ENVIRONMENTAL HEALTH AND SAFETY ISSUES IN SUGAR FACTORIES

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IN THE NAME OF ALLAH, THE MOST MERCIFUL AND BENEFICIENT

Title of Thesis: **Environmental Health and Safety Issues in Sugar Mills**

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Viva Voice Committee

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Dated: 15th April, 2011

DEDICATION

I salute all those workers who lost their lives while working at their work place in different accidents and also those who still working at the cost of their health and lives in the different nature of industrial units, generally all over the world and especially in developing countries like Pakistan.

I dedicate my work to my father, Hazoor Bukhsh Baloch, whose life as a factory worker with all its difficulties, is live in my memory and became a motivational force for me to work on the Environmental, health and safety issues in Sugar Mills.

DECLARATION

I Miss Farzana Yasmin D/O Hazoor Bukhsh Baloch, Registration No.2FBAS/MS-ES/F07, a student of MS Environmental Sciences, International Islamic University Islamabad (IIUI), do hereby solemnly declare that the thesis entitled " Environmental Health and Safety Issues in Sugar Factories" submitted by me in partial fulfillment of the requirements for the degree of MS, is my original work, and has not been submitted or published earlier and shall not, in future, be submitted by me for obtaining any degree from this or any other university or institution.

Name FARZANA YASMIN

Signature

Date

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All praises to Almighty Allah, The most Merciful, Kind and Beneficent. He is the only one God who can help us in every field of life. All respect and appreciation goes to our Holy Prophet Mohammad (PBUH), who is the forever guidance and knowledge for all the mankind.

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I would like to thank Pakistan Sugar Mills Association (PSMA) and Sustainable Development Policy Institute (SDPI) Islamabad, for their very useful assistance and for sharing the necessary data of Sugar Mills in Pakistan.

I am very grateful to Last, but certainly not least, I wish to thank Rana Nazir Mehmood for his advice to work in future research on the economic part of the work that is environmental health and safety and its relation with the production, export and finally the economic gain.

Farzana Yasmin

ENVIRONMENTAL HEALTH AND SAFETY ISSUES IN SUGAR MILLS

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ABSTRACT

To find out the Environmental, Health and Safety issues in sugar mills in Punjab province of Pakistan, Pattoki Sugar Mills in the central Punjab was visited. The required data of environmental parameters and health and safety was collected through detailed survey of each unit, instrumentation and Questionnaire based interviews of the workers, managers and supervisors. It was found that more than 70% - 80% accident in the sugar mills were due to the lack of awareness of Environmental health and safety measures; lack of environmental health and safety laws implementation and lack of monitoring at government level. There is a facility of first aid but there is no trend of regular medical examination or keeping the record of accidents. More than 40% workers said that they did not get any health and safety or job specific training except that of some instructions from the supervisor of unit. Less than 30% workers were of the opinion that they are provided or using personal protective equipments (PPE's) during their job. Less than 10% workers were provided proper ventilation system to effectively eliminate dust and fumes. Only 16% workers were in comfortable temperature. Noise was a prominent issue at Pattoki Sugar Mills. There were less than 10% places that have barriers for noise minimization and have been insulated to absorb sound. It was observed the sugar mill was untidy; there were spills of oil, and grease and chemicals at many places and chemicals drums were laying in the open air. There was obstruction in the pathways; stairs are without railing at many places. Interviews of 50 workers, mangers and supervisors of each unit in the Pattoki Sugar Mills showed that the health and safety situation of the workers in sugar mills was very unsatisfactory. Open channels and heaps of baggasse were causing irritation of eyes and throat. Baggasse was being used as fuel in the boilers and kilns. The burnt particles of baggasse, that was coming out of chimneys, clings on the adjacent walls and also the outside environment, causing serious environmental problems.

There was no safety management program for the mills workers. The research shows that there is also an immediate need of environmental health and safety management system, the revision and strict implementation and monitoring of the environmental health and safety regulation in the industrial sector.

List of Abbreviations/Acronyms

BOD	Biological Oxygen Demand
$CaCO_3$	Calcium Carbonate
Ca (OH) $_2$	Calcium Bicarbonate
CIWCE	Center for Improvement of Working Conditions & Environment.
COD	Chemical Oxygen Demand
CO_2	Carbon dioxide
CO_X	Oxides of Carbon
EHS	Environment, Health and Safety
FINJEM	Finnish job-exposure matrix
HSE	Health, Safety and Environment
HSE MS	Health, Safety and Environment Management System
ILO	International Labor Organization
MSDS	Material Safety Data Sheet
NEQS	National Environmental Quality Standards
NO_2	Nitrogen dioxide
NO_X	Oxides of Nitrogen

NWFP	North West Frontier Post
OHS	Occupational Health &Safety
OSHA	Occupational Safety and Health Administration
PSMA	Pakistan Sugar Mills Association
PM	Particulate Matter
PPEs	Personal Protective Equipments
R&D	Research &Development
SDPI	Sustainable Development Policy Institute
SPM	Statistical Parametric Mapping
SO_2	Sulfur dioxide
SO_X	Oxides of Sulphur
TDS	Total Dissolved Solid
TCD	Tones Crushing /day
TSS	Total Suspended Solid

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Chapter no. 1

INTRODUCTION

Pakistan is mainly an agricultural country and its agricultural activities depend on its world famous river system and its tributaries that produce the food and other crops to sustain its 160 million population.

After textile industry the sugar industry is the second largest agro based industry. Pakistan has 84 sugar mills that has distributed mainly in its provinces Punjab Sind and Khyber Pakhtunkhwa (formerly known NWFP). This big industrial sector has its annual crushing capacity more than 6.1 million tones and it accommodates over 75000 skilled, semi skilled, and management, financial and technical experts. It was estimated that in a short span of ten years that is 1999-2000, the cultivated area under cane increased at average rate of 10.7 percent, output of cane production rose at average rate of 24 percent and the yield per hectare went up at the average rate 11.7 percent (Memon, 2002).

Pakistan is the fifth largest country in the world in terms of area under sugar cane cultivation, 11^{th} by production and 60^{th} in yield. Sugarcane is the primary raw material for the production of sugar. Since independence, the area under cultivation has increased more rapidly than any other major crop. It is one of the major crops in Pakistan cultivated over an area of around one million hectares.

With the advent of Industrialization, there came many changes in the thoughts and mode of lives of the people of the nineteen and twenty century. Although it was thought a symbol of prosperity in term of a major source to satisfy human

materialistic approach but at the same time, these big and dirty machines not only replaced human but also became their master.

Due to the globalization, occupational health and safety got importance for its different level of hazards got serious concerns in the last decades of the twentieth century. The safety and health of workers in manufacturing units are gaining increasing attention in the recent days (ILO, 2000).

Despite of the economic gains from sugar sector, we cannot ignore its environmental and health impacts within the work environment within sugar mills and its surrounding during different processes.

Environment is a whole context of human life that is its natural, social and cultural conditions that influence the individual and its society. It encompasses the whole range of diverse surroundings, in which we observe, practice and respond to event and changes. It includes the air, water, land, vegetation and the whole social order. It also means the entire range of external influences either natural and manmade, that can affect the life support systems essential for health and survival. Within environments, there are hazards that can affect us or disturb our surrounding's physical, biological and chemical setting. Hazards is anything that can cause (1) injury, disease or death to human, damage to personal or public property or, (3) deterioration or destruction of environmental components (Wright., 2005).

The environmental health is the study that connects the hazards in the environment and its effects in the form of injuries, diseases and deaths. While we study the nature of environmental hazard, we examine the pathways that affect the human, its consequences and finally the interventions made to alleviate the risk associated to it.

The environmental management system not only addresses the environmental issues in and surrounding of the work place but also helps to conserve the resources and in turn boost the business.

1.1. Objectives of the study

The objectives of the study are as follows:

- To document any likely occupational environmental health and safety issues in Pattoki Sugar Mills and factors associated with these issues.
- To suggest measures to improve the existing environmental health and safety conditions among the workforce.

1.2. Scope of the study

The scope of the study is to highlight and understand the environmental health and safety hazards among workers in the Pattoki Sugar Mills.

This study will provide opportunity to researcher to gain practical knowledge of the laws related to industries, loopholes in them and lack of implementation at the current scenario. This research experience will helps the other researchers in identifying the occupational health and safety in the current era and also will be great source of help in future endeavors. The research can be useful as a source of information for similar projects. Proposed mitigate measures will be helpful for planers and policy makers to minimize the harms related to occupational health.

1.3. Organization of the study

This research work mainly presents five parts regarding the environmental health and safety issues in the sugar factories.

The first part is an overall introduction of the sugar industries in Pakistan, increased growing of sugarcane due to the increased demands of sugar. The risk of lives and health hazards of the workers in sugar mills, the objective and limitations of the research and finally the need of implementation of environmental health and safety laws in industrial sector.

The second part has the cited literature that explains the significance of sugar sector, its process involve and the health and safety issues associated to it in the major sugar producing countries in Pakistan.

The third part provides the description of the material and the methodology used to conduct the study, the primary and the secondary data details.

The fourth part includes results of the study areas, Results obtained and discussion related to it is also mentioned in the form of tables and graphs which describe the air quality and occupational health and safety situation of the working area.

The fifth part has the recommendations to minimize the impacts on heath and to ensure the health and safety within the workplace especially and to the overall environment generally.

1.4. Limitation of the study

The objective of the study was to evaluate all the parameters of environmental health and safety in Pattoki Sugar Mills and to know how these factors influence the heath of workers. Some constraints that became hurdles in the accomplishment of the study objective were the unavailability of the medical record of injuries and accidents of workers and equipments or instrument in the sugar mills for the recording of data, the

CIWC& E, IRI Lahore assisted me in this respect and make the instruments available to take the data of few parameters, to conduct the study.

Chapter no. 2

LITERATURE REVIEW

The book having the title of "Health, Safety and Environmental Control" consists of the readings written by Reynolds L.Hoover, Robert L. Hancock, Kevin L. Hylton, O. Bruce Dickerson, George E.Haris, published by The Van Nostrand Reinhold, New York in 1989. It contains the chapters on History and Organization that describes the evolution of safety, legislative history of health and safety law Industrial Safety, what should be the health, safety and environmental control mission statement and also the basic requirements for the relevant professionals. Besides these other chapters are Industrial Hygiene, Environmental Control and Health and Safety Information Systems. In these chapters, writer describe the responsibilities of the director of health, safety and environmental control for the unification of every facet of "safety" that is the minimum requirement of industrial safety, safety policy, anatomy of accidents, accidents investigation and prevention strategy. It also addresses another important aspect of industries that is waste generation, transportation, minimization and reduction through environmental management system.

The book with the title of "Policies For Cleaner Technology, A New Agenda for Government and Industry" is written by Anthony Clayton, Graham Spinardi and Robin

Williams published by Earthscan Publications Ltd, London, in 1999. It emphasizes the scope and implementation of cleaner technologies and the greening of industry in different industrial sectors. In the chapter nine regarding Sugar Sector by Soren Kerndrup with Leo Baas, Ole Erik Hansen and Brendaan Ryan, page 161 to 184, in which writers presented the role of regulations and of environment management to improve the production capacity, sustainable use of water and energy and the improvement of environmental behavior by presenting the comparison of case studies each in The Netherland, Ireland and Denmark.

The book having the title of "Occupational and Environmental Safety Engineering and Management" is written by Hamid R. Kavianan and Charles A.Wentz, Jr published by Van Nostrand Reinhold, New York, in 1999.The book comprehensively narrates the different aspects of industrial safety and management, like industrial toxicology, Fire Hazards, Noise, spill, radiation and electricity control and management. Not only this, in this book the legislations, Regulations and Standards regarding safety Engineering and management and especially, determining the causes of accidents and how to conduct an effective safety audits and development of computerized safety data system(CSDS) statistical methods to avoid and minimize the mishaps at work have been discussed.

The area of my special interest in the book is the "Safety Engineering and Management" in which stress is given upon the immediate need for safe working condition. It is the professional

responsibility of engineers and managers that by utilizing their knowledge they have to play their vital role to minimize the risk of accidents and to protect human health and Environment.

A thesis submitted in partial fulfillment of the requirement for the degree of masters of Science education in Environmental science in the university of Canterbury, by Georgia- Rose Travis in December 2007 with the title of "An overview of sugar culture in Morocco, particularly within a Berber community in Rastabouda" includes the issues of importance and history of sugar industry. The area of my special interest in the thesis is the topic "Environmental and the health impacts" in which the sugarcane industry is considered a major source of environmental pollution in Morroco. In his research work he addresses the environmental problems like deforestation and desertification due to the felling of trees that are used as fuel in the factories.

Sugar industries are one that consumes a great amount of water during the processing and the wastewater that is discharged directly in the nearby fields or water bodies like streams and used for irrigation and other human usages. Burning of sugarcane leaves in the fields during the harvesting and use of baggasse as fuel also has deleterious effects on health in the form of air pollution. Besides the older and obsolete machinery and technology and non-compliance to the regional, national and international regulation and guidelines aggravate the situation.

As Akbar and Khwaja (2006) opined that waste water, one of the major effluents from sugar factories with its high BOD and COD become the reason of septic like conditions

with foul smelling of hydrogen sulfide, that after reaction turn the water black and highly toxic and harmful for livings when this wastewater without any treatment is discharged to the receiving water bodies.

According to the Finish institute of occupational health estimates, in Finland, those Out of one million accidents in a year; about 120,000 are occupational accidents resulted an average resulting in a sick leave of about 15 days on average. Each year, about 40 people die in occupational accidents and another 40 in traffic accidents during work hours. The institute suggests through their research, conducted that by adopting preventions, accidents and injuries are reduced. Occupational health and safety measures can improve the work environment and human suffering and financial losses that result from them can be minimized.

The research article published in Oxford journal, Occupational Medicines in 1991by H.N. Phoolchund, having title ***"Aspects of Occupational Health in the Sugar Cane Industry"*** deals with the issues of worker's occupational health, diseases and accidents at work place in sugar factories, generally in the world and particularly in the third world countries. The main focus of the researcher is the high rates of accidents and diseases like lung cancer and Bagassosis caused by the use of pesticide and the exposure of baggasse respectively.

The research article published in Elsevier Science journal, Health & Place in 1995 by Harry Phoolchund, having title "Occupational and environmental health in Mauritius: a review of trends and recent studies" presents comprehensively the physical and the chemical hazards in the working environment, and the potential dangers to the general environment in the developing countries like Mauritius and the need of the evolutionary process in the legislation to protect the natural environment, environmental management system and their relation to the environmental problems like air pollution sources and their impact on air quality; population exposure to vehicular lead and a pilot study of dietary lead intake and the review of health and safety in 16 factories.

To meet the challenge, some changes brought in the system were the need of Environmental impact Assessment, setting of national environmental standards of water, noise and effluents and also the enforcement of these standards and the compliance with the law.

With the help of the project regarding Mauritius surveys including air pollution sources and their impact on air quality; population exposure to vehicular lead and a pilot study of dietary lead intake and the review of health and safety in 16 factories.

The outcome of the study was that the updating the legislation keeping in view the finding of survey in 16 factories, and by ensuring their implementation at workplace, the occupational and the general population health hazards can be minimized in the developing countries.

Chris Harris,(2009) senior editor of TheBioenergySite, presents his critical review on the book Sugar Ethanol - Contributions to Climate Change Mitigation and the Environment, published by Wageningen Academic Publishers, edited by Peter Zuubier and Jos van de Vooren.

Brazil is a prominent land regarding the sugarcane yield and its bio products that is ethanol. The country has two thirds of the global increase sugarcane production and 75 per cent of the increase in the area of land allotted to sugarcane between 2000 and 2007. Between 2002 and 2006, 773 hectares of pasture land changed to production of sugarcane, 103,000 hectares changed from land used for other crops and 125,000 hectares started to be used for the sugar cane production from land previously unused and reached to 11.7 million hectares. This expansion will affect the agricultural economy, land use changes and the environment. The book says that ethanol production for Brazil, can contribute to achieving the Millennium Development Goals because of its advantages over fossil fuels and the reduction of greenhouse gas emission that has been scheduled the end of sugar cane burning by 2014.

It seems a major contribution regarding alternate green energy source and the Climate Change Mitigation but on the other hand factor of land use change and biodiversity.

A new Finnish job-exposure matrix (FINJEM) was constructed for exposure assessment in large register-based studies. Unlike most other JEMs, FINJEM was designed to contain definitions, inferences, exposure data, and references. This documentation enables FINJEM to be applied also as a general exposure information

system for hazard control, risk quantification and hazard surveillance. The system includes, e.g., workforce data, and it provides information on the numbers of exposed workers in Finland by agent, occupation, and level of exposure. The exposures of FINJEM cover major physical, chemical, microbiological, ergonomic, and psychosocial factors. The assessment period is 1945-1997, divided into several sub periods. Exposure is described by the prevalence of exposure and the level of exposure among the exposed, both estimated mainly on continuous scales. The user may also define the final criteria of exposure, and thereby influence the magnitude of misclassification.

For exposure assessment in large register-based studies, T. Kauppine, J.Toikkanen, E. Pukkala (1998), Previous job-exposure matrices (JEM) having usually cross-tabulated classified exposure information by chemical agent and occupational class compared with a new constructed Finish Job Exposure Matrix (FINJEM) in their research "From cross-tabulations to multipurpose exposure information systems: A new job-exposure matrix"

This documentation enables FINJEM to be applied also as a general exposure information system for hazard control, risk quantification and hazard surveillance. The system includes, e.g., workforce data, and it provides information on the numbers of exposed workers in Finland by agent, occupation, and level of exposure. The exposures of FINJEM cover major physical, chemical, microbiological, ergonomic, and psychosocial factors. The assessment period is 1945–1997, divided into several subperiods. The prevalence of exposure and the level of exposure among the exposed, both estimated mainly on continuous scales, describe exposure. The user may also define the final criteria of exposure, and thereby can improve the way of classification.

T P Kauppine T J Partanen, S G Hernberg, etal (1993) in their research work "Chemical exposures and respiratory cancer among Finnish woodworkers" studied the relation of chemicals exposure in the different processes at work place with the diseases was assessed for the cases and the controls by a plant and period specific job exposure matrix. An excess of respiratory cancer was associated with phenol. An excess risk and an increasing exposure-response relation were found for engine exhaust from petrol and diesel driven factory trucks. Exposure to wood dust, mainly from pine, spruce and birch, at a level of about 1 mg/m3, was not associated with lung cancer, upper respiratory cancer, or Aden carcinoma of the lung.

Pietroiusti A, etal (2006) found the linkages between the shift work workers and the peptic ulcers. He found a correlation between the workers, who work other than general day time duty hours and of ulcer. Workers in shift are more vulnerable to peptic ulcers than the workers day- time workers. Gastric ulcer was diagnosed in 3.9% of shift workers and 1.2% of day workers. The authors conclude that shift work increases the ulcerogenic potential of *H pylori* infection, especially in the duodenum. They suggest that treatment of infection in this high risk group could improve workers' health and reduce the economic impact of peptic ulcer disease.

Organic dusts are considered one of the significant reasons of problems related to respiration, and may be carcinogens. An online published journal in 2006, Occupational and Environmental Medicine, Laakkonen *et al* (2006) has cited a research

about the exposure to eight different organic dusts and respiratory cancers in Finland. In this study, over 20 000 incident cases of nasal, laryngeal, or lung cancer, and mesothelioma were reported. To assess the Exposures to organic dusts, a job exposure matrix (FINJEM) was used for this purpose. The evidences showed that the exposure to organic dusts may be a major risk factor for respiratory cancer.

Timo Kauppinen, Timo Partanen *et al.(1995)* conducted a nationwide case control study in Finland to identify occupational risk factors for pancreatic cancer, by applying several; approaches in the assessment of previously suggested and other occupational exposure. They used occupational exposure history of 595 of exocrinic cancer of pancreatic cancer of pancreas in Finland and found that Occupational exposure of chemicals contribute in pancreatic cancer in the consequences of industrial work.

Chapter no. 3

RESEARCH METHODOLOGY

Environmental health and safety are important determinant for the evaluation of any environmental hazards and disease or injury at working environment. It is also used to devise the strategies to minimize bad occupational impacts in the form of injuries and accidents. There are many environmental health and safety issues associated with sugar processing and the sugar mills are an important industrial sector of Pakistan. In Pakistan there are 84 sugar factories distributed in the province Punjab, Sind and Khyber Pakhtunkha (formerly known as NWFP). Sugar mills in Pakistan starts its crushing season normally in October and it ends in March/April. The sugar mills are normally situated and operating in agricultural surrounding. So it is important to highlight the EHS issues in this sector and should be addressed.

Mill wise sugarcane crushing, raw utilization, Sugar production, recovery %age and molasses production for season 2008-2009 details in each province is given in the annexure A.

3.1. Background of Research Study area

Pattoki is the second big city of district Kasur and is also one of the biggest tehsil and trade center of province Punjab. It is situated on G.T. road at a distance of 80 kilometers from Lahore, Kasur and Sahiwal. Pattoki is also famous due to its big,

fertile agricultural fields. The city is famous for its good quality nursery farms and flower farms. Due to the number of big flower farms, it is called the city of flowers.

3.1.1. Company profile of Pattoki Sugar Mills

Pattoki sugar mill is named by the city in which it is situated. It is surrounded by the big agricultural land. It started its first crushing in 1976. . The crushing capacity of Pattoki sugar mills is now 7000 tons per day. The sugar production or the recovery is mainly dependent on the availability of the sugarcane. About 660 workers work in off-season and during the crushing season number of the workers double to 1132. There is also the residential area or colony, adjacent to the factory area, for the workers and management staff.

3.1.2. Environmental Profile of Pattoki Sugar Mills.

The major environmental problems are wastewater, odor of molasses, baggase and fly ash and noise. Wastewater has been the primary issue demanding the wastewater treatment facility to reduce the BOD content. Wastewater having different process chemicals is normally carried to nearby streams and water bodies. As occupational health and safety is an important part of organization and the management of any organization is much concerned about it so to get the required data of environmental health and safety issues in Pattoki sugar mills, I got permission from the general manager to visit the sugar mills thoroughly. The personnel manager of the mills escorted me to explain the processes involved in each unit or section. During the visit of each section the environmental health and safety parameters were evaluated.

3.2. Methods

To meet the research objectives broadly the tasks under taken included, the primary data collection in sugar mills, instrumentation for the recording different environmental parameters. Moreover secondary data was used to support the study through literature.

3.2.1. Primary Data

The tools are used for the primary data collection and assessment was instrumentation, observations, questionnaires and interviews.

A. Monitoring / Sampling

The different air quality parameters including CO2, NO2, SO2, Suspended particulate matter (SPM), Noise level/ sound level, Dust Level, Illumination Level, Temperature/ Heat stress and Relative Humidity are affected by sugar processes. The parameter data was compared with the environmental standards. These are parameters data of parameters that I could manage to get by using the above respective instruments is given below:

i. Dust Level.
ii. Illumination Level.
iii. Temperature/ Heat stress.
iv. Relative Humidity.
v. Noise level/ sound level (SL)

B. Observations

Observations during the survey formed a significant part of our research data, functioning as a cross-check to interview material and providing new opportunities for understanding the complexity of a given labour sector. Significant time was spent quietly observing employees at the workplace in each unit. Some units were observed in significant detail and findings were enhanced with worker's interviews.

C. Questionnaire

The Sugar Mills staff can be divided into three main sections. The Employer/ as well as employees were interviewed. Employees were further divided into following three sub-sections.

- Administrative staff.
- Supervisory staff.
- Work force directly engaged in milling process.

Questionnaire was designed to investigate the current situation of EHS issues in each unit of Pattoki Sugar Mills, number of personnel from each section were questioned regarding the existing practices of the sugar mill. The sample questionnaire is given in annexure B.

D. The interviews

The interviews of the employer, management staff, supervisory staff and workers helped me to know how the environmental health and safety is viewed by different staff members. These interviews helped me to get the required information of the questionnaire and also provided facts and figures that supported the views during the field work.

i. Key informant interviews

Key informants were those knowledgeable individuals, employers or employees in each area who could provide an overview of the kind of people engaged in the labour sector and the health safety problems faced by them being explored. Key informants also helped to identify other individuals for formal interviews.

ii. Informal interviews

The informal interviews were in fact the discussions with individuals in different departments or processing units in the visited factories. These interviews proved a valuable source of information. As the official or managing staff was reluctant to provide any information regarding environmental, health and safety issues in their factory, so these informally structured interviews were the bedrock of our rapid assessment methodology and the themes of safety and health issues were explored with numerous individuals and their employers during this rapid assessment.

iii. Formal interviews

This category includes in-depth interviews with individuals (Employers, Management staff, Department or unit heads, Employees) in the research sectors, as well as structured focus groups. The interviews were documented for analysis.

3.2.2. Secondary Data

For secondary data following sources were used;

i. Books, thesis reports, journals, articles etc were studied for relevant literature review to get help in related data collection.

ii. Centre for the Improvement of Working Conditions & Environment (CIWC&E) Lahore, Industrial Relations Institute Lahore; Labour & Human Resource Department Government of Punjab provided useful resources (instrumentation in the factory, laboratory access for preparation of samples and getting results of those samples), to conduct and fulfill the research work.

iii. The annual reports of Pakistan Sugar Mills Association (PSMA) also provided the necessary data about the sugar factories and their concerns.

iv. Sustainable Development Policy Institute (SDPI).

Chapter no. 4

RESULTS AND DISCUSSIONS

4.1. Sugar processing in factories

Sugar milling process from the sugarcane is same in most of the mills with little bit difference due to the difference in technology adopted in the newly installed plants. In sugar industries, mostly heavy machineries are installed due to the nature of the processsess involved to finally get the sugar from sugarcane.

Mainly the processing of sugar from the sugarcane can be classified into two sections keeping in view the status of sugar i.e. raw sugar and refined sugar.

According to Aldaba and Cororaton in 2001, the raw sugarcane goes through five major operations that are; Milling, Clarification, Evaporation, Crystallization and Centrifugation before the process of its refining.

In factory C, major operations involved in the processing raw sugar cane are as follows. And the data flow diagram of the process is attached in annexure A.

1) Milling

2) Primary Heating

3) Defecation / Liming

4) Secondary Heating & Evaporation

5) Crystallization & centrifugation

6) Affination and melting

7) Clarification

8) Refine Crystallization & centrifugation

9) Refine sugar packing

Milling

The process starts as the sugarcane reaches in the mill house where it is weighed, unloaded manually or with the help of automatic platform movement that throws the cane into the channeled stream of cane. After that it is disintegrated into smaller pieces and washing, cutting and shredding takes place. Further sugar cane passes through a series of heavy rollers in order to extract juice. After that the juice is extracted from the cane in the mill house by pressing it, then the juice and bagasse is separated and this bagasse having 50- 52% moisture is sent to the boilers and used as fuel.

1) Primary Heating

The mixed juice is sent to the juice heaters for the primary heating with the temperature up to 75 ^{0}C, the condensation process starts.

2) Defecation / Liming

Cane juice is clarified by liming/ Defecation with the addition of milk of lime to attain a pH of 7.5 to 8.5. At this stage the Brix is 180. After treating with milk of and the juice is heated to a few degrees above 100^{o}C. During this process suspended particles and impurities are trapped and settled allowing the juice to be drawn off and sent for evaporation.

3) Secondary Heating & Evaporation

During secondary heating and condensation at 105^{0}C, then the juice is clarified with the polyelectrolyte. After that juice is evaporated, until it gradually

thickens to syrup like condensate having consistency 55% sucrose, 35% water, and 10% non-sugars.

4) Crystallization & centrifugation

At 500 brix the juice is called syrup. The condensate is crystallized by the centrifugation to the A sugar transforming to refine sugar and A heavy molasses, and this molasses is sent to the storage tank. After that the raw sugar is transformed to refine sugar. This is then melted with the steam water to Brix 65.

5) Affination and melting

Affination is the removal of molasses that rises to the top of the mixture and forms a skin over the top.

6) Clarification

Carbonation, heating, and bubbling of CO_2 gas from the boilers into the mixture results in the formation of calcium carbonate ($CaCO_3$) precipitate which entraps any suspended and insoluble impurities including ash.

7) Refine Crystallization & centrifugation

At 500 brix the juice is called syrup. The condensate is crystallized by the centrifugation to the A sugar transforming to refine sugar and A heavy molasses, and this molasses is sent to the storage tank The concentrated liquor is then sent to vacuum pans where sugar crystals are precipitated. The liquor is then further evaporated. When the optimum crystallization is attained, the crystal-molasses drop to

centrifugal machines where they are purged to separate the crystals from the molasses and the run off goes to Refine Pan boiling.

8) Refine sugar packing

The sugar, after refine drying with hot air is then ready for packaging and export. Meanwhile these processes produces significant waste products that have the potential to have a significant detrimental effect on the environment.

4.1.1. Chemicals used in the sugar manufacturing process

The chemicals used in sugar processing are used to facilitate the recovery of the impurities of the sugar cane. These chemicals are also used to improve the quality of sugar and to make it pure and do not become the part of the end product.

Following are the chemicals used;

a. **Calcium Hydroxide**

Calcium hydroxide is used for clarifying sugar cane juice. It increases the PH of the juice in the defecation process. It is also used in coagulation and precipitation of impurities.

b. Phosphoric Acid

In phosphitation process, Phosphoric acid is used for clarification of liquor. It also improves the clarification process in the liming of sugar cane.

c. Poly electrolytes

Polyelectrolyte are polymer-based chemicals, which are used to coagulate the impurities precipitated during defecation process. The coagulated impurities settle down at the bottom and are removed.

d. Caustic soda and soda ash

Juice heaters usually foul very quickly. It is necessary to clean these to remove the deposited scale. The caustic soda is used in boiled form in the heaters.

e. Other chemicals

Other chemicals used in processing are Sulfur, Talo Float, Talo floc etc.

Processes of sugar manufacturing affect both environmental qualities within the mills effecting health of workers and nearby residential and agricultural areas. To assess the air quality at different units, data was collected through instruments and the reported results were compared with the guidelines and the standards. The purpose of these guidelines is to provide a basis for protecting environment from the adverse affects of pollution and ensure the workers health and safety. The results obtained of the parameters are given in tabular form with their respective standards used for comparison and analysis and then discussed. Moreover questionnaire and interviews of the workers also helped to have an idea of environmental health and safety conditions.

4.2. Environmental Parameter assessment at work place

The tables having the details of the recorded data of the following parameters in the target factory is given in the annexure –D.

4.2.1. Dust level

The dust comprised bagasse, sugar dust and the burnt carbon particles coming out of chimneys of the boilers in the result of the burning of bagasse and oil in the boilers for steam boilers For Dust Level, Apex and Apex Pro Personal Air Sampling Pump Model No. 02036 is used. According to OSHA standards Dust level should be 10 (mg/m^3). The Apex pro personal Air Sampling Pump' filter was prepared before sampling.

The dust level measurement was made at three sections, during the working sugar mills that is walkways near boiler house, at the plate form of mill house (upper floor) and at mill house (ii). The table 4.1 shows dust data that it was exceeded from permissible limits and the observation also favored the analysis, it was found that the suspended particles of un-burnt bagasse causing inhaling problems and irritation in eyes. There were also evidences of burnt carbon particles clinging on the adjacent machines and walls of sugar mills.

4.2.2. Illumination level

Proper illumination level is necessary in any work place so that the workers can perform their duties in comfortable environment without any difficulty. This Illumination level can be achieved by the natural source that is sun and also by artificial source that is electrical bulbs and tube lights.

Illumination level meter used for the measurement of illumination is TECPEL 530 Digital light meter. Table 4.2 shows the measured illumination levels of various units within the factory areas, which are not meeting the requirement of international standard.

4.2.3. Temperature

According to the Factories Act 1934, workplace temperature should be 25 degree Celsius with plus minus 5 degree from the source. Digital hygrometer TH-Calc Model No. 8720 by TSI was used for the measurement of temperature.

Table 4.3 shows the heat stress situation in the factory by measuring the temperature in different units and by comparing it with the national standards. Due to heat workers do not feel comfortable and it results in reducing the working capability. Heat stress for a long time can cause physiological changes in human.

4.2.4. Relative Humidity (%) Level

Recommended humidity level is very important to let the workers do their work at comfortable level. Digital hygrometer TH-Calc Model No. 8720 by TSI was used for the measurement of Relative Humidity. The acquired data presented in the table 4.4 that at all working area there is no humidity issue and the measured levels are within permissible limits. According to the Factories Act 1934, Humidity level at workplace should be 55-65%.

Table 4.4 explains the Relative humidity levels in the different units of sugar mills. The humidity level in these areas, mentioned in the table is within permissible limits.

4.2.5. Noise

In factories, most of the operations involve a number of heavy machines, equipped with moving and rotating parts, which result into elevated noise levels at work place. Workforce and management, in general, do not consider noise to be health hazard therefore no provision exists to save workers from this nuisance. Noise may have both physiological as well as psychological effects on human beings. Occupational

exposure limits specify the maximum sound exposure levels and exposure times to which nearly all workers may be repeatedly exposed without adverse effect on their ability to hear normal speech. According to the Pakistan National Environmental Quality Standards, an occupational exposure limit of 85 db for 8 hours should protect most people against permanent hearing impairment induced by noise after 40 years of occupational exposure.

For the noise data, Noise Level Meter by Quest Technologies U.S.A was used. According to the table 4.5, noise levels in the various houses and sections of the study area are in the range of 96.1 – 104.5 dBa.

4.2.6. Air Emissions

In sugar factories, normally two types of air emissions are known. Broadly classified as point and diffused emissions.

- Point emissions are mainly from the boiler stacks and exhausts. Emissions from these sources can be quantified and easily monitored.

- Diffused emissions are those, which generally go directly into the occupational atmosphere of the production areas from open points. The emitted pollutants are generally dispersed in the occupational environment and in the atmosphere, and their exposure might result into various environmental and health hazards for workers and also to nearby residents.

At sugar mill, bagasse is used in boilers as the principal source of energy and Furnace oil is also used for the supplement of fuel requirement. The guidelines for Self Monitoring and Reporting by EPA require that sugar mills should report their gaseous

emissions quality of the priority parameters to EPA on quarterly basis (category- B industry for gaseous emission). These parameters are Cox, Sox, NOx and particulars.

4.3. Occupational Health and Safety (OHS) Situation

From field observations, questionnaires and interview of all working staff including management, the conditions of EHS was assessed and different parameters were focused to know the actual prevailing occupational health and safety situation of workers. The data of different parameters is given below:

Electrical safety

Figure 4.1 shows the electrical safety situation of electrical safety n the visitor factory. There is an immediate need of managing electrical safety system installation and inspection and the boxes, electrical wires and open electrical appliances should be covered.

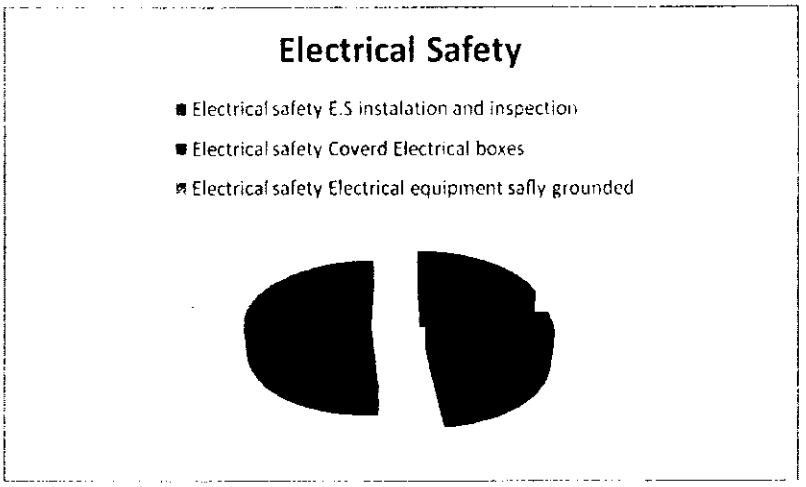

Figure 4.1: Electrical Safety

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.1 Fire safety

Fire safety was unsatisfactory as there was no regular training or drills to meet the emergency situation of fire. The emergency routs are not marked moreover there is improper storage of flame able material as illustrated in the figure 4.2.

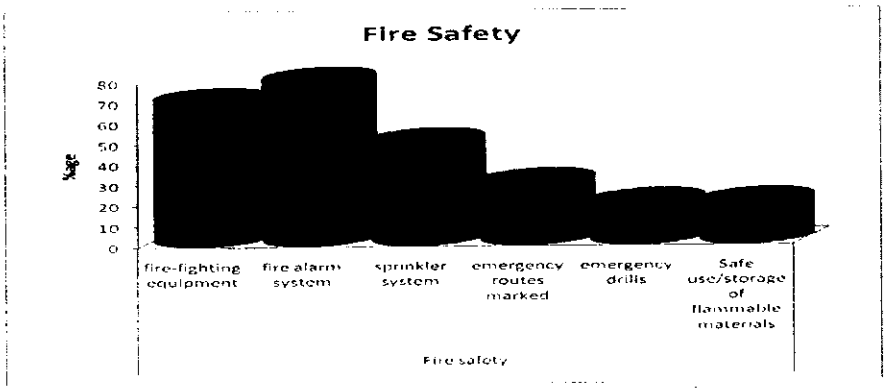

Figure 4.2: Fire Safety

4.3.2 Machine safety

Figure shows that in many units of Pattoki sugar mills, the moveable parts of machinery was not properly guarded nor were they regularly inspected resulting in increased risk of accidents. Most of machinery was not in safe working order.

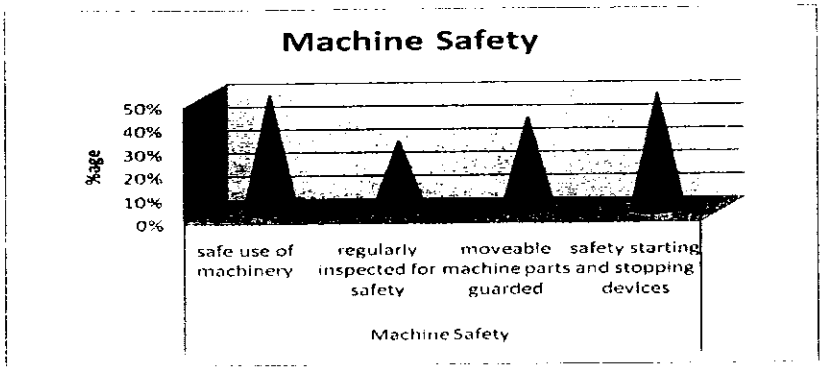

Figure 4.3: Machine Safety

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.3 Noise Handling

Noise situation in the factory was worst. Regarding the noise handling practices in the factory, few machines were sealed and covered at the sources of noise whereas the ceiling, floors and wall surfaces were not properly insulated. There were no barriers to separate the noisy and quiet places.

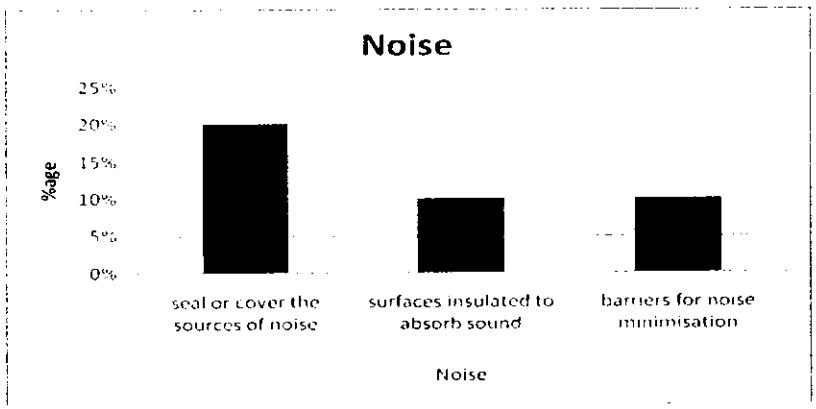

Figure 4.4: Noise handling

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.4 Temperature and heat minimization

As we can assess from the given graph 4.5 the situation of in house temperature at workplaces in sugar mills. In many work areas due to the specified process, temperature was very high. There were arrangements to fresh air can circulating in work area by electric fans or ventilators but at many places like boilers house had extreme temperature. The heat-producing machinery, equipment, surfaces, etc. were insulated at some places but in many sections there was loss of heat due the improper insulation.

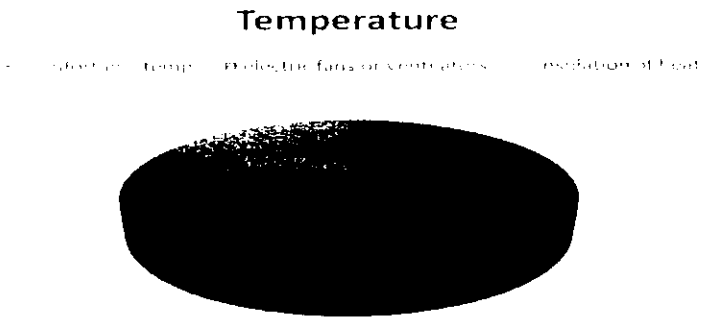

Figure 4.5: Temperature management

4.3.5 Proper ventilation

The graph 4.6 shows that the ventilation systems e.g. air-conditioning, fans and ventilators were not provided in each work area. The present ventilation system were unable to effectively eliminate hazardous substances e.g. dust, fumes as they are not properly cleaned and maintained.

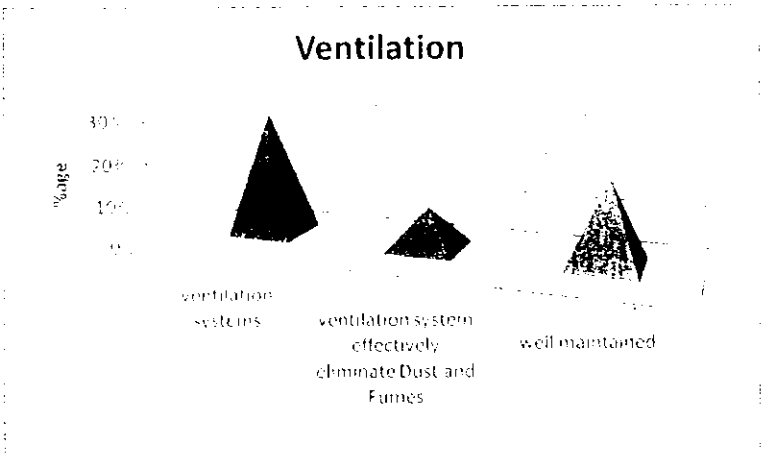

Figure 4.6: Ventilation Facility

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.6 Proper lighting

Graph 4.7 shows the lighting situation at the different places of the visited factory. The graph shows the need of change in the arrangement of the workstations to get the maximum benefits of natural daylight in other cases to save the workforce from the stress on their eyes.

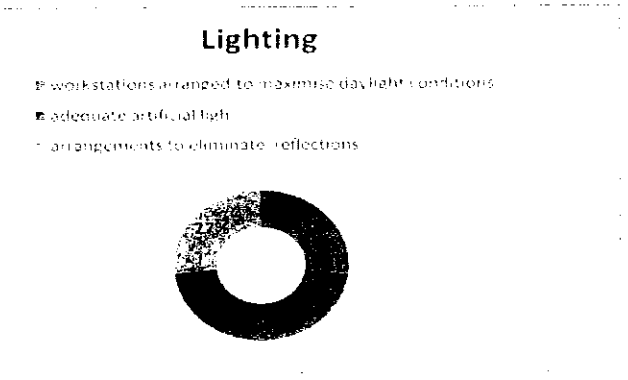

Figure 4.7: Lighting Facilities

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.7 Handling of hazardous substances

The following graph 4.8 is showing the situation regarding the handling of hazardous substances used in different processes in the sugar mills. There is no such practice of replacing hazardous substances and to get replaced with less hazardous. There were also no effective engineering controls like closed/ partially closed process and handling of system or ventilation systems at all the workplaces. At some restricted areas, there were warning signs. It was observed that at some places the chemicals used in different processes were open and not properly sealed and labeled.

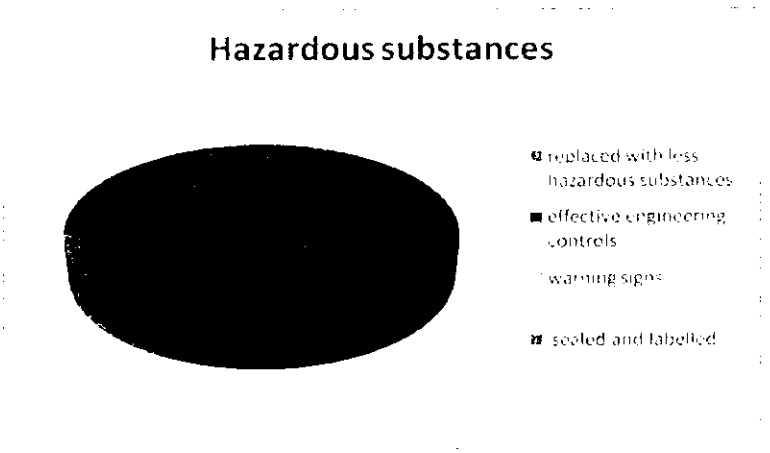

Figure 4.8: Hazardous substances Management

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.8 House keeping and storage

Regarding the house keeping and storage conditions in the workplace as shown in the graph 4.9, it was assessed that the over all situation was un satisfactory as there were spills on the floor at many places, the floors were unclean, greasy. There were no proper racks for storage and piles of obsolete things gave an impact of untidy workplace. A large number of drums were lying with the wall of the factory outside.

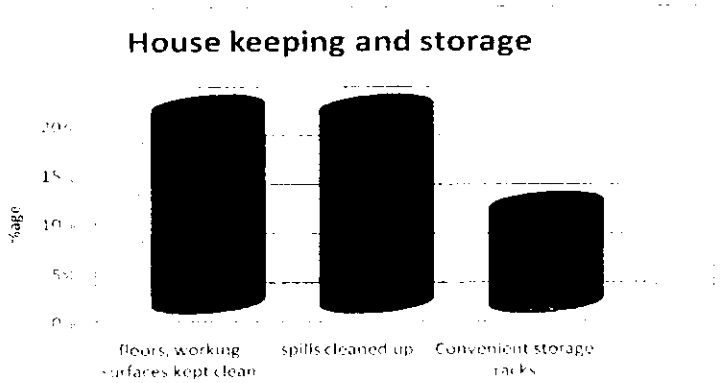

Figure 4.9: House keeping and storage.

4.3.9 Protective Clothing and Equipment

As shown in the graph 4.10 that the Personal Protective Equipments(PPE's) are not available to the workers although the 40% of the workers were of the opinion that they got the training of correct usage and limitation of the PPE's but these equipments are not cleaned, maintained and replaced to maximize their efficiency.

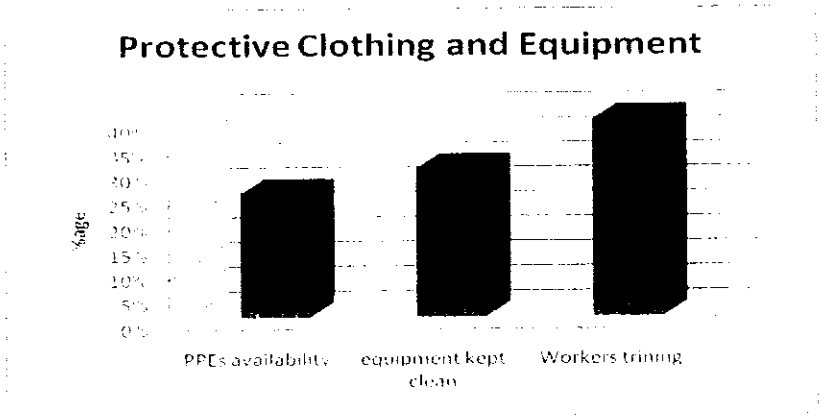

Figure 4.10: Provision and maintenance of PPEs.

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.10 Safe pathways, floor and stairs

The floors, passages and stairs assessed are shown in the graph 4.11. Figure shows that floors, pathways and stairs do not have sound construction and at most of places there are hazards of slips and trips.

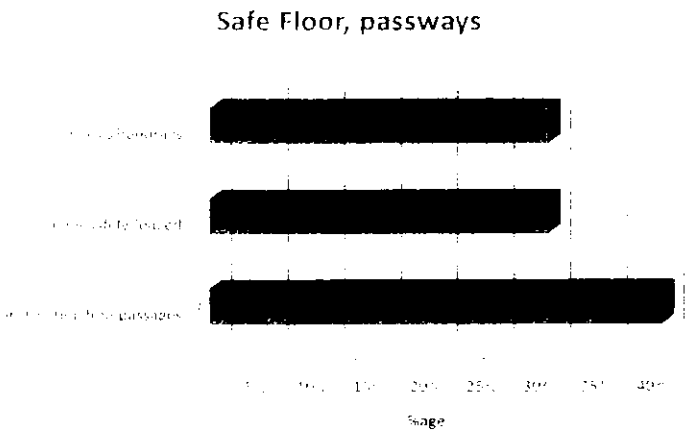

Figure 4.11: Safe Pathwasys and floors

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.11 Medical facility

The medical supervision and treatment facilities were assessed that first aid facility is present in the factory for a specific time that is day shifts and not in all shifts and if there is any injury or accident the workers are sent to nearby hospital. Moreover there is no regular health examination of workers as shown in the graph 4.12.

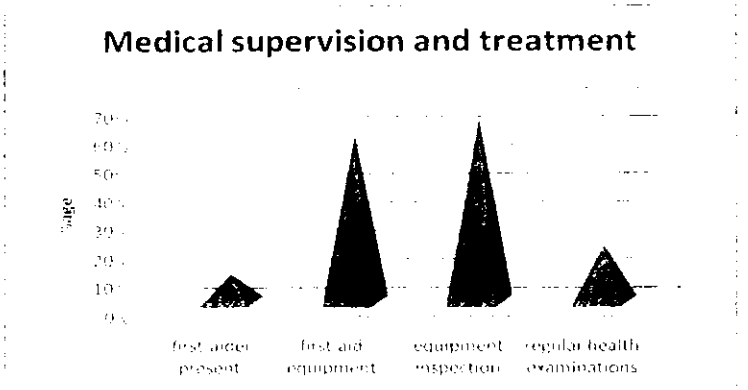

Figure 4.12: Provision of Medical Facilities

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.12 Welfare facility

The welfare facilities elaborated in the graph 4.13 shows that the number of adequate washing facilities are less and the system of seasonal hot and cold water supply is present just in the offices but not for the workers.

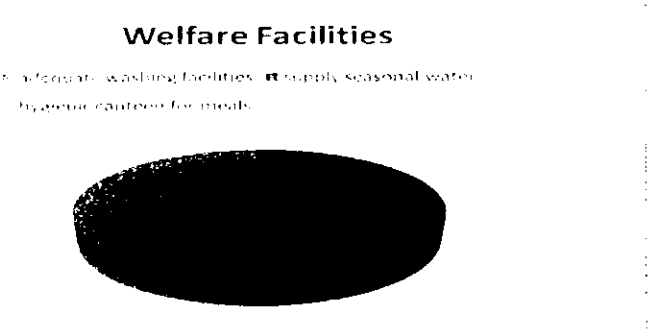

Figure 4.13: Provision of Welfare Facilities

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.3.13 Reasons for EHS Issues

EHS issues are mainly due to the lack of awareness among the work force and management. Govt. oficials do not monitor the factories to have an idea of health and safety issues. Due to the lack of regular monitoring, there is no implimentation of rules nad regulations. Although, management is responsible for maintaing occupational health and safety of the workers and environmental oprotection but this area is mostly ignored. All these factor leads to unsatisfactory situation at the sugar factories.

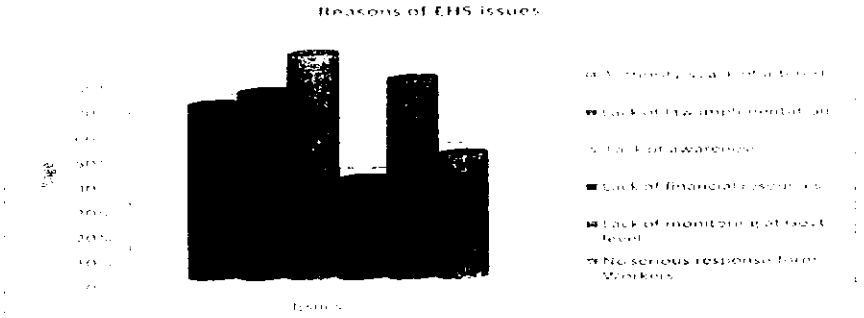

Figure 4.14: Reasons of EHS issues.

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.4 Accidents in the sugar mills:

During the survey of the factories it was found that there is no accident record in the factory.There was no Environmental Health and Safety manager in any visited factory.The management staff told that there is no serious accidents or injuries and deaths so far except that of the minor cuts, burn and such incidents are tackled in the local dispensary in the vicinity. If there is some serious physical problem then the patients are sent to the nearby hospital by using an ambulance.

4.4.1. Type of Accidents

Here are the types of aacident that occurred in the past two years according to the workers

Sr.No.	Type of Accidents	Ranking of cases
1	Small Cut	Common
2	Finger Cut	common
3	Hit by falling Objects	None
4	Back Pain	Common
5	Sickness Flue/Fever	Common
6	Sprain	Common
7	Bone Broken	None
8	Heavy Cut and Bleeding	Rare
9	Serious Burning	None
10	Loss/ Cut of Body Parts	None
11	Physical Injuries Caused by machine	Rare
12	Permanent Disability	None
13	Death caused by serious accident	None
14	Any Insurance Claim due to injuries	None

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

The detail of the incentives and punishments in the target factory is given in the following table.

4.4.2. Type of Incentive

Sr.No.	Details of incentives	Frequency
1	Any Incentives	None
2	Salary increments	Yes, on yearly basis
3	Bonus	Yes, on yearly basis
4	Extra day leave with pay	No
5	Recognition Certificate	No
6	Safety Training	Some times

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.4.3. Type of punishment

Sr.No.	Details of punishment	Frequency
1	Warning	Some time
2	Penalty	None
3	Fired	Yes, on serious issues
4	Demotion	None
5	Transfer to other dept.	Yes
6	Salary deduction	No

Source: Pattoki Sugar Mills, Compiled by Farzana Yasmin

4.5. Accident Analysis

In sugar mills, accidents normally occur due to many reasons. Type of accidents varies as workers work in different units/sections. It also depends upon processes and machinery in these units. For instance, while unloading the sugar cane manually and lifing the sugar bags in the godowns, the workers suffer from back pain. In the mill house, the accidents are due to slip, being pressed under weight, cut due to sharp edge or any electric shock due to not using personal protective equipments. Sometimes the accidents are due to the lack of training of the specific work on which the worker is appointed or due to the work load and overtime workers can not handle the machinery with attention. Some times, untrained workers have to work in a place about which job description and machinery use , they are not familiar with. Some accident are due to the working with unguarded machinary.

The heavy machinary of sugar mills seems very dangerous as at every step, there is risk of minor or major accidents and the workers knowledge about machine operation, regular training machine use and compulsory use of PPE's only can save them from the high risk of accidents. While interviewed the personnel manager it was known that most of the workers do not use PPE's as they do not feel easy working using them. On the other hand workers told that PPE's are outdated and are not affective any more.

So there is an immediate need of strict implementation of health and safety measures and these measures must be regularly updated according to the need of working environment.Every new employer must have proper training according to his work and opertion of machinery befor going to work. Every small or large industry should ensuer workers health and safety trainings at mid teerm or annual basis.

Chapter no. 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

After the completion of the research, it is concluded that the health and safety of the workers, working in any industry is very important as the workers are the backbone of every small scale or large scale industrial units .So it should be very important for every industry to follow all the safety norms, but still we can find a number of industries, which overlook safety measures.

So there is a dire need of creating awareness among workers and the owners about the importance of the occupational Environmental health and Safety which is the ignored area although if applied, it would benefit both workers and the owners of the industries and now it has become the legal requirement for all the industrial sector and the international buyer/customers also demand for legal compliance and environmental certification. Labor unions should play their vital roles in the implementation of the laws.

In Pattoki Sugar mills, it was noticed that due to the less attention to industrial hygiene, poor housekeeping, unsafe storage of chemicals, there are issues for employee protection. It also shows that there had not been any practical training of the

workers and the management staff that supervise the relevant units in the Pattoki Sugar Mills.

The owner and the management in the Pattoki sugar mills are unaware of the need legal compliance. Besides the laws must be revised and updated and then should be strictly implemented. Due to the unemployment, labor is cheap and easily replaceable, so employers never feel a need of investment to train the labor for improving occupational health and safety conditions.

The industrialist should be sensitized that the environmental health and safety is the global trade requirements as the sugar is being exported to many countries out of Pakistan.

RECOMMENDATIONS:

Occupational Health and Safety (OHS) Measures

Occupational health and safety hazards for sugar mills are similar to those of other industrial units. OHS issues those may be specifically associated with sugar mills operation comprised of the following:

- Physical hazards such as trips and falls during the manual throwing of cane into the cutter channels and also caused by slippery floors, stairs and elevated platforms.
- Exposure to dust (during bagasse transportation, loading and storage. During sugar straining and packing to bags process.
- Use of bagasse as a fuel in the boilers for thermal energy
- Exposure to chemicals.
- Exposure noise and vibrations.

Housekeeping:

House Keeping Measures

House keeping is an important part of maintaining a system aimed to reduce or eliminate risk in the workplace. Workers, supervisors and managers all have roles to

play in maintaining the required house keeping standard in their work areas. Key methods for maintaining good house keeping include:

Working Environment

The conditions under which workers perform their tasks have a great influence on their health, efficiency, productivity and industrial relations. Poor house keeping often becomes the reason of most of the injuries at workplace. Good house keeping contributes to the productivity improvement.

The presence of good and healthy working conditions bring about a contented labour force, besides increasing production/productivity of the workers through an increase in their efficiency, lowering down the rate of absenteeism and high labour turn-over to rather minimum.

Proper working conditions should be provided to workers at work place in order to avoid hindrance in work and also to avoid impairment in their efficiency. Parameters that should be maintained at work place are as follows:

- Adequate ventilation and air circulation
- Comfortable temperature
- Low noise intensity
- Avoidance from dust/particulate matters
- Proper light intensity
- Drinking water quality

- Ergonomics
- Fencing on moving parts
- Occupational health & safety conditions

Key factors related to working conditions that have an impact on productivity are listed below:

Safe plant and equipment

It must be ensured that all plant involved in different type of processing, production and equipment that requires maintenance should be identified, that the maintenance is done or not and also that new or second hand plant and equipment meets health and safety standards, before purchasing it.

Chemical handling and storage practices and advantages of using personal protective equipment. They should be educated and well trained about the importance of aforesaid issues, best practices and the consequent benefits.

Safe Chemical Storage

Generally sugar mills do not use very toxic or hazardous chemicals except for equipment cleaning where acid or alkaline based chemicals are used.

For sugar manufacturing process generally lime, clarifying flocculants, decolorizing agents (polymer) and the de-foaming (silicon based) etc are used.

Following are some recommendations for the safe chemical storage:

- Classify chemicals according to their physical and chemical properties.
- Incompatible chemicals should not be stored close to each other.
- Emergency plans including fire fighting arrangements and spill response procedures should be developed and the concerned staff should have adequate trainings in this regard.
- All chemical drums should be arranged in one layer only and piling one over another should be avoided.
- Secondary containment should be made available.
- Flammable chemicals should not be stored near source of heat.

Safe Chemical Handling

For the safe chemical handling, mills management can proceed in the following sequence:

- Avoid the use of such chemicals for which no MSDS is available.
- Never use chemicals that don't have a label to reference.
- Don't mix chemicals without specific authorization from the formulator.
- Mixing incompatible products can render them ineffective, or it can produce toxic materials that present unsafe exposure conditions.
- When pouring chemicals, pour concentrates into the water and not vice-versa.

This way whatever splashes out will be primarily water and not the concentrated chemicals.

- Never pour chemicals into an empty, unlabeled container.
- Pesticides, fungicides, etc always must be stored in a safe and elevated position.
- Develop and implement procedures for safe handling of the chemicals.
- Provide training and awareness to the workers about the safe chemical handling practices including the harmful effects of spillages.
- Workers should be trained to read labels and look for the terms and warning words that they might recognize such as caustic, corrosive, toxic and flammable. The frequent violations are failure to read or follow the label directions.

Use of Personal Protective Equipment (PPE's)

It was also noticed that workers usually do not use PPE's, although the management staff told us that the workers are provided with appropriate PPE's and also management instruct them to use and maintain them and they do not use it as they feel uneasy and feel hurdle in their work.

The use of Personal protective equipments should be mandatory as these are designed to protect employees from serious workplace injuries or illnesses, resulting from contact with chemical, physicals, mechanical, electrical or other workplace

hazard. Following is the list of the PPE's, which should be provided to workers according to nature of their work by the factory management;

- Helmet
- Gloves
- Safety shoes
- Apron
- Dust mask
- Ear plugs or muffs
- Goggles

Safety Instructions

Safety instructions and procedures should be established and displayed at each relevant working area in the form of posters and banners to avoid accidents. Results show that there is an immediate need of staircases handrails and the machines should be safely fenced to avoid the workers from the accidents.

Safety instructions on following topics may be displayed;

- Safety from moving parts
- Slip prevention

- Use of personal protective equipments
- Noise protection
- First Aid
- Fire Fighting

Use of Safety Guards on Moving Parts

During the walk through survey it is noticed that many machines and moving motor belts have danger zones where workers can be caught in moving parts. To protect employees and workers from injury, it is recommended to install machine safety guards. These guards should be designed in such a manner, to keep employees from inadvertently contacting equipment/ belts.

In addition job specific regular training is also necessary for employees regarding the use of machinery, tools, chemical storage and handling to minimize the risk of injuries, accidents and that may impact their job function on the mill overall performance.

Environmental Policy and Environmental Management system

Presently in Pakistan, rules and regulations dealing with the health and safety management are needed to be redesign and updated according to local conditions for present and the future need.There are guidelines for the Environmental, health and safety management but these guidelines are not being strictly implemented. Keeping in

view the overall working situation in the sugar mills following recommendations can be given generally:

Sugar mills must formulate in the documented form the environmental health and safety policy that has measurable and practicable objectives.

There must be a proper and consistent process and procedure of regular risk assessment. The risk analysis and the safety management is an important aspect of the good governance in any business. Therefore the environmental health and safety manager should prioritize the safety issues. The regular training of the workers regarding EHS is indispensable. The environmental standard, ISO 14001, the aim of the **OHSAS 18001** specification is to provide a framework for providing a safe and healthy working environment. In addition, the standard provides guidelines on how to integrate health and safety policies into your overall management system. The owner should understand the important relation of improved environmental, health and safety standards practices with the cost saving, economic gains and the credibility of the factory at national and international level.

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ANNEXURE-A

TABLE (1)

MILLWISE SUGARCANE CRUSHING, RAW UTILIZATION

SUGAR PRODUCTION, RECOVERY % AND MOLASSES PRODUCTION FOR SEASON 2008-2009

PUNJAB		NO. OF DAYS	CANE CRUSHED	PRO. TONNES	REC.%	MOLASSES PRO.	REC%
1.	ABDULLAH		184,994	14,828	8.06	10,110	5.46
2	ABDULLAH(Yousaf)		183,103	15,875	8.66	9,925	5.42
3	ADAM	103	256,030	24,835	9.47	12,060	5.65
4	ASHRAF	117	440,358	42,502	9.65	19,861	4.51
5	BABA FARID	93	219,035	17,306	7.91	10,885	4.98
6	BROTHERS	109	409,378	36,277	8.88	20,530	5.02
7	CHANAR	111	468,292	42,818	9.14	22,556	4.82
8	CHAUDHRY	112	413,261	36,162	8.75	18,382	4.44
9	CHISHTIA	93	280,164	24,419	8.70	13,616	4.86
10	COLONY- PHALIA	105	305,445	25,687	8.41	14,270	4.67
11	COLONY(PUNJAB)	130	382,585	39,049	10.22	17,090	4.47
12	CRESENT	106	182,317	14,404	7.90	8,329	4.57
13	ETIHAD	108	539,555	57,650	10.69	18,646	3.46
14	FATIMA	114	732,309	68,014	9.29	34,335	4.69
15	FECTO	99	411,435	32,940	8.00	17,993	4.37
16	G.SAMANDURI	93	124,140	9,051	7.50	6,828	5.50
17	HAMZA	108	1,665,064	170,351	10.23	64,295	3.87
18	HAQ BAHU	117	295,145	28,190	9.55	13,116	4.44
19	H.WAQAS		162,502	12,270	7.60	8,800	5.47
20	HUDA(FAUJI)	95	194,641	16,525	8.47	8,972	4.60
21	HUNZA	102	566,664	49,695	8.75	27,500	4.84
22	HUSEIN	108	428,961	36,919	8.60	20,215	4.71
23	INDUS	95	498,386	52,631	10.56	19,006	3.81
24	ITTEFAQ	107	366,514	31,962	8.72	17,813	4.86
25	J.D.W - I	107	1,488,463	165,968	11.15	62,002	4.16
26	KAMALIA	104	975,579	101,356	10.39	43,584	4.47
27	KASHMIR	108	450,751	42,307	9.37	21,267	4.71
28	KOH-E-NOOOR	117	318,959	29,163	9.14	15,742	4.93
29	LAYYAH	111	803,900	75,273	9.36	33,591	4.81

ANNEXURE-A

30	MADINA	105	453,039	41,961	9.24	21,888	4.80
31	NATIONAL	97	209,876	17,028	8.11	10,074	4.80
32	NOON	98	358,130	30,965	8.65	17,838	4.98
33	PATTOKI	118	612,972	55,255	9.00	26,000	4.24
34	RAMZAN	106	376,331	36,743	9.78	16,935	4.50
35	SAFINA(TIC)Ph-Wali	99	338,769	30,328	8.95	16,633	4.91
36	SHAHTAJ	103	700,063	65,089	9.30	31,582	4.51
37	SHAKARGANJ(1)	104	360,758	33,878	9.37	14,980	4.15
38	SHAKARGANJ(II)	103	387,372	34,695	8.96	16,075	4.15
39	SHAKARGANJ(III)	50	35,926	3,027	8.54	2,015	5.64
40	SHEIKHOO	115	904,501	78,910	8.72	41,892	4.63
41 & 42	TANDLIANWALA-I & TANDLIANWALA-II		808,550	77,579	9.59	39,714	4.91
43	JDW-II(UNITED)	103	595,765	67,044	11.25	23,395	4.02
44	MACCA	122	87,107	7,030	8.27	4,225	4.85
45	R.Y.K		700,000	700,000	10,00	33,950	4.85
Av. No of Days							
TOTAL 2008-2009			**20,677,089**	**1,963,957**	**9.50**	**928,514**	**4.49**
TOTAL 2007-2008			**33,063,564**	**2,952,784**	**8.93**	**1,607,042**	**4.86**

Source: Pakistan Sugar Mills Association Annual Report 2009

ANNEXURE-A

TABLE (2)

MILLWISE SUGARCANE CRUSHING, RAW UTILIZATION

SUGAR PRODUCTION, RECOVERY % AND MOLASSES PRODUCTION FOR SEASON 2008-2009

KHYBER PAKHTUNKHWA		SEASON DAYS	CANE CRUSHED	PRO. TONNES	REC.%	MOLASSES PRO.	REC%
1.	AL-MOIZ	98	463,719	40,885	8.81	23,187	4.99
2	CHASMA	100	680,677	56,392	8.28	32,002	4.70
3	CHASMA (Exp)	101	370,129	28,841	7.88	17,200	4.65
4	FRONTIER	**NON-OPERATING**					
5	KHAZANA	76	119,405	11,596	9.71	5,160	4.32
6	PREMIER	75	88,612	8,006	9.20	3,393	3.85
7	TANDLIANWALA (ZAMAND)	106	497,761	40,652	8.17	29,135	5.85
8	Non- Members BANNU	59	93,422	7,396	7.93	4,243	4.55
Av. No of Days							
TOTAL 2008-2009			**2,313,725**	**1,93,768**	**8.37**	**114,320**	**4.94**
TOTAL 2007-2008			**2,976,356**	**226,750**	**7.62**	**164,596**	**5.53**

Source: Pakistan Sugar Mills Association Annual Report 2009

ANNEXURE-A

TABLE (3)

MILLWISE SUGARCANE CRUSHING, RAW UTILIZATION

SUGAR PRODUCTION, RECOVERY % AND MOLASSES PRODUCTION FOR SEASON 2008-2009

SINDH		NO. OF DAYS	CANE CRUSHED	PRO. TONNES	REC.%	MOLASSES PRO.	REC%
1.	AL-ABBAS	115	513,887	52,850	10.28	26,390	5.13
2	AL-ASIF	102	191,744	19,672	10.25	9,550	4.98
3	AL-NOOR	114	736,420	66,495	9.03	35,528	4.83
4	ANSARI	112	491,346	38,686	7.88	24,456	4.98
5	ARMY WELFARE	94	267,162	26,814	10.03	13,046	4.88
6	BAWANY	70	134,539	12,940	9.61	6,555	4.87
7	DEWAN	80	272,256	27,019	9.92	13,204	4.85
8	DEWAN KHOSKI	72	140,980	15,080	10.70	6,765	4.80
9	DIGRI	113	384,316	38,484	10.01	17,850	4.65
10	FARAN	123	685,778	63,473	9.26	33,984	4.96
11	GHOTKI	94	552,646	62,484	11.30	22,250	4.02
12	HABIB	120	780,578	77,051	9.87	35,368	4.53
13	KHAIR PUR	119	262,459	22,578	8.60	11,464	4.37
14	LARR	68	169,223	16,823	9.97	9,765	5.78
15	MITIARI	126	433,714	42,108	9.71	21,421	4.93
16	MEHRAN	113	538,930	55,678	10.33	24,532	4.55
17	MIR PUR KHAS	114	435,690	46,235	10.61	22,509	5.17
18	MIRZA	89	176,738	18,000	10.18	8,198	4.64
19	NAJMA	75	67,769	5,569	8.48	3,495	5.16
20	NAUDERO	94	121,110	12,211	10.08	5,180	4.28
21	NEW DADU	84	147,039	11,821	8.06	7,131	4.85
22	PANGRIO	86	123,413	11,950	9.68	5,575	4.52
23	RANI PUR	124	308,707	27,415	8.88	13,696	4.44
24	SAKRAND	100	330,553	27,555	8.33	15,850	4.79
25	SANGHAR	132	597,111	57,308	9.58	30,279	5.06
26	SERI	96	169,185	14,487	8.51	10,158	5.96
27	SHAH MURAD	92	482,166	47,690	9.85	24,560	5.09
28	SINDABAD GAR	98	267,402	25,000	9.31	14,800	5.53
29	TANDO M. KHAN	84	121,500	10,537	8.60	7,071	5.81
	NON- MEMBER						

ANNEXURE-A

30	THARPARKAR	139	244,241	22,403	9.20	12,450	5.10
TOTAL 2008-2009			**10,148,603**	**976,420**	**9.62**	**493,079**	**4.86**
TOTAL 2007-2008			**16,737,003**	**1,561,378**	**9.33**	**889,566**	**5.31**

Source: Pakistan Sugar Mills Association Annual Report 2009

TABLE (4)

PROVINCE- WISE TOTAL PRODUCTION OF PAKISTAN

SUMMARY 2008-2009

	CANE CRUSHED	RAW UTILIZED	BEET SLICED	SUGAR (Cane)	PRODUCTION (Raw)	(Beet)	TOTAL SUGAR	MOL. C+R+B
PUNJAB	20,677,089	NIL	NIL	1,963,957	NIL	NIL	1,963,957	928,514
SIND	10,148,603	NIL	NIL	976,420	NIL	NIL	976,420	493,079
KHYBER PAKHTUN KHWA	2,313,725	NIL	9,301	193,768	NIL	947	194,715	114,739
Total 2008-2009	33,139,417		9,301	3,134,145	NIL	947	3,135,092	1,536,33
Total 2007-2008	52,776,922	6,000	64,095	4,740,913	5,929	5,532	4,752,374	2,663,78

Source: Pakistan Sugar Mills Association Annual Report 2009

ANNEXURE-B

Health and safety factory inspection checklist

Part I: General Information Checklist on Health and Safety

1. Investigator: .....
2. Name and address or the factory: .....

   .....
3. Number of workers: .....

   Total workforce: .....
4. Work schedule
   a. Morning shift: From To
   b. Afternoon shift: From To
   c. Night shift: From To
5. Work area(s) inspected: .....

   .....
6. Date of inspection: .....

Electrical Safety

1. Are electrical systems properly installed and regularly inspected for safety?
2. Are switch boxes or panel boards appropriately covered?
3. Is all electrical equipment safely grounded?

Fire safety

4. Is there an adequate number of serviceable fire extinguishers and fire-fighting equipment?
5. Is there a fire alarm system?
6. Are emergency routes and exits clearly marked and unobstructed?

7. Are emergency drills conducted on regular basis?
8. Are combustible and flammable materials used and stored safely?

Floors, passageways and stairs

9. Are all floors, passages and stairs of sound construction and kept free from obstruction and slippery hazards?
10. Are all open spaces in floors and machines safely fenced?
11. Are all staircases provided with suitable handrails?

Hazardous substances

12. Are hazardous substances, e.g. cleaning solvents in use which could be replaced with less hazardous substances such as soap?
13. Have effective engineering controls e.g. closed/partially closed process and handling systems, ventilation systems etc., been installed to prevent exposure to hazardous
14. Have operational controls that involve the safe use, storage and disposal of hazardous substances been implemented?
15. Have restricted work areas (with appropriate warning signs) been established for operations involving hazardous substances with access limited to essential personal?
16. Are dyes, bleaches, solvents, adhesives and other hazardous substances properly sealed and labeled?

Housekeeping and Storage

17. Are floors, working surfaces etc., kept clean?
18. Are spills cleaned up?

19. Have convenient storage racks for raw materials and equipment parts been installed?

Lighting

20. Are workstations arranged to maximise daylight conditions?

21. Is adequate artificial light provided for precision work?

22. Have arrangements been made to eliminate glare or reflections which strain the workers' eyes?

Machine Safety

23. Is machinery kept in safe working order?

24. Is machinery regularly inspected for safety?

25. Are moveable machine parts guarded?

26. Are machines fitted with safety starting and stopping devices?

Noise

27. Are machines designed and maintained to seal or cover the sources of noise?

28. Are ceilings, floors or wall surfaces insulated to absorb sound?

29. Are barriers, screens or walls inserted to separate noisy and quiet workplaces?

Medical supervision and treatment

30. Is there a doctor or qualified first-aider present during all work shifts?

31. Is first-aid equipment available?

32. Is first-aid equipment regularly inspected and all items replaced after use?

33. Are regular health examinations conducted?

Protective Clothing and Equipment

34. Are suitable and adequate numbers of protective clothing (e.g. boots, coats, gloves, overalls) and equipment (e.g. earplugs, helmets, face-guards, respirators) provided?

35. Are all forms of protective equipment kept clean and properly maintained to maximize their efficiency?

36. Have workers been informed and trained about the purpose, correct use and limitation of all protective equipment?

Temperature

37. Are all work areas maintained at a comfortable temperature?

38. Is fresh air circulated in each work area by air conditioners, electric fans or ventilators?

39. Are heat-producing machinery, equipment, surfaces, etc. insulated as-far as possible?

40. Are sufficient work breaks provided for those working in high temperature conditions?

Ventilation

41. Are ventilation systems e.g. air-conditioning, fans, extractors, provided in each work area?

42. Does the ventilation system effectively eliminate hazardous substances e.g. dust, fumes?

43. Are ventilation systems well maintained and regularly cleaned to maximize their efficiency?

Welfare Facilities

44. Do washing facilities include a supply of cold and hot running water?

45. Are there adequate numbers of washing facilities for workers?

46. Is there a hygienic canteen for meals?

Workstations

47. Are tools of appropriate size and shape for easy and safe use?

48. Are all chairs and working surfaces easily adjustable for correct height?

49. Are all chairs equipped with a sturdy backrest?

50. Can work be performed without having to adopt uncomfortable postures, such as bending positions?

51. Has a job rotation system been introduced so that workers can alternate between jobs that involve repetitive work?

Part III: Worker's Questionnaire on Health and Safety

1. Name and union position of interviewer: .....
2. Date of interview:
3. Name and address of the factory: .....

   .....

   .....
4. Name of the interviewee: .....

   .....
5. Job title: .....
6. Job description: .....
7. Equipment and machines that he works with: .....

   .....

   .....
8. Substances he works with or produces and those that are nearby to his workstation:

   .....

.....

9. What he perceives to be the main health and safety hazards or potential hazards in their work area? .....

.....

.....

.....

10. Has he or anyone else in their work area suffered any injuries or illnesses that were work-related? Describe, including frequency: .....

.....

.....

11. Does he receive regular advice and information on health and safety issues?

.....

.....

.....

12. Has he received any training on the occupational hazards involved in their job and the health and safety measures that are necessary to prevent their exposure to these hazards?

.....

.....

.....

13. Would the interviewee like to make any final remarks?

.....

.....

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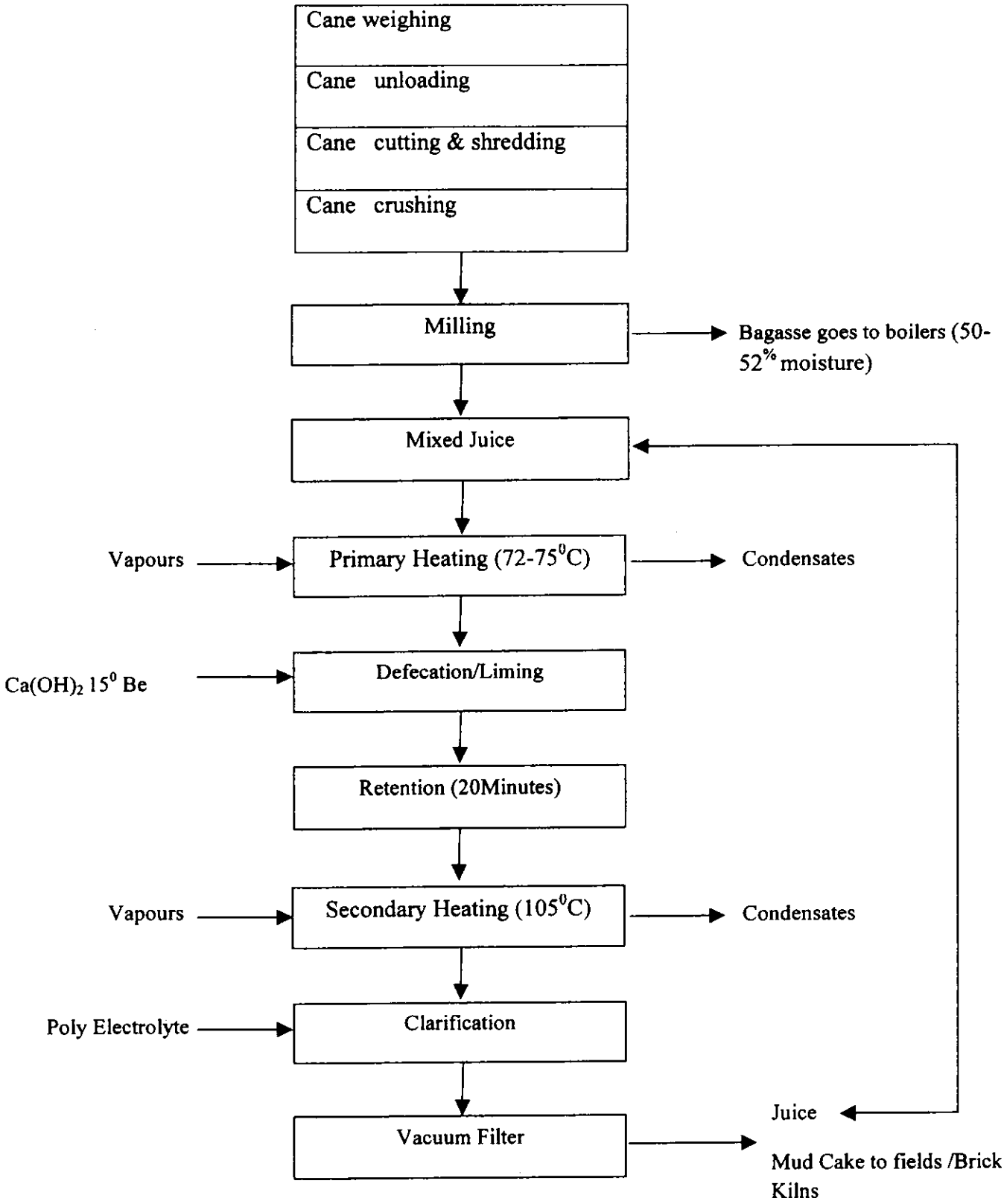
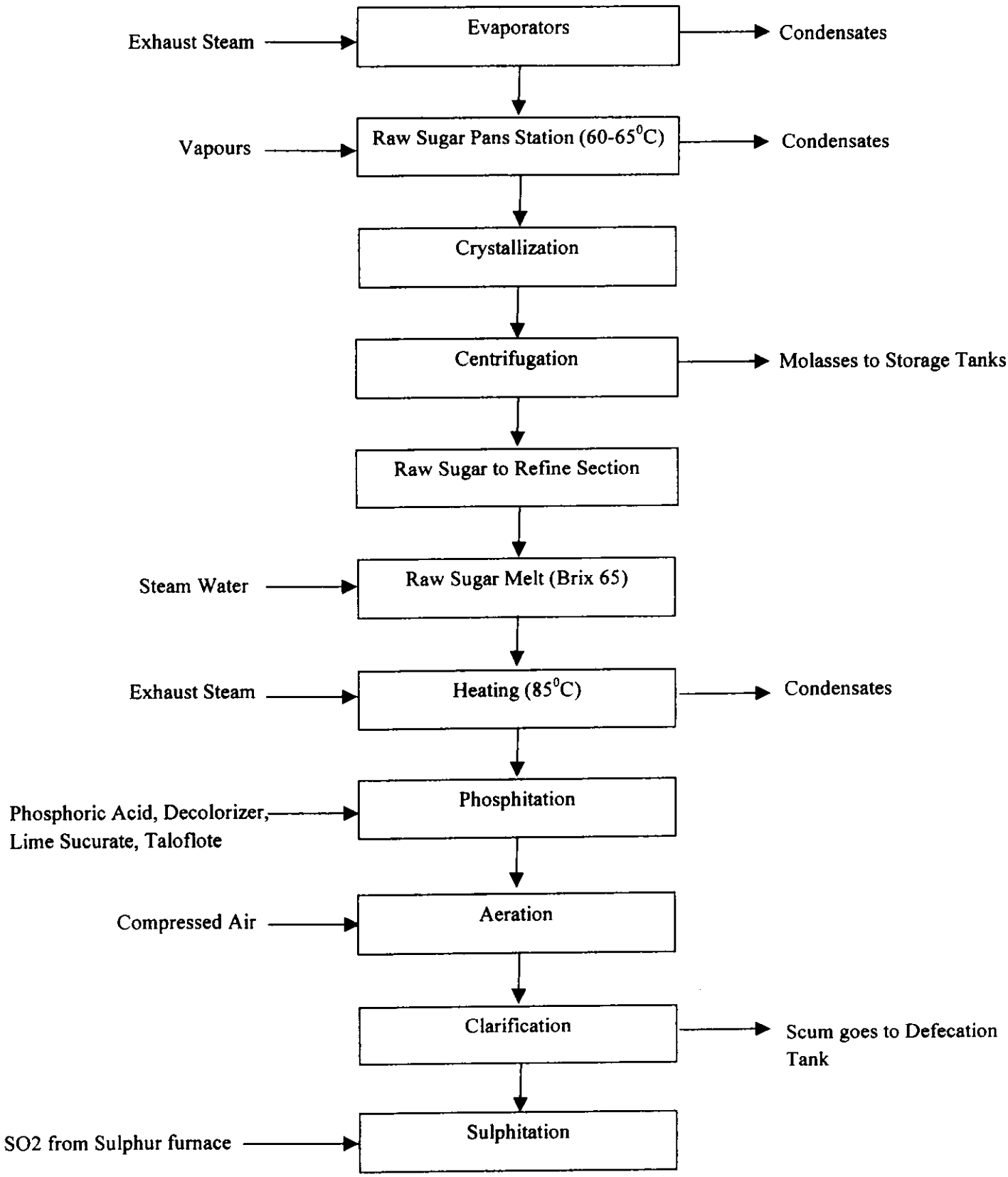
ANNEXURE-B

ANNEXURE -C

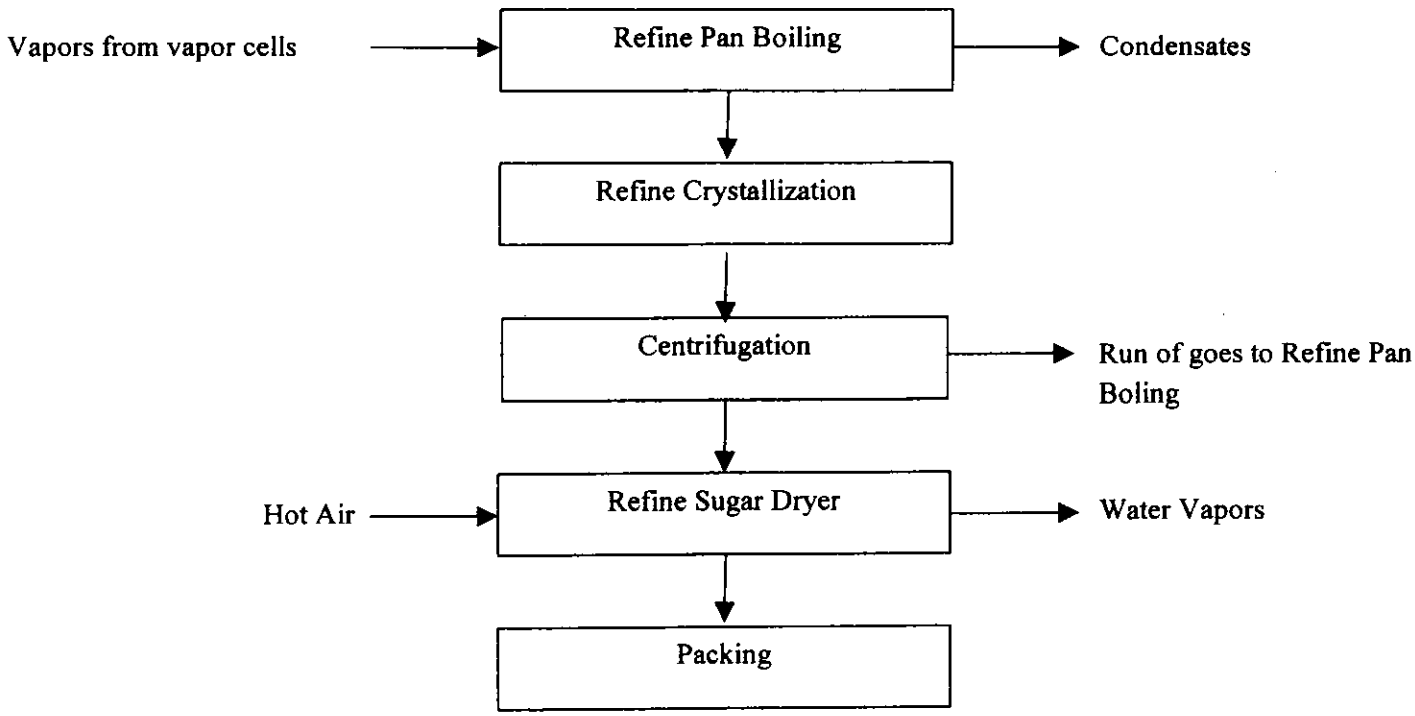
Process flow diagram of sugar processing



ANNEXURE -C


Exhaust Steam
Evaporators
Condensates
Vapours
Raw Sugar Pans Station (60-65^{0}C)
Condensates
Crystallization
Centrifugation
Molasses to Storage Tanks
Raw Sugar to Refine Section
Steam Water
Raw Sugar Melt (Brix 65)
Exhaust Steam
Heating (85^{0}C)
Condensates
Phosphoric Acid, Decolorizer,
Lime Sucurate, Taloflote
Phosphitation
Compressed Air
Aeration
Clarification
Scum goes to Defecation Tank
SO2 from Sulphur furnace
Sulphitation

ANNEXURE -C


Vapors from vapor cells
Refine Pan Boiling
Condensates
Refine Crystallization
Centrifugation
Run of goes to Refine Pan Boling
Hot Air
Refine Sugar Dryer
Water Vapors
Packing

ANNEXURE-D

Tables

Table 4.1: Dust Level in factory C

Sr. No.	Section	Dust Level. (mg/m^3)	OSHA/NIOSH Standard in (mg/m^3)
1	Walkway near Boiler House	10.67	10(mg/m^3)
2	Plate form Mill House II (Upper Floor)	11.71	10(mg/m^3)
3	Mill House II	10.67	10(mg/m^3)

Source: Pattoki Sugar Mills compiled by Farzana Yasmin .

Table 4.2: Illumination Level in Factory C

Sr.No.	Section	Illumination Level (Lux)	OSHA / NIOSH
1	Mill House II (Inspection)	470	200 (Lux)
2	Mill House (Ground Floor)	350	200 (Lux)
3	Walkway (Boiler House)	540	200 (Lux)

Source: Pattoki Sugar Mills compiled by Farzana Yasmin

Table 4.3: Temperature in Factory C

Sr. No	Section	Temperature (°C)	(Factories Act 1934) Standard
1	Mill House No. II Upper floor	33.7 °C	25 °C
2	Mill House No. II Upper floor	33.1 °C	25 °C
3	Boiler house	33.8 °C	25 °C
[illegible]	[illegible]	[illegible] °C	[illegible] °C
[illegible]	Process Hall	32.8 °C	25 °C
6	[illegible]	30 °C	[illegible] °C

Source: Pattoki Sugar Mills compiled by Farzana Yasmin

Table 4.4: Relative Humidity Level in Factory C

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Mill House No. II Upper floor	[illegible]	55-65%
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Boiler house	[illegible]	55-65%
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Process Hall	[illegible]	55-65%
[illegible]	[illegible]	[illegible]	[illegible]

Source: Pattoki Sugar Mills compiled by Farzana Yasmin

Table 4.5: Relative Humidity Level in Factory C

Sr. No.	Sections / Units	Noise Level (db A)	Pak. NEQS
1	Mill House No. II Upper floor	96.1	85 (db A)
2	Mill House No. II Upper floor	94.8	85 (db A)
3	Boiler house	84.7	85 (db A)
4	Cutter turbine	103.4	85 (db A)
	Shredder turbine	104.5	85 (db A)

Table4.6: Air Emission Sources and Qualitative Characteristics

Source	Mechanism	Major Pollutants
Point Emission		
Stack of steam boilers	Combustion of bagasse	SOx, NOx, Cox, PM
Diffused Emissions		
Bagasse storage yard	Bagasse is dropped from conveyer	PM

ANNEXURE-E

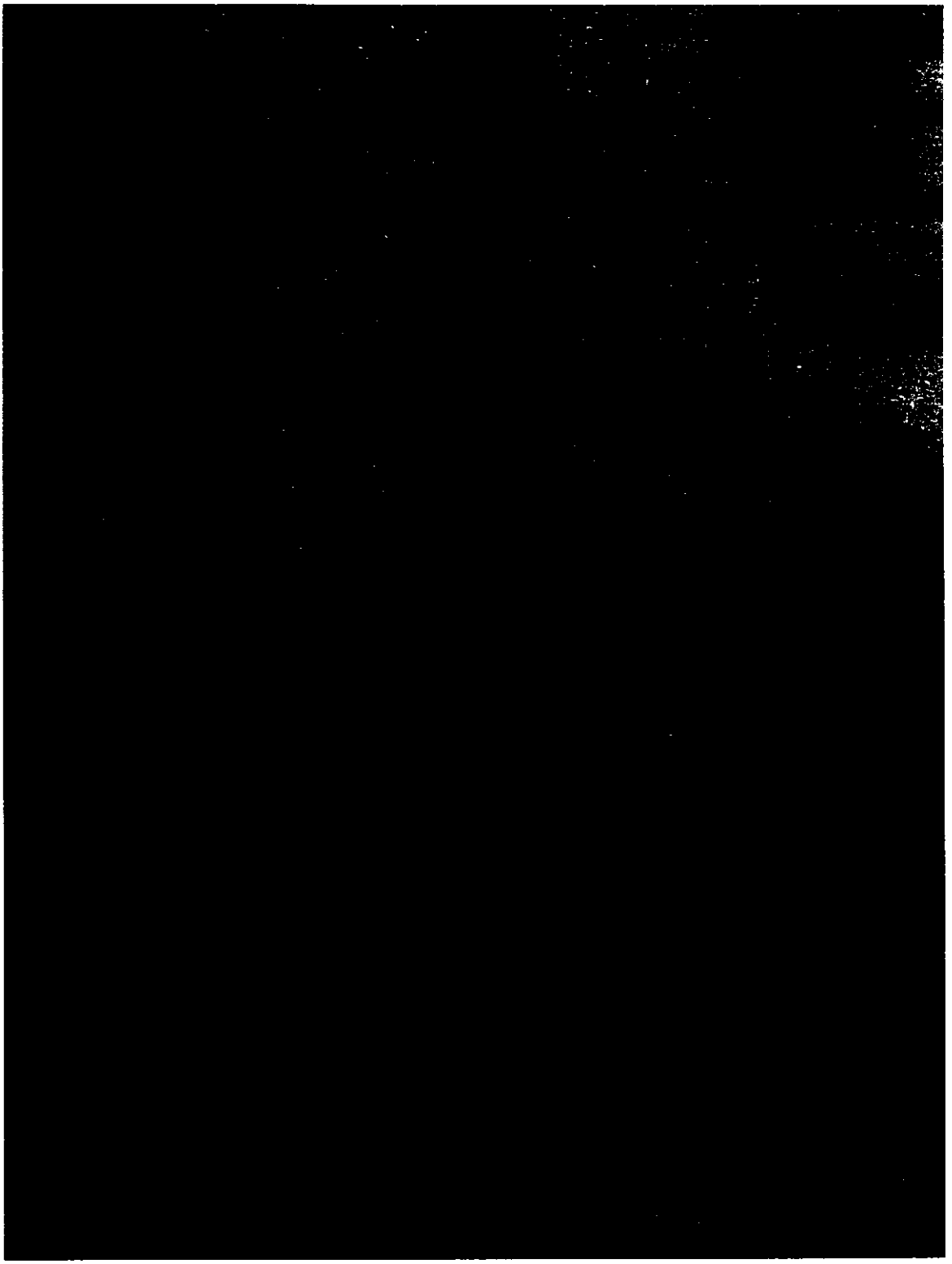


Figure 1: Surrounding area of the target Factory

ANNEXURE-E

Figure 2: Vehicle with overloaded sugar cane in the factory cane yard

ANNEXURE-E

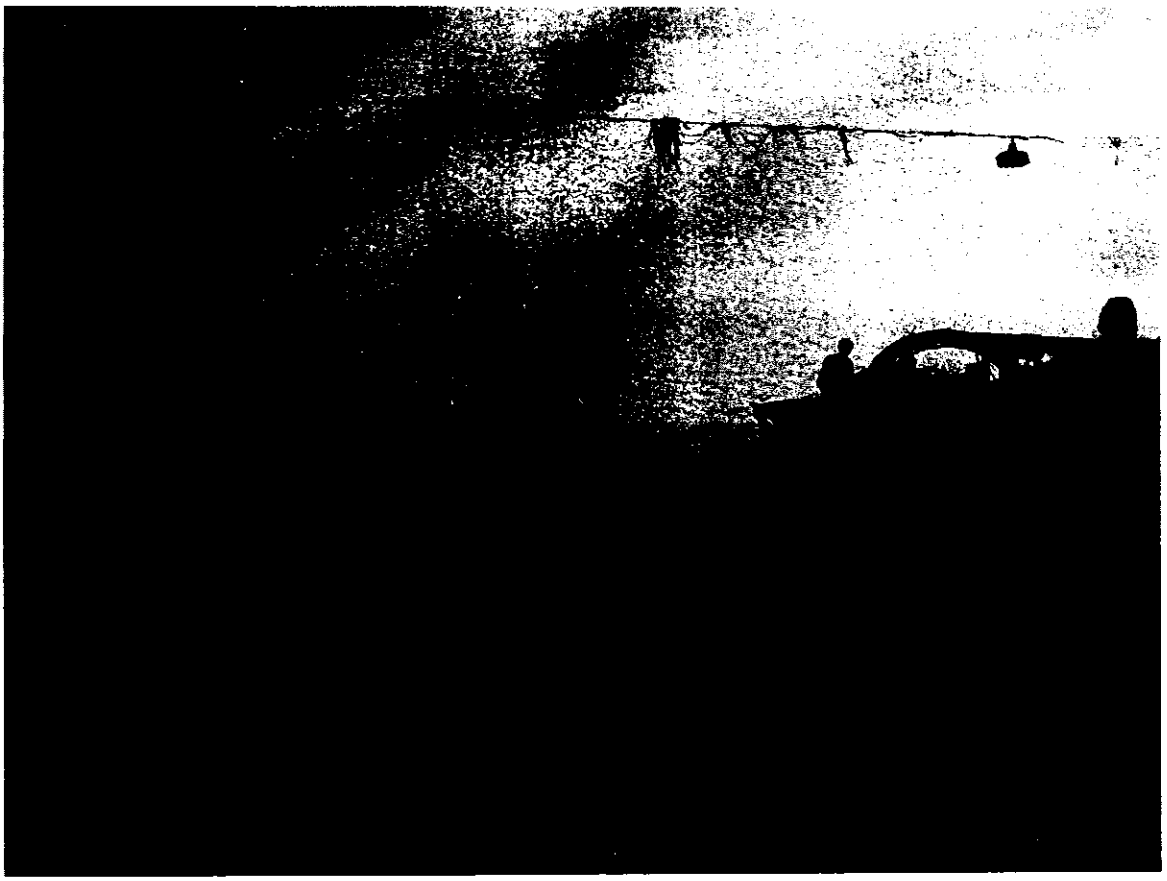


Figure 3: Manual unloading of Sugar cane.

ANNEXURE-E

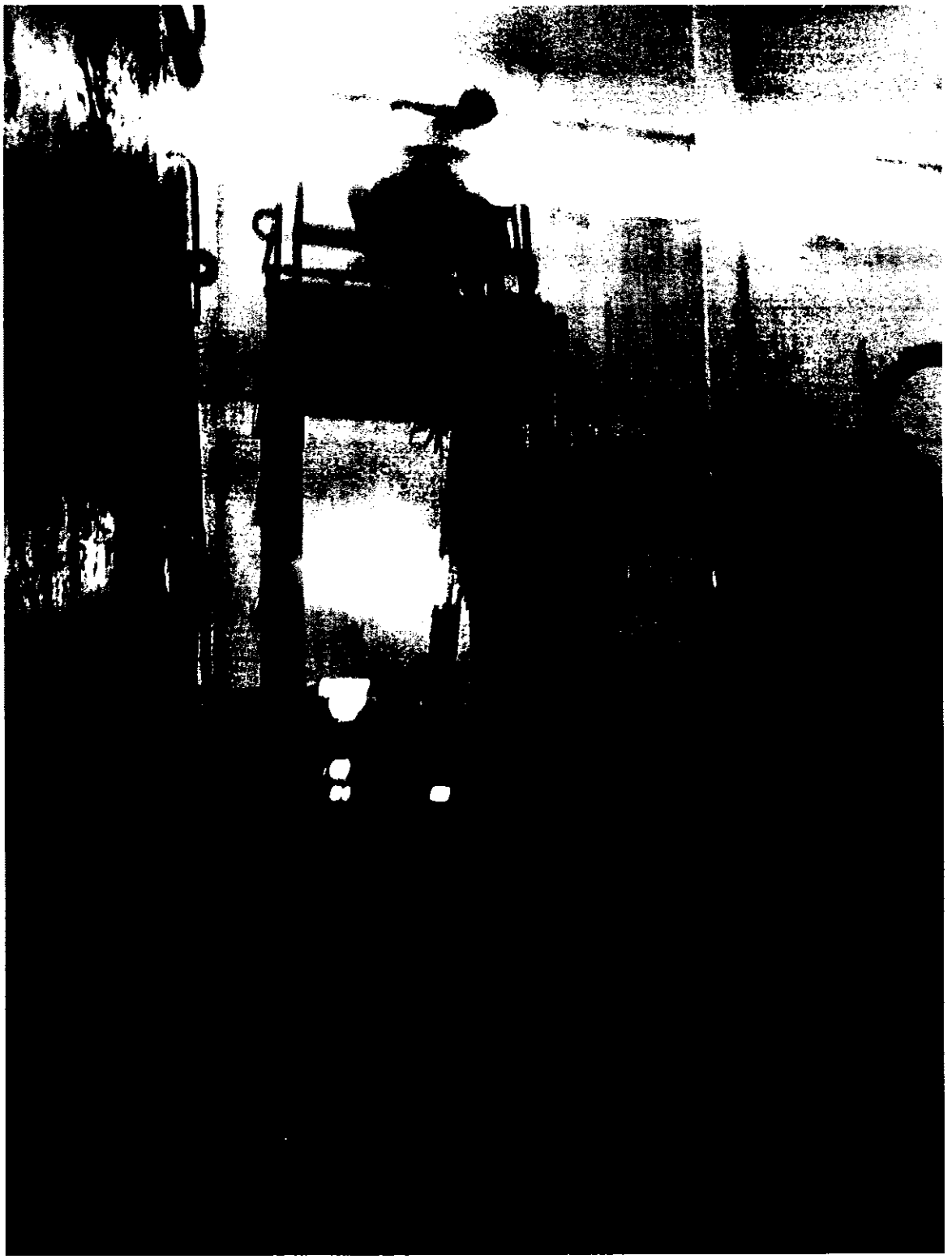


Figure 4: An open baggasse carrying channel

ANNEXURE-E

Figure 5: Liquor Refinery

ANNEXURE-E

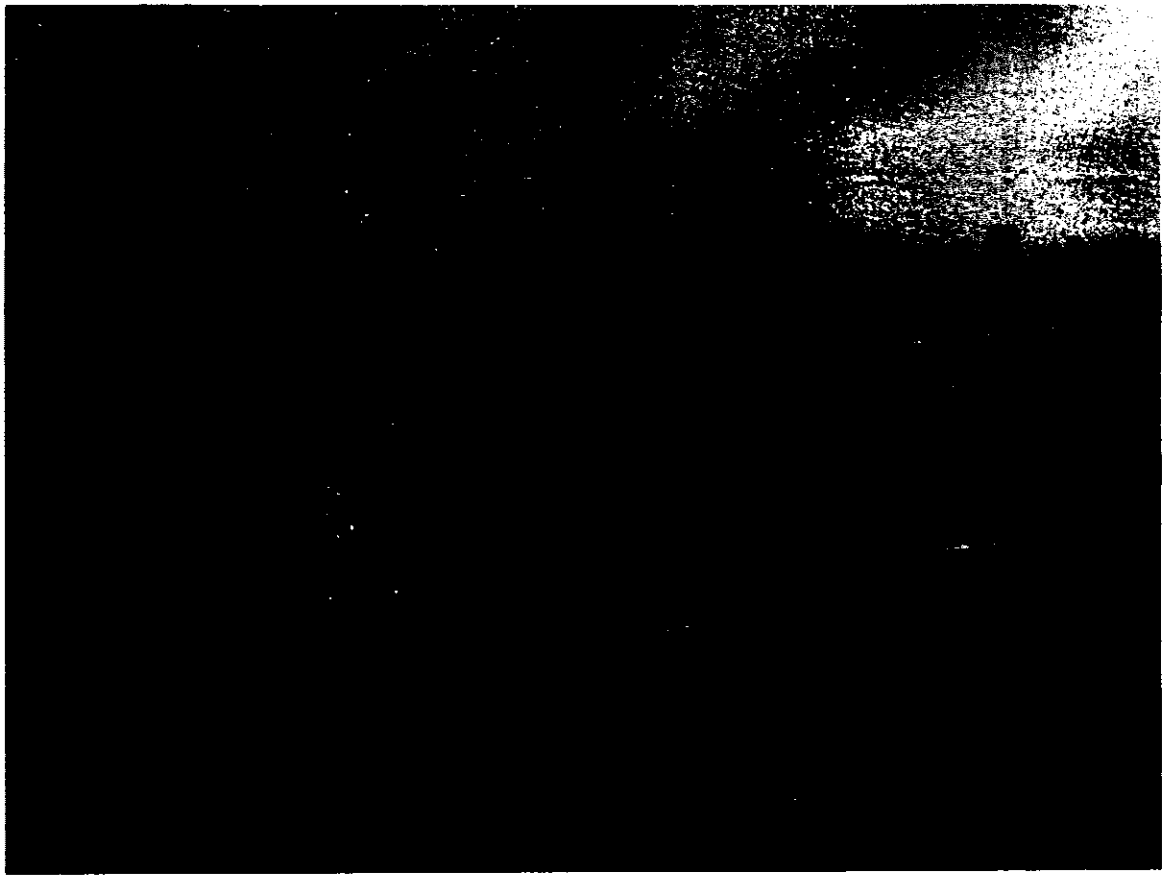


Figure 6: An open pond of molasses causing odor problems

ANNEXURE-E

Figure 7: Worker welding without PPEs.