

Occupational Hazards and Safety in Railways Maintenance

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ABSTRACT: Occupational hazards typically associated with locomotive and railcar maintenance activities may include physical, chemical, and biological hazards as well as confined space entry hazards. The aim of the present study is to assess the occupational hazards among workers involved in locomotive and railcar maintenance activities and to evaluate Occupational health and safety performance. Physical and chemical hazards are evaluated. On comparing with TLVs. Workers in welding and wood working are exposed to noise of (78.4-102.0) dB (A) with the mean of 90.96 ± 10.6 , and (84.0-100.0) dB (A) with the mean of 90.98 ± 6.7 , respectively. Although workers in wood working are exposed to insufficient lighting in the range of (100-190) lux with the mean of 140 ± 35.4 , workers in thermal station and compressors station are exposed to defective lighting in the range of (60-360) lux with the mean of 164 ± 121.2 and (70-520) lux with the mean of 248 ± 176.8 due to improper light distribution as lighting was only adequate near gates. Exposures to chemical hazards are below the limits except for acid mists in batteries recharging process; this may be due to the limitation of the area in spite of the fact that the area is opened. Other hazards may include the potential for fire and explosion during the conduct of hot work in storage tank systems. Confined spaces may include access to railroad tank and cars during repair and maintenance. The need for improvement of occupational safety and health standards in the unorganized sector assumes very high priority. It is required to provide machinery and equipment which are safe and also to maintain guards in position and working order while a machine or equipment is in use. Specific requirements relating to protective equipment for eyes, for workers entering confined spaces or working at heights have been made. In terms of the administration of the OSH legislations, there has been a lack of educational and awareness effort. The general approach has been to make legislation and expect compliance while the need is for a proactive approach to reach out the persons responsible for compliance through well designed educational/awareness campaigns. Railway maintenance is considered one of the unorganized sectors in Egypt. Data base and health education are recommended.

INTRODUCTION

Typical railway components include repair facilities.^[1] Locomotives and railroad cars, known as rolling stocks, in addition to fixed infrastructure, includes tracks, stations, fueling facilities, and maintenance and maintenance activities may consist of routine servicing or heavy mechanical maintenance activities. Routine maintenance activities may include

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lubricating oil changes and mechanical safety inspections, exterior washing of locomotives and wagons, and interior washing of rail tankers. Heavy mechanical maintenance may include replacement of rolling and engine components, engine overhauls, mechanical tests, and adjustments. It may also include parts machining, welding, cleaning (including degreasing), and other types of activities typically conducted in metal machines shops. Passenger and cargo wagons may also be cleaned and painted, including touch up painting, during heavy maintenance.^[2]

Occupational hazards typically associated with locomotive and railcar maintenance activities may include physical, chemical, and biological hazards as well as confined space entry hazards. Physical hazards may be associated with work in proximity to moving equipment (e.g., locomotive and other vehicles) and machine safety including work portable

tools, and electrical safety issues. Chemical hazards may include potential exposure to a variety of hazardous materials (e.g., asbestos, PCB, toxic paint, heavy metals, and VOCs including those resulting from the use of solvent-based paint and cleaning solvents in enclosed space. Other chemical hazards may include the potential for fire and explosion during the contact of hot work in storage tank systems. Biological hazards may include potential exposures to pathogens present in sewage storage compartments. Confined spaces may include access to railroad tank and grain car during repair and maintenance.^[3]

Occupational health and safety performance should be evaluated against internationally published exposure guidelines. Projects should try to reduce the accidents among project workers to a rate of zero, especially accidents that could result in a loss work time, different levels of disability, or even fatality.^[4]

The aims of the present study are:

- 1- To assess the occupational hazards among workers involved in locomotive and railcar maintenance activities.
- 2- To evaluate Occupational health and safety performance.

MATERIAL AND METHODS**1-Material**

There are three governmental workshops in Alexandria that carry out routine maintenance activities, two of them are in Kabaari zone and the third one is in El-Hadara zone. The pattern of work in the three workshops is identical.

2- Methods***A-Physical hazards***

The main physical hazards to be evaluated are noise, illumination, and heat stress. Noise is considered the main physical hazard. It was measured in different departments and operations in the selected facilities using sound level meter calibrated at 114 dB.^[5] Illumination was measured using Lux meter.^[6] Heat stress

was measured as WBGT index using WBGT-Heat stress monitor.^[7]

B-Chemical hazards

Particulates were collected using cellulose membrane filters fitted to a portable personal pump of about 2L/min flow rate.^[8]

VOCs were evaluated using Teflon tubes of about 10 cm long filled with charcoal of known weight fitted to portable personal pump of about 0.12 L/min flow rate.^[9]

Nitrogen oxides (NO_x) and sulphur dioxide (SO₂) were determined by Griess– Saltzman reaction using 20ml of 0.1% N-(1-naphthyl)–ethylene diamine dihydrochloride as trapping medium for NO_x^[10] and colorimetrically using 20 ml of 0.04 M potassium tetrachloromercurate as trapping medium for SO₂^[11], respectively. Carbon monoxide (CO) was determined by using direct reading CO-analyser. ^[12]

Occupational health and safety were be evaluated against internationally published

exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines published by American Conference of Governmental Industrial Hygienists (ACGIH).^[13]

RESULTS AND DISCUSSION

At present, comprehensive safety and health statutes for regulating safety and health of persons at work exists only in respect of factories. In addition, there is a need for regulating safety in particular activities, operations, sectors such as transport, storage and handling of explosives, petroleum, insecticides, radioactive materials, installations, use and maintenance of boilers and unfired pressure vessels and operations of Railways, Shipping and Aviation. Thus, the approach is to lay down specific and detailed requirements to prevent risk of injuries in specific operations or circumstances. This approach lacks uniformity and well-coordinated approach

to safety and health in all sectors of the economy.

A-Physical hazards

Table (1) shows the physical hazards in different maintenance operations including: Smithery, Wax removal, Welding, Turnery, Wood working, Batteries, as well as thermal and compressors stations. On comparing with TLVs, the exposure range has slightly exceeded the TLVs among workers in smithery and welding who are exposed to heat stress of (23.4-27.5) °C with the mean of 25.58 ± 1.5 and (22.2-27.5) °C, with the mean of 25.24 ± 2.1 , respectively (TLVs = 29.4 °C). As measurements were taken in spring, it is expected that the values may be higher in summer.

Workers in welding and wood working are exposed to noise of (78.4-102.0) dB (A) with the mean of 90.96 ± 10.6 , and (84.0-100.0) dB (A) with the mean of 90.98 ± 6.7 , respectively [TLVs = 90 dB (A)]. The upper limits of exposure

ranges were due to using of equipment and tools in these departments.

Although workers in wood working are exposed to insufficient lighting in the range of (100-190) lux with the mean of 140 ± 35.4 , workers in thermal station and compressors station are exposed to defective lighting in the range of (60-360) lux with the mean of 164 ± 121.2 and (70-520) lux with the mean of 248 ± 176.8 due to improper light distribution as lighting was only adequate near gates (permissible level = 215 lux). Otherwise, it is clear from the proceeding results that heat stress, noise, and level of illumination were within the permissible limits,

B-Chemical hazards

Table (2) shows the chemical hazards in different maintenance operations including: Smithery, Wax removal, Welding, Turnery, Wood working, and Batteries. Workers are exposed to nitrogen oxides (3.32 ± 0.08), sulfur dioxide (2.35 ± 1.25), carbon

monoxide (0.67 ± 0.58), and particulates (4.69 ± 0.99) in smithery in the safe level below the TLVs of 5, 6, 55, and 10 mg/m^3 , respectively. Workers in wax removal are exposed to hydrocarbons of $372.65 \pm 10.77 \text{ mg/m}^3$ in the safe level below the TLVs (500 mg/m^3). Workers are exposed to nitrogen oxides (4.43 ± 0.40), sulfur dioxide (3.28 ± 0.38), and particulates (5.16 ± 0.04) in welding in the safe level below the TLVs (5, 6, and 10 mg/m^3 , respectively). Workers in turnery and wood-working are exposed to particulates of (5.18 ± 1.79) and (4.80 ± 0.62), respectively in the safe level below 10 mg/m^3 . Workers are exposed to acid mist in batteries recharging process of (2.14 ± 0.96) in comparable to TLV of 1 mg/m^3 .

Exposures to chemical hazards are below the limits except for acid mists in batteries recharging process; this may be due to the limitation of the area in spite of the fact that the area is opened.

Other hazards may include the potential for fire and explosion during the conduct of hot work in storage tank systems. Confined spaces may include access to railroad tank and cars during repair and maintenance. All of these occupational health and safety hazards should be managed based on the recommendations provided in the general OHS guidelines.

The need for improvement of occupational safety and health standards in some unorganized sectors assumes very high priority in today's social environment. Ministry of Labor being the apex body in the country with a mandate of alleviation of working conditions for the large sector not covered so far envisage that the new plan schemes proposed would go a long way in achieving of the goal of safe and healthy workplace for the whole of labor force of the country.^[14]

It is required to provide machinery and equipment which are safe and also to

maintain guards in position and working order while a machine or equipment is in use. Specific requirements relating to protective equipment for eyes, for workers entering confined spaces or working at heights have been made. Special equipment such as hoists, lifts, cranes, and other lifting appliances, pressure vessels, and exhaust equipment are required to be tested and periodically examined and certified by competent persons. Precautions for preventing fire and explosions and escape in case such events take place are provided. The Inspectors have been empowered to stop any work where danger to the life or limbs or health of workers is imminent.^[15]

In terms of the administration of the OSH legislations; there has been a lack of educational and awareness effort. The general approach has been to make legislation and expect compliance; while the need is for a proactive approach to reach out the persons responsible for

compliance through well designed educational/awareness campaigns such as the targeted conferences, seminars, literature in the form of simple leaflets, and media participation.^[16]

CONCLUSION AND RECOMMENDATIONS

Railway maintenance is considered one of the unorganized sectors in Egypt.

Recommendations

1- Data-base: Shortage of data is always an obstacle in organizing, developing, and supplying of occupational health and safety services. As regards railways workers, the scheme of work is not definite and also the number of working hours as they depend on the actual work required. So that, we are badly in need of establishing data base of different occupational exposures and

their adverse health effects on railways workers.

2- Health education: As railway maintenance includes diversity of processes and uses diversity of equipment and tools, health education programs should be directed to manage workers safe acts and behaviors.

3- Control of hazards and stress factors: Efforts should be directed to control of hazards such as applying local exhaust ventilation for acid mist and particulates, maintenance of tools and equipment and applying ear protection for noise. Also, regulations should be stricted towards the number of work hours.

Table (1): Physical hazards in different maintenance processes

Process	Heat stress (WBGT: °C)	Noise (Decibel)	Level of Illumination (Lux)
Smithery			
Range	(23.4 - 27.5)	(88.4 - 93.2)	(225 - 390)
Mean±S.D.	25.58±1.5	89.78±2.4	321±70.4
p	<0.05*	>0.05	<0.001*
Wax removal			
Range	(19.2 - 24.0)	(79.3 - 83.9)	(280 - 400)
Mean±S.D.	21.6±1.8	81.28±1.8	338±51.7
p	<0.05*	<0.05*	<0.001*
Welding			
Range	(22.5 - 27.5)	(78.4 - 102.0)	(220 - 400)
Mean±S.D.	25.24±2.1	90.96±10.6	324±82.6
p	<0.05*	>0.05	<0.001*
Turnery			
Range	(20.0 - 22.5)	(82.5 - 92.2)	(200 - 300)
Mean±S.D.	21.3±1.0	86.08±3.7	246±39.7
p	<0.05*	<0.05*	<0.01*
Wood working			
Range	(19.0 - 20.0)	(84.0 - 100.0)	(100 - 190)
Mean±S.D.	19.48±0.4	90.98±6.7	140±35.4
P	<0.05*	>0.05	<0.001*
Thermal station (Boilers)			
Range	(19.1 - 19.7)	(86.0 - 88.0)	(60 - 360)
Mean±S.D.	19.32±0.2	87.04±0.8	164±121.2
P	<0.05*	<0.05*	<0.01*
Batteries			
Range	(20.0 - 24.0)	(62.0 - 70.0)	(270 - 300)
Mean±S.D.	21.9±1.6	66.6±3.2	283±12.0
P	<0.05*	<0.001*	<0.01*
Compressors station			
Range	(19.5 - 23.5)	(60.9- -80.9)	(70 - 520)
Mean±S.D.	21.5±1.6	69.58±8.0	248±176.8
	<0.05*	<0.001*	<0.01*
Permissible limits	29.4	90.0	215

- n = 5

Table (2): Chemical hazards in different maintenance processes

Process	Chemical hazards	Concentration		TLVs	P
		Range	Mean±S.D.		
Smithery	Nitrogen oxides	(3.25 – 3.40)	3.32±0.08	5.00	<0.01*
	Sulfur dioxide	(0.91 – 3.18)	2.35±1.25	6.00	<0.01*
	Carbon monoxide	(0.00 – 1.15)	0.67±0.58	55.00	<0.001*
	Particulates	(3.54 – 5.32)	4.69±0.99	10.00	<0.05*
	Hydrocarbons	(363.35-384.45)	372.65±10.77	500.00	<0.05*
Welding	Nitrogen oxides	(4.00 – 4.80)	4.43±0.40	5.00	>0.05N.S
	Sulfur dioxide	(2.97 – 3.70)	3.28±0.38	6.00	<0.05*
	Particulates	(5.12 – 5.20)	5.16±0.04	10.00	<0.05*
Turnery	Particulates	(3.33 – 6.90)	5.18±1.79	10.00	<0.01*
Wood working	Particulates	(4.10 – 5.30)	4.80±0.62	10.00	<0.01*
Batteries	Acid mist	(1.11 – 3.00)	2.14±0.96	1.00	<0.05*

- n = 3
- Values are expressed as mg|m³

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