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Analyzing the existing hazards in structuring the metal frame of the building with PHA method

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ABSTRACT

Every day in workplaces, continues events occur that cause death and injury. These accidents usually happen because of lack of exploring the potential hazards and lack of training of employees. Hence, with exploring and evaluating the hazards of workplace and utilizing the suitable procedures, it is possible to prevent from many of these hazardous incidents. Exploring, evaluating and controlling the potential hazards have been the initial stages of scientific safety assurance in every system. Preliminary hazard analyzing is the first effort in analyzing hazards. In this method, usual hazards in sighted job are explored, using the usual hazards table for developing the basis of PHA, the PHA checklist is prepared and at last the PHA table completed and the appropriate suggestions are given. In this paper, we present an implementation of PHA method in one of industries located in city of Tehran, Iran. The proposed study uses 15 explored hazards, where 2 are unacceptable, 9 are undesirable and 4 are acceptable with need of revisal. By eliminating and reducing each hazards risk, some controlling solutions are suggested. The most important of these solutions are utilizing and using the regulations of the welding with electrical archer.

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1. Introduction

A risk assessment is an important step to protect workers and businesses, as well as complying with laws and regulations. It helps to focus on important risk factors, which influence workplaces and can potentially create some injuries. In many instances, suitable measures can readily control risks, for example, we must make sure that spillages are cleaned up promptly so people do not slip, or cupboard drawers are kept closed to ensure people do not trip. The law does not expect us to eliminate all risk factors, but we are required to protect people as far as 'reasonably practicable'. This is not the only way to do a risk assessment, there are other methods that can work well, particularly for more complex risks and circumstances. However, we believe this method is the most suitable for most organizations. A risk assessment is simply a careful examination of what could cause injury in our work, so that we could weigh up whether we have taken enough precautions or should do more to prevent harm.

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Workers and others have the right to be protected from harm caused by a failure to take reasonable control measures. Accidents and illness can ruin lives and affect business too if output is lost, machinery is damaged, insurance costs increase or have to go to court. We are legally required to assess the risks in our workplace so that we implement a plan to control the risks (Glade, 2004; Nasiri et al., 2006). Welders are working in the widespread kinds of industries and working in each of these environments has its own problems. Structuring the metal frame of the buildings with use of electrical archer welders is one of the welders work basis, in addition to continuous hazards that congenitally exists in process. Because of implementing the job in hard situations like working in places with high height, probability of accidents is increasing (Kolverzi, 2009). From the researches, Ingredients that cause the accident in welding are:

- 20% insufficient experiment
- 10% incapability
- 70% not following safety recognitions

With spotting the above numbers, we can find out the necessity of training, culturizing and obeying laws and safety recognitions in welding. It is expecting that this paper could help through the culturize for safety society (Kolverzi, 2009).

2. Research framework and methodology

Today, there is a steady increase in using the methods of risk assessment in different industries. There are over 100 kinds of quantity and quality analyzing methods, where each of these methods has specific theory canton, advantages and disadvantages. Major of risk analyzing methods are suitable hazard analyzing methods and their results can be used for management and decision making in controlling and reducing events. In most of these kinds of analyzing methods, the appropriate methods are chosen based on some necessary goals (Coutu et al., 2012). These techniques have known as different names such as HAZOP, FM & EA, BT & EA, and PHA (Arghami & Pouya, 2006) and can be used in different stages such as planning, producing, maintenance, etc. (Menson,2004). Preliminary hazard analysis (PHA) is the first effort in exploring hazards, which is a procedure for detecting hazards and the most important and the first safety comparison examination that starts with exploring and analyzing the hazards (Sadeghi, 2006). The best time to implement PHA is in planning and manufacturing system (Evans, 2006). Results from PHA can sighted as risk control by management (Leggett, 2012). In this research, we propose a method for risk assessment using some tools like checklists, matrixes, descriptions, instruments dissection, events report, surveying information and similar occupations, review of last reports, talking to the contractors and manufacturers (Table 1). After completing usual hazard table, preliminarily hazard list is provided and the causes and effects in hazardous situations are characterized. Also for determining the risk priority according to hazards and developing a criterion for decision making, list of hazard intensity (Table 2), hazard possibility (Table 3), and risk evaluation matrix (Table 4) are evaluated. Next, based on the information of hazard intensity, possibility and risk evaluation matrix, PHA are completed and suggestions are given to prevent, to control or to reduce possible hazards.

3. Analyzing the suggested method

All hazards and possible hazardous events must be identified and it is important to consider all parts of any system, operational modes, maintenance operations, safety systems, and so on. All findings should be recorded and unimportant hazards must be ignored. Murthy’s law must be borne in mind: “If something can go wrong, sooner or later it will” (Park, 2008). Preliminary hazard analysis (PHA) is a semi-quantitative analysis that is performed to:

- Identify all potential hazards and hazardous events that may lead to an accident,
- Rank the identified hazardous events according to their severity,
- Identify required hazard controls and follow-up actions.

The PHA should consider hazardous components, safety related interfaces among various system elements, including software, environmental constraints including operating environments, operating, test, maintenance, built-in-tests, diagnostics, and emergency procedures, facilities, real property installed equipment, support equipment, and training, safety related equipment, safeguards, and possible alternate approaches, malfunctions to the system, subsystems, or software (Pompa, 2009).

3.1. PHA prerequisites

3.1.1. Establish the PHA team

3.1.2. Define and describe the system to be analyzed

- System boundaries (which parts should be included and which should not)
- System description; including layout drawings, process flow diagrams, block diagrams, etc.
- Use and storage of energy and hazardous materials in the system
- Operational and environmental conditions to be considered
- Systems for detection and control of hazards and hazardous events, emergency systems, and mitigation actions

3.1.3. Collect risk information from previous and similar systems (e.g., from accident data bases)

3.2 PHA team

A typical PHA team may consist of:

- A team leader (facilitator) with competence and experience in the method to be used
- A secretary who will report the results

Team members (2-6 people) who can provide necessary knowledge and experience on the system need to be analyzed. Some team members may participate only in parts of the analysis.

3.3.System functions

As part of the system familiarization it is important to consider:

- What is the system dependent upon (inputs)?
- What activities are performed by the system (functions)?
- What services does the system provide (output)?

3.4.System breakdown

To be able to identify all hazards and events, it is often necessary to split the system into manageable parts, for example, in three categories:

- System parts (e.g., process units)
- Activities
- Exposed to risk (who, what are exposed?)

3.5. Process explanation

Electro current engenders from streaming electrons in ductile path. Because of different voltage and existing current, the air (gas) between the two ductile materials become ionized and the current in between establishes, the electrical archer happens. This is used as thermal recourse in welding. In this case, electrode fuses and causes the conjunction of two materials.

Table 1
Usual hazards group

Group	Title	Group	Title
1	Elapsing	7	Eye fulgurate
2	Scorching	8	Inflaming
3	Fumes	9	Inflaming generator
4	Electric shock	10	Welding machine
5	Eye injury	11	Sound pollution
6	Leg injury	12	Ergonomic

Table 2
Category of hazard severity

Hazard kind	Category	Definition
Catastrophic	1	Death or waste of system
Critical	2	Injury, job illness or system damage is high
Major	3	Injury, job illness or eye injury is fractional
Minor	4	Injury, job illness or eye injury is very fractional

Table 3
Probability of hazard level

Probability	Hazard level	Hazard definition
Frequent	A	Happens frequently
Probable	B	It happens probably in systems life
Occasional	C	It happens sometimes in systems life
Remot	D	The probability of happening is very low
Improbable	E	The probability of happening is very low that can consider it as zero

Table 4
Risk assessment matrix

	hazard severity			
Probability	Catastrophic (1)	Catastrophic (2)	Catastrophic (3)	Catastrophic (4)
Frequently	1a	2a	3a	4a
Probable	1b	2b	3b	4b
occasional	1c	2c	3c	4c
Remot	1d	2d	3d	4D
improbable	1e	2e	3e	4e

Table 5
Risk determination

Risk priority	Risk category
unacceptable	1A-2A-3A-1B-2B-1C
Undesirable	3B-2C-3C-1D-2D
Acceptable with review	4A-4B-3D-1E-2E-3E
Acceptable	4C-4D-4E

Table 6
Preliminarily hazard list

PHL
System name: Welding with electro archer
Page: 1 of 2

Hazardous situation	Reason	Effect	Risk level	Preamble
Down falling	1. Electric shock 2. Improvidence 3. Not using PPE	1.fractioning 2.Handicapping 3.Death	2B	1.working in high positions bylaws 2.national building regulation section 12
Scald	1.Purring weld outlets on body or clothes 2.Falling electrode on body or clothes 3.Touching glowing surfaces	1.Clothes & body fire 2.scalding	3C	1.safety welding & cutting bylaws 2.NFPA standards
Fumes	1.dust and fumes Aspiration 2.welding painted surfaces 3.welding chemical smeary surfaces	1.raspiratory illnesses 2. coughing 3.lungs inflation 4.asthmatic 5.teeth enamel etching 6.lung illnesses 7.asthma 8. pneumonia 9.lung cancer	3C	1.safety welding & cutting bylaws 2.ACGH related standards
Electric shock	1.naked wires 2.attrited wire coat 3.not using suitable PDA 4.melting dielectric wire 5.humidity of building 6.humidity of welder's clothes 7.gadget defective 8.irregular use of gadget 9.short circuit 10.contact of conductor to framework 11.device macerate	1.electric shock 2.down falling 3.scalding	2B	1.safety welding & cutting bylaws 2.ASME & NEMA standards 3.weldors gadget related standards
Eye Physical injury	1.extrusion of weld dust because of hammer hooking or other instruments	1.eye injury 2.face injury	2D	1. safety welding & cutting bylaws
Leg Physical injury	Falling of iron materials: cornerstone, leg lchky,headrester	1.leg bruising 2.leg fraction 3.mutilation	2E	1. safety welding & cutting bylaws
Eye fulgurate	1.welding ultraviolet rays 2.welding infrared rays	1.eye ailment 2.cataract 3.headache 4.scalding cornea 5.tearing 6.retina injury	2D	1. safety welding & cutting bylaws

PHL
System name: Welding with electro archer
Page: 2 of 2

Hazardous situation	Reason	Effect	Risk level	Preamble
Firing	1.purring outlets of weld or ends of electrodes on combustible substances 2. welding on inflammable or combustible surfaces	1.firing and damaging resources, materials and instruments 2.individuals scald 3.death	2C	1.NFPA standards 2.safety welding & cutting bylaws
Generator firing	1.over heating the motor 2.flamable & combustible substances existing around device	1.damage & waste of generator 2. individuals scald	3E	1.safety welding & cutting bylaws 2.NFPA standards
Firing Welding device	1.device short circuit 2.overworking 3.overloading the device 4. over heating the device	1.damage & waste of device 2. individuals scald	3E	1.NFPA standards 2.safety welding & cutting bylaws 3.ASME & NEMA standards
Sound pollution	1.electricity generators working 2.old electricity generators	1.bombination of ear 2.sibilating ear 3.down falling hearing 4.nerve provocation 5. stupefaction	3D	1.safety welding & cutting bylaws 2.OSHA standards
Ergonomic	1.doing repetitive jobs 2.moving heavy utensils 3.work in not suitable positions 4.keeping long time instruments	1.Bone illnesses 2.backache 3.sholders ache 4.reduction of muscle power 5.wrist ache 6.whitening fingers 7.knee illnesses	3C	1. safety welding & cutting bylaws

Table 7
Preliminarily hazard analysis

PHA
System name: Welding with electro archer
Page: 1 of 3

Hazard	Reason	Effect	RAC 1	Evaluation	Suggestions	RAC 2
Down falling	1.Electric shock 2.Improvidence 3.Not using PPE	1.fractioning 2.Handicapping 3.Death	2B	Not acceptable	1.when working in positions higher than 1.8m use safety belt 2.training rules of working in high places	4B
Electric shock with contacting to conductor	1.naked wires 2.attrited wire coat 3.not using suitable PDA 4.melting dielectric wire	1.electric shock 2.down falling 3.scalding	2B	Not acceptable	1.all electric parts in contact should have damper 2.conjunction part of source cable to device should be dampened 3.device should has interruptive current part 4.safety training to employees 5.replace defective cables 6.barn cables & gadgets after finishing job in order to prevent physical injury 7.cables be flexible and straighten 8.forbiden use of any conductors instead of electricity current cable 9.cables chosen according to maximum welding current 10.in places in danger of physical & mechanical injuries prepare appliances	4B
Electric shock because of humidity	1.humidity of building 2.humidity of welder's clothes	1.electric shock 2.down falling	1C	Not acceptable	1.dry the floor and structure when welding, if not use safety gloves or shoes 2.metal frame should has earth contactor or be damper	3E
Electric shock in contact with gadget	1.gadget defective 2.irregular use of gadget	1.electric shock 2.down falling	1C	Not acceptable	1.keep dry the gadget & electrode 2.don't touch electrodes or parts without damper 3.outer part of gadget & mandibles should be dampened 4.don't use electrodes witch length decreases to 38 to 55mm after use 5.don't use water in order to cooling electrodes 6.turn off the device in order to move poles of electrode 7.keep gadgets in suitable places after operation 8.if the device is on and operation is down, put gadgets in damper position	3D
Electric shock in contact with device	1.short circuit 2.contact of conductor to framework 3.device macerate	1.electric shock 2.down falling 3.fibrilation	2C	undesirable	1.device keys are according to NEMA or ASME standards 2.devices & instruments be inspected routinely by firm 3.devices have effective earth 4.earth should not contact to body frame 5. device should has interruptive current part(fuses) 6.contact places of source cables to device by bolds & beads should be dampened 7.major input terminals planned in device 8.seperate devices from electricity after work 9.inorder to prevent dominance of water into device when is rain falling, accomplish appliances 10.before movement disconnect electricity	2E

PHA
System name: Welding with electro archer
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Existing hot materials & substances(scald)	1.Purring weld outlets on body or clothes 2.Falling electrode on body or clothes 3.Touching glowing surfaces	1.Clothes & body fire 2.scalding	3C	undesirable	1.don't use petroleum yarn & inflammable clothes 2.hot welding points become denoted 3.sit opposite to the wind 4.use suitable self protection tools: greave, apron, gloves, shoe, damper helmet to fire 5.use appointed gadget to protective blazon	4D
Fumes(dust and fumes)	1.dust and fumes Aspiration 2.welding painted surfaces 3.welding chemical smeary surfaces	1.raspiratory illnesses 2. coughing 3.lungs inflation 4.asthmatic 5.teeth enamel etching 6.lung illnesses 7.asthma 8. pneumonia 9.lung cancer	3C	undesirable	1.use specific masks(with ffp2 filters) 2.abstain welding on painted materials & stainless & chemical substances, if impossible use specific masks 3.shorten encounter time 4.use standard electrodes	4C
Eye Physical injury,	1.extrusion of weld dust because of hammer hooking or other instruments	1.eye injury 2.face injury	2D	undesirable	1.use eyeglasses or shields with bright glass	4E
Ergonomic	1.doing repetitive jobs 2.moving heavy utensils 3.work in not suitable positions 4.keeping long time instruments	1.Bone illnesses 2.backache 3.sholders ache 4.reduction of muscle power 5.wrist ache 6.whitening fingers 7.knee illnesses	3C	undesirable	1.correct consignment of things 2.not working long time in same position 3.work in suitable high position 4.place things and instruments correctly 5.reduce shaking and put leg in staddle 6.resting in middle of work 7.use flexible and light weighted tools 8.reduce work time	4D
Combustible materials (Firing)	1.purring outlets of weld or ends of electrodes on combustible substances 2. welding on inflammable or combustible surfaces	1.firing and damaging resources, materials and instruments 2.individuals scald 3.death	2C	undesirable	1.don't work around places that have greasy materials, borings, etc 2.if it's impossible protect these places with fireproof mantling 3.give proceeding to prevent purring outlets of weld 4.use bails to throw end of electrodes 5.control the environment after work to be sure it's clean of hot outlets, flake or flame 6.chemical dry powder capsules be available to put out fire A,B 7.dry & clean places smeary to solvent before welding	2E
Eye fulgurate	1.welding ultraviolet rays 2.welding infrared rays	1.eye ailment 2.cataract 3.headache 4.scalding cornea 5.tearing 6.retina injury	2D	undesirable	1.welders according to their job should use masks with suitable diameter 2.use proper eye drugs in eye fulgurate 3.places in people footwork should cover with 2meter high walls(in dark grey, blue or green)	

PHA
System name: Welding with electro archer
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Sound pollution	1.electricity generators working 2.old electricity generators	1.bombination of ear 2.sibilating ear 3.down falling hearing 4.nerve provocation 5. stupefaction	3D	Acceptable in need of reconsideration	1.Isolate sound source 2.increase sound source distance from people 3.use earmuffs or ear pluck	4D
Leg Physical injury	Falling of iron materials: cornerstone, leg lchky, headrester	1.leg bruising 2.leg fraction 3.mutilation	2E	Acceptable in need of reconsideration	1.put device characteristics on it 2.put CO_2 capsule near device 3.all instruments & tools periodically be visited by manufacturer 4.welding devices should be according to ASME & NEMR standards 5.be certain about corrective use of device maximum ampere 6.continues measurement of Transformator heat cortex 7.put device in suitable place	4E
Generator firing	1.over heating the motor 2.flamable & combustible substances existing around device	1.damage & waste of generator 2. individuals scald	3E	Acceptable in need of reconsideration	1.don't refuel when device is on or moving 2.dry fuel bar, before starting and after refueling eradicate fumes & steams 3.before maintenance turn off the engine 4.put device in suitable place 5.chemical powder or foam extinguisher be available	4E

4. Discussion and Conclusion

PHA table (Table 7) is organized according to the points given in PHL table (Table 6) related to risk levels and pursuit priority of 3 levels of unacceptable, undesirable and acceptable in need of reconsideration. By giving controlling suggestions, risk level has reached to acceptable level by reconsideration and without reconsideration. Baseless to this table down falling hazard had intensity number 2 and probability level B with risk evaluation 2B,with using safety belts and training work laws, it's risk level became 4B or acceptable. But with financial supports and facilities it can be reduce to lower levels. Hazards associated with electricity shock such as contacting to conductor, humidity, having contact with gadget and welding device that caused electric shock, scalding, down falling and even death accidents can be reduce from unacceptable levels like 2B, 1C, 2C to acceptable levels like 4B, 3E, 3D, 2E. This could happen with observing regulations and welding instructions, training, using standard instruments, and self protection devices. When there are some hot devices such as weld outlets, remaining of electrode's bottoms or working materials, employees may face a chance of having unexpected fire incidents, which could harm them, severely. This hazard with 3 intensity, probability on C and risk evaluation 3C can be reduced to acceptable level 4D with using leather clothes or other adamant materials versus heat or fire. Fumes with 3C risk level cause breathing and pulmonary disease like coughing lung inflation and asthma, which could reduce to 4C with observance to safety notes and using suitable masks.

In some points that welders cut out weld dust with hammer or other instruments, eye injury hazard with D probability, 2 intensity and 2D risk evaluation exists. In order to prevent these injuries employees must use eye glasses with crystal shields to reduce risk evaluation to 4E. Moving and

anagrammatizing tools and heavy things, doing repetitive work, work on bad situations and keeping long time instruments can cause bone illnesses, muscles, back ache, shoulders ache, reduction of muscle power, whitening fingers, knee illnesses, etc. The risk associated with these issues could be reduced from 3C to 4D by observing ergonomic points. Existence of flammable and combustible substances near welding place or around it can cause resources firing and instruments or even individual's injury. Therefore, with 3 intensity, C probability and 3C risk evaluation, the risk can be reduced to acceptable 3E by observing regulations and welding and cutting work laws and instructions. There are 2 kinds of sting rays, one is acute visible light and the others are UV and IR, the first one, with 2D risk level, can cause eye pain, cataract, scalding cornea, tearing and retina injury and the best way to reduce this risk item is to 4E, which is using welding masks. Old electricity generators always have sound pollution, which cause combination of ear, sibilating ear, down falling hearing, nerve provocation, stupefaction, etc. This risk item can be reduced from 3D to 4D by isolating sound resources, increasing sound source distance from people, using earmuffs or ear pluck. Other injuries include bruises, leg injury, fracturing categorized in 3E risk level, which could happen because of falling down materials, cornerstone, headrester, etc. It is possible to use of safety shoes and to increase attention at work in an attempt to upgrade safety level to 4E. The risk of 3E level could happen because of device short circuit, overworking, overloading the device, over heating the device. It is also possible to upgrade the risk to 4E by continues measurement of device heat, putting device in suitable place, capsules being available

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