American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN: 2320-0936
Volume-03, Issue-04, pp-178-188
www.ajer.org

Research Paper Open Access

Working conditions for welders

Eduardo Ferro dos Santos[1], Karine Borges de Oliveira[2]
[1](Lorena School of Engineering / University of São Paulo (USP)/ Lorena/SP/Brazil)
[2](Production Engineering / Unisal / Lorena/SP/Brazil)

Abstract: - *This research examines from the point of view of ergonomics, the possibilities of intervention onimprovements in working conditions of industrial welders. We raised the main factors leading todifficulties and constraints in this activity, especially with regard to biomechanical conditions. Inaddition, the study presents a structured approach as the requirements of ergonomics Frenchconfronting the real problems of welders, which are not in work, performed by outsideconsultants who, in a sense, hide real conditions of work. It was through a case study, the majority ofwork in both the scientific literature on the work of external consulting expertise. The constraints of thewelders are characterized as postural and behavioral risks, not showing that behind these, there arecharacteristics of requirements the solder that force the worker to adopt efforts biomechanical posture to which they are unable to behave properly as stated in the research.*

Keywords: *–ergonomics, risk analysis, safety and health to welders, working conditions*

I. INTRODUCTION

For this research, it takes the analysis and discussion of theworking situations of industrial welder and likely proposedergonomic intervention in a mechanical assembly of industry,from internal demands and pre-existing work carried out byexternal consultants. The analysis begins in the field informing a support group (called in this work-force task) thatassists the researcher in the analysis and understanding ofactivities, this group composed by the welders. Differenttechniques are used in research, such as direct observation,statistical observation record of biomechanical variables(physiological and Kinesiology), building on a collection ofdata related to information of the object under study.

The activity of the welding industry in question the need forresearch, in a first level of formulation, process of respondingto that in industrial activities of welders, is understood as aprocess of work necessary for the conduct of their duties.

Thus, given these explanations, a second question for theresearch comes to establishing the company under study, whatare the factors that related to rates of accidents and diseasesfrom the activities of industrial welding and that the companyis doing to manage these issues, beginning of course. The establishment of harmfulness that are submitted the subject intheir work processes and what the previous work that mayhave contributed or not the assessment of the difficulties andconstraints of the biomechanical welders. A company in thearea of mechanical assembly, inside a steel factory inPindamonhangaba, São Paulo, Brazil, selected as the unitof study.

II. THE COMPANY'S INITIAL RESEARCH

The demand

The company contacted and received the attention ofthe Medical Professional, who started the initial schedule forthe discussion of the work. In this discussion, theproposal presented to the completion of an ergonomicanalysis of work in order to care for a demand to given bythe company, which coincided with the current needs of thesame conduct in this work. The Medical Review of Laborshows that the company has invested in studies of occupationalhygiene and ergonomics and has no satisfactory return of thiswork, because the rate of absenteeism by musculoskeletaldisorders has been growing gradually in recent years.According to him, given the analysis of this function, morethan half of the company assessed, as the existing manualprocess is now completely dependent on this activity.

It found that the vast majority of searches came fromoutpatient welders. Of these, the most frequent related tomusculoskeletal disorders.
Even as demand, the company say that the future possibilityof extending the work of ergonomics research in the otheractivities of the organization in a proactive vision, as thecompany moves to the process of certification to OHSAS18001:1999 [1] and need for job analysis proactive risk to meetthis certification.
It is for this research to investigate the causes of, seeking thestatus of work to explain them. As the posture is a dependentvariable (not free) the constraint can found in the posturaldemands of the task in your product and obtained, theequipment and tools, etc.

The stages of progress of research

The basic steps established by the methodology used in thisresearch is proposed on the formation of a participatory group(task force) in order to collectively analyze the work, coveringthe prescribed task and analysis of activity in different stagesof the real work and the analysis of work of advice onergonomics developed by the company.Through this method, the contacts established by a group ofwelders used to systematize the observations to identify thespecific requirements of the processes related to ergonomics.The group studied includes the experience of a group of 08pre-selected by officials of the area supervisors, based on theirexperience of more than five years in office.
Accordingly, there were interviews with: group of welders, coordination of operations, safety engineering, chosen at time of field research on a random, asexercising their duties, with observations open the work ofwelders, followed by verbalizations about the activity, totalingover 450 hours of fieldwork settings and reports.We also collected information on official documents on theorganization of work and on the population under study, buthave not found (or supplied) detailed flow of production. The researcher a plan of systematic observation of the activity of work, which allowed reaching the final diagnosis and recommendations to overcome the problems identified later defined this.
The data for analyzing the characteristics of the populationof workers were in general, scattered among several locations(sectors) in the company, and filled in various forms and codedaccording to their nature. Some, such as indicators ofproductivity, health problems and accidents at work weredifficult to obtain.

The task of welding in the company

A striking feature of the activities of welders in theindustrial enterprise is its wide range of tasks, which, in manycases in which maintenance activities conducted outsidethe warehouse, customers in industries, even in open sky, as inthe case the maintenance of cookers. In each project there aresignificant number of activities, each project generates aunique final product, most times not exactly, an activity issimilar to another in their working conditions and humanvariables. This entails various problems, hindering theestablishment of a standard solution related to the organizationdevelopment of measures for the protection and physicalintegrity of the employee.

The activity linked to human factors that need large amount of workers and the physical strength of theoperator feeds the manipulation of pieces by the interface withthe brazier and the assembler. The labor of the worker is upalmost exclusively in the handling and use of tools (weldingequipment, mallets, keys, etc.).The tasks delegated to employees, according to the companydocumentation, are: the manufacture of light and heavy piecesof steel, consisting of mapping, cutting, notch, bend, mangle,bridge, build, weld, test, wash, paint, inspect, packaging andstorage, and repair parts in the various sectors of the steel millcustomers. Given individual protection equipment for theactivities in the company, such as coat of scraper, safetyfootwear, gloves scraper, welding mask, safety glasses, earprotection, gaiter to shave and others.

The productivity of the sector given by the relationshipbetween indicators. Efficiency, which combines indicators ofratting security (score proposed by the work safety inpercentage that ranks the performance of the sector in relationto work safety and environment), productivity, costs and hasthe limit considered acceptable if over 1.0% (not given accessto the type of calculation in any of the indicators).Another feature of the company is recruiting people withtechnical training in methods of welding, as required specifictraining. Consultations the department of human resources ofthe company to demonstrate the systematic recruitment ofemployees from the removal of technical courses for industrialwelder's SENAI (National Services of Industrial Learning) orschools for that purpose. The tasks require specialized almostmore rigorous selection, which is the practical application oftest relevant to the function requested, held opposite points ofsoldering. There are also courses in business development ofthe workforce, usually directed to the most qualifiedprofessionals.

The day's work distributed in three-fixed shift of 8 hours, in anon-rotating. In peak periods, where there is increasedproduction and effective temporary, an accumulation of tasks,with imposition of accelerated rhythms and overtime (onaverage 3 hours per week) for better utilization of each stageof the process. These peaks are given in construction ofhydroelectric power plants and particularly, but not have a characteristic average pre-set time. The rest breaks and lunchare fast (about 15 minutes), in the workplace, with

longerintervals for lunch (1 hour) in the company gym work (15minutes at the beginning of the shift) and 10 minutes ofdialogue Security (DDS) as always in the early rounds. It alsohas enough time to voluntarily the physiological needs.

The organization of production

The order for the manufacturing sector of the weldingengineering sector of production, then, is the materials sector,which through budgets and purchases, provides the necessaryexpenses. The engineering of production defines the design ofthe piece and the service sector. In general, theplanning of production varies according to the request andtakes a day to 3 months, depending on the size of the project.

The welding industry depends on the punctuality of othersectors, such as heating, planning and warehouse, as is mostoften the last activity in the production of a play, as timebegins to run before the play reaches the welding. In general,there are no delays. To set the time that will employed witheach order, the planner makes an estimate of the timepreviously used with similar items and with the completion ofthe piece, computed the time spent in its completion.When the order reaches the manufacturing sector in chargeof this welder that will define the service, depending on theamount of tasks for each. The welder should then follow theprocedures prescribed for their work, which delivered byresponsible for the shift, which received the same area ofproduction planning. The worker must record all events (timeand code) for its work in the play of note in the bulletin of theworkforce. After their work, the pieces are for quality controlto verify the need or not to rework due to possible failures thatoccur in the solder joints that often occurs with the reworkto remove the solder, cutters, hammer and the new process ofwelding and inspection.

The Engineer of Work Safety, the number of employees inthe company declined in recent years due to societal changesin the company that reduced production and consequently theeffective. However, in the case of welders, the renewal of themanagement of staff is difficult because not if you think theworkforce available due to the growth of construction industryin recent years.The company's installations do not have a proper state ofrepair. The noise of the environment is intense, said the changein the PPRA 2006 (Prevention Environmental Program) are 82to 95 decibels (93 dB on average) that sometimes comesfrom other sectors, or grinding equipment. The operation ofequipment depends directly on demand. Therefore, the noise may be lower or higher, varying accordingto the number and type of activities in operation. From a briefanalysis of the results of noise monitoring carried out by anexternal consultancy in 2005, concluded that the vast majorityof employees exposed to noise levels that require the use ofprotection equipment and other measures to control noise.

Workers already use the ear protectors and the department of occupational health now identified conduct periodic audiometry, with no cases of hearing loss.The risks of smoke present in the welding industry regarded as the most critical condition in the literature. For thesake of direct exposure of the worker and the daily livingenvironment in the sector which is minimized by fans andexhaust. However, not out the characteristic of an unfavorableenvironment for the health of those who develop theiractivities there. Also in the environmental monitoring carriedout by external consultants, the levels are within limits and theEPI's (Individual Equipment Protection) listed are sufficient tominimize the impacts to human health.The lighting is good and efficient as well as the ventilation,due to large openings in walls. The floor is uneven in the shed covered by waste, grease, and dust particles that areslippery, making walking workers. There was large number ofpieces of different sizes and work equipment scattered on thefloor throughout the length of the sector, hindering themovement of workers and allowing sometimes accidents andfalls pieces. There are a few boxes of welding in the industry(4 existing), with quarters of work for small parts. At this point,the lighting is poor. The boxes have shelves, but there is notsufficient to house parts and tools.

Support activities in the areas of steel mill customers, thereis an activity of high criticality, the welding of resistance ofpots and ovens. Here the activity performed in open air or inimprovised sheds with canvas. In the solder pots, the operatoris common to spend two days in the development of a piece,with a daily demand service.With respect to tools, there is a routine preventivemaintenance for these vehicles and most of them are outdatedand extremely heavy. The wheels of the carts have no welding and specific lubrication carts with wheels locked wherethe operators have to drag the equipment.The EPI's are used for specific purposes indicated, however,for the helmet, it is poorly preserved, heavy and sometimes wecan hardly see through it, allowing it only to see sparks fromwelding.

As the organization of equipment on the desktop, it wasobserved that the sector does not provide safe workingconditions according to the improper disposal and the largevolume of inputs and other instruments deposited in theworkplace, there are risks of injuries and falls in handlingsector. Accordingly, the issues are out of the clutter of trafficof people and in particular the workers, as well as thereduction of physical dimensions for the assembly ofequipment, thus characterizing a condition of employmentwith sufficient potential to cause accidents and damage tophysical integrity of the worker and the other operating inplaces.Regarding safety, all staff said that the company providesand ensures the replacement of individual protectionequipment (EPI)

necessary to carry out their duties and saidthat the company requires the use of EPI's, agreeing with theofficials the need of them, but feel uncomfortable.
In searching the internet, we found several suppliers ofequipment for welding, not the same distribute (sell) moreexisting models in the company (the models in this study).Today, a helmet can found around 60% lighter than thoseused in the company can and the advances in technology to combatthe inhalation of smoke from welding are great. It seems thatthe company did not have to worry about updating theequipment and insists on staying with the same old and evenwith improvisations.

When asked about the dangers of the work they perform themajority of workersconsidered dangerous due to the verynature of work. In addition, in the field trip, it noted that inattempting to store the materials in the optimization of space,to occupy the smallest space possible. There are shelves onwhich the welding carts are stored at times not recommendedfor the proper handling postural therefore require that thewelder stay the same weight to save on the shelves.This shows the great concern ofthe firm on the issue of workplace accidents due to the rigor ofthe Brazilian labor legislation [2].

In explanation of what the most critical and uncomfortableto work, all were unanimous in citing the pans. The pans take alonger time, because cracks have to weld whichsometimes have more than 1 m in length and up to 10 cm in diameter. This makes it more difficult to weld and takespositions that require more time. For no specific locations forthis activity, it is the entry of customers or sectors in theexternal area opposite the hangar for maintenance and do nothave a suitable cover, with characteristics of a specific sectorof solder. During the afternoon, or when the midday sun, thereis activity being carried out in these parts, which are veryuncomfortable to welders. The head of the industry claims thatthis activity carried out sporadically and recently, moreexactly 3 years ago had an increase in demand and not yetadapted to a specific sector that. Says that the company has not yet approved a specific location, but there areprojects for that. I question where they are and he laughs saysthe head of personnel.

III. ERGONOMICS ANALYSIS

Comparison of initial findings with the task force

For a comparison of findings at first examination, the researcher workers throughout their working day (480 minutes) in various tasks observed three. These comments thenfollowed in the chronic form of activities, which enabled thedevelopment of the steps below:
- Preparations start in the industry - Before starting theirduties, the welding part of a DDS (Security Dialogue)where they discussed issues of production, the company'smanagement, health, work safety, with activities in gymwork;
- Receipt of instructions - with the leadership, the welderreceives instructions from work orders through theservice and by informal means;
- Displacements - Walk throughout the company in searchof parts, materials, equipment, instructions, amongothers;
- Meals - Food Main and coffee;
- Preparation of materials - Adjustment on equipment,materials and parts;
- Physiological needs - Bathrooms, water, among others;
- The consultation procedures - the consultation documents,orders of service, boilermakers and leaders;
- Inspections in the service - Verification of the serviceperformed in the play and equipment;
- Welding - Output of solder in itself;
- Standby Time - Time spent waiting and other features inwhich the employee performs breaks from the process

In general, it perceived that the tasks of the welder doesnot restrict the solder itself. The welder most often performstasks such as preparation of welding, soldering, sanding,inspection and marking, which are inherent duties in this role.One of the most important constraints in this task is that thereis great variability in posture due to the diversity of parts,creating static postures moments specific to each piece orpoint of solder, which maintained for periods that aredetermined by the characteristic point of welding. For example,the higher the place to welded, the greater the residencetime in a static posture.The errors considered hazardous by characteristicrelevant to welding. One example is that the official in anattempt to weld a fast can cause lack of fusion and penetrationin the weld and this leads to cracks and reduce the resistance ofthe solder. This then is one of the reasons that makes theemployee is in a long position or holding a piece, because if itis fast, no fusion of solder.Improvisation of the seats also occurs due to variability ofpostures necessary tasks. In certain moments, there is a needfor support or to sit, to which no specific equipment for suchbehavior, because the engineering processes do not provide them and supervision, where the welder improvisesomething to support or to sit and this improvisation for it isoften useful and begin to developed / used by other welders.

The observation in working highlights the rigidity of posture,muscle contraction, the extreme angles, environmental risks,and the discomfort of EPI's. Employees perceive the negativeimpacts mainly of posture and environmental conditions. Thephysical burdens, with forced postures are stores in almost allactivities of the

welder, whether in the handling of parts, use ofmachinery and tools, among others. Complaints of pain in thearms, pain in the body and physical fatigue are the mostcommon reports of physical overload. The worst condition given according to the reports of the solder pots, to requiremuch time in the same posture and sky.

The distance from the electrode to the piece influences theposture for long periods of trunk flexion in order to close thewelding, because the greater the distance, the greater are theproblems of fusion and low resistance of the solder, whichleads also to crack and cracks that lead the future rupture of thepiece.The loads with significant professional standing or movingparts andcharacterized by the welding equipment duringthe operation of final selection of the piece and at its assembly.Of comments, most of them stop and carries a maximum 15 kg.Loads above 30 kg cannot be handled individually, accordingto company rules, but what you see is the individual handlingof up to 60 kg at times, but low frequency of approximately 10to 15 times per turn (as reported the welders). Hydraulic equipment, forklift, and traveler usually transport higher volumes or carving, depending on the location is ready, butthey are all moving in the same place.

Regarding the prevalence of musculoskeletal pain, thewelders used expressions such as back pain, problems in thespine, back pain and arthritis of the knee. Complaints ofshoulder are also common, as several times adopt the posturefor lifting the arms into position above the static level of theshoulders.One of the constraints is the most typical disruptionthroughout the industry. Inobserving the layout of the sector there has, in most cases, thearea available for storage of material and equipment isinsufficient obstructing the movement of work from the sector.Thus, the trader uses to stock immediately, close to their placeof welding, which require everyone to move constantlybetween pieces. There is also a need for welder's frequenttravel in search of tools, which are not always available onyour desktop, because according to them, no one keeps theequipment in part exchange. This is because the lack of placesfor this organization.

The production process is very dynamic. Several operatorsworking at the same time in different parts of the samemachine as the determinations of the supervisor, except in theactivities of the solder pot, which is fixed. Notes from the field,variability of time pressure and does not note the time ofproduction during the field research.

The pre-diagnosis as the target of systematic observation

As such, maintenance of postures for a long period identified as the main difficulty of welders, since these lead tofatigue, leading to accidents and musculoskeletal pathologies.They stay for a long period in the play needed for thesolder does not present problems of fusion and escape thecontrol of the operator. For more to try to maintain goodposture it is not possible for the necessary condition for goodfusion of solder, which requires that the welder stay longerand closer to solder.

The cases of removal by musculoskeletal disorders isincreasing in recent years, mainly for symptoms related to thespine and shoulder. Among the reported activities, requiringmuscular discomfort there is a solder in pots, which willgenerate uncomfortable postures for long periods, held in theopen. This increase has been a common feature the work ofwelding, which require efforts of biomechanical welders. Thispre-testing provides an explanation for the probleminitially in demand. From this point will be chosen the mostappropriate methods to work in the clippings will be made inthe activity.

The systematic observation of the condition inbiomechanical analysis of activitiesthe systematic observations made based onpre-diagnosis. It outlined a plan based on a cutting remark. Forthis initial phase was chosen stock variable time to understandhow they are distributed along a weld. The task identified asthe most critical positions in the maintenance of thesestructures forced by long period is the maintenance of cookers.In general, is to hold patches cracks in the pots used insteelworks and forge the steel industry customers. Theoperator who performs the solder remains for days in thisactivity. The solders have large diameters and thicknesses,requiring more time in carrying out activities. According to thereports, the welder stays by 2 to 3 days in one piece, but thedemand for parts is continuing and the client needs this pieceroutinely repaired. This activity is even avoided by theoperators, but generally end up with more experience are betterconsidered and more time in the company because it is a pieceof risk of the customer and a service of welding accidents cantrigger bad run with the casting of liquid steel pan, or even tobreak the pot.

There was the analysis of actual activity of work,considerable gap between job requirements and work. Thesolder pots, it was noted that not all employees enjoy this task.Traders attributed that to "know" that this activity takes longerto pay, more time to remain in static position. The reason related to the care that the welder must have finished in each ofthe cracks (the local soldiers are). Then perform some typeof voluntary pause, because if he weld "part" of the crack, theplace can cool until even if it exposed to air and dust,making it possible to crack occurring in this region. Countingwhich usually presents a pan 3 to 4 cracks and that each crackcan take up to 3 hours to welded, the welder is to remain fordays in the piece.Thus, while other activities of lead solder and less time tocomplete and therefore less time in static position, are theoldest in the task involved in this activity. This fact leads himto understand that this activity by having to move less, is lesstiring, without

thinking whether it is in this pot, it requiredmore time in prolonged static posture and the risk of quality ofwelding (cannot stop not to generate cracks) is higher in thistask.

The times in a welding of pans obtained through theobservation of five welders in five times of each operator and theaverage obtained. Systematic observation of a spreadsheet wasprepared to be able to monitor the transition from one action toanother and the interval between them. All actions confronted with the demand and given by the removal ofvariables that relate to the growing number of injuries andcomplaints of symptoms related to shoulder and lumbar spineduring the welding activities. Posture of flexion ofthe lumbar spine during the execution of activities andposture andmotion in flexion of the shoulder during the execution ofactivities.

Generally, this occurs by specific requirements and the taskof welding and not misconduct of the welder as shown. Thesemovements and postures adopted by welder repeatedly, foryears, can affect your muscles and even itsconstitution-articular bone, especially the spine and limbs,resulting in short term, in which pain extends beyond officehours and long term, can result in permanent injuries anddeformities. Many authors studied in this work, the welder's areparticularly susceptible to injuries in the back by the fact thatthey remain in this position for long periods. In the case of thewelder of pans, this period may be even greater.

A systematic analysis given on an observation of 30minutes, which is the average time that the operator remains inthe activity without pause. Extrapolating these data to theaverage time for completion of the welding activities ofsystematic observation (124 minutes in the day), whichrepresents 26% of the total time of the day. Thus, given thesample refers to 25% of the total time of welding. For theevaluation of variables, were used the necessary footage andinterviews in an attempt to identify the main constraints. Thetemporal data recorded, as shown in the related itemsbelow.

- Sequential welding: weld the part, inspect the weld,welding electrode exchange, get the helmet to view theweld, get the helmet to continue welding, cleaning of thepart / welding, no action;
- Changes in the lumbar spine: standing, sitting andcrouching down (all positions examined in lumbarflexion and neutral position);
- Movement of the shoulder: the act of welding, a bendingof the shoulder against resistance in which they wereassessed as in flexion and in neutral position.

Based on these findings we can observe that:

- Helmet - This activity performed with amovement of flexion of neck motion in acceleration andstop, making the weight of the helmet by the kinetics ofthe movement close up. The stride can cause long-termpain in the neck and can be harmful if the individual hasdegenerative pathologies in the cervical region. Wereperformed 20 movements in the sampling period, wherethis extrapolation on the total day, up to 160 movementsper day;
- Lift the helmet - This activity carried out with theopening of the helmet with the upper limb, most often theleft and presents no significant risk. Are carried out inorder to display the (inspection) of the welded area isreduced when the helmet is closed due to the blurringlens of the worker protection.
- Operators perform these activities in the inspection of thewelding helmet that is handled (open and close), it doesnot display automatically (already available and low costin current technology) and that was not acquired by thecompany due to ever be asked (and leader of the secondarea) to the general direction. It is worth highlighting that:the greater the time to stop to inspect the weld betweenan electrode and another, the greater the risk of formingcracks, but this parade is physiologically beneficial to thewelder so he can get out of a static posture for longperiods. This inspection is performed to stop constantlyto "see if it does not bubble," according to the operator.The leader also said that when asked if have to do this,because if you play the bubble can generate and weldcrack, predisposing to accidents. This does not occur asdetermined by the company and, yes, but securitystrategy adopted by operators.
- Inspection or cleaning - are made in cleaning burrssporadically. Among the range of an electrode andanother is a visual inspection done quickly. The absence of suchfavors the corrosion of solder.Exchange of lead - in period of observation were 19exchanges of electrodes, in which extrapolation of theworking day on average represent 76 trade. You couldsay that the exchange considered beneficial, becausenow there is that both the shoulder and the spine remainsin neutral position. The mean change observed was 04seconds, with minimum of 02 seconds and maximum of07 seconds. Several precautions must take withelectrodes. It begins the same size as your gauge varies asthe size of crack or notch to weld. This difference insize is also with the welder change constantly accordingto the gauge thickness where the crack in time. Otherscare about the storage and handling should made tohave a good weld.
- Welding - The welding activities are the main riskassociated with musculoskeletal disorders in the spineand shoulder in this work. The welder when weldingremains in long period with flexion of the spine andshoulder flexion (bending motion in the shoulder againstresistance). A prolonged stay in this position may thenlead to the tables above. The posture of the shoulderflexion maintained by 21 times, representing 70% ofthe time of the sample (then totaling 21 minutes).Whereas throughout the day, remains so forapproximately 01 hours and 20 minutes. The minimumobserved was 02 seconds and a maximum of 01 minutesand 03 seconds with an average of 25 seconds. In lumbarspine, the activity of solder integrated part of otheractivities such as bending in standing

posture, in sittingposture and posture under knees, which togetherrepresent the same period observed in posture associatedwith the shoulder;
- Postures - There is a predominance of crouching downposition (52% of the time), followed by sitting (44% ofthe time) and standing (4% of the time). The sittingposture may adapted by an improvised seat by thewelders. In the standing posture, the worker stayed forless time, but depending on the place of welding, thismay be higher. Have the attitude under knees, in additionto load spine, may also pose risks of injury associatedwith knee joint. All the above positions observed inneutral and flexed postures. Welders should forceinto positions that do not even want because he is closerto the weld. The extreme distance of the electrode canalso generate the problem of fusion and penetration thatleads to cracks in the solder. The distance also favorsexaggerated the asperson of solder, which thencomplicate the cleaning of the garment and can be thestarting points of corrosion.The angle of solder influences the quality of welding. If thewelder does not use proper angles according to the places ofwelding, the weld can become fragile, and have difficultieswith porosities of fusion. To ensure these angles, forcedpostures as the trunk and upper limbs are required for longperiods.The positions of flexion of shoulder and lumbar spine arealways associated with muscle tension is maintained by thesame, whether the context of apprehension in performing anactivity in a solder point. Furthermore, the static posture isone of the staff responsible for the development of pain(musculoskeletal).

To show fatigue in the shoulder, was held in the collectionelectromyography welder, which were used two electrodespositioned in the deltoid muscle, the middle portion, in theirpoints of origin and insertion.We observed a decrease in initial median frequency whencompared to end, from 652.98 in the initial collection (held to09:00 pm) and 572.98 in the second collection (held at 11:00pm the same day). Index clearly the presence of fatigue fromthe second collection, made 2 hours after the initial collection.In flexion of the shoulder evaluated, could observed inflexion associated with abduction of the shoulder than 45. Theopening of the arms considered excessive since graduationgo beyond this to be a contraction of the muscles andsupra-spinous upper trapezius, which undermines the cervicalspine and scapular waist.

After reviewing the positions, it was possible to identify thekey attitudes that adapted during welding. Deflection with abduction of shoulder, Deflection of thelumbar and cervical spine, more pronounced in thelumbar region leading to lack of support for the lumbar spine,tilt the head to visualize the solder, inadequate support andinadequate seating.These postures trigger pain, discomfort, fatigue andpredispose to acquire the professional musculoskeletaldiseases. The welder does not perform scheduled breaksduring the day, but takes voluntarily ranges between a solderand another to chat, reflect on the work performed (options tobetter point of solder) and when required for the activity forcoffee, a water and achieve physiological needs.
Work performed with both hands and this choice leads thewelder to adopt a position of work where he must be near thepiece of equipment and materials. This makes it a lead solderwith a higher degree of tension due to static posture of thetrunk and shoulders. The welder has to move to differentpoints depending on the point or path that needs to welded.This system of work will be stressful to work on the workingtime, but may encourage the breaks in static postures held forlong periods.

A risk factor, skeletal muscle can defined operationallyas a generic term for the factors of work that have associationwith musculoskeletal diseases. The main determinants ofthese factors work disorders are fixed postures, repetitivemovements, and use of excessive force, vibration and lowtemperatures. Thus, the ill are related to several factors thatact of working together, not allowing the workers to adapt tophysically and mentally for situations at work and that,therefore, any preventive action should consider the capacityof all persons involved to seek strategies for transformation ofworking conditions. The nature of the work of the welderrequires the adoption of positions away from the central axisthat regulates the field vertically and horizontally. This ismore important where the duration of the task is a factor ofaggravation. In the case study identified as unfavorablepositions on these.

The welder adopts positions that are static, withshort movements, and it can take a certain position for half anhour or even a whole day, which represents a factor ofphysical stress. Most studies on the problems of themusculoskeletal welders focuses on problems related to theshoulder joint complex, for the most part receive the loadfrom both the posture and the maintenance of the hand tool,with a consequent increase in time on the shoulder, thewas evidenced in this study. The welders have highprevalence of musculoskeletal symptoms and signs because,first, that the load on the shoulders, neck and lumbar region.Thus, the work of welders can described as "a work withstatic postures typically characterized by specific patterns ofmovement of the articular complex of the shoulder andspine." For each general posture of the body, there arevariations in the positioning of the arms and hands, for whichthe task of the welder requires their position and attitude inspace is of high precision. The muscle fatigue characterizedas the fatigue experienced in regional muscles in response tostress and posture, and manifest as pain, has also decreasedengines.

To demonstrate the findings, elements of the activity couldthen be broken down again, now taking into account thesystematic observations given in the activities, with their mainproblems and considerations that lead us to the diagnosis. Theactivity of welding presents biomechanical requirements asstatic posture of shoulder in

flexion with support of the helmet;static posture of the trunk flexion (lumbar and cervical),uncomfortable postures of legs in the squatting position (heldin a few moments, given the flexibility posture), requiringconcentration and attention to avoid rework and solderingproblems.Given the findings of the validation and confrontation withthe players, the activity of weld itself still needs care as:

- The arc length directly affects the width of the pool thatshould fill the crack. You must be the shortest arc possible, soyou get as near the weld. This control of the length of the arcvoltage is to be done so carefully, observing the otherparameters such as contamination of the electrode, improperfeeding of material addition, changes in temperature in theelectrode and the electrode erosion;
- The speed of progress affects the penetration and width inthe process, the latter much more affected. Itsimportance lies in the fact it determined the cost of theprocess to closely link to the speed of the process.However, many times the speed it is only a consequence fromthe definition of quality standards and uniformity. In the caseof speed, cookers may not be high because it cannot fill thevoids properly. Is increasing the speed of feeding the wiresolder it produces less penetration and decreasing convexprofiles to increase speed to penetrate, which is not the case of pans. The low speed alsofavors the posture of the welder, favoring the tablesof postural fatigue in low back pain;
- The shape of the feed material for the addition is anotherimportant parameter. In manual processes, the way thematerial added influences the number of passes and theappearance of the finished weld. The more electrodes USA isin the same weld, the greater the chance of cracks and flaws,as the composition of the material may be slightly different. Ittries to end a piece when it starts to work on it.
- The contamination must be avoided, but more a factor tostay for long in one piece. The contamination occurs when theelectrode welder accidentally dip the electrode in the pond orplaying the lead with the addition of metal. An improperprotection can also cause oxidation of the electrode andconsequent contamination of the solder. Other sources ofcontamination: vaporization of metals in the arc, oreruptions of aspersion pond caused by trapping the gas andevaporation of surface contamination. Contamination canaffect the characteristics of the arc and cause inclusions in theweld metal. If this occurs, the operation should discontinued and the contaminated portion of the electrodeshould remove, with new grind in accordance with therequired characteristics at the tip. This creates even morework to the welder. The atmosphere on the side opposite the solder can also contaminate the solder. To avoid thisproblem, try the same welder at low speed; not stopping until they finish the face welded and it may take up to 3 hours.
- It must take not to be too much pressure, especially inthe last five centimeters, to prevent blowing of the pond orconcavity of the root, which is losing the solder in pots.
- Any stop in the filling of a crackpot of (pond) generatesdiscontinuity. When these discontinuities lead tothe material does not meet the requirements of the work to done they are classified as defects. The typical causes of theseinclusions are in contact with the electrode tip pool, theaddition of material contact with the heated tip of theelectrode, the electrode contamination by aspersion of thepond; extension of the electrodes beyond the torch, resultingin overheating; Electrode improperly arrested; inadequaterates of gas or excessive winds, defects as cracks and broken.Along with these factors, the age of the welders considered in the research on the effects of work on themusculoskeletal system, as older workers to remain in solderpots. Despite complaints of shoulder, pain had been associatedwith the worker's age, characteristic of older workers are not,and however, a phenomenon solely dependent on age, may appear in younger welders. The main difference lies in the factthat in most new welders, relaxation and exchange of workcan result in regression of symptoms that, in older, tend tobecome chronic. Thus, in addition to the experience of thewelder does not guarantee immunity against localized musclefatigue, you should consider also that the cumulative effect offatigue can affect the body's response to the continued workin inappropriate positions.

The exercise of the profession of welding leads then to usethe same intense way of the upper limbs and spine, which cancause musculoskeletal pathologies. However, in addition tofixed posture, stress as a component that can enhance theconditions of work. Allied to this are also the hereditarycharacteristics and lifestyle adopted by each.The issues driving the activity of work presented in theaspect of physical and cognitive work. The cost of upper limbposture and spine in the activities of solder pots (major causeof complaints among welders) are due to the size of parts,length of stay and they need to see well the solder to avoidcracks and rework other. Therefore, that contrary to what you think inthe activity of soldering (handwork) is very prompt andintellectual attention. Thus, the questions turned to broaderissues related to technology and distribution of employees inthe company.

Terms of conduct ergonomic

For the recommendations suggested in the workplaceevaluated, it considered for both the views of socialactors involved in the task force. Now, it added because of the inter-relationships and by selecting somerecommendations that deemed important, emphasizing thecritical points that observed. Some ergonomic proposalsare impractical and costly in the short term and others in theface conditions under which the work

executedare independent of the emergency core charges.As can see on visits to the achievement of this research, there are factors that converge in the technology andinsecurity in the activity as a whole, starting with the locationof buildings, always in the open areas and lack of technologyto support the pieces. This deficiency of technology used atthe solder pots causes of accidents and injuries amongworkers. The data collected in the field through interviewsand footage on video, along with the assessment of attitudescertify this disability, requiring improvements in layout andequipment support.

These simple factors preventing a valuable aid to reducingthe physical constraints of the worker: the use of hydraulicturn in support for the piece, allowing the lifting equipment,displacement, and lateralization of the movement against theoperator pans and placing this activity in a sector covered.For tools, you should seek EPI's more comfortable and,through testing, replace the existing ones. This not doneuntil today according to the company (director responsible) for the request get no leadership, because if no one evercomplained formally, this information has validatedamong welders.

Studies should focus on trying to improve the quality andregular maintenance of equipment, with the current market ofequipment more comfortable and lightweight for use in thecompany. It also observed that workers improvise banks, stairs, supports, where equipment that even more sophisticated improvised, mended with wire, ladders and stools made bythe officials. In general, to avoid improvisation shouldmade available more tools and equipment for the tasks (seats, ladders, platforms, etc.). In addition, closets for better organization ofthe sector (to prevent a lack of local materials are scattered).In relation to redefine the layout of the workplace, it isproposed to resize the physical plant of the hall is locatedwhere all the activities related to the assembly of equipmentin the management of parts and materials to improve theopportunities for work and display the same. The greaterpurpose is to ensure the movement of workers in safety, whenthe activities, being necessary to rearrange the tools availableon shelves, to the rational use of space, to increase the areapassable and facilitate the procedures for cleaning. Theactivities carried out in pots, it is necessary to establish aspecific area for this activity where the welder not exposedto weather, building a shed where the tasks performed.

The floor of the site must kept free from cables to ensuresafety. Thus, the entire supply for the equipment, such aselectricity, gas and wire, it came up. In cleaning the office andorder must remain, the only recommended equipment reallyneeded to work.Says nothing to guide the employee,require a good attitude, if it generated because ofensuring a good weld without aspersion, broken, points thatfacilitate the corrosion and porosity. It is important to notethat the phenomena of oxidation depend operativeconditions and the length of the arc, which provided whenthe operator approaches the piece, tilting the trunk andpushing your posture. A long range (long distance operator inhandling the equipment) will lead to oxidation reactions moreimportant than a short arc (uncomfortable posture).

Adopt the true concept of work for four hands is certainly asolution to reduce the stress and increase productivity, but theadjustments to reduce fatigue, exposure to occupational risksand to work with two hands in the current context arefollowing:

- Insert basis of turning water to drive the parts to weld. In the case of pots, a large hydraulic equipmentshould developed, because the pots have commoncharacteristics and are frequently performed maintenance.These equipment spin, usually called positioners, devicesare controlled by electric or automatic controls that allowthe turning of the piece in both horizontal and vertical,allowing various combinations and greater control of thepositioning of the joint. The nice (sort of platformpantographic mechanical) can elevate the piece to weld to a certain height. This will relieve the worker toclimb the structure or to maintain uncomfortable posturesfor long periods and reducing the risk of accidents.
- Insert chairs, ladders and platforms from variousaccording to a bank of suggestions given by welders,official projects of accessories to replace theimprovisations of welders;
- Replace the helmet used for lighter equipment andautomatic display, which avoids that the employee has tolower and raise the helmet in order to repeat each need todisplay;
- It must seek to reduce musculoskeletal efforts through theplacement of tools and work plan, to ensure that thewelder can perform their tasks with the hand in optimalposition (between the waist and the level of theshoulders), no need to assume postures that twisted ortilted forward;

When it comes to lifting weight, you should establish thatany object that is handling heavier than 10 kg should beloaded with about the use of balance's, tables, hoists orsimilar aids. The torch of the weight bearing on the staticmuscle load, and recommended that the welding torches havereduced weight to reduce the risk of fatigue ormusculoskeletal disorders, occurring also affected the shapeof the torch, as it also affects the degree of muscle activation.

The format depends on the correct grip size, but also withattention to the design of its cross section and surface textureof the handle, so to facilitate comfortable and firm grip of thetool, with a minimum of effort. The trigger for activation ofthe torch should also receive special attention, for thatrequires little under pressure. Furthermore, it is important thatthe welding torches are flexible cables and capacity to absorbvibration. The weight of the tool is dependent, also the sizingof cables and the electrode. There are welding torches thathave a

system of extraction of fumes generated during theprocess, which can influence on your weight. These torchesare a result of an evolution whose initial attempts at removalof smoke near the source consisted of the addition of productsfrom the extraction of smoke flares. This system contributesto the weight of the tool and is responsible for extraction of upto 40% of the smoke generated in this case, the suggestionshould suspended, and the welding cables.

If existing technologies found in other companies, andused on a small scale in the company evaluated can see thatresources exist to reduce the physical constraintsof the worker. Starting with the weight of the equipment, thedisplay of welding by spinning gear, the hall covered withexhaust systems.Obviously, these technologies are not an end. You cannotspecify whether the postures assumed by workers in thesefacilities are ideal. As can be seen in the posture review, someof the worst postures performed with the employee bentforward or crouching down. These positions are the points ofwelding also located at the base of pans. Therefore, a goodproject as a hydraulic gyro for example, must allowshareholders in areas close to the floor, to reduce constraintson the spine and legs of the worker.

The cost factor is one of the obstacles to improving this type.It is natural that entrepreneurs want to reduce your operatingcosts and these costs include an inexpensive equipment. This,then, is one of the reasons why are still focusing on how theimplementation of solders constructs and equipment inmaintenance and hinders the implementation of improvementsin this case.Recommended to pay attention to these issues, thecreation of operational seminars. These seminars designedto promote discussion of the problems of the sector betweenofficials working in the field with management and leadership.Such actions promote the enrichment of the task by the staffand facilitate the understanding of real working situations.

IV. TO THE DIAGNOSIS OF REAL ACTIVITY

A case study research method also applied on this work [3]. The diagnosis as the factors to considered enabling a transformation of the work situation [4]. Independent ofthe parts to be welded are present the static postures held forlong periods because they provide conditions for the focuspoint for soldiers and support to increase the precision manual.This fact leads the welder to position so that it can beuncomfortably close to the piece, hold and maintain the toolsand parts required. This position requires a professionalabducted and flex the left shoulder to position the uppermember, perform a bending of trunk (lumbar and cervical) forthe direct view of the face to weld. Connected to this, isthe weight of the helmet that it is obsolete, outdatedtechnological front of the product.

Associated with these factors is the organization of workthat leads to the professional conduct many shifts andmovements necessary to find the desired material that seems tocause physical fatigue, but may facilitate the maintenance ofpauses for long periods in static contraction.Because different parts, the variability of posture requiresgreat constraints, to the maintenance of forced postures thatmay compromise the physical integrity of workers. In the caseof solder in pots, the maintenance of posture is more criticaland required longer on this constraint intensifies it. Thesupport of the same static posture for long period’s causesmuscle fatigue and musculoskeletal pathologies.The task of welding allows postures with lumbar solicitationdegrees because the successive postures in flexion of trunk,aggravated by handling of heavy loads during the operations tohandle the pieces. Contrary to what said inmany literature and research on the biomechanical conditionsof welding required for activity, escapes the control of weldingto maintain the so-called "correct posture" in the activities. Because they are kept independent of the control of weldingbecause it is required to obtain a good fusion of the solder,good arc welding, the lack of aspersion and porosities in theweld. If these positions not forced to approximate the parts,such items are impossible to guarantee and no currenttechnology available to ensure this.In addition, these factors contribute negatively on theappearance of signs and symptoms related to musculoskeletalsystem. Thepoor sector about the organization and layout, the discomfortof the EPI's, environmental risks, the dissatisfaction bymaintenance of low wages and bad postures for long periods instatic muscle contraction.

You can say, before the observed reality, that workers aresubject to a variety of types of risk, which varies in relation tofrequency, the intensity and time of exposure, to ensure thequality of welding.The bending of the spine and shoulder highlighted as theactivities of greater risk in contributing to the generalframework of reports of musculoskeletal disorders, but thisposture is difficult to avoid in the variability of industrialwelding postures required by different types of parts and theneed to ensure good fusion and penetration of the solder.

The precarious conditions of space and poorly organizedtools intensify the constraints of the welders. For welding tomaintenance, work, such as cookers, held in open sky, withthe welder exposed to excessive weather in a region dominatedthe heat, besides the difficulty of moving material to the areawith the client, as mentioned in pre-diagnosis.

V. CONCLUSION

All these factors, alone or in interaction, requiring theoperator to adopt new methods and leave the settings usedduring daily activities, without incident, to ensure the controland management of risks of mistakes and accidents at work.This behavior, which is outside the control of the welder,reduces the margin of an attitude of prevention, submitting to asituation of physical constraint, with the results achievedthrough changes in the internal state of workers, which canlead to, over time, attacks on health.

The construction of an ergonomic analysis of work andfocus on the activity of workers was crucial to understandingthe real situations at work. There were not only risks related tobiomechanical postures adopted to meet the demands of workas well as cognitive to the "good weld". The difficultiesencountered by operators in performing their tasks contributedto the emergence of postural constraints the procedure adoptedby them, characterized by the submission of requirements forinspection and attention to welding and other developmentnecessary for the completion of the activity.

The action of all these factors indicates the presence ofidentified risk factors for the development of musculoskeletaldisorders arising from work activity, especially ofmuscle-skeletal disorders of the lumbar spine and shoulder.

REFERENCES

[1] OHSAS 18002:2000. Interpretação da OHSAS 18001, especificação da gestão em saúde e segurança do trabalho.British Standard Institution, UK. Traduzida por Francisco deCicco, 2000.
[2] MTE, Ministério do Trabalho e Emprego. Manual deaplicação da norma regulamentadora n. 17. 2. ed. Brasília:MTE/SIR, 2002.
[3] Dul, J., Hak, T. Case Study Methodology in BusinessResearch, Butterworth-Heinemann, Oxford, 2007.
[4] Guérin F., Laville A., Daniellou F. Teiger C.Kerguelen A. Compreender o Trabalho para depoistransformá-lo. São Paulo: Edgar Blucher, 2001.