

ORIGINAL ARTICLE

ERGONOMIC RISK ASSESSMENT ON SELECTED HOT-WORK WORKERS AT COMPANY XXX

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ABSTRACT

Company XXX is a factory that involving manufacturing of offshore containers in where the hot works are one of the crucial activities in fabrication and structuring the framework of the containers. This study had been conducted at hot work section to conduct initial and advanced ergonomic risk assessment to identify ergonomic risk factors involved among hot-work workers which cause the significant number of reports on ergonomic related health issues at hot works area from the year 2011 to year 2017. The initial and advanced ergonomic risk assessment had been conducted based on DOSH latest release of guideline on ergonomic risk assessment 2017 and all findings had been tabulated and analysed. Based on the initial ergonomic assessment, total score achieved is 17.7 with main risk factors identified through the hot work activities are including awkward postures, repetitive motions, static and sustained work postures, vibration, insufficient ventilation, exposure of noise and working in extreme temperature. Based on Advanced ERA conducted on selected 3 workers, the study shows Muscle Fatigue Assessment (MFA) with average score for risk level shown 'High' and 'Very High' categories, Rapid Entire Body Assessment (REBA) with average total score more than 10 which categorized as 'High Risk' and Quick Exposure Check (QEC) which shown the workers have very high risk for back and shoulder or arm parts with score level are between 29 to 40 for back static and 41 to 56 for shoulder and arm parts. Based on results of the assessment, company XXX recommended had been to conduct further investigation for improvements to determine effective control measure for the work process in order to reduce that risk level towards the hot work workers.

Keywords: Hot-works, ergonomics, ergonomic risk assessment, awkward postures

INTRODUCTION

Ergonomics can be defined as the scientific discipline that concerns with the understanding of interaction between humans and work system. Ergonomics focuses on changing things including tools, equipment, or facilities and not changing people [2]. Company XXX widely known as it built its own reputation by manufacturing custom-made first-class quality containers and metallic covers to support the oil and gas industry and also other servicing industries. Company XXX is one of the largest manufacturers of custom designed and build offshore containers and modular solutions in Malaysia and the region. Metal fabrication, steelwork frames structuring, fitting works are major component in production of metal containers here. So, hot works including welding, grinding, oxy-cutting are very crucial tasks carried out by most of the general workers here at Company XXX.

Hot work safety and reducing work related risk activities are major concerns for metal fabrication industries because these activities introduce many ergonomic challenges to workers. More than 60 workers out of total 95 general workers at this company are involved in hot work activities which are core activities of the company business. The workers at Company XXX currently use metal sheets and plastic tools as per shown in Figure 1 to sit for welding,

grinding and other hot works activities for long hours with awkward positions which led to many health issues including muscle cramps, back pain, leg and ankle pain and many of them under medication as per stated in medical records and employee feedback forms. Based on HSE incidents statistics of company, there are significant number of incident reports on ergonomic issues involving hot works activities which indirectly affecting the production target and effectiveness.

The researcher has done initial review of the incident and injuries record of the company and based HSE performance statistics and medical records of company. Researcher found that there are about 303 number of reports on ergonomic issues had been reported at hot works area from the year 2011 to year 2018 as per shown in Table 1. Based on the record, there are more than 10 workers from hot work section had been instructed for medical removals by Occupational Health Doctors because of permanent back pain which suspected due to works. The researcher also had conducted an initial study through walkabout, observation and interviews for duration of 3 months with hot work workers to identify potential ergonomic issues and ergonomic risk factors and found that there are quite number of risk factors involved at hot works section at Company XXX based on current practice of welding, grinding and other

hot work activities which may led to more critical MSDs and other ergonomic effects. Therefore this study to be conducted to identify risk ergonomic risk factors of workers who are directly involved in hot-works based on their current practices through initial and advanced ergonomic risk assessment at Company XXX which expected to guide the company on the involved risk factors and by then they able to implement proper corrective and preventive actions.

Table 1. Number of Reports & Employee complains at Company XXX

Years	Number of Reports at Company XXX		
	Hot workers	work	Other workers (painting, blasting, cleaning, general works)
2011	42		23
2012	50		27
2013	36		18
2014	48		15
2015	45		20
2016	42		13
2017	40		15
2018	61		34

This study aimed to evaluate the ergonomic risk factors among the hot work workers by conducting initial and advanced level ergonomic risk assessment including Rapid Entire Body Assessment (REBA), Quick Exposure Check (QEC) and Muscle Fatigue Assessment. The ergonomic risk assessment conducted were based on Ergonomic Risk Assessment guidelines 2017 released by Department of Occupational Safety and Health.

LITERATURE REVIEW

Ergonomics

Ergonomic the word origins from combination of two greek works which comprises with ‘ergon’ which mean work and ‘nomos’ means laws (31). It generally giving the meaning as laws or rules of works which can be summarized as how the works can be done safely by considering factor of comfortability when carry out the work [15]. It was used for the first time by Wojciech Jastrzebowski in a Polish newspaper in 1857 (21).

Ergonomics Risk Factor

An ergonomic risk factor is any attribute, characteristic or exposure that may cause or contribute to a musculoskeletal injury, the mere presence of a risk factor may not in itself result in an injury. In general, two or more risk factors may be present at one time, thereby increasing the risk of injury (26).

Low Back Work-Relate Musculoskeletal disorders (MSDs)

Low back work-related MSDs affect the bones, muscles, ligaments and tendons of the lumbar spine associated with physical work, manual handling and vehicle driving activities, involving lifting, twisting, bending, static postures, and prolonged seating. Low back work-related MSDs include spinal disc problems, muscle and soft tissue injuries (30).

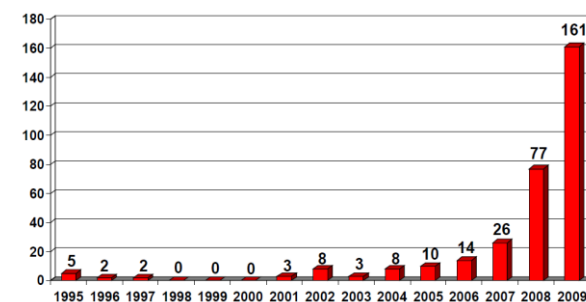
Hot works

Hot-work is defined as cutting, grinding or welding operations for operation activities that involve the use of portable gas or arc welding equipment, or involve soldering, grinding, or any other similar activities producing a spark, flame, or heat (2). Hot works requiring physical demands on the welder’s wrist, elbow, arms, shoulders and neck due to awkward postures and forceful exertions required (27).

Hot works and problems associated with ergonomics

The musculoskeletal injuries (MSI) are very common among welders and other hot works, with female welders at additional risk in often due to poor equipment design (1). Based on report from SOCSO in Figure 1, the total musculoskeletal injuries reported and claiming numbers shows drastic increases from the year 2003 to the year 2009 and the most highest number reported on the year 2009 which is about 161 cases.

Figure 1. Occupational Musculoskeletal injuries statistic 1995 - 2009



Source: Annual Report SOCSO 1995 - 2009

Another hand, according to latest report released by SOCSO in Table 2 on the number of invalidity and survivors’ cases reported on the year 2016, there are total 1607 cases had been reported which consist of 949 cases from male and 658 cases from female workers. Table 3 which also been extracted from the same report released by SOCSO as above, about 1006 musculo-skeletal disease cases reported in total caused by specific work activities/ work environment where particular risk factors are present. In this context of research study, the possibility of getting musculo-skeletal diseases are higher in any sort of working environment

including hot works which involving a lot our awkward and improper body postures.

Table 2. Number of Invalidity And Survivors' Cases Reported, 2016

Disease	Accident reported		TD paid			
	Male	Female	Male	Female	Male	Female
Diseases of the musculoskeletal system and connective tissue	949	658	1,607	88	24	112

Table 3. Occupational Musculoskeletal Disorders

Agent Causes	Accident reported			TD paid			PD paid		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Musculo-skeletal diseases caused by specific work activities/ work environment where particular risk factors are present	683	323	1,006	210	87	297	274	97	371

There are many ergonomic issues facing by hot work workers all around the world because of multiple factors. Prolonged static postures associated with neck flexion, working for extended periods on knees or in positions that create awkward postures of the spine, and hand gripping are the leading causes of injury to workers performing hot work in metal or steel related industry. Additional risk factors are the frequent bending, stooping, squatting and crouching inherent to performing the hot work including welding, grinding and others. Working on the knees which cause the contact stress is also a frequent cause of musculoskeletal injuries. This issue can become more severe if the kneeling posture maintained for extended periods. Bending forward at the waist and maintaining the bending over position causes a significant strain on the lower back, compresses the spine and if its happened for long time, it could damage the shock absorbing pads and disks which are located between the vertebrae [6]. Working while in siting posture will cause excessive muscle strain at back and shoulders on workers besides than the problems of lumbar kyphosis. Improper body position or mainly called as awkward positions are another major factor for frequent cause of injuries to workers who performing hot working routinely. This working environment requires that workers place themselves in improper body positions or awkward positions often for extended periods of time and also as repetitive activities. Welders for example may find themselves in limited spaces, welding horizontally from bottom up to the roof of the containers and vertically from one end to other end of containers where they must lie on their backs with extended arms and carry out the welding task in awkward positions (7). Additionally, many hot works tasks at metal container fabrication requiring workers to bend, stoop, sit on metal cans and stretching legs. Based on conducted study, among the various work postures, restricted awkward postures were found to be most highest factor in causing occupational risk injuries (12). Working while bending over is common in hot works at metal

fabrication industry. Bending over posture as in Figure 2.4 will compresses the spinal column and places strain on the lower back, which can lead to chronic back pain or a more significant back injury if the task carried out in long term durations.

Working on the knees which cause the contact stress is also a frequent cause of musculoskeletal injuries. This issue can become more severe if the kneeling posture maintained for extended periods (2). Bending forward at the waist and maintaining the bending over position causes a significant strain on the lower back, compresses the spine and if its happened for long time, it could damage the shock absorbing pads and disks which are located between the vertebrae (24).

METHODS

An ergonomic risk assessment involves a process from planning, assessing to controlling. This study just deals with planning and assessing only. The method used in this assessment follows Guidelines on Ergonomics Risk Assessment at Workplace, 2017 by Department of Occupational Safety and Health. Generally, Ergonomic Risk Assessment consists of qualitative, semi-quantitative and quantitative data collection method to obtain necessary data. Qualitative data gathers information which is not objective and not quantifiable such as instructed interviews and observations. Semi-quantitative date converts qualitative data, typically the observed parameters of interest and score the observation based on available reference such as being applied in Rapid Upper Limb Assessment, Quick Exposure Checklist and Muscle Fatigue Assessment

Ergonomics Risk Assessment

Ergonomics Risk Assessment is a systematic plan and an objective approach in identifying, assessing and controlling ergonomics risk factors associated with the work tasks and activities in the workplace. The objective of conducting ergonomics risk assessment are to identify more ergonomics risk factors that may cause harm to employees, determine likelihood arising from exposure to the ergonomics risk factors and also to recommend appropriate control measures towards risk reduction. The assessment depends on the types of ergonomics risk factors identified. The exposure duration of each work posture may different depending on the professional judgment of the trained person. There are several number of Ergonomic Assessment tools which was proven by previous studies that could be used in identify, assess and evaluate the risk factors. Some of the assessment methods had been stated in Guidelines on Ergonomic Risk Assessment at Workplace 2017 had been used by researcher in

this study to identify, assess and evaluate risk factors that associated with hot works in the effort of reducing ergonomic issues facing by the involved workers at this company. The trained person should select appropriate method for specific risk factor. There are basically 2 main steps as per shown in Figure 2 has been involved in overall process of evaluating risk factors in hot works at Company XXX. Step 1 is identified the need of the problem which had be analysed through feedback from employee, observations, medical records, interview with employees and questionnaire which designed specially. Step 2 is assessing the ergonomic risk factor which will be identified through Initial ergonomic risk assessment and also part of advanced ergonomic risk assessment which including REBA, MFA & QEC methods. All the data collected through assessment will be further analysed. In this study, the ergonomic risk assessment had been conducted by researcher on three male workers who randomly selected at hot work section at Company XXX. The samples of this study labelled as worker A, B and C respectively. The risk assessment carried out for 8 hours and 1 hour rest based on daily work duration of workers where maximum work regime in a day is work 4 hours straight, 1 hour rest and work 4 hours straight again. Tasks involved by the study sample were including welding, grinding, and oxy-cutting works at hot work section. This assessment only focused at hot work section of this company and study sample only from hot-work workers. After the assessment, medical record of this there workers were investigated and found worker A have a report of severe back pain since one year ago and he is under medication. However worker B and worker C does not have any past history of medical issues involving MSDs.

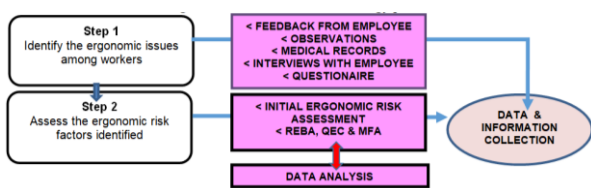


Figure 2. Flow chart of methodology process

Initial Ergonomic Risk Assessment

Initial Ergonomic Risk assessments will be conducted for all identified manual handling and ergonomic hazards and risk factors. These will be conducted prior to any MSDs related complaints from workers, any ergonomic related reports or SOCSO claims by workers, instruction by local authority and also upon by management request. Initial Ergonomic Risk Assessment (Initial ERA) is the latest checklist drafted under Guidelines of Workplace Ergonomic Risk Assessment by Department of Occupational Safety and Health Malaysia. Initial Ergonomic risk assessment based on the types of ergonomic risk factors identified

are awkward posture, static - sustained work posture, forceful exertion, repetitive Motion, hands-arm - whole body vibration and finally an environmental factors.

Advanced Ergonomic Risk Assessment

Advanced Ergonomic Risk Assessment (Advanced ERA) has been conducted in this study based on the latest checklist drafted under Guidelines of Workplace Ergonomic Risk Assessment 2017 by Department of Occupational Safety and Health Malaysia. Advanced ERA conducted consists of three assessments which are Muscle Fatigue Assessment (MFA), Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC)

- **Muscle Fatigue Assessment (MFA)**

The muscle fatigue assessment method (MFA) which also known as the functional job evaluation technique was developed in the effort of characterizes the discomfort by workers on fabrication tasks (30). The frequency of muscle efforts determines how much recovery time is available between efforts. To make the method easier to use, and to help prioritize between tasks when choices have to be made about which problem should be addressed first, the effort levels, effort durations (or holding times), and effort frequencies were reduced to three categories each. Studies of physiological muscle fatigue for different effort levels and holding the basis for this method (25). The frequency of muscle efforts will determines how much recovery time is available between efforts for the involved workers. The amount of accumulated fatigue in a muscle during hot work task can be characterized and assessed by estimating how much time is needed from the recovery time curves and compare this to the actual time between efforts of the same intensity (26). In this context of study, the MFA method will be suitable for identifying, assess, evaluate and analyze the muscle fatigue conditions suffering by hot work workers as per reported during the initial survey. This assessment been carried out by using multiple combinations of the three factors which are Effort, Duration and Frequency. Table 4 and Table 5 shows how to calculate how much fatigue had accumulated (6) among the selected working during hot works.

Table 4. "Priority for Change" Score from Three-Number Rating

Effort Level = 1			Effort Level = 2			Effort Level = 3		
Duration	Frequency	Priority	Duration	Frequency	Priority	Duration	Frequency	Priority
1	1	L	1	1	L	1	1	L
1	2	L	1	2	L	1	2	M
1	3	L	1	3	M	1	3	H
2	1	L	2	1	L	2	1	H
2	2	L	2	2	M	2	2	H
2	3	M	2	3	H	2	3	VH
3	1	L	3	1	M	3	1	VH
3	2	M	3	2	M	3	2	VH
3	3	*	3	3	*	3	3	*

Note : Enter with the scores for effort level (top row) and for duration and frequency (columns within the section for effort level). The “priority for change” from the table is low (L), moderate (M), high (H), or very high (VH). “*” This combination of duration and frequency is not possible.

Table 5. Category Scores in the Order of Increasing Fatigue for Three-Number Rating (Effort, Continuous Effort Duration, and Frequency)

Low (L)	Moderate (M)	High (H)	Very High (VH)
111	123	223	323
112	132	313	331
113	213	321	332
211	222	322	
121	231		4xx
212	232		x4x
311	312		xx4
122			
131			
221			

• **Rapid Entire Body Assessment (REBA)**

Rapid Entire Body Assessment (REBA) specifically designed to be sensitive to the type of unpredictable working postures in health care and other service industries (19). Rapid entire body assessment (REBA) was developed to assess the type of unpredictable working postures found in health care and other service industries (18). The more there is deviation from the neutral posture, the higher will the score of each body part. Data on the body posture, forces used, type of movement or actions, repetition and coupling were collected and a final REBA score is generated will give an indication of the level of risk and urgency with immediate action required to be taken. In this study, REBA will be play a major role in risk assessment since hot work workers at Company XXX almost using whole body in the hot work activities, and also with some static, rapidly changing and unstable body postures. Basically REBA consisting of 6 main steps including observe the task, select the postures for assessment, score the postures, process the scores, establish the REBA score and confirm the action level with respect to the urgency for control measures [26].

• **Quick Exposure Check (QEC)**

The Quick Exposure Check (QEC) was designed to fulfill ergonomic practitioner’s requirements for a practical method of assessing exposure to WMSDs risk factors at the workplace. It was developed throughout the entire process if development, testing, modification and validation based on simulation and real work tasks which covering wide range of activities including manual handling, repetitive task, static or dynamic task, seated or standing tasks (29). QEC checklists mainly have two parts to be filled

up. First part is to be completed by observer based on their observation on the worker and second part was filled up by worker themselves. The answers from the observer and worker transferred into scoring Table and total score were calculated. The total score for each body area is determined from the interactions between the exposure levels for the relevant risk factors as shown in Table 6, and their subsequent addition. It is a crucial to identify which interactions were contributes most to the overall score for each body area. The exposure scores for the back, shoulder/arm, wrist/hand and neck have been categorized into 4 exposure categories: Low, Moderate, High or Very High as per shown in Table 7.

Table 6. List of interactions between the exposures levels for the relevant risk factors

Important risk factors	
Back	Wrist/hand
<ul style="list-style-type: none"> • Load weight • Duration • Frequency of movement • Posture 	<ul style="list-style-type: none"> • Force • Duration • Frequency of movement • Posture
Shoulder/arm	Neck
<ul style="list-style-type: none"> • Load weight • Duration • Frequency of movement • Task height 	<ul style="list-style-type: none"> • Duration • Visual demand • Posture

Table 7. Exposure categories in QEC

Score	Important risk factors			
	Low	Moderate	High	Very High
Back (static)	8 – 15	16 - 22	23 – 29	29 – 40
Back (moving)	10 – 20	21 – 30	31 - 40	41 – 56
Shoulder/Arm	10 – 20	21 – 30	31 – 40	41 – 56
Wrist/hand	10 – 20	21 – 30	31 – 40	41 – 46
Neck	4 - 6	8 – 10	12 - 14	16 – 18

RESULTS

Ergonomic risk assessment

The ergonomic risk assessment including Initial Ergonomic Assessment and Advanced Ergonomic Assessment has been conducted at hot work section of this company and on selected 3 hot-work workers.

Initial Ergonomic Assessment

Initial Ergonomic Assessment carried out at hot work section involving workers A, B and C based on guidelines on ergonomic risk assessment at workplace 2017 released by DOSH Malaysia. Workers carry out their daily task as usual and researcher did direct observation on the workers and record the findings based on the checklist. Video recording and photo pictures also were taken as evidence for reporting. Table 8 shows as summarized table of result obtained during initial ergonomic assessment which shown the details of assessment and list of ergonomic risk factors which were identified through the assessment. In general worker A, B and C achieved total score of 18, 18 and 17 respectively.

Table 8. Results of Initial ERA conducted on selected 3 workers (Worker A, B and C)

Risk factors	Total Score	Minimum requirement for advanced ERA	Result of Initial ERA			Need Advanced ERA? (Yes/No)		
			A	B	C	A	B	C
Awkward Postures	13	≥ 6	10	11	10	Y	Y	Y
Static and Sustained Work Posture	3	≥ 1	2	2	2	Y	Y	Y
Forceful exertion	1	1	0	0	0	N	N	N
Repetition	5	≥ 1	3	2	2	Y	Y	Y
Vibration	4	≥ 1	1	1	1	Y	Y	Y
Lighting	1	1	0	0	0	N	N	N
Temperature	1	1	1	1	1	Y	Y	Y
Ventilation	0	1	0	0	0	N	N	N
Noise	2	≥ 1	1	1	1	Y	Y	Y
TOTAL SCORE	30		18	18	17			
AVERAGE SCORE	30			17.7				

Based on the assessment, ergonomic risk factors were found in workers are awkward postures, repetitive motions, static and sustained work postures, vibration, insufficient ventilation, exposure of noise and working in extreme temperature. The results generally shows that workers affected by same risk factors and especially awkward postures found with the highest score involved in this study. Those risk factors with score more than minimum requirement will be proceed for advanced ergonomic risk assessment to evaluate further on the identified ergonomic risk factor.

Advanced Ergonomic Risk Assessment

The three advanced ergonomic risk assessments carried out were Rapid Entire Body Assessment (REBA), Muscle Fatigue Assessment (MFA) and

Table 9. Scores obtained by workers using REBA

Workers	Score A	Score B	Score C	Activity Score	Total score	Risk Level
A	4	9	8	2	10	High
B	6	8	9	2	11	Very High
C	6	9	10	2	12	Very High

Ergonomic Risk Assessment by Muscle Fatigue Assessment (MFA)

Four fatigue outcomes were chosen from the more detailed analysis and all calculated based on a continuous period of 5 min of work on the task. These were <30 sec (low), 30 to 90 sec (moderate), >90 sec to 3 min (high), and >3 min (very high). Table 10 shows the category scores in the order of increasing fatigue for three-number rating (Effort, Continuous Effort Duration, and Frequency). The outcomes from the muscle fatigue assessment carried out for all the three workers as per shown in Table 10 in below. Muscle fatigue assessment data which is Effort - Duration -Frequency scores shows that very high fatigue for right shoulders, right wrist/hands/fingers, right legs/knees and high

Quick Exposure Check (QEC). The advanced ergonomic risk assessments carried out on workers A, B and C based on guidelines on ergonomic risk assessment at workplace 2017 released by DOSH Malaysia

Ergonomic Assessment by Rapid Entire Body Assessment (REBA)

In this study, REBA method has been conducted on selected 3 workers who exposed to muscle discomforts due to hot works. The overall score obtained for all the three workers for REBA as shown in Table 9. Based on the results, found that one worker with total score ‘10’, categorized as ‘High’ and another two workers who each of them obtained total scores of ‘11’ and ‘12’ were categorized as ‘Very High.

fatigue for neck, left shoulder, back, left legs/knees parts. However other parts including right and left arms/elbow, left wrists/hands/fingers, right and left ankles/feet/toes whos moderate level of fatigue undergone by the workers during the hot works. This overall shows that there is significant fatigue level among hot work workers at this company due to ergonomic risk factors in their daily hot work task. Even the record of medical leaves and doctor reports from the company shown that workers who from hot work section effected by muscle cramps, back pain, leg, ankle pain and other MSDs which complained by workers since many years. Company history also shown many of them who were affected with MSDs are under medication.

Table 10. Result of muscle fatigue assessment for selected workers

Region	Effort - Duration -Frequency scores							
	Worker A			Worker B			Worker C	
Neck		223	High	223	High	223	High	
Shoulders	R	323	Very High	323	Very High	323	Very High	
	L	223	High	223	High	223	High	
Back		223	High	223	High	223	High	
Arms / Elbow	R	232	Moderate	232	Moderate	232	Moderate	
	L	222	Moderate	222	Moderate	222	Moderate	
Wrists / Hands / Fingers	R	332	Very High	332	Very High	332	Very High	
	L	232	Moderate	232	Moderate	232	Moderate	
Legs / Knees	R	331	Very High	331	Very High	331	Very High	
	L	322	High	322	High	322	High	
Ankles / Feet / Toes	R	223	Moderate	223	Moderate	223	Moderate	
	L	222	Moderate	222	Moderate	222	Moderate	

- **Ergonomic Assessment by Quick Exposure Check (QEC)**

Quick Exposure Check (QEC) assessment had been conducted on the three workers during the study. Table 11 and 12 shows the total scores obtained by worker A, B and C respectively through the Quick Exposure Check (QEC) assessment. Results shows that all the workers assessed have very high risk for back (moving)

and shoulder or arm parts where the score level are between 29 to 40 for back static whereas 41 to 56 for shoulder and arm parts. Risk factor like back (static) and wrist or hand parts shows high risk to workers. It was found workers having very high risk in neck part also where the score level was within 16 to 18. Other than that exposure levels shows that workers found sometimes difficult in keeping up with the hot works, using vibrating tools frequently and having moderate stress level during the hot works.

Table 11. Exposure scores for Important risk factors

	Important risk factors		
	Worker A	Worker B	Worker C
Back (static)	18	26	22
Back (moving)	30	29	30
Shoulder/Arm	46	48	48
Wrist/hand	38	40	36
Neck	16	16	16

Table 12. Exposure scores for other risk factors

	Exposure level		
	Worker A	Worker B	Worker C
Driving	1	1	1
Vibration	4	4	4
Work pace	4	4	4
Stress	9	9	9

People naturally are having limitations based on their physical factors including weight, height, age, fitness and health conditions. When the work design exceed the normal limitations, excessive wear and tear might occurs in their body when working in improper body postures, sitting on unsuitable materials, doing repetitive works for prolonged time and more others which it will increasing the damage that can lead to work related musculoskeletal disorders. If these ergonomic issues not were rectified in hot works, it may be repeated throughout the year by multi-

level of employees which can cause a significant impact on total profit of the company. By reducing the risk of musculoskeletal injuries, company can reduce absences of employee due to injuries, medical treatments and also reduce overtime payments for replacement workers who maybe not efficient or competent to do hot works. By eliminating stressful posture and motions also might reduce employee turnover and training cost of the welders who are not competent. So investing in providing hot work chairs which designed by researcher definitely

will improve the overall ergonomic issues faced by hot-work employees in Company XXX or even other company which have similar operations. Workers who involved in hot works whenever possible, they should position their work between waist and shoulders to make sure they working in a close to a neutral posture line.

DISCUSSION

Based on the one to one interview session with workers and direct observations on the workers current practices during hot works, found with unsuitable workplace design where they were sitting on the metal sheets during the hot work activities for long hours while carry out the welding or grinding activities where the worker's head and trunk flexed forward and shoulders flexed and abducted. In this situation, high rate of workplace MSDs occurrence are expected since it involving awkward position, static, or repetitive movement for long hours. High expenditure of medical treatment required for those workers affected with these permanent damages on absorbing pads and disks on vertebrae. The workers also maybe will be restricted permanently by doctors to continue with welding or any other hot works. In overall, based on initial and advanced ergonomic assessment, it is recommended that further investigation should be taken to determine effective control measure for the work process in order to reduce that risk level towards the worker. From observation by researcher on the workplace design, interview sessions with hot work workers, employee complains and also based record of incident reports, there is need of drastic change in their working posture with properly designed hot work chair. Currently, workers are using metal sheets and plastic containers to sit for welding, grinding and other hot works repetitively for long hours, without back support and with awkward positions. The ergonomic principles which proven could improve the working way of welding or other hot work operators in performing their tasks and this will reducing the exposure to risk factors, thereby will simultaneously increasing the company's productivity. A simple designed work station adjustment or use of different tools can create more impactful difference on worker's health and safety for long term as well as company's reputation on health and safety performance. This designing a specific hot work chair is an engineering control which is most effective in reducing or eliminating risk factors in the workplace compared to other types of controls including administration control and usage of personal protective equipment. Proper actions including design a comfortable chair or workspace is crucial at this company to prevent injuries and stress that can affects the involved workers and also to increase employee productivity and improves the whole system of

work. If a new ergonomic solution had been designed, fixed and installed at workplace, it is important to reinforce the hot work workers to ensure that designed chair is utilized effectively. The main aim of designing this new hot work chair is to secure the safety of the hot work workers which requiring high and consistent commitment from both workers and company management. The benefits of ergonomics is only can be gain in a team effort which ultimately provides a comfortable work environment and safe working postures which leads to a more productive and profitable hot work operation and also maintaining a long-term health of hot work workers.

CONCLUSION

Ergonomic risk assessment including initial and advanced ergonomic risk assessment has been conducted at Company XXX at hot-work section workers. There are some ergonomic risk factors are identified as factors which may contributed for the statistic of health issues reported at Company XXX as per first objective of this assessment. Based on the study, hot work workers at this company affected by risk factors including awkward postures, repetitive motions, working surfaces are too high or too low, maintaining same work positions or posture for a long period, sitting for a long time, working in extreme temperature, vibration and high noise exposure. For the second objective of the study, advanced ergonomic risk assessment has been conducted and results obtained shows that there is significant ergonomic risk level among the hot work workers at this company. Based on REBA assessment, it was found that worker A with score 10 which categorized as "high risk". Worker B and C shows score 11 and 12 respectively which categorized as "very high risk" and need further investigation immediately and changes to be implemented as soon as possible to reduce the risk level. Muscle fatigue assessment which is Effort - Duration -Frequency scores shows that 'Very High' fatigue found among the workers for right shoulders, right wrist/hands/fingers, right legs/knees and 'High' fatigue for neck, left shoulder, back, left legs/knees parts. According to QEC assessment, back (moving), shoulder/arm, and neck scores showed very high value and need to take immediate control measure to reduce the risk level of exposure. Back (static) and wrist/hand shows high score but still need attentions to not exceed the value into very high in future. Vibration, and work peace level showing moderate level of exposure. Stress level of workers looks high and however in driving its in low level. As an employer Company XXX required to take immediate corrective and preventive actions at hot work section. Further investigation should be taken to determine effective control measure for the work process in order to reduce

that risk level towards the worker. This is in line with the requirements of the Occupational Safety and Health Act 1994 in Section 15 (1) stating that it is the duty of every employer and every person employed to ensure safety, health and welfare while working against all employees.

ABBREVIATIONS

ERA stands for Ergonomic Risk Assessment. REBA stands for Rapid Entire Body Assessment. QEC stands for Quick Exposure Check. MFA stands for Muscle Fatigue Assessment.

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COMPETING INTERESTS

There is no conflict of interest.

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