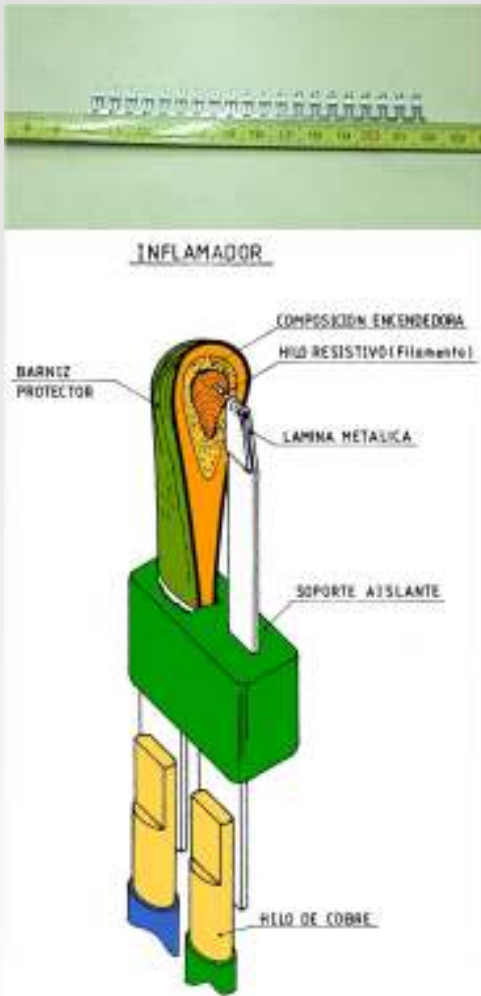
These injuries caused temporary sick leaves which seriously altered the installation's production process. As a consequence of the seriousness of the matter, both from a medical and industrial point of view, on the initiative of the Risk Prevention Service, and in collaboration with the installation's technical experts, a study was carried out on the possible causes of the said pathology.

Once the causes and possible origin of the injuries were discovered, appropriate measures were taken to minimize them and an analysis was then carried out to check the measures adopted.

The characteristics of the post will be described in this presentation, together with the improvements introduced and their repercussion on the re-evaluation of the ergonomic risks present.

# Description of the post under study

20 teeth form a comb



Machine with an embossed hoop on each surface from which a PVC band progressively makes the stamps, folds, welds and necessary checks, by means of placing a bridge of chrome-nickel wire to make the “tooth combs”, which are subjected to quality control.

The work consists of connecting the main electricity switch of the welding machine and that of the computer. The coil hoop and wire corresponding to the type of teeth to be made should also be positioned. Once the machine is started, the operator should control any incident that may arise during the process, such as:

- Failure in the wire welding detector.
- Considerable difference in the width of the “prongs” of the teeth.
- Off-centre combs.
- High or low weld resistance.
- Burnt wire.
- Opening of the teeth.

## Description of the post

The operator removes the production from the machine placing it in a small container. It involves around 75 combs every five minutes. Before storing, these combs should pass a quality control, consisting of the following:

**Selection or classification of combs.** Consisting of a visual control and later classification according to the width of the PVC band.

**Visual control** of the correct placement of the wire and correct welding to the tooth. This control is carried out by looking at the welds with a 10 magnification microscope, checking the correct proportion of the “prongs” of the teeth and that they are centred in the comb.



## Description of the post

**Cutting of the teeth.** This control stage consists of cutting and separating the teeth using pincers.



**Measuring resistance.** Resistance of the teeth is measured by an ohmmeter that registers readings in a microprocessor.

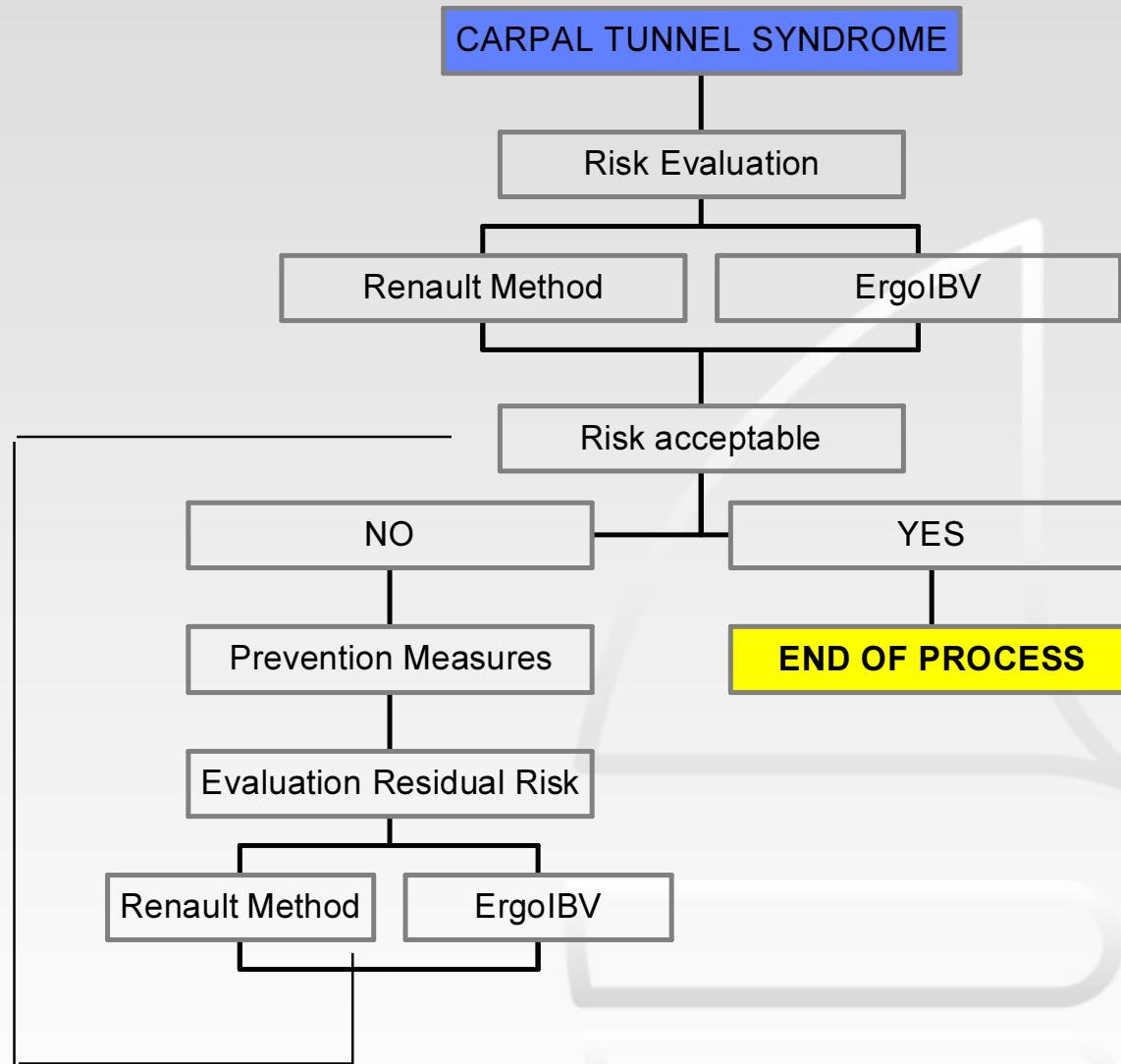


## Description of the post

**Placement on trays.** The combs made in this shift by the machine are placed on “trays” perpendicularly aligned with the bottom of the tray.



A fast and precise use of the fingers of both hands is needed for this operation, which can be comparable to the movement of a typist.





# Renault Method

- Four factors of global conception of post
- Eight evaluation factors

The analysis provides a satisfaction level for each criteria:

5 = Very poor or dangerous. Priority improvement needed.

4 = Poor or dangerous. To be improved.

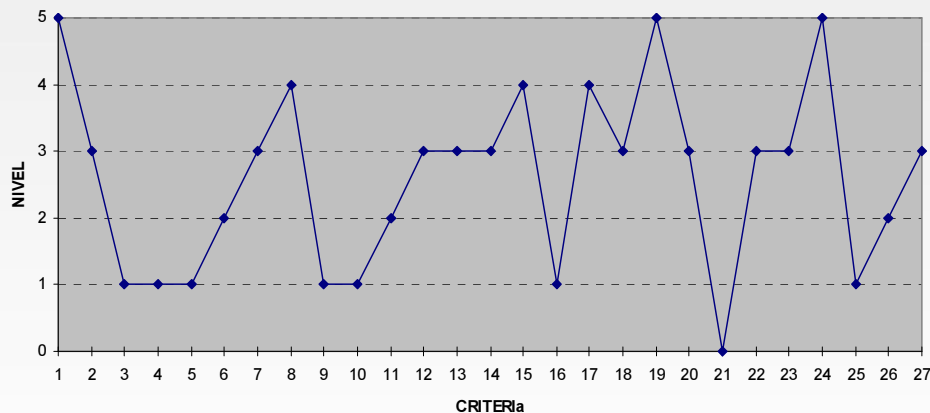
3 = Acceptable. Improve if possible.

2 = Satisfactory.

1 = Very satisfactory.

## Results in our case

Profile of BILHER machine



Factors	Criteria
<b>CONCEPTION OF POST</b>	<b>Height - distance</b> 1
	Supply - Evacuation 2
	Agglomeration - Accessibility 3
	Controls - Signals 4
<b>SAFETY FACTOR</b>	Safety 5
<b>PHYSICAL ENVIRONMENT</b>	Thermal environment 6
	Sound environment 7
	<b>Artificial lighting</b> 8
	Vibrations 9
	Atmospheric hygiene 10
	Appearance of post 11
	Main posture 12
	Most unfavourable posture 13
<b>PHYSICAL LOAD</b>	Work effort 14
	<b>Working posture</b> 15
	Maintenance effort 16
	<b>Maintenance posture</b> 17
	Mental operations 18
<b>NERVOUS LOAD</b>	<b>Level of attention</b> 19
<b>AUTONOMY</b>	Individual autonomy 20
	Group autonomy 21
<b>RELATIONS</b>	Independent work relations 22
	Dependent work relations 23
<b>REPETITIVENESS</b>	<b>Repetitiveness of cycle</b> 24
<b>WORK CONTENT</b>	Potential 25
	Responsibility 26
	Interest in work 27



# IBV Method

Method of Risk Evaluation applicable to repetitive tasks with upper limbs.

- Level of risk based on objective measurements of exposure factors.
- Very useful in complaints involving neck-shoulder and hand-wrist area.
- Average exposure of worker to successive tasks carried out during working day.
- Calculates the risk associated to the overall task.

To apply the method, it is necessary to compile information on the different tasks undertaken by the worker and their duration; as well as codifying work postures and levels of muscular effort and activity in each task.

## *Meaning of risk levels:*

Risk Level I: Ergonomically acceptable work situations.

Risk Level II: Situations that can be improved but in which short-term action is not necessary.

Risk Level III: Involves undertaking modifications in design of post.

Risk Level IV: Involves priority ergonomic intervention.



# IBV Method

	Risk of trouble or injury	Short-term	Medium-term	Long-term
<b><i>Comb selection</i></b>	Neck	II	III	III
	Wrist	IV	IV	IV
<b><i>Visual control of welds</i></b>	Neck	III	IV	IV
	Wrist	III	III	III
<b><i>Cutting of teeth</i></b>	Neck	II	III	III
	Wrist	IV	IV	IV
<b><i>Resistance control</i></b>	Neck	III	III	III
	Wrist	III	III	III
<b><i>Storage of teeth</i></b>	Neck	III	IV	IV
	Wrist	IV	IV	IV
<b><i>Global risk levels</i></b>	Neck	III	III	IV
	Wrist	IV	IV	IV

# Discussion of results

Applying the Renault method, the following shortcomings have been detected:

- design of post
- physical environment
- physical load
- nervous load
- in repetitiveness factor (non-compliance with IT)

Applying the ERGO IBV method, the following was observed:

- high repetitiveness of movement,
- inadequate postures (flex-stretch)
- insufficient rest periods for recovery,

# Improvements introduced in the post

## Conception of the work post.

Work table at 1000 mm. - real distance elbow -floor of the two workers is 1010 mm., including shoes.

Replace actual stool by another permitting:

- ideal support with legs extended
- ease to stand up
- relief of spine
- straight back position
- freedom of movement for legs

Design a table to include tools within the normal working areas

These modifications would allow the criteria:

- height in relation to floor and
  - distance in depth
- to be classified with level 1

In addition, by providing a large deposit for the combs, the collection frequency would be reduced and thus pass to level 1.





# Improvements introduced

## *Physical load factor.*

The criterion of static posture load goes to level 2 for the main posture and the most unfavourable. Now, having introduced the changes, the worker can either work standing up or sitting on the stool.

The criterion of dynamic work load passes to level 1.

Substitution of the pincers for cutting the teeth for another system that avoids efforts made by the hand,  
Reduction of cutting frequency according to the proposal to reduce the number of controls by more than 80%.

The criterion of posture during effort goes to level 1.

Due to work carried out standing up and drop in frequency of controls on teeth.

## *Nervous load factor .*

The criterion level of attention goes to level 3.

Although precision of work does not vary, reduced duration of visual control allows this improvement.

# Improvements introduced

## *Repetitiveness factor.*

The pincers used to cut the teeth were replaced by a pneumatic cutter activated by a foot pedal



This cutter is set in the table in such a way that the comb runs along a small rail and positions the tooth over the cutting area.

The tooth to be cut is held by the thumb and index finger.

Wrists supported by palm on the table in neutral position.



# Improvements introduced

The resistance of the tooth is measured by an ohmmeter also set in the table and in line with the cutter, so that without letting go of it in the right hand, the cut tooth is placed in the ohmmeter, the right hand being in a neutral position and the left hand uses the left-hand key of a mouse on the table to fix the tooth.

Pressing the right-hand key takes the resistance reading and sends it to the microprocessor.

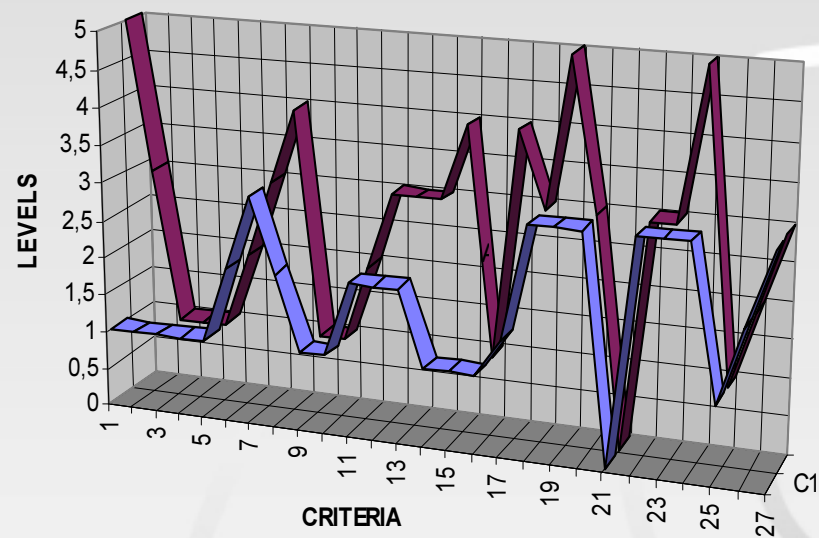


The tooth storage trays were substituted for 21x15x6 cm boxes fitted on a lever with the table. In this way, flexing movements of the palm are avoided when placing the combs horizontally in the box.



Renault Method

PROFILE COMPARISON BEFORE & AFTER MODIFICATIONS



IBV Method

	Risk of problems or injuries	short-term	medium term	long term
<b>Risk level - before</b>	Neck	III	III	IV
	Wrist	IV	IV	IV
<b>Risk level - after</b>	Neck	II	II	II
	Wrist	I	I	I



# Conclusions

The modifications made in the work post, as well as the modification of the Technical Work Instructions, have significantly improved this post.

According to the RENAULT method, from being at very poor or dangerous levels requiring immediate improvements, it has passed to acceptable levels.

According to the IBV- ERGO method, it is evident that from risk level IV requiring high priority ergonomic intervention, it has passed to:

- Situations that can be improved but not requiring short-term action, such as neck postures
- Ergonomically acceptable situations, such as position of wrists

Having evaluated the residual risks and according to the evaluation systems used, we understand that we now have a work post that may be considered fully acceptable and satisfactory in many aspects.