

Occupational Health Hazard Identification and Risk Mitigation at Engineering Procurement and Construction Projects: Sultanate of Oman

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Abstract

This research was carried out at Renaissance Service EPC project to identify the workplace hazard and control measures to improve the Environmental Health and Safety practices, and the different enhancements that can be joined to the administration framework to further develop the Environment wellbeing and safety standard of the association. The examination techniques including Studying and investigating the Oman Labor Law, International guidelines and understanding the framework adhered to by comparable associations in the country. Confirming, regardless of whether the distinguished legitimate and different necessities are considered in the administration of wellbeing and security and concentrating on the business best practices techniques connected with development exercises. Workplace selected for this research is one of the major projects called SR-CPP ‘Saihrawl Central Processing Plant under PDO, sultanate of Oman. Research was carried out to identify the opportunity for OHSMS improvements, through the method of referring the labor law, interviewing employees at various levels, reviewing the documents, and referring the standards. During assessment of levels of risk posed by workplace hazard identified, such as Exposure to vibration while working with pneumatic jack hammers and plate compactors is found to be the serious hazard which needs immediate action. The data collection measurements of case-1 have a vibration magnitude of 9.3 m/sec² and exposure duration of 3.5 hours and Case-2 which have a vibration magnitude of 14.5 m/sec² and exposure duration of 3 hours, the excessive vibration led to a high risk of Hand arm vibration syndrome for the workers, this can lead to violation of article of MD 286/2008 of Occupational Health and Safety, control of vibration a work regulation 2005, PUWER 1998. The system of hierarchy of control measures advised and cost benefit advantage examination is done and an extra absolute expense of OMR 5500 expected to be caused to carry out the proposals. It will save the association from the enormous concealed costs from loss of creation, clinical treatment, non-attendance, claims from the people in question, legitimate costs lastly can be saved from loss of notoriety.

Keywords: Environment Health and Safety; Renaissance Service; SR-CPP; Vibrational syndrome; Environmental hazards; Occupational health hazard.

1. Introduction

This research is made after carrying out a careful and critical study at Renaissance service, SR-CPP project Oman, involved a detailed review of existing risk assessment site observation, carrying out the risk assessment

and prioritizing the control measures. SR-CPP is in the central Oman under the Gas Directorate operations. The operating base for the field areas is GNOC, which is 350 km from Muscat, the area is a desert plain, comprising

alluvial gravel fans arising from several wadis.

The aim of this report is to carry out a detailed review of health and safety performance of Renaissance SAOG, Oman and to provide an action plan.

The Objectives of this study are follows;

- 1) Identifying the health hazards at workplace
- 2) Introduce action plan to improve risk assessments.
- 3) Necessary resource allocation toward risk control

The project consists of 1459 manpower working.

2. Methodology

The methodology adopted for this research as follows:

2.1 Research methods

Referring the Oman Labour Law, International regulations and understanding the system followed by similar organizations in the country. Checking, regardless of whether the distinguished legitimate and different necessities are considered in the administration of wellbeing and security and concentrating on the business best practices procedures connected with development exercises.

2.2 Workplace inspections

Workplace inspection to understand the potential hazards involved in the operation, Interviews, Consultation with employees, interviews were done with associations Top, Middle and Lower the board All the important directors in the working environment, bosses, Operators, laborers and partners likewise remembered for the meeting and every one of the focuses were recorded. Casual conversation with managers and laborers during the working environment assessment additionally completed to distinguish their perspectives on comprehension of the wellbeing and security culture and to assess the wellbeing and wellbeing society among the representatives.

2.3 Document reviews and risk assessment

Reviewed all the available documents and records like work method statement, risk assessment, incident records, incident investigations, injury and first aid records, equipment maintenance records, manufacturers recommendations, material safety data sheet, client, consultant and insurance company enquiry, Training Records, Health surveillance records, Inspection or tour report, safety committee minutes, employee complaints, labour law of the state of Oman and warning or fines from the government authority.



Figure 1. Renaissance SAOG, Oman

2.4 Description of organization and work location

Renaissance service SAOG is Oman based company an Excellent Grade Omani Local company providing high quality products and services for all the major industrial sectors in the Sultanate of Oman., which started its operation in the year 1991. This research is based on the project under the PDO, Oman. Since its inception, it moved forward and become a pioneer in the construction and development. Its' services include Construction and maintenance, facility management, supply of manpower and Trading and supply of products for Oil and Gas and other companies. The company is backed by a highly professional and experienced team and capable to execute varied jobs in diversified sectors like Oil & Gas, Refineries, Petrochemicals, Chemical, Power, Ship building and other core industries which involves Fabrication, Construction, Erection and Maintenance of Piping, Structures, Boilers, Tanks & Vessels, Reformers, Heaters, Erection of heavy Static & Rotary equipment's etc. for its' customers.

The company is on its way to get certified to ISO 45001-2018 and is maintaining its own health and safety management system. To cater its different exercises organization is furnished with an adequate number of vehicles, different development hardware's and so forth the labor force of the organization is multicultural and multilingual, convenience for representatives is given by the organization. Work environment chose for this examination is one of the major patching up projects under PDO, Oman. The venture has different exercises that cover practically every one of the scopes of issues in the development.

2.5 Description of the project area

The project area is situated at Saihrawl, interior of Oman. The project started 10 months ago. The project consists of bend fabrication and laying of flow lines more than 300 kms. Establishing the workshop for fabrication work of pipelines almost completed. Excavation for the construction

work is yet to be started. Some part of the excavation is likely to pass close to the sea area where dewatering facility is required to be arranged. Accommodation with attached toilet facility for all the staffs is arranged in the Portable cabins near the workshop facility. Dining facility and drinking water is provided for all staffs near the accommodation. When the excavation activities start, the accommodation for the construction associated workers required to be shifted as per location of the activities. Table 1 defines the nature of employee's day to day work-style including working hours, duty-hours and so on.

Below were list of the major activity which performed by employees on day to day work

List of Activities/ Works

- Excavation
- Concreting
- Electrical work in the Workshop
- Fabrication
- Scaffolding erection and dismantling
- Hot Works
- Lifting Activities
- Chipping and drilling
- Confined space work
- Hydro test on pipelines
- Painting
- Steel fixing
- Removal of Waste material
- Manual handling
- Transportation of materials

2.6 Employment profile

2.6.1 Environmental impact on Health and Safety

Organization locales are working in hot, moist, and dusty climate for right around 7 to 8 months of the year. The barometrical temperature changes from 20 to 50 degree centigrade and Relative moistness between 30 to 80% and wind speed might reach 85 KMPH during dust storm. During the different phases of the task every one of the specialists are in the open spot next to no shades are accessible.

Table 1. Working Employee details

Categories	Details	Note
Working day on Project	Saturday to Thursday	Friday- Weekly off (Overtime as per Oman labour law, if employees work)
Duty hour	7:00 am – 7:00 pm	8 hours with 1 hour lunch break and 3 hour overtime
Number of worker	Approximately 500 employees	At peak expecting about 650 employees
Category of employees	Carpenter, Mason, Steel fixer, Welder, Electrician, Pipe fitter, Operator, Signal man, Scaffolding erector, Technical staff, Supervisor/Engineer, Painter, QC inspector, HSE advisor, Clerk	Majority of employees are male. Few female employees are employed for clerical jobs in the planning department, reception
Nationality	Employees from different countries are working on this project	Most of the workers and staffs are from Oman, India, Phillippines, Bangladesh
Language	Majority of the workers can understand Hindi, Tagalog, Arabic. Most of the employees can understand English	-
Competency	Around 45% of the employees are skill based workers, 10% are knowledge based and the rest of the employees are unskilled labours and new construction employees who trained by the company	All managerial and engineers are well qualified and experienced. Supervisory and technical staffs are qualified and experienced and are competent in their roles.

2.6.2 Equipment in use

Variety of mechanical equipment is in use such as grinders, plate compactor, jack hammer, excavators, 25T to 450TN mobile crane, JCB, Shovel, concrete machine, concrete pouring pump-ray equipment’s, radiation equipment.

2.6.3 Legal Environment

The Sultanate of Oman is monarchy which occupies the Southeastern parts of the Arabian Peninsula. Sultanate is divided into nine administrative regions. Whilst the enforcement of OSH is mandated to Ministry of Manpower under the Labour Law issued by Royal Decree No.35/2003 and its accompanying Regulation, there are several other related instruments and tools which contribute to the implementation of OSH at the national level. There include decisions, guidelines and activities carried out by other related Ministries

2.7 Laws and regulations

The following international laws are applicable to the areas where there is a gap.

1) Control of Substances Hazards to Health (COSHH) Regulations 2002 (as amended) to protect the employees and other persons from the hazards of substances used at work

2) Provision and Use of Work Equipment Regulations 1998 (PUWER) addresses control and prevent workers risk of injury and death from equipment they use during their jobs

3) Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) which places duties on people and companies who own, operate or have control over lifting equipment

4) The Work at Height Regulations 2005 (as amended) Construction Regulations 1996

5) BS 5973:1993 Code of practice for access and working scaffolds and special structures in steel

6) Control of Vibration at Work Regulations 2005

3. Results and Discussion

3.1 Identification of occupational health hazards

Hazard identification is a process of identifying the hazards involved in the works being carried out in the workplace. Hazard identification is the first step and, is the one of most important steps in the Risk Management. Various methods can be used to identify the hazards, such as workplace inspection, observing the activities, discussion with employees, using check list, referring manufacturer’s instructions, looking into ill health records etc.

On completion of the review of the OH&S MS, a visit was undertaken to the workplace to ensure implementation of the control measures for identified existing hazards and to identify the new hazards, if any. In the process the methods, such as workplace inspection, observation

of the activities and discussion with the employees, were mainly used. During the tour of visit, the following activities were observed.

Excavation, Concreting, Electrical work in the Workshop, Hot Work & Fabrication, Working on Scaffolding, Lifting activities, Hydro test on pipelines, Painting, Confined space work, Transportation of materials.

Generally, the identified existing hazards, except few, were well controlled. However, during the progress of the work, few new hazards have been evolved. The newly evolved hazards and the existing identified hazards for which control measures have not been implemented, were identified during the workplace visit, are appended in a tabular form. The hazards have been prioritized as Serious, High, Medium, and Low. The identified hazards have been prioritized with justification, recognized the implications, and identified who will be affected.

Table 2. Risk matrix

		Severity of harm		
		Slightly Harmful	Harmful	Extremely Harmful
		1	2	3
Likelihood of harm occurring	Highly Unlikely	1 Low	2 Medium	3 Medium
	Unlikely	2 Medium	4 High	6 High
	Likely	3 Medium	6 High	9 Serious

Table 3. Health hazard prioritization

SL NO.	HAZARDS	PEOPLE HARMED	RISK IMPLICATION	PRIORITISATION	JUSTIFICATION FOR PRIORITISATION	RISK GROUP	VIOLATION TO APPLICABLE LAW
Workers found working in the trench.							
1.	Using of pneumatic jack hammers and plate compactors exposed to excessive Vibration	Total of 22 employees engaged in operation of 4 pneumatic jack hammers and 7 plate compactors.	Lead to Hand Arm Vibration Syndrome and vibration related carpal tunnel syndrome	High	Considering the probability and potential for hand related injuries such as tingling / numbness / pain etc.	People	RD 35/2003, PUWER 1998, Control of vibration at work regulation 2005



Figure 2. Excessive vibration work

3.2 Occupational Health Hazard findings

High Risk: Workers is exposed to excessive Vibration

Using of pneumatic jack hammers and plate compactors exposed to excessive Vibration which was identified at excavation work in Saihrawl south area. There was a high potential risk to the workforce which can result in musculoskeletal disordered, and hand arm vibration and article 87 of RD 35/2003 and MD 286 and PUWER 1988 use of work equipment regulation, control of vibration at work 2005 is violated- High Risk.

Case 1

The project has been using seven plate compactors manufactured by M/s Atlas Copco Compaction model 'LF 100 Diesel' with Hand Arm vibration standard handles. The Manufacture specific vibration magnitude of the above equipment is 9.3 m/sec².

The equipment has been found 2 years old and on physical observation reveals an absence of periodical maintenance. This will adversely affect the vibration magnitude specified by the manufacturer. However, this risk assessment will be based on the minimum of 9.3 m/sec² as specified by the manufacturer.

The daily exposure time of individual

been calculated as 3 hours 30 minutes on a daily duration of 8 hours. Hence the personnel vibration exposure level of the individual is being calculated with the help of the following formula as described in the Para 87 Schedule 1 of the Guidance to 'The Control of Vibration at Work Regulations 2005'

Hence the daily exposure here is = $9.3\sqrt{3.5 \times 60 \times 60/8}$ hours.

i.e $9.3\sqrt{12600/28800} = 9.3\sqrt{0.44} = 9.3 \times 0.66 = 6.138$

This indicates the daily exposure of the employees is in 6.13 m/sec² which is much higher than the ELV of 5m/sec².

Case 2

In other case eight employees been operating four 'Atlas Copco TEX 180PS: Pneumatic breaker' for rock breaking purposes. The manufacture specification (attached as Appendix-IV) indicates the vibration magnitude of 14.5m/sec². The duration of exposure of individual has been calculated as 3 hours in a working day of 08 hours. Hence the daily exposure level of each employee has calculated as: $14.5\sqrt{3 \times 60 \times 60/8}$ hours

i.e. $14.5\sqrt{10800/28800} = 14.5\sqrt{0.375} = 14.5 \times 0.61 = 8.845$

This indicates the daily exposure of the employees is in 8.845 m/sec² which is much higher than the ELV of 5m/sec².

The daily exposure to vibration (A(8)) of a person is ascertained using the formula:

$$A(8) = a_{rw} \sqrt{\frac{T}{T_0}}$$

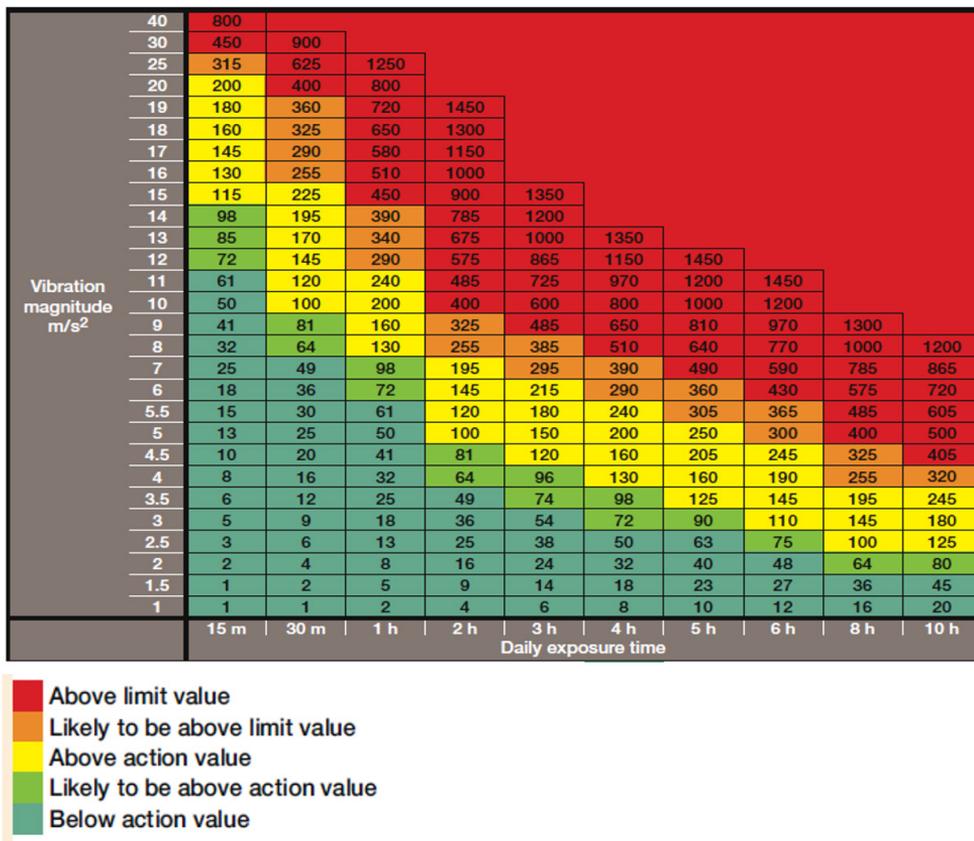
where:

a_{rw} is the vibration magnitude, in metres per second squared (m/s²);

T is the duration of exposure to the vibration magnitude a_{rw} ; and

T_0 is the reference duration of 8 hours (28,800 seconds).

(Source: Illustration from Guidance on the Control of Vibration at Work Regulations 2005)



(Source : Illustration from Guidance on the Control of Vibration at Work Regulations 2005)

For concreting the above statement the data has been assessed with the help of below mentioned ‘Ready-Reckoner for vibration exposure’ chart from ‘Control of Vibration at Work Regulations 2005’.

Case one, which have a vibration magnitude of 9.3 m/sec² and exposure duration of 3.5 hours falling in the table with approximately 620 points.

Case two, which have a vibration magnitude of 14.5 m/sec² and exposure duration of 3 hours falling in the table with 1275 points.

The above levels indicating the exposure limit above Exposure limit value. This will result the employees with ‘Reportable occupational diseases such as Hand-Arm vibration syndrome (HAVS) and Carpal Tunnel Syndrome. This will adversely affect the nerves, blood vessels, muscles and joints of the hand, wrist and arm of the individual and become severely disabling if ignored. This includes Vibration White Finger, which can cause severe pain in the affected fingers.

This will be resulted with increased in absenteeism, loss of production, loss of trained and competent manpower, medical expenditure, and legal claims in future. Moreover, this will create painful situation to the individual and family. As it is a reportable case, the organization is about to fail to achieve its goals including aims and objectives.

3.3 Assessment of Risk

Risk Assessment is the process of identifying the hazards, analyzing, or evaluating the risk associated with that hazard and determining appropriate ways to eliminate or control the hazard. Risk Assessment form an integral part of a good OS & H MS. RA is to be done by competent team individuals, with technical background, who have good working knowledge of workplace.

On completion of Hazard Identification and Prioritization process highly prioritized hazards in the category of health hazard

were selected for closer risk assessment, considering the probability of occurrence and hazard potential if the harm is released. They are as follows.

Exposure to Vibration hazard while working with Pneumatic jack hammers and Plate compactors, to accomplish the aim and objective of the organization the following standard risk assessment steps adapted to assess risks associated with the abovementioned Physical and Health & Welfare hazards.

Step 1: Identify the hazard

Civil crew were found engaged soil compaction near foundations using plate compactors and 04 numbers of civil crew were using pneumatic jack hammers to break the rock for trenching purposes the machines are found old with excessive vibration and each machine have been operated only with two persons alternatively for the entire duration of civil construction, resulting into prolonged exposure to excessive vibration. This endanger situation enhance the risk of Hands- arm vibratory syndrome and vibration-related carpal tunnel syndrome amongst the target population and become a major hindrance to achieve the aims and objective of the organization.

Step 2: Decide who might be harmed.

Jack hammers and plate compactors are being operated by 22 (8 + 14) personnel from the civil construction crew and they are considered as target population. This will further effect the organization by increased absenteeism, loss of production, loss of trained and competent manpower, medical expenditure, legal claims in future and finally this risk outcome has been categorized as reportable diseases and thus will be a hindrance to achieve the objectives and aims of the organization along with loss of reputation.

Step 3: Evaluate the risk and decide on precautions.

Evaluation of current risk

The exposure limit for hand arm vibration, as per 'The Control of Vibration at Work

Regulations 2005 Part 1(Regulation 4), is as follows:

(a) The daily exposure limit value (ELV) is 5 m/sec².

(b) The daily exposure action value is 2.5 m/sec².

Note: The daily exposure limit value (ELV) is the maximum amount of vibration an employee may be exposed to on any single day of 8 hours.

The daily exposure action value (EAV) is the level of daily exposure to vibration above which organization are required to take certain actions to reduce exposure.

The manufactures records are not available with the equipment's for references, as they procured years before. The facilities as per Para 192-196 of the Guidance to 'The Control of Vibration at Work Regulations 2005' are not readily available at site for physical vibration measurement for the sake of this risk assessment. Hence the information's related to the specific equipment's been obtained from the manufacture's website for this assessment. On assessing the risk, considering the probability and severity, the risk is high.

Evaluate the existing control measures and further precautions

The existing control measures such as job rotation, using of gloves etc. found not specific in nature to control the exposure related each type of the equipment. As per the existing control measures each equipment is being operated by two personnel alternatively. This has been proven insufficient by the above Risk Assessment. In addition to above, hand gloves also specified as a control measure in HEMP, but not specified the nature of gloves and its protection level. The workers have been issued with normal cotton gloves which do not have any ability to absorb vibration from the equipment.

The elimination of the hazard by using mechanical excavators is not possible due to the threat of other interlinked hazards, such as energized oil and electrical underground facilities. The specific activities are expected to be remaining only for four months in the project. Hence it is not profitable or justified to procure new equipment's for this short tenure. In view of the above vibration absorbing

gloves with silicon padding can be provided for personnel working with plate

compactors in addition to the job rotation with specific time period as mentioned below.

The current exposure level as per ‘Ready-Reckoner for vibration exposure’ chart is approximately 620 points where vibration magnitude of 9.3 m/sec² and exposure duration of 3.5 hours (210 minutes) while 2 personnel alternatively operate the plate compactor. If the employees step down the exposure duration of 105 minutes, the exposure level will be 310 points, which is categorized as a ‘likely to be above limit value’ and further it can be controlled by providing vibration absorbing gloves with silicon padding. The production can be maintained by providing addition 14 personnel for the activity.

The exposure level of the employees with of the jack hammer is too high in range with 1275 points in the ‘Ready-Reckoner for vibration exposure’ chart. The current equipment is having 14.5 m/sec² as vibration magnitude. As the elimination and new procurement is not justified, it is highly advised to lease four jack hammers with a vibration magnitude of 8 m/sec² which is readily available in the market for lease. This will reduce the exposure limit of the employees below ELV and the organization will get same production with available manpower where the exposure points will be 385 in the table. This can be further controlled

by providing vibration absorbing gloves with silicon padding.

Step 4: Record the findings and implement them

Excessive vibration amongst the plate compactor operators shall be minimized below Exposure limit value by reducing the exposure duration and the production can be maintained by increasing the number of operators for the activity. The jack hammer usage must be suspended for duration of two days within the organization can hire the equipment’s having a vibration magnitude of 8m/sec². A vibration protective silicon padded gloves can be restrict the vibration exposure further. A review is to be carried out on implementation of the suggested recommendations. A health surveillance of once in three months amongst the target population is highly recommended for review the effectiveness and further continual improvement.

Step 5: Review

Up on implementing the above recommendations in the prescribed time frame, management must review the effectiveness and adequacy of the same through health surveillance program amongst the target population in every three months for continual improvement.

3.4 Health risk assessment for vibration

Risk assessment for the health hazard selected: vibration											
Hazard	Risk	Initial risk				Controls	Residual risk				
		Severity (S)	Likelihood(L)	Risk rating(SxL)	Risk level		Severity (S)	Likelihood(L)	Risk rating(SxL)	Risk level	Recovery measures
Inadequate information, instruction and training	Lack of knowledge, operational error	2	1	4	Medium	hand arm and whole body vibration training to be provided for all operatives and supervisors Thereafter everyday toolbox talks can be done as refresher training	1	1	1	L	

3.4 Health risk assessment for vibration (Cont.)

Risk assessment for the health hazard selected: vibration											
Poorly maintained equipment	Increase vibration, electric shock, noise, situation enhance the risk of Hands- arm vibratory syndrome and vibration-related carpal tunnel syndrome	3	2	6	High	Inventory to be maintained at the store Equipment is checked before use; high vibration levels and faults are to be reported and removed from the period of work Maintenance program needs to be in place for high use tools that cause hand arm vibration (HAV)	1	1	1	L	Emergency preparedness\ First aider
Unsuitable equipment	Manual handling risk, varied vibration syndrome	3	3	9	Serious	Supervisors to ensure that the equipment provided is suitable for the intended use. For new equipment preference to be given to low vibration tools Compare vibration data from different manufacturers prior to purchasing products. Create equipment replacement plan, prioritizing according to vibration levels and usage.	1	1	1	L	First aider, Mechanic
Monitoring		2	2	4	L	HAV levels to be measured for rotary and percussive equipment High risk equipment to be colour coded and labelled and staff informed.	1	1	1	L	
Excessive vibration Exposure	HAV, musculoskeletal disorders, irregular heartbeat, Vibration White finger	3	3	9	Serious	Restrictions in place to limit duration and frequency of using high vibration equipment. Job rotation to limit the exposure of the employees Outdoor workers to provide with clothing appropriate to weather including gloves Workers exposure to be regularly reviewed and discussed at team meetings and alternative ways of working developed Vibration exposure to be monitored by supervisors via log sheets.	1	1	1	L	First aider Emergency vehicle

4. Conclusions

A careful report into the association strategy, construction and the board framework archives and its word related wellbeing and safety framework records was done to complete an itemized survey of the Health and Safety execution of “Renaissance SAOG, Oman”. The company follows its own H & S management system, but it needs improvements. The OH & S Policy is seems to be specific to the nature or scale of risks and committed to comply with Oman labour law (Royal Decree No.35/2003). Though the company has procedure for Hazard Identification and Risk Assessment, the behavioral aspects of employees are not considered, and PPE related hazards are not identified. About legal and other requirements,

it found to be complying with applicable legal requirements and updated. The Corporate Objectives clearly specifies the method of measuring their compliances.

Proposed Control Measures

Training needs must be identified and right candidate to be selected for the appropriate training based on training need analysis to benefit the organization from man hours spend and cost involved. Develop training programs, on critical activities such as working at height /confined space, use of hand arm vibration tools etc. to provide training identified candidates and, also covering learning lessons from accident/incident and provide specific training to line management covering incident investigation

and corresponding corrective and preventive actions to be taken. This will improve the quality of root cause analysis and lead to better corrective and preventive action being taken, so that incident rate and lost time injuries can be reduced considerably. 4 Pneumatic jack hammers to be replaced with less vibration magnitude of 8 m/s² against 14 m/sec² (to be hired for three months) which will help to bring down the vibration magnitude below the ELV. Vibration protection gloves with silicon padding to be procured and provided to the employees who using Jack hammers and Plate compactors which will help to protect the employees against the vibration from the equipment while on job. 14 additional trained employees to be deployed with the team of plate compactor to reduce the exposure of the employees through job rotation. A health surveillance program was conducted after implementing the recommendation against the Health and Welfare Hazard for early detection of Hand – arm vibratory syndrome and remedial action.

Cost-benefit analysis

In the analysis it is found that most of the recommendations could be implemented by, economically utilizing the man hours of the existing employees of the organization. However, some additional expenditure is required to be incurred for implementing some of the recommendations made. The costs are given below.

Possible residual Risk

There can be residual risk to the people due to the vibration hazard as the level of exposure is already exceeded, hence it will be vital to carry out a health surveillance to identify the group who have already affected so as to reduce their further exposure to vibration.

Recovery measures

Can include proper health surveillance, qualified first aiders, shaded rest place, emergency procedure as per client requirements, available of standby vehicle or ambulance at workplace is added advantage for quick emergency response. All staff and workers should be made aware of the emergency procedure and how to take necessary steps in case of any emergency.

Advantages and Benefits of implementing control measure:

Total additional expenditure of OMR 5500 is required to be incurred to implement the recommendations. These recommendations are generally proactive measures. With these measures the organization can control the hazards in as low as reasonably practicable without any adverse effect on the operation of the business. The benefit from this expenditure is intangible in nature. It will save the association from the enormous concealed costs from clinical treatment, truancy, loss of creation, claims from the people in question, legitimate costs lastly can be saved from loss of notoriety.

Table 6. Cost Benefit Analysis

Cost benefit analysis of the recommendations			
SN	Description	Cost in OMR	Remark
1	Appointment of consultant to develop training program covering learning	1000	
2	Appointment of certified agency to provide training to scaffold erectors	1100	
3	Hiring of jack hammers as recommended (@OMR 100/month x 04 numbers x 03 months)	1000	
4	Total cost of the gloves @ OMR 2.5 per gloves	1500	
5	Ear protection (ear muff) (RO 8 per muff * 3 months)	300	
6	First Aid training RO 95/person	600	
	Total Expenditure	5500	
Total number of target population: 36 Number of gloves required for 14 weeks (with 15% extra) : 580			

References

- BS 5973:1993 Code of practice for access and working scaffolds and special structures in steel.
- BSI (2007) BS OHSAS 18001:2007 Occupational health and safety management systems- Requirements, London UK.BSI.
- Construction (Health, Safety and Welfare) Regulations 1996
- Five steps for risk assessment: <http://www.hse.gov.uk/pubns/indg163.pdf>
- Hand-arm vibration The Control of Vibration at Work Regulations 2005 <http://www.hse.gov.uk/vibration/hav/regulations.htm>
- Law of handling chemicals RD 46/95
- Manufacture records for vibration equipment's: <http://www.atlascopco.com/greatcompactionus/Products/forwardplates/>
- Occupational health and safety regulations MD 19/1988
- Occupational Health and Safety (Manual Handling) Regulations 1988 <http://www.legislation.vic.gov.au>
- Oman Labour law: http://www.pdo.co.om/hseforcontractors/Environment/Documents/Oman%20Laws/Royal%20Decrees/labour_law.pdf
- PDO Approved COP 122 :<http://pdointernet/hsems/Pages/HSEMSDocuments.aspx?MSECode=MSEM>
- Regulation to noise Pollution MD 80/94
- Royal Decree 40/1979 – occupational diseases and accidents compensation law
- The Work at Height Regulations 2005 (as amended)