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ASSESSMENT OF HEALTH AND SAFETY RISKS IN A TEXTILE INDUSTRY

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Abstract

Work place diseases and injuries are common prevalence in industries of Pakistan. The present study aimed at evaluating occupational health and safety (OH&S) conditions and risks posed to textile workers. Environmental and noise level monitoring at selected textile industry was carried out for three months. Hazard identification and risk evaluation was performed using OH&S audit checklist and questionnaire survey. Monitoring results showed relatively higher noise level in stitching unit. PM_{10} at 'Grey' inspection and 'Cutting' sections while temperature at 'singeing', 'De-sizing' and 'stitching' units exceeded the prescribed limits. Audiometric testing identified hearing losses among workers diagnosed with hearing disabilities. The frequency for testing hearing loss in left and right ears was set at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. Significant risks of exposure to cotton dust, chemicals, increasing noise level and minor physical injuries at the work site were identified.

Keywords

OH&S audit, Risk assessment, Monitoring, Audiometric, Control

1. Introduction

Textile is the second largest industry worldwide, after agriculture (Sangeetha *et al*, 2013). In Pakistan textile industry plays dominant role in the manufacturing sector and is considered as the backbone of Pakistan's economy. Among Asian countries, Pakistan is the 8th largest exporter of textile products. With a share of 8.5% in the national GDP, the sector provides employment to 46% of total labor force and contributes appreciably in export earnings of the country (Ahmed, 2008). Pakistan is ranked as the 4th largest cotton producer, with 3rd largest spinning capacity in Asia; it adds 5% to the global spinning capacity. This textile sector has an overwhelming impact on the growth and development of the Pakistan's economy (Memon *et al*, 2016).

Pakistan lags in enabling legislation in the area of occupational safety and health (OS& H) whereas the infrastructure to promote and enforce (OS& H) is inadequate (Malik *et al*, 2010). Industrial indoor environmental quality is one of the major concerns for any commercial activity as it has a profound

impact on potentially exposed population and environment. If not managed, industrial practices become a precursor to a number of physiological and psychological health issues/ injuries for employers, employees and also the visitors. When specifying the work environment of a textile industry, health elements mainly include elevated noise levels, vibrations, ventilation, illumination, heating, in adequate sanitary facilities, clothing storerooms and safe eating and drinking facilities (Nuwayhid, 2004).

Textile industry workers are faced with several health problems such as headaches, cough, depression, cold, sleep disturbances and skin allergies. These issues can be linked to workers duration of exposure, smoking, alcohol drinking, tobacco chewing and dietary pattern (Singh, 2015). Major reasons behind occupational injuries in textile industries' workers can be traced to inadequate health & safety conditions. One year official data, based on occupational injuries and questionnaire survey of 456 randomly chosen workers in Ethiopia, concluded that the majority workers were untrained, unequipped (PPE) and were suffering from job stress and sleeping disorders which contributed as the main reason towards occupational harm (Aderaw *et al*, 2011). While other factors like excessive workload, low social support, high depressive signs and more variance between workload also result in potential occupational injuries (Nakata *et al*, 2006).

Air pollution is a significant occupational and environmental issue in many textile industries. Health impacts arise due to exposure to dust/ particulate matter (PM), high noise levels and numerous chemicals (solvents, VOCs etc.) utilized at various stages of textile production. Exposure to dust/PM in cotton textile industries is associated with prevalence of respiratory diseases like asthma, nasopharyngeal, bronchitis, byssinosis etc. among the exposed population (Ahasan *et al*, 2000; Li *et al*, 2006; Sellappa *et al*, 2010; Liaqat *et al*, 2009; Alemu *et al*, 2010; Donbak *et al*, 2006). In China, 67 cases of nasopharyngeal cancer were reported in a cotton textile industry mainly as a result of exposure to dust, acids, caustics and cotton (Liaqat *et al*, 2009). Moreover, continual exposure to chemicals in textile industry, especially in dyeing sections, reportedly lead to microcytic anemia and hypersensitivity (Liaqat *et al*, 2009). High noise level is another area of potential risk within the industries, with high incidence of "Noise Induced Hearing Loss (NIHL)". Regular exposure to intense noise level for a period of more than eight hours may result in damage to human ear leading to hearing impairment and under severe conditions, hearing loss. According to official data of "National Institute for Occupational Safety and Health", around 16 percent of global hearing loss was an outcome of uncontrolled exposure to noise for more than 8 hours a day at workplaces (Nelson *et al*, 2005).

Regular health and safety Assessment of the industry is essential to ensure current practices are in compliance with the existing standards and to highlight any gaps and loopholes/ non-conformity existing in the industry in order to

address the same. In this perspective, the present study was carried out to evaluate the existing H& S practices at a textile industry in comparison with internationally accepted practices and Standards, identify potential hazards and risks within the workplace and devise a suitable corrective action plan to promote a safe and healthy environment within the facility.

2. Methodology

The methodology adopted for the study was as follows:

2.1. Selection of study area

The industry under study is located at Faisalabad. The industry, known for its quality in polyester, poly/cotton and cotton products, manufactures bed sets, comforters, quilt covers, sheet sets and curtains. Preliminary survey of the industry was undertaken to collect basic information about industry, plant layout, production processes, utilities, H & S conditions and waste collection and disposal mechanism.

2.2. Designing OH&S Questionnaire and Checklist

Occupational H& S based questionnaire and audit checklist were designed to assess the common health and safety practices and prevailing conditions at the study area. The questionnaire anticipated to collect information pertaining to the profile and personal health status of the employees, safety conditions within the facility, knowledge and awareness of personal safety amongst the workers and hazard awareness among the employees. The OH&S audit checklist was targeted to acquire data regarding work environment, identification of hazards, health and safety management, Emergency management plan and Compliance/ conformity with the legal standards.

2.3. Environmental Monitoring

Environmental monitoring was carried out to evaluate the existing environmental conditions at the facility. The parameters monitored sampling points for monitoring along with the equipment used for monitoring is given in Table 1.

Table 1.Environmental Monitoring Parameters

Parameters	SI unit	Equipment/Model	Monitoring units/sections
Noise level	dBA	Sound Level Meter TES-1350a	Singeing, packaging stitching
PM_{10}	µg/m³	HAZSCANNER^{TM}HIM-6000	Grey fabric storage inspection
Volatile OrganicCompounds	ppb	HAZSCANNER^{TM}HIM-6000	Printing and dying
Light Intensity	Lux	Digital Lux Meter TES-1332A	Stitching, inspection, Packaging, Cutting, Counting
Ventilation (in terms of CO_2)	ppm	HAZSCANNER^{TM}HIM-6000	Processing hall, Ware house, Folding, Stacking, Laboratory
Temperature	°C	Thermo-Hygrometer Testo 622 (0560 6220)	Singeing, De-sizing, Stitching
Humidity	% RH (non-dewing)	Thermo-Hygrometer Testo 622 (0560 6220)	Singeing, De-sizing, Stitching

2.4. Employee Health Assessment

2.4.1. Questionnaire based Health Survey& audiometric testing

An OH&S questionnaire, designed to suit the purpose of assessing the employee health and their attitude towards safety, was used to identify any chronic diseases or other health related issues prevailing among the workers at the workplace. The interview based questionnaire survey was conducted among a randomly chosen sample of 100 workers.

To identify any hearing damages or losses among the workforce subjected to increased level of noise in the 'singeing' and 'stitching' unit of the facility, sample of 10 randomly chosen workers from each unit/section was subjected to audiometric testing in a sound resistant room with a back ground noise level of less than 20 dBA in accordance with ANSI/ASA 1991. The frequency for testing hearing loss in left and right ears was set at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. At each frequency the subject was introduced to changing tones and sound intensities starting from 5 dBA. The reading was noted just when the respondent signaled. Hearing level of the employees was tested using Ambco Model 15000 Audiometer.

2.5. Hazard Identification, Risk Assessment and Corrective Action Plan

Environmental and human exposure to potential hazards within the work facility were identified and characterized to categorize the associated risks as low, medium or high risk using an OH&S Audit checklist and an interview based questionnaire survey. A risk matrix was prepared based on the likelihood and severity of hazards that might occur or have been occurring over the time using the risk criteria standard set by IAPA (Industrial Accident Prevention Association, 2006) (IAPA, 2006). Based on the results, corrective Action Plan for the industry was devised and post control monitoring advised to ensure effective implementation.

3. Results and Discussion

3.1. General conditions at the facility

Safety hazards at the workplace were identified using checklist filled-in during a walk through survey of each processing unit at the work site.

Emergency exits, first aid kits, fire extinguishers and safety sign boards in English, Urdu and symbolic language were clearly marked at measured distances within the work site. All the switch boards were seen to be marked and kept free from obstructions, but uncovered plugs and sockets were observed at many places within the work place presenting a risk of electric shock.

The machinery and auxiliary equipment at the facility was generally very well maintained, however, few machines, especially in singeing and printing units, lacked machine guards and engineering controls to help control hazards and avoid accidents. Workers were provided with PPEs but only a very few were seen putting them to use, i.e. the workers were least concerned about their health and safety and the use of PPE was not observed to be stressed upon by the administration.

Some of the process units followed good housekeeping and maintenance. But, printing and stitching units were improperly managed. The spaces at these units were not properly organized and presented a high risk of bumping into objects and falling down. Work settings within the printing unit were improper and presented a risk of falling from height. Chemical storage was also not satisfactory as barrels used were uncovered and unlabeled. The staircases within the work facility were slippery and lacked proper support or slip resistant strips therefore they presented a high risk of tripping over.

The OH&S policy was displayed at the main office but neither was the safety manual available at hand, nor were the standard operating procedures made available to employees at each unit. Moreover, the emergency management plan of the industry lacked presence of safety showers, emergency eye wash units, emergency lighting and breathing equipment, workplace violence awareness and prevention program. Also, the updated emergency plan was as yet not reviewed and communicated with the nearby hospitals, police stations or the firefighting station. Similarly, the records lacked reporting of number of minor accidents at the facility within the last year. Training program for the workers was found to be deficient in the element of specificity as poor work practices were observed during the survey.

3.2. Monitoring Results

Results of Environmental monitoring of the work place are given in Tables 2-3.

Noise level was monitored in three of the noisiest units i.e. singeing, stitching and packaging and was found to be high enough in the singeing and stitching units as to pose hearing disabilities among the exposed workers. The average values for noise levels in the three months at singeing, stitching and packaging were 74.1 dB, 70.2 dB, and 85.9 dB, respectively. The increased noise level in singeing and stitching units was attributed to lack of engineering controls. In spite of high noise levels, the workers were not equipped with appropriate PPE. Such increased noise level might become a cause of various physical as well as psychological disabilities, e.g. frustration, headaches, fatigue, variation blood pressure levels, cardiovascular problems and even induced or permanent hearing disabilities. In fact the survey results indicated hearing impairment among workers. In similar study, Sacko *et al*, 2016 observed that 85% of textile industry worker were suffering from varying degrees of hearing impairment and this hearing deterioration became prominent after 10 years of employment. Hearing loss problem in textile industry worker is linked with age and time of exposure to noise (Caldart *et al*, 2006).

Varying intensities of light are required to accomplish different tasks. Light intensities at the workplace were monitored at inspection ($A_{vg.}$ value= 854 Lux), stitching ($A_{vg.}$value= 872 Lux), cutting ($A_{vg.}$ value= 446 Lux), packaging ($A_{vg.}$ value= 931 Lux) and counting ($A_{vg.}$ value= 206.3) units. All the units understudy were adequately illuminated with respect to the minimum limit of 250 Lux for

stitching, cutting, packaging and counting and 650 Lux for inspection and quality check set by OSHA. However, excessive lightning is not only harmful for eyes; it also means wasteful consumption of energy in a country struck by energy crisis.

Particulate matter is one of the major concerns of a textile industry credited to cotton dust from the grey fabric. Concentration of PM_{10} was monitored in the grey store inspection and cutting unit. Results showed PM_{10} concentration of 309.5 µg/m^3, 302 µg/m^3 and 311 µg/m^3 in the grey store inspection unit while a concentration of 226 µg/m^3, 234.2 µg/m^3 and 227.3 µg/m^3 in the fabric cutting section during the three monitoring months respectively. PM_{10} content in both the units, exceeded the permissible limit of 150µg/m^3 set by NAAQs and WHO, which also explains the reason behind prevalence of respiratory diseases among the exposed workers as reported by the workers.

Cotton dust is released in the workplace atmosphere during the handling and processing of cotton. According to Pakistan Institute of development economics Islamabad, 35.5% workers in textile industry in Faisalabad suffered from varying health issues (wheezing, 65.5%; phlegm, 58% ;chest tightness; 72% throat irritation) and other respiratory diseases (Mehwish *et al,* 2016).

Dyes make use of Volatile organic compounds (VOCs) which enter body through inhalation and bio-accumulate in the blood leading to cancers. The printing and dyeing sections were monitored for presence of VOCs in air. The results showed total VOC concentration of 0.00325 ppm, 0.00325 ppm and 0.00326 ppm in the printing unit while 0.0005 ppm, 0.0005 ppm and 0.0006 ppm were measured in the dyeing unit.

Ventilation conditions at the chosen industry were generally good except at the singeing, de-sizing and stitching units. The flow of air in the other units was observed to be plentiful, attributed to the construction design. Ventilation was measured, in terms of carbon dioxide (CO_2) just before the exit doors of the production hall ($A_{vg.}$Value= 1266.6 ppm), ware house ($A_{vg.}$Value= 412 ppm), folding and stacking ($A_{vg.}$ value= 605.6 ppm) and the industrial laboratory ($A_{vg.}$ Value= 804.6 ppm). Although the concentration of CO_2 in all the units was found to be within the permissible exposure limit of 5000 ppm set by OSHA. However, CO_2 concentration indoor is advised to be maintained below 1000 ppm in order to achieve a good indoor quality. The concentration in the singeing, de-sizing and stitching halls was above 1000 ppm mainly because of the congested space and lack of exhausts. Improper ventilation in these units was also a cause to high temperature and humidity levels.

Temperature and humidity levels were measured in singeing, de-sizing and stitching units because of the uncomfortably high temperature observed at these sections during the preliminary survey. Temperature at three of these sections exceeded the permissible range (20-24.44 °C) set by OSHA. While, the humidity level at singeing ($A_{vg.}$ value= 51.3

%), de-sizing ($A_{vg.}$ value= 56.3%) and stitching ($A_{vg.}$ value= 50 %), sections remained at the threshold of the prescribed range (20%-60% set by OSHA). These high values of temperature and humidity within these sections were partly attributed to the burning flames within the singeing machine and mainly to lack of proper ventilation techniques in the particular units. High levels of temperature and humidity are known to stimulate the growth of bacteria, aggravate asthma. Also, heat stress is a usual problem faced by workers working in high temperature and humidity conditions.

3.3. Questionnaire Survey Results

The health status of the employees was assessed by carrying out a questionnaire based health survey among the workers. Majority workers (64%) at the industry were mostly of young age between 16-25 years, very few (4%) were qualified above primary educational level which explains why only a minor percentage (6%) of workers were aware about the OH&S policy of the facility they were working in. However, almost all of the workers well understood the safety sign boards displayed around the workplace.

The low BMI scores (18.5 or below) indicated poor health status among 29% of workforce A noticeable number of workers (29%), especially from the inspection and stitching units, were suffering from chronic respiratory diseases like bronchitis and asthma, Apart from chronic diseases, headaches (77%), respiratory problems (69%), hearing problems (48%), stiffness (81%), heat stress (49%), frustration (72%) vibrations (46%) and humidity (28%) were common issues faced by the workers frequently. Most of these problems may be attributed to continuous exposure to loud noise, cotton dust, high indoor temperature and paint fumes accumulated within the surrounding air. The problem of stiffness, however, indicates fatigue and maintenance of constant postures while working.

Such diseases have also been observed among textile workers elsewhere. Physical examination of cotton textile workers exposed to airborne cotton dust in Kermanshah, Iran, showed that 51% of the workers exhibited respiratory symptoms while 31% depicted respiratory signs (Liaqat *et al,* 2009). Moreover, literature supports that exposure to cotton dust result in obstructive lung pattern and have shown to decline FEV1/FVC among cotton workers in textile industry (Alemu *et al,* 2010; Donbak *et al,* 2006). Nonetheless, improvement in lung function can be attained by ceasing exposure to cotton dust (Mehwish *et al,* 2016).

Complaints regarding minor cuts, burns, rashes and nail injuries (87%) and slips and trips (26%) were common among all the workers indicating absence of machine guards or poor work practices. Although the entire working staff was provided with PPE including gloves and masks, yet very few (7%) considered using those as they consider it a hindrance in their work efficiency. Hence most

of the workers (93%) were not comfortable using PPEs.

Though unsatisfactory housekeeping was observed in inspection, printing and stitching units with respect to handling and storage of chemicals and general tidiness, yet a large percentage of the workers (85%) were satisfied with conditions. More than half of these workers were not even aware of the harmful effects of exposure to chemicals and safety procedures to be adopted in case of accidental exposure. Lack of such knowledge indicates illiteracy and also absence of regular training workshops for workers.

According to the workers, the industry was adequately equipped with first aid facilities, warning sign boards, firefighting facilities, emergency exits, emergency treatment facilities, emergency transportation and efficient waste disposal systems. However, they were unaware of any arrangements regarding regular monitoring of the existing environment.

Audiometric testing was conducted to ascertain any noise induced hearing losses among 20 workers of varying age working in the singeing and stitching unit within the textile industry (Tables 4-5). From amongst the chosen sample, almost all the workers in the singeing unit suffered from slight (40%) to moderate hearing loss (30%), while 80% of workers in the stitching unit were suffering from moderate hearing loss. Noise induced hearing loss among these tested workers was found to be related to the years of employment and ages of the workers, i.e. hearing loss was prevalent among the workers working at the facility for more than 5 years and also, among the workers over the age of 25 years. Prevalence of such hearing loss at these units is attributed to continuous loud noise and non-usage of PPE, which can be prevented by the use of PPEs and engineering controls (Roozbahani *et al,* 2009).

In an earlier study hearing threshold levels of 145 workers (290 ears) were assessed. Results of this test showed that 73.8 percent of 145 textile workers in Egypt faced mild to severe sensorineural hearing loss (Ebtessam *et al,* 2014). Likewise many textile workers in Sudan suffered from NIHL. It was observed that NIHL increased with working experience as researcher reported that worker working from more than 10 years are at high risk than worker working from less than 10 years in textile factory (Ahmed *et al,* 2015). Continued long duration exposure, high frequency noise levels, non-usage of appropriate PPEs and age of workers all contribute to hearing issues, including NIHL, among textile industry workers, which can be prevented by the use of PPEs and engineering controls (Sacko *et al,* 2016; Roozbahani *et al,* 2009; Ahmed *et al,* 2015).

3.4. Risk assessment

Risk assessment of the identified hazards showed significantly high risk of worker's exposure to cotton dust and chemicals in the grey store and inspection unit as no control measures were taken to avoid human contact with such hazards, which indicated an increased risk of developing chronic respiratory diseases like byssinosis,

tuberculosis and bronchitis etc. Tables 6-7 show the OH & S hazards associated with processes at industry and risk evaluation of the health and safety conditions at the study area.

Similarly, heat stress, continuous exposure to loud noise, poor work practices and improper ventilation were high rated risks in the singeing and de-sizing sections. Singeing and de-sizing processes make use of heavy machinery that was observed to be releasing loud noise and high amount of heat into the surrounding air presenting a risk of noise induced hearing loss, heat stress.

The key area of concern at the bleaching and dyeing unit was the improper storage and handling of chemicals posing a risk of spillage and direct exposure to harmful chemicals and fumes and, thus, it presented a high risk of development of tumors and skin related problems within the workforce.

Exposure to fumes, poor work practices, poor walking space, vibrations, slips and trips, poor work settings were the basic concerns in printing and finishing sections. Moreover, printing makes use of dyes and paints which releases VOCs in the atmosphere. Exposure to VOCs can lead to cancers and dermatitis. The printing unit was set on a comparable height. The linking staircase was observed to be in a very poor condition and so was the walk through area. Such poor work settings might lead to accidents like falling off the height, tripping over the stairs, getting struck into objects or machinery. Unsatisfactory work practices were also observed at the printing unit. Neither was the machinery guarded with controls and nor were the workers using protective equipment for their safety.

However, the maximum risks (high significance) were associated with the cutting and stitching units including primarily, exposure to loud noise, vibrations, improper light intensity, exposure to cotton dust, poor walking space and improper ventilation. Fabric cutting at large scale releases cotton dust into the surrounding environment. These dust particles, in the absence of protective equipment, can be easily inhaled lead to respiratory problems with cough and colds being common occurrence among workers of cotton industry (Singh, 2015).

Such was the condition observed at the cutting unit of the work facility. Similarly, the stitching unit was crowded more than it could feasibly support, lacking proper ventilation and housekeeping services. Moreover, the machines which were been used for stitching propose were associated with such high level of noise and vibrations, that could cause noise induced hearing loss.

In order to achieve its goal of sustainable production, the industry immediately needs to manage the existing flaws in its working. A Corrective Action Plan (Table 8) was devised, consistent with the identified hazards, to minimize the health hazards associated with the process flow at the industry under study. The machinery and equipment used at the workplace, especially in the singeing and stitching units, need to be isolated or retrofitted/silencers need to be installed to limit the exposure of workers to such loud noise or otherwise job rotation be practiced by

the administration in order to limit the duration of exposure. Moreover, guards or sheds need to be installed in the equipment used for inspection of the fabric in order to avoid direct contact with light as continuous contact with such light intensity might lead to eye strains.

To control high temperature and humidity observed at the singeing, de-sizing and stitching units, it is proposed to install power fans need to indoor air quality healthy and in accordance with the Standards. Power fans need to be installed to keep the indoor air quality healthy.

The most prominent problem identified at the worksite was exposure to cotton dust which is the basic safety concern in most of the textile industries. This problems needs to be immediately taken care of. Dust collectors need to be installed in the inspection and stitching units. Also the housekeeping in these units should be very efficient to minimize the associated risks. Exposure to chemicals used for work process can also be reduced through efficient housekeeping services and adoption of standard work practices.

Most of the drains at the worksite were uncovered, offering a breeding ground for many parasites and hence presenting a risk of parasitic diseases among the exposed workers. These drains need to be redesigned such that they are properly covered.

Other significant safety and ergonomic concerns observed at the facility were associated with poor work practices including heavy weight lifting in folding and lifting the fabric yarn, repetitive movements in inspection of the fabric, improper work settings and careless attitude towards operating machinery. All these problems need to be eliminated at the earliest through proper training and counseling of the workers.

General attitude of workers towards the use of PPE was observed to be lax in all the work units. It is very essential on part of the administration to make the workers realize the importance of using PPE through counseling or/and strict implementation.

Hence, Health & Safety regulations constitute a crucial element for any work activity due to economic, legal and, also, ethical reasons. They, not only, promote business productivity but also help evade any accidents and failures in the management. An experimental study, based on a sample of 116 different companies, compared the performance of work places in compliance with safety regulations with those without safety management procedures, The results, based on hypothesis testing of employee awareness about health and safety practices, risk assessment & management and employee training, indicated higher performance levels at work places working under adaptation to “Safety Management Systems” (SMSs) in comparison to non-adopters (Bottani *et al*, 2009). Therefore, organizations around the world are now emphasizing on integrating sustainable means of industrialization within the firms at micro and macro levels. Integration of sustainability patterns within workplaces would not only ensure quality production but also a quality and safe environment within and outside the firm. Many organizations have now

incorporated cleaner technologies to guarantee safe effluent and ambient air; however these technologies do not offer complete safety and health for the population within the firms (Rocha *et al*, 2007). Health and safety practices must be addressed, stressed and implemented strictly within the industrial premises.

4. Conclusion

To achieve its goal of sustainable production, the industry needs to ensure an excellent health and safety environment at all times. Environmental parameters concerning health and safety conditions at the facility, especially noise level, PM_{10} and the indoor temperature, were found to be exceeding the Standards established by national authorities (NAAQS)resulting in prevalence of hearing disabilities and respiratory problems among the workers. Moreover, significant risks vis-à-vis exposure to chemicals and minor physical injuries were evaluated. Therefore the workforce need to be made aware of their safety rights and trained to protect themselves against probable hazards. Health and safety practices must be addressed, stressed and implemented strictly within the industrial premises.

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Table 2. Results of Environmental monitoring

Months	**Parameter and SI unit**											
	Noise Level (dBA)			**Light Intensity (Lux)**					**PM10 (µg/m^3)**		**VOCs (ppm)**	
	Singeing	**Packing**	**Stitching**	**Inspection**	**Stitching**	**Cutting**	**Packaging**	**Counting**	**Inspection**	**Cutting**	**Dyeing**	**Printing**
November	73.3	70.8	84.2	938	973	425	993	202	309.5	226	0.0005	0.00325
December	74.2	68.6	87.1	732	899	462	802	205	302	234.2	0.0005	0.00325
January	74.8	71.2	86.4	892	746	451	998	212	311	227.3	0.0006	0.00326
Average	**74.1**	**70.2**	**85.9**	**854**	**872.6**	**446**	**931**	**206.3**	**307.5**	**229.16**	**0.00053**	**0.00325**
Permissible Limits	[a] 75 **85			*250/650					[a,*]150			

*WHO, **OSHA, [a]NAAQS ,Pakistan,

Table 3. Results of Environmental Monitoring

Months	**Parameter and SI unit**									
	Ventilation (CO_2) (ppm)				**Temperature (°C)**			**Humidity (RH %)**		
	Processing Hall	**Folding Stacking**	**Ware House**	**Laboratory**	**Singeing**	**De-sizing**	**Stitching**	**Singeing**	**De-sizing**	**Stitching**
November	433	601	401	804	32	30	30	52	51	46
December	412	612	417	804	35	32	31	39	58	48
January	435	604	418	806	39.5	26	24.5	60	60	58
Average	**426.6**	**605.6**	**412**	**804.64**	**35.5**	**29**	**28.5**	**50.3**	**56.3**	**50.6**
Permissible Limits										
OSHA	5000				20-24.44			20-60		

Table 4. Summary of results (Audiometric Health Assessment in singeing unit)

WORK UNIT: SINGEING												
Respondents	**Age (years)**	**Years of employment**	**Duration of exposure (hours)**	**Mean Hearing Threshold on pure tone Audiometer**								**Hearing Loss**
				500 Hz		**1000 Hz**		**2000 Hz**		**4000 Hz**		
				R (dB)	**L (dB)**	**R (dB)**	**L (dB)**	**R (dB)**	**L (dB)**	**R (dB)**	**L (dB)**	
1.	26	6	8	15	20	15	20	15	20	15	20	Slight
2.	27	8	8	30	20	25	15	40	20	40	20	Mild
3.	19	1	8	15	20	15	20	15	20	15	20	Slight
4.	32	10	8	30	30	30	30	35	35	35	35	Mild
5.	35	13	8	40	30	55	30	50	40	55	35	Moderate
6.	28	8	8	30	30	25	25	35	35	35	40	Mild
7.	33	8	8	40	45	40	45	50	50	50	50	Moderate
8.	38	15	8	45	45	40	45	45	50	55	50	Moderate
9.	22	3	8	20	20	15	15	25	20	20	20	Slight
10.	24	3	8	15	5	15	10	20	5	20	15	Slight

Table 5. Summary of results (Audiometric Health Assessment in singeing unit)

WORK UNIT: SINGEING											
Respondents	**Age (years)**	**Years of employment**	**Mean Hearing Threshold on pure tone Audiometer**								***Hearing Loss categorization**
			500 Hz		**1000 Hz**		**2000 Hz**		**4000 Hz**		
			R (dB)	**L (dB)**	**R (dB)**	**L (dB)**	**R (dB)**	**L (dB)**	**R (dB)**	**L (dB)**	
1.	28	7	40	40	45	45	55	50	50	55	Moderate
2.	31	5	30	45	30	50	40	50	35	55	Moderate
3.	32	7	35	35	40	40	45	45	50	50	Moderate
4.	27	6	30	40	30	55	40	55	45	50	Moderate
5.	30	5	40	40	45	45	50	50	55	55	Moderate
6.	19	1	15	5	15	10	20	5	20	15	Mild
7.	26	4	45	45	40	45	45	50	55	50	Moderate
8.	32	6	40	40	45	45	50	50	55	55	Moderate
9.	36	8	55	55	50	55	55	50	65	60	**Moderately Severe**
10.	19	1	40	40	40	40	50	50	50	55	Moderate

*Guideline for hearing thresholds (AMBCO Model 15000 Audiometric manual)

00 – 15 dB	Normal hearing
16 – 25 dB	Slight hearing loss
26 – 40 dB	Mild hearing loss
41 – 55 dB	Moderate hearing loss
56 – 70 dB	Moderately hearing loss
71 – 90 dB	Severe hearing loss
91 + dB	Profound hearing loss

Table 6. Health and safety hazards associated with the process at the industry

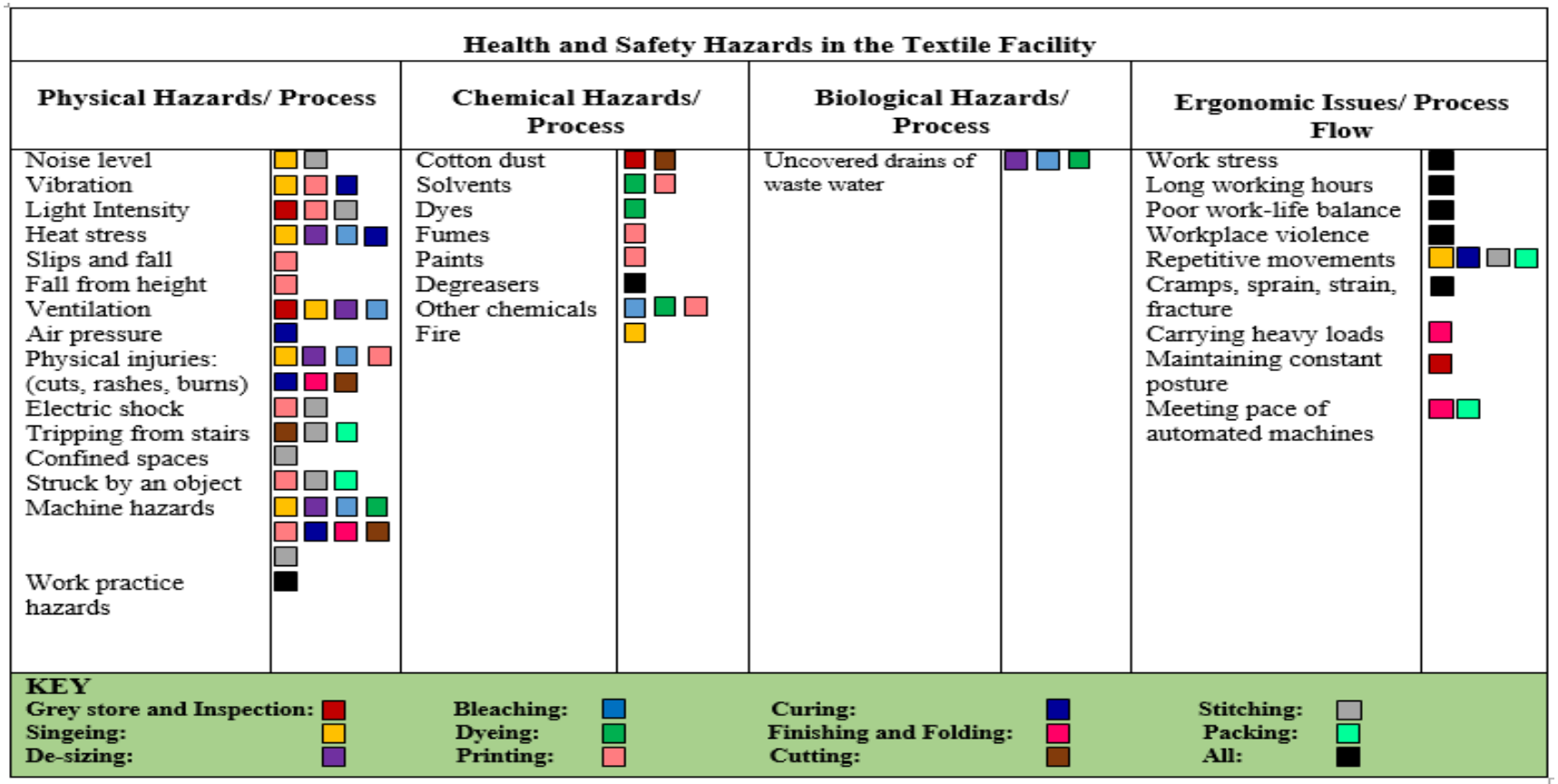

Table 7. Risk Evaluation of Health and Safety conditions at the textile facility

Work Activity	**Hazard Category(Health and Safety)**	**Identification of Hazards**	**Risks Assessment**				**Training Requirement**	**Controls in Place**	
			Severity (0-6)	**Frequency (1-3)**	**Probability (-1-+1)**	**Significance (0-10)**	**Y/N**	**Y/N**	**Adequacy Y/N**
Grey Store and Inspection	Physical	Improper light intensity	2	2	-1	3	Y	N	N
	Chemical	Exposure to cotton dust	6	3	+1	10	Y	Y	N
	Chemical	Improper storage of chemicals	4	1	+1	6	Y	N	N
	Ergonomic	Manual handling of heavy fabric yarn	2	2	0	4	Y	N	N
	Ergonomic	Repetitive movements	2	2	0	4	Y	N	N
Singeing and De-sizing	Physical	Heat Stress	4	3	+1	8	Y	N	N
	Physical	Increased noise levels	6	3	+1	10	Y	Y	N
	Physical	Improper ventilation	2	2	+1	5	Y	N	N
	Physical	Unsafe use of machinery (poor work practice)	6	2	+1	9	Y	N	N
	Physical	Physical injuries: Burn	6	1	+1	8	Y	N	N
Bleaching and Dyeing	Chemical	Improper storage and handling of chemicals	4	1	+1	6	Y	N	N
	Physical	Improper ventilation	0	2	0	2	Y	Y	N
	Biological	Uncovered drains: breeding ground for parasites	4	1	0	5	Y	N	N
Printing and Finishing	Chemical	Improper storage and handling of dyes	2	3	0	5	Y	Y	N
	Physical	Unsafe use of machinery, (poor work practice)	6	2	+1	9	Y	N	N
	Physical	Poor walking space	6	2	+1	9	Y	N	N
	Physical	Vibrations	6	3	+1	10	Y	N	N
	Physical	Slips and trips	6	3	+1	10	Y	N	N

	Physical	Fall from height (poor workplace setting)	6	1	+1	8	Y	N	N
Cutting and Stitching	Physical	Increased noise level	6	3	+1	10	Y	Y	N
	Physical	Vibrations	6	3	+1	10	Y	N	N
	Physical	Improper light intensity	4	3	+1	8	Y	N	N
	Physical	Exposure to cotton dust	4	2	+1	7	Y	Y	N
	Physical	Poor walking space	4	3	+1	8	Y	Y	N
	Physical	Improper ventilation	2	3	+1	6	Y	N	N
	Physical	Physical injuries: Cuts	4	1	0	5	Y	Y	N

Table 8. Proposed Corrective Actions

Non-Conformities		Consequences	Control Actions		
			Most recommended → Least recommended		
			Engineering	**Administrative**	**PPE**
Physical	Exposure to Noise	Noise induced hearing loss	Isolation of Machines Use of silencers	Ensure a reduction of exposure time	Ear muffs
	Exposure to Light	Eye strains	Machine guards	Ensure a reduction of exposure time	Goggles
	Exposure to Heat	Heat stress	Installation of powered fans	----	Protective clothing
	Improper Ventilation	Headache, Drowsiness, Irregular breathing etc.	Installation of powered fans	----	----
Chemical	Exposure to Dust	Respiratory problems	Installation of dust collectors	Ensure good house keeping	Breathing masks
	Exposure to Chemicals	Dermatitis and tumors	Storage of chemicals in suitable, labeled and air tight containers Allocate a separate storage area for chemicals	Train workers to handle all chemicals safely Dispose the chemicals in compliance with regulations Ensure good house keeping	Goggles, Gloves, overcoats
Biological	Uncovered drains of wastewater promoting parasitic breeding	Health issues/ Parasitic diseases e.g. Malaria	Redesigning drains such that they are covered	Ensure good house keeping	Protective clothing
Ergonomic	Lifting Heavy weight	Muscular skeletal disorders	Use appropriate trolleys	Train workers to follow safe manual handling procedure	Appropriate footwear
	Repetitive movements	Fatigue	Use of conveyer belts	Establish job rotation system	----
	Improper work practices	Physical injuries: burns cuts etc.	Use of machine guards	Train workers to follow standard work practices Keep supervision	Protective clothing and footwear
	Improper work setting	Slips and trips, Falling from height, Bumping into objects, getting electric shock	Use of slip resistance on floor Installation of properly engineered staircases Securing electrical sockets and plugs	Ensure good housekeeping and enough confined spaces	Protective clothing and footwear