Initial Environmental Examination for Power Plant in Local Sugar Mill

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ABSTRACT

This research presents the IEE (Initial Environmental Examination) and EIA (Environmental Impact Assessment) for sugar mills as power generation business. The study evaluates the proposed project according to the environmental assessment requirements of the Pakistan Environmental Protection Agency. The study has been conducted using standard environmental assessment methodology with the consultation of national and international environmental guidelines such as World Bank environmental and International Finance Corporation (IFC). The environmental impacts for the installation of a cogeneration thermal power plant adjacent to existing sugar mill located in district Muzaffargarh has been considered as a case study. It has been concluded that the residual impacts of the proposed operation will be of minor significance and careful implementation of the Environmental Management Plan (EMP) will ensure that environmental impacts are managed.

Key words: EIA (Environmental Impact Assessment), IEE (Initial Environmental Examination), Sugar mill and power generation

1. INTRODUCTION

Environmental Impact Assessment is a planning tool and its main purpose is to give the environment its due place in decision making process by clearly evaluating the environmental consequences of a proposed activity before action is taken. The cultural, social, and health effects are considered as an integral part of Environmental Impact Assessment and particular attention is given to practical implementation of Environmental Impact Assessment to prevent and mitigate significant adverse effects of proposed undertakings [1]

Pakistan is the 5th largest country in the world in terms of area under sugar cane cultivation, 11th by production and 60th in yield.[2] 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.[3]

The sugar industry in Pakistan is the 2nd largest agro based industry comprising 81 sugar mills with annual crushing capacity of over 6.1 million tones. Sugarcane farming and sugar manufacturing contribute significantly to the national exchequer in the form of various taxes and levies. Sugar manufacturing and its by-products have contributed significantly towards the foreign exchange resources through import substitution. [4]

Bagasse is the matted cellulose fiber residue from sugar cane that has been processed in a sugar mill. Previously, bagasse was burned as a means of solid waste disposal. However, as the cost of fuel oil, natural gas, and electricity has increased, bagasse has come to be regarded as a fuel rather than refuse. In general, bagasse has a heating value between 3,000 and 4,000 British thermal units per pound (Btu/lb) on a wet, as-fired basis. Most bagasse has moisture content between 45 and 55 percent by weight. [5]

The cogeneration of electricity in the sugar industry is linked to energy security and avoided greenhouse gas emissions. Electrical energy and thermal energy are the primary energy types used for sugar processing [6]

The sugar mills in the country generally operate during the winter from November through April. Previously, Sugar mills were used to generate the electricity for their in-house use by burning bagasse in their boilers. This steam not only meets the heating requirements of the sugar manufacture but also produces electricity with the aid of steam turbines. [7]

According to Pakistan Sugar Mills Association (PSMA) around fifty registered sugar mills are operating in Punjab Province. National Electric Power Regulatory Authority (NEPRA) statistics states that around twenty two sugar mills have earned the power generation license while considerable number of sugar mills is preparing to combat the current energy crisis of the country. [8]

For the commercial power generation, sugar mills will have to generate power around the year. But bagasse is available only in sugar cane season; therefore, sugar mills will burn some secondary fuel

for year around power generation. These secondary fuels are generally fossil fuels (coal & petroleum goods). Fossil fuel combustion in agricultural areas may pollute the atmosphere in physical, biological and environmental aspects. In this research the potential impact areas will be studied in detail under the relevant guidelines to keep the atmosphere environmental friendly in best possible ways. To limit the research, the most pollution potential case is studied in detail in which the secondary fuel is imported coal to generate electricity around the year. Environmental Impact Assessment is a systematic process to identify, predict and evaluate the environmental impacts of proposed actions and projects. The process is applied prior to major decisions and commitments being made. Wherever appropriate, social, cultural and health effects are considered as an integral part of environmental impact assessment. Particular attention is given to practical implementation of environmental impact assessment to prevent and mitigate significant adverse effects of proposed undertakings.

2. LEGAL FRAMEWORK

The environmental impacts are evaluated under the guidelines of national environmental policy, legislation and international conventions. The National Environmental Policy, 2005, National Environmental Legislation, Pakistan Environmental Protection Agency Review of IEE and EIA Regulations – 2000 [9,16], Project Monitoring and Compliance [10], The National Environmental Quality Standards [11], Canal and Drainage Act, 1873[12] are the basic national legal frame works were used to access the potential environmental impacts.

World Bank Guidelines are used to solve environmental issues related with power plant operations including the air emissions, energy efficiency and greenhouse gas emissions, water consumption and aquatic habitat alteration, effluents, solid wastes, hazardous materials and oil, noise. [13]

International environmental guidelines such as World Bank environmental [15] and International Finance Corporation (IFC)[17]are followed for international guidelines for industry specific impacts & mitigation management.

It also provides occupational health and safety risks and mitigation measures during plant construction, operation and decommissioning to overcome the same with special emphasis on non-

ionizing radiation, heat, noise, confined spaces, electrical hazards, fire and explosion hazards, chemical hazards, dust. [14]

This theoretical and legal framework is used in order to investigate the environmental impact assessment of sugar mills as a power generation business by using following methodology.

3. METHODOLOGY

The environmental impact assessment was started with the scoping process. The purpose of scoping was to identify the important issues such as the appropriate time and space boundaries and the significant effects and factors. All the relevant necessary information for decision-making was collected. A generic description of the proposed project of sugar mill as a power generation business and its related activities was collected from the proponent. A legislative review of the applicable laws, regulations, guidelines and standards from various organizations and literature was done. Baseline of the area's environmental and socio-economic settings was collected through literature review and field surveys. Baseline of the area was measured through a change in the environment, resulting from a designated action or activity. To establish an environmentally sound preferred option for achieving the objectives of the proposed project, technology alternatives were studied in collaboration with the project proponent.

The collected information was used to assess the potential environmental impacts of the proposed project activities. Detailed methodology and mitigation measures were evaluated to reduce the impacts of project activities on environment. The issues such as physical environment of the area, biological environment of the area and socio-economic environment of the area were studied during impact assessment and were detailed in Table 1.

4. CASE STUDY

The bagasse generated as by-product in the sugar mill will be burnt as fuel in the power plant. The steam produced by burning the bagasse in the boilers will produce electricity in return and will also meet the process steam requirement of the sugar mill. In the absence of bagasse in non-cane crushing season, imported coal (low sulfur contents) will be burnt in the boilers and the electric power will be exported to the national grid. The range of options for the control of SOx emissions is wide because of large differences in the sulfur content of different fuels.

The proposed project involves power generation process and equipment. Project process and equipment involved are boilers, steam turbines, generators, cooling towers, biomass storage and handling facility, coal storage and handling facility, and grid-station.

Spreader Stoker boiler technology has been planned which is globally proven for efficient use of biomass as fuel for boilers. Since this technology primarily uses biomass fuel such as bagasse and cotton stalks, hence it is environmentally, economically and technically sound. Baseline of the area's environmental and socio-economic settings was collected in a way like what are water resources, what is quality of water, climate, ambient air and noise.

The Muzaffargarh canal and Indus River are the principal surface water resource in the project area. The Muzaffargarh canal is located about 10 Km on east side of the project site which is major source of irrigation. Ground water is the major source of drinking water in the area. Depth of fresh water bore wells in the area is about 5-10 m. Exploitation of ground water through tube wells for irrigation is also observed in the area. To determine the quality of surface water in the project area, two water samples were collected from surface water canals. These canals are originating from Muzaffargarh canal. In order to examine the ground water quality of the area, water samples from different locations were collected and analyzed. Water sampling was carried out at different locations.

Climate of Muzaffargarh district is extremely hot in summer and cold in winter. The summer from April to September is very hot (temperature rises to 51°C). The winter from mid-November to end of January is sufficiently cold (temperature drops to 2°C).. The spring commences from early February and continues till mid of April. When the temperature starts raising rapidly, the monsoon usually break during July and August, when moderate showers of rain are received. The wind direction in summer is towards south and southeast; whereas in winter it is towards north and northeast. The dust storms and hot winds blow continuously during the months of March to August. Wind speeds and seasonal patterns vary considerably in the project area.

The project area is rural, and cultivation is the main occupational activity. The potential existing sources of air pollution in the project area are road traffic, brick kilns, farm machines, and agricultural activities.

There is no continuous major source of noise in the project area. Intermittent sources include farm tractors, farm equipment, and road and rail traffic. Considering the intermittent nature of these noise sources, it can be concluded that the noise pollution in the area is low.

The potential impacts of the project are identified by desktop screening exercise, using checklist during field visits for collection of baseline data, professional judgment, published literature on environmental impact of similar projects and standard environmental guidelines. A critical step in identifying potential impacts is discussed with project proponent, consultation with stakeholders and community to identify their concern. The main aspects associated with potential impacts are geomorphology, water resources (aquifer and surface water quality), ambient air quality, waste discharges, noise pollution, greenhouse gases emissions, ozone depleting substance, protected areas, ecology of the area, including flora and fauna, vehicle movement, socio-economic conditions, and archaeology.

The potential impacts are classified according to the type of potential receptors. The impacts have been assessed by following standard international guidelines and best available practices. The method defines three levels of consequence (or severity) and likelihood (or probability of occurrence) - high, medium or low - of an impact. A standard risk based approach has been used in which the significance of an impact is determined on the basis of the level of consequence and likelihood of the impact e.g. an impact of medium severity is assigned a low significance if the likelihood of occurrence of the impact is low and high significance if the likelihood of occurrence is high or almost certain.

The identified environmental and socio-economic impacts associated with the proposed project construction activities are evaluated in detail. Construction activities here mean construction of campsite, platform and fabrication of plant. The impact assessment of construction activities are discussed in detailed in Table 1.

Impacts associated with operation activities are air emission, water resources, GHG emissions, hazardous materials, ozone depletion, plant noise, wastewater and solid waste management

Air emissions

Potential impacts: impacts on local air quality may arise from biomass/coal combustion, particulate matter emissions results from unburned carbon and impurities in fuels Likely impacts of these activities may include deterioration of local and regional air quality, respiratory diseases in local community, global warming and acid precipitation.

Assessment of potential impacts: power plant air emissions may have a major impact on the local and regional air quality. A significant impact will be interpreted if the concentration of pollutants in the ambient air exceeds the NEQS or recognized international guidelines for ambient air quality such as World Bank and World Health Organization (WHO) [18] ambient air quality guidelines.

Mitigation measures: The proposed mitigation measures to reduce the impacts on air quality during the proposed operation activities are either use of cleaner fuels (low sulphur) or for each boiler, dust emission (particulate matter will be ensured by an electrostatic precipitator. The maximum limit of SO_2 will be ensured by use of low sulphur coal and in case of local coal use (with higher coal sulphur), by mixing local coal and international coal with low sulphur contents.

Table 1: Impact Assessment of Construction Activities of power generation adjacent to Sugar mill

Environmental aspects	Potential Impact	Description	Consequence severity rating	Likelihood / Frequency	Nature of impact	Geographical location of Impact	Duration of Impact	Reversibility of Impact	Significance of Impact
Protected Areas	Habitat loss, temporary relocation	No protected areas, wetlands or wildlife sanctuary were found inside or in the close proximity of the area.	Low	Low	No impact	Not applicable	Not applicable	Not applicable	Low
Geology and Soils	Soil erosion, soil contamination by the spillage of fuel, oil and chemicals	The construction activity will involve a little bit clearing of land for the purpose of installation of power plant units. The land is already acquired by proponent and in use as yard. During construction and fabrication activity, there is the potential for spills of fuel, lubricating oils and chemicals that could lead to soil contamination.	Medium	Medium	Direct	Local /Regional	Short Term	Reversible	Medium
Water Resources	Depletion of aquifer from overuse, and contamination of water resources	The fresh water is available at 5-8 m depth, so proposed project activities will not impact on local water resources. Surface and aquifer quality may deteriorate if pollutants are mixed with	Medium	Low	Direct	Local /Regional	Short Term	Reversible (depending on the rainfall pattern and aquifer recharge).	Low

	by the spillage of fuel, oil and chemicals	surface runoff during rain and carried to water resources in the vicinity, or if pollutants leach into the ground.							
Air Quality	Vehicular emission, Dust emission	Construction and fabrication of plant activities can generate locally exhaust emission and dust during activities such as 'earthmoving' operations by using tower cranes, bulldozersetc and other pollutants emission from diesel generators and vehicles.	Medium	Low	Direct	Local/ Regional	Short Term	Irreversible	Low
	GHG Emissions	The main source for GHG emissions will begenerators and vehicles.	Low	Low	Indirect	National	Long term	Irreversible	Low
	Ozone Depletion	HCFC and CFC's if any of them used during project activities, can deplete ozone layer.	Low	Low	Indirect	National	Long term	Irreversible	Low
Noise	Impacts at nearest community, Disturbance to the wildlife	There is a potential of disturbance to nearby community due to noise. There is also potential of wildlife temporary relocation because of noise.	Medium	Low	Indirect	Local	Short term	Reversibility	Low
Waste	**Liquid Waste**: risk of liquid waste contaminating aquifer,	The proposed project activity would generate liquid waste from campsite.	Medium	Low	Direct	local	Short term	Reversible	Low
	contaminating surface water								
	Solid Waste (Non-hazardous) Aesthetic issues	The proposed project works will result in the generation of a range of non- hazardous solid wastes.	Low	Low	Direct	Regional	Short term	Reversible	Low
	Hazardous waste:	Hazardous waste such as waste oil, batteries,	Medium	Medium	Direct	Local	Short term	Reversible	Medium

	soil, surface and aquifer contamination	chemicals and clinical waste generated during construction and fabrication activities.							
Traffic	Disturbance to local community	During the project activities, the traffic movement on the main highway and project site will increase. The project site is located on main KotAddu to Gujarat road with very low traffic movement, so no major issue will be raised due to movement of vehicles.	Medium	Low	Direct	Local	Short term	Reversible	Low

Permissible limits of NOx will be ensured by boiler design (to limit NO_x generation). Monitoring of ambient air parameters (PM10, SO_2, and NO_x) emissions should be carried out to ensure compliance with the NEQS as per requirement of SMART.

Residual impact: If the mitigation measures are effectively implemented, the residual impact of the proposed activities on the area's air quality is expected to be low in significance.

Water resources potential impacts: Proposed activities could affect the area's water resources in two ways by overuse and contamination.

Assessment of potential impacts: Water will be required during operational activities. Water will be exploited from groundwater aquifer through deep bore wells. Water conservation practices will be utilized to reduce the water consumption. The domestic effluents shall be collected and treated through on site wastewater treatment system including septic tanks. Process effluents will be collected and treated in a separate network to comply with NEQS.

The project area may expect heavy rain and to protect the area from this impact, campsite location will be selected on relatively high ground. All spills will be handled as soon as reasonably practical.

Mitigation measures: Follow good housekeeping practices with all machinery that may potentially discharge wastewater. No untreated effluents will be released to the environment.

Residual impact: The nature of impact is direct and its reversibility depends on the rainfall pattern, catchment size and associated aquifer recharge to the project area. The significance level given is low, because the water in the area is abundant due to the project area's proximity to the Indus River. Proper implementation of the required mitigation and monitoring techniques will prevent any adverse water quality impacts.

GHG emissions

Potential Impacts: Greenhouse gases are released as a result of combustion process. The increase in greenhouse gas emissions in the atmosphere due to human activities such as combustion and land use change contributes to the global warming.

Assessment of potential impacts: The Kyoto Protocol is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC) an international treaty on global warming. The proposed project has a high thermal efficiency relative to alternative systems and will produce lower CO_2 emissions per kilowatt of electric generation produced. Greenhouse gas mitigation options include sequestration of CO_2 in biologic 'sinks' such as plant biomass. Proponent committed to plant 20,000 trees along roads, boundary walls and in orchards.

Mitigation measures: There are no generally accepted methods for the mitigation of CO_2 emissions. However, one possible mitigation strategies will be given consideration. This includes carbon sequestration by planting trees. As the plant site is in the area with an average rainfall of 212 mm on the basis of last 10years data, carbon sequestration by planting indigenous trees near the plant site could be viable remedial measure.

Residual impacts: CO_2 emissions contributes to the global warming however, CO_2 emissions from the proposed project will be considerably less per unit electricity generated compared to any other conventional alternative.

Hazardous materials potential issues: The operations of power plant will require use of process chemicals for water treatment, lubrications and corrosion control etc. Some of these chemicals may

be of hazardous nature. These chemicals may have a potential to harm human health and contaminate soil, surface and groundwater if not handled correctly.

Assessment of potential impacts: A significant impact will be interpreted if the hazardous materials are not handled properly. The chemicals for the plant operations will include various salts, coagulants, flocculants, sulphuric acid and caustic soda for water treatment and regeneration systems, lubricants etc. for use in plant maintenance and workshop.

Mitigation measures: A chemical and hazardous material handling procedure will be prepared that will contain storage and handling of hazardous materials will be in accordance with international standards and appropriate to their hazard characteristics, storage areas for fuels and liquid chemicals will be designed with secondary containment to prevent spills and contamination of soil and groundwater. Labeling will be placed on all storage vessels/containers as appropriate to national and international standards. The labeling will clearly identify the stored materials. Supporting information such as material safety data sheets (MSDS) will be available for all hazardous materials. Hazardous materials such as used oil filters, batteries, chemical containers, grease traps etc. will be hauled away by contractor for recycling.

Residual impacts: Implementation of the proposed mitigation measures is not likely to leave any significant impact.

The proposed project will avoid use of ozone depleting compounds such as Halon, Chlorofluorocarbons (CFC), Hydro chlorofluorocarbons (HCFC) or any other source which deplete the ozone layer, so the overall assessment of the impact is significantly low.

Plant noise potential issues: The proposed power plant extension will result in increase in noise. The increased noise may be a source of disturbance to nearby communities and residential areas.

Assessment of potential impacts: Noise sources in the community mostly intermittent in nature including road traffic. It can therefore be concluded that area surrounding the power plant boundary has low noise pollution.Noise levels at the power plant location will be high, however only

concerned staff will be working in the area with required PPE, and the exposure will be limited to short durations. The residential area is located about 1 Km away from the proposed project site and there will be no significant impact on community. Plantation along the boundary walls of plant will also act as noise barrier and will prevent the noise pollution.

Mitigation measures: Effective noise suppression design and plan will be made for all noise producing equipment.Plantation will be developed along boundary side of plant site.

Residual Impacts: Implementation of the mitigation measures proposed above will result in negligible / no residual impact due to plant noise on surrounding environment.

Wastewater potential issues: The power plant operation will generate wastewater in the form of cooling tower blow down, plant low volume wastes and sanitary wastewater from plant colony. The wastewater may be a potential source of pollution to surface and groundwater resources of the area.
Assessment of potential impacts: A significant impact will be interpreted if discharged to the environment exceed the NEQS limits for effluent discharge or World Bank guidelines for effluent discharge from power plant. Similarly a significant impact will be interpreted if wastewater contaminates the groundwater.The wastewater will be treated by using an appropriate treatment technology before discharging into open environment. Treated effluents will comply with NEQS.

Mitigation measures: Wastewater will be treated before discharging into nearby drain canal. Monitoring of effluents should be carried out as per requirement of SMART to ensure compliance with the NEQS and World Bank guidelines.

Residual impacts: Implementation of the proposed mitigation measures and regular monitoring is not likely to leave any significant impact of the wastewater from the proposed power plant.

Solid waste management potential issues: The solid waste generated during the operational phase of proposed project may pose health hazard, pollute soil, surface and ground water if not managed properly.

Assessment of potential impacts: A significant impact will be interpreted if the waste management is not carried out properly; which may effect to health of workers, pollution of soil, surface or groundwater. Any person is exposed to potentially hazardous waste generated by the project.Excessive wastes are generated, recyclable waste is not recycled, waste are scattered, handling of wastes results in contamination, and wastes are improperly disposed of causing pollution. All wastes generated from the project will be properly handled, stored and disposed of. The environmental impacts will be tiniest after the implementation of the proposed mitigations.

Mitigation measures: It includes separate waste bins will be placed for different type of wastes - plastic, paper, metal, glass, wood, and cotton. Recyclable material will be separated at source and hauled away by contractor for recycling, Non-hazardous non-recyclable wastes such as construction camp kitchen wastes will be properly dispose off. No hazardous such as organic waste (fruit and vegetable etc.) waste will be dumped at any location outside the plant boundary. All hazardous waste will be separated from other wastes. Hazardous wastes will be stored in designated areas with restricted access and proper marking.Surplus materials including partially filled chemical and paint containers will be returned to suppliers. Inert wastes will be disposed off onsite as fill material.Training will be provided to personnel for identification, segregation, and management of waste.

Residual Impacts: Proper implementation of the mitigation measures will ensure that the residual impact from waste is minimum.

5. ENVIRONMENTAL MANAGEMENT PLAN

The potential environmental impacts are identified from the planning stage of proposed project through Environmental Impact Assessment process.

The Environmental Management Plan (EMP) is a tool that serves as to manage environmental impacts and specifically focuses on implementation of mitigation measures in its true sense against likely environmental impacts.

The primary objectives of the EMP are to facilitate the implementation of the identified mitigation measures. It defines legislative requirements, guidelines and best industry practices that apply to the project and the responsibilities of the project proponent. It also defines a monitoring mechanism and

identifies monitoring parameters in order to ensure the complete implementation of all mitigation measures and the effectiveness of mitigation measures. It provides the requirements for environmental monitoring and auditing and mechanism for taking timely action in the face of unanticipated environmental situations. The management and monitoring plan is attached in Table 2.

Table 2: Management and Monitoring Plan

No	*Impact*		*Mitigation Measures*	*Responsibility*	*Monitoring*	*Timing*
1.	**Air Emissions**	1.1	Monitoring of gaseous emissions should be carried out regularly to ensure compliance with the NEQS and World Bank emission guidelines.	FEL	Records of operationalparameters / periodicmonitoring of stackemissions	Operation phase
2.	**Water Resources**	2.1	Follow good housekeeping practices with all machinery that may potentially discharge wastewater;	FEL		
3.	**Waste Water**	4.1	Wastewater will be disposed off after required treatment.	FEL	Provision ofwastewater treatmentplant at design phase/ Monitor compliance	Operation phase
		4.2	Sanitary wastewater will be treated as per waste management plan	FEL	Monitor compliance /wastewater samplingand testing records	Operation phase
		4.3	Monitoring of effluents should be carried out as per requirement of SMART to ensure compliance with the NEQS and World Bank guidelines.	FEL	Monitor compliance /wastewater samplingand testing records	Operation phase
		4.4	No hazardous untreated effluents will be released to the environment	FEL	Monitor compliance	Operation phase
4.	**Waste Management**	5.1	Separate waste bins will be placed for different type of wastes - plastic, paper, metal, glass, wood, and cotton	FEL	Monitor compliance Operation phase	Operation phase
		5.2	Recyclable material will be separated at source.	FEL	Monitor Compliance	Operation phase
		5.3	Non-hazardous non-recyclable wastes such as construction camp kitchen wastes will be disposed off on designated site.	FEL	Monitor Compliance	Operation phase
		5.4	No waste will be dumped at any location outside the plant boundary.	FEL	Monitor compliance	Operation phase

		5.5	All hazardous waste will be separated from other wastes. Hazardous wastes will be stored in designated areas with restricted access and proper marking.	FEL	Monitor compliance	Operation phase
		5.6	An emergency response plan will be developed for the hazardous waste (and substances).	FEL	Develop and implement emergency response plan.	During construction phase
		5.7	All containers of hazardous waste will be appropriately labeled.	FEL	Check compliance	During construction phase
5.	**Hazardous Material**	6.1	Storage and handling of hazardous materials will be in accordance with international standards and appropriate to their hazard characteristics	FEL	Monitor compliance	Operation phase
		6.2	Storage areas for fuels and liquid chemicals will be designed with secondary containment to prevent spills and contamination of soil and groundwater.	FEL	Monitor compliance	Planning and designphase/Operation phase
		6.3	Labeling will be placed on all storage vessels/containers as appropriate to national and international standards. The labeling will clearly identify the stored materials.	FEL	Monitor compliance	Operation phase
		6.4	A Hazardous Materials Register will be in place to cover hazardous material name, HAZCHEM/United Nations Code, Material Safety Data Sheet (MSDS), summary of maximum inventory, storage requirements and precautions, location, physical properties of the materials and approved disposal methods.	FEL	Monitor compliance /Disposal records	Operation phase
6.	**Occupational Health & Safety**	7.1	**Electrical Hazards**			
		7.1.1	Written procedures to de-energize circuits that will be impacted by the repair activity will be prepared.	FEL	Monitor compliance	Operation phase
		7.2	**Confined Space Entry**			
		7.2.1	Standard procedures for confined space entries will be prepared. The procedure will include: electrical lockout, air testing before and during entry, proper respiratory protection if required, standby help (buddy system), and piping system disconnection.	FEL	Monitor compliance	Operation phase
		7.3	**Machine Guarding**			
		7.3.1	Proper machine guarding, which is critical for the prevention of injuries to workers by isolating them from moving machinery, will be provided.	FEL	Monitor compliance	Planning and design phase
		7.4	**Eye Head and Foot Protection**			

		7.4.1	Head protection will be worn in appropriate plant areas, i.e., power block and production areas. Open-toed shoes will be prohibited. Eye protection will be required during all maintenance activities involving dust exposure or the production of particulates from sanding or grinding activities.	FEL	Monitor compliance	Operation phase
		7.5	**Fire and Explosion Hazards**			
		7.5.1	Firefighting equipment will be available in the form of ABC fire extinguishers as a minimum, and their locations will be clearly marked.	FEL	Monitor compliance	Operation phase
		7.5.2	Exits from work places will be well marked and visible in dim light.	FEL	Monitor compliance	Planning and design phase
		7.5.3	Fire water will be located throughout the plant in well-marked piping.	FEL	Monitor compliance	Planning and design phase
		7.5.4	An emergency response plan will be prepared for evacuation of personnel and equipment.	FEL	Emergency responseplan, record of drills	Operation phase
		7.6	**Housekeeping**			
		7.6.1	Housekeeping will be frequent and thorough to prevent slips, trips, and falls.	FEL	Monitor compliance	Operation phase
		7.6.2	A lockout / tag out program will be implemented.	FEL	Records oflockout/tag out	Operation phase
		7.7	**Chemical Exposure**			
		7.7.1	Proper precautions will be taken to minimize employee risk to chemical exposure	FEL	Records ofoccupational air monitoring.	Operation phase
		7.7.2	Provision will be made for respirator usage in areas where chemical exposure concentrations are exceeding the guideline values.	FEL	Monitor compliance	Operation phase
		7.8	**Noise Level Exposure**			
		7.8.1	Provision will be made for PPEs in areas with noise levels exceeding the guideline values.	FEL	Monitor compliance	Operation phase
		7.8.2	A hearing conservation programme for plant workers will be started which may include: audiometry, training in the use of hearing protection (ear muffs, plugs, canal caps), identification of areas that have high (85 dB (A) or above) sound levels, and discussion of the effects of noise exposure.	FEL	Monitor compliance	Operation phase
		7.9	**Heat Related Stress/Illness**			
		7.9.1	Staff will be trained for management of heat related stress and illness, such as proper work/rest cycle and increased intake of fluids	FEL	Monitor compliance	Operation phase

			during hot weather.			

6. CONCLUSION

The sugar industry has a significant potential to contribute towards the supply of bio-energy to Pakistan community especially bagasse powered electricity. Energy audits are very crucial for a successful energy management system. It is imperative for cogeneration to be adopted in the industry to increase electricity output and to make better use of process steam. This study contributes to decision making efforts in Pakistan and in other sugarcane producing countries on maximizing energy efficiency and bio-power production and use in the sugar industry. The research studies conclude that the residual impacts of the proposed operation will be of minor significance and careful implementation of the Environmental Management Plan (EMP) will ensure that environmental impacts are managed and minimized and all statutory requirements are met by the project proponent.

7. ACKNOWLEDGEMENTS

The funding and support provided by University of Engineering and Technology Lahore Pakistan, is acknowledged.

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