OCCUPATIONAL HEALTH AND SAFETY STUDY (OHSS) OF BRICK INDUSTRY IN THE KATHMANDU VALLEY

REPORT

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GLOASSARY OF TERMS

Accident - An unplanned, unforeseen and unwanted or undesired event that results in physical harm (illness, injury, or death) and/or property damage.

Aerosol – A dispersion of solid or liquid particles of microscopic size in a gaseous medium. Smokes, fogs, fibres, dusts, and mists are examples of common aerosols.

Air pollutant – any substance in air that could, in high concentration, harm people, animals, or vegetation, or damage non-living material. Such pollutants may be from solid particles, liquid droplets, gases, or any combination of these.

Chronic exposure – *Chemical* - Continual exposure to low levels f a chemical over long period of time (usually three years of more), that can produce symptoms of the disease.

Continuous monitoring – Usually refers to air sampling conducted at locations where leaks may occur, or where hazardous materials are handled in high quantities.

Dilution Ventilation - dilution of contaminated air with uncontaminated air in a general area, room or building for the purposes of health hazard or nuisance control, and/or for heating and cooling.

Dust – Air borne or settled particles usually formed by abrasion or arising from soil, bedding, or from surfaces such as floors and walls.

Exposure – The amount of biological, physical or chemical agent that reaches a target population; the route by which an organism comes in contact with a toxicant (inhalation, ingestion and dermal absorption, injection)

Exposure Limits- established concentrations, which, if not exceeded, will not generally cause adverse effects to the worker, exposed. Exposure limits differ in name and meaning depending on origin. For example:-

1. Threshold Limit Values *(TLVs)* are exposure guidelines developed by the ***American Conference of Governmental Industrial Hygienists (ACGIH).*** Several governments and others have adopted them as their legal limits. They are expressed as follows:-

   TLV – Refers to airborne concentration of a substance and represents the conditions under which the American Conference of Industrial Govermental Hygienists believes that nearly all workers may be repeatedly exposed day after day without adverse health effects.

   TLV-TWA *Threshold Limit Value - Time-Weighted Average:* The time-weighted average concentration for a normal 8 hour work day and a 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Gingivitis – Inflammation of the gums of the mouth.

Globe thermometer – A dry bulb-thermometer suspended in the center of a sphere that has been painted flat black and is used to measure radiant heat.

Hazard - A risky, perilous, or dangerous condition or situation that could result in the exposure of individuals to unnecessary physical or health risks. Hazards can be biological, chemical, physical, mechanical, human-made, or naturally occurring.

Heat stress – Thermal stress on the body for the surrounding environment, including heat stroke, heat cramps, and heat exhaustion, caused by the body's inability to rid itself of excessive heat.

Heat disorder – any condition resulting from exposure to heat or hot work environments that results in an adverse effect on the health of the exposed individual. Such disorders include hat cramps, heat exhaustion, heat stress, and heat stroke. Also referred to as heat stress.

Hygiene – Refers to the science of health and preservation of well being

Local Exhaust Ventilation (**LEV) System** - involves the capture of pollutants at the source. Air handling system designed to capture and remove process emissions before they can escape into the work place or the environment generally consisting of a hood, conveying ductwork, and an air handling device, a fan and an exhaust stack

Occupational Illness – Any abnormal condition or disorder, other than resulting from occupational injury, caused by exposure to environmental factors associated wit h employment. This includes any acute or chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact.

Occupational Injury – any injury that results from a work accident or from a single instantaneous exposure in the work environment.

Particles – small, distinct masses of solid or liquid matter such as dust, fume, mist, or smoke.

Particulates – Fine liquid or solid particles such as dust, smoke, mist, fumes pr smog, found in air or emissions

Personal monitoring – The practice of having an individual wear monitoring or sampling devices during their workday to measure exposures to various hazardous substances or agents.

Personal Protective Equipment (PPE) – Any of a number of devices or types of equipment (hard-hats, gloves, goggles, shoes, etc.) worn to provide protection against various hazards.

Radiant heat load – Energy that is transformed into heat when it strikes an object. The human body can both emit and receive radiant energy.

Respirable dust – Airborne particulate matter capable of passing through upper respiratory system and being deposited in the lungs. Such particles are typically less than 10 micrometers in diameter.

Safety – The development of systems and techniques to assure that individuals in occupational settings and their environment are relatively free from conditions that could cause death or serious physical harm.

Sample – In industrial hygiene, a process consisting of the withdrawal, isolation or concentration of a fractional part of a whole as related to environmental media such as air, water, soil, or other liquid, solid, or gas, for analysis by acceptable procedures. Samples can b either cumulative (i.e. collected over time), in which case the result is expressed as time-weighted average, or instantaneous.

Ventilation - the movement of air.

Wet Bulb Globe Temperature (WBGT) Index – an index of heat stress in humans when work is performed in hot environments.

EXECUTIVE SUMMARY

Healthy workers are productive. Brick industry has been an informal sector, predominantly seasonal in Nepal. Brick technologies and work processes have been continually evolving for the better product optimization. However, understanding of occupational health hazards that are associated with the technologies takes a lower priority.

Consequent to the request and providing grants, a research project of Occupational Health and Safety Study (OHSS) is conducted in factories following FCBTK and VSBK brick manufacturing technologies. The findings are presented in this report. Brick making by Fixed Chimney Bull Trench Kiln (FCBTK) is in existence since long in Nepal. The Vertical Shaft Brick Kiln (VSBK) technology of brick production is of recent origin in Nepal, although in existence in India relatively for a longer time. VSBK Program, Nepal intended to extend the benefit of promotion of occupational health and safety and welfare to the concerned employees and entrepreneurs as an inbuilt component of its project endeavor.

A research project proposal for hazard risk assessment of occupational environment pollutant exposure levels by monitoring of working environment including a health-monitoring program was formulated basing on a preliminary survey of both VSBK and FCBTK factories. Occupational health and safety study in two major factories having FCBTK technology and two factories manufacturing bricks by VSBK technology was carried out in four different spells during a period of one year.

The study included surveillance of the working environment and of workers' health. The objectives of the study were to protect workers in brick production industry from the occupational safety and health hazards and risks in their work; to prevent and reduce incidence and severity of illness and injuries in brick production industry and to provide practical control measures for minimizing occupational exposure to dust, heat, toxic gas and other hazardous factors from different production processes.

The work environment air monitoring to quantitatively assess the dust, gas and heat pollution was carried out by standard procedures using calibrated and exclusively dedicated monitoring equipments. Subjective concentration of pollutants through personnel monitoring was given emphasis. Simultaneous health examination of listed workers in each factory by qualified medical professionals on four occasions has been investigated. The measured levels of pollutants were compared with prescribed Threshold Limit Values after due considerations. The results and the findings and inferences drawn are presented. The occupational safety aspect was carried out by observation and assessment of existing safety practices in place. Suitable, appropriate and adequate measures in the form of suggestions and recommendations are provided to minimize occupational injuries and promote health of employees in brick factories.

The work spots

VSBK factories: The **Green brick carriers –**Carry the air-dried green bricks from moulding areas to the first floor green brick loading platform of VSBK factories for the purpose of firing the bricks inside the shafts. The **fire masters** arrange the bricks in the shaft, place requisite amount of coal for firing in the first floor. They also unload red

bricks by lowering the shaft, cooling the bricks for some time and shifting the bricks to the storing place in the ground floor.

In VSBK factories the areas covered for pollution monitoring were: Green brick loading area (first-floor, shaft input - fire master); red brick unloading area (Ground floor- shaft output and transport area - fire master); coal area (coal, breaking, store-yard – coal handler).

FCBTK factories: The **green brick carriers** transport green bricks from moulding places to the trenches. The **green brick loaders** organize bricks in the trenches by arrangement. The **fire masters** feed coal at regular intervals into the stoking holes on the top surface of trenches and conduct the firing process. The **red brick transporters** transfer by carrying the fired red bricks from trenches to the transporting vehicle.

The **coal handlers** break the big lumps of coal into required sizes needed for firing. This job was similar at both VSBK and FCBTK factories. The **administration section** had personnel involved in account keeping and managerial work at respective FCBTK and VSBK factories.

The dust and heat pollution in the present study was monitored at the actual work - near green brick loading area (inside trench – green brick loader); red brick unloading area (transport area – red brick loader); coal area (coal breaking, store-yard – coal handler); coal feeding on surface of trenches - fire place (fire master).

Dust pollution: The dust and heat pollution was found to be higher at FCBTK brick technology compared to VSBK brick making technology. The results indicated that high dustiness of work environment at FCBTK factories compared to corresponding VSBK work areas. The major findings with respect to work environment monitoring was that the respirable particulate pollution was a problem in and is a serious one with respect to both green brick loaders as well as red brick loaders at FCBTK factories.

Gas pollution: The sulfur dioxide (SO_2) gas monitoring indicated that VSBK factories were associated with higher SO_2 levels; the average levels were within prescribed threshold limit value. However, there is a scope to reduce gaseous pollution at green brick loading area of VSBK factories.

Heat Stress: The thermal stress (radiant heat) prevalent in FCBTK fireplaces was higher compared to the fireplace work at VSBK technology. The difference was statistically highly significant suggesting that FCBTK brick making technology exerts a higher thermal stress on the fire-masters. The study indicated level of thermal stress prevalent at FCBTK technology was considerable to induce health disorders to the FCBTK fire-masters who are exposed on a chronic scale. This finding is corroborated with noting of high blood pressure levels among the fire masters engaged in FCBTK factories.

Since elaborate and repetitive measurements have been carried out representing all possible work-cycle-situations, the findings reflected work environmental quality. The work practices as well as the FCBTK technology in general contributed to considerable levels of dust and heat pollution.

Safety observations*:* Basing on the findings, the study has suggested suitable recommendations. It has provided engineering control measures in order to minimize hazard and risk levels as well as workers' exposure to hazardous factors. Recommendations have been given with respect to the provision of appropriate personal protective clothing and equipment. The study has stressed necessity of giving adequate information, education and training. Source pollution, the exhaust ventilation to be located as close as practicable to the emission sources; water spraying of yards and interior routes to minimize dust emission; maximal mechanization of process particularly in material handling and transportation are a few suggestions among others.

The employer should provide personal protective equipment including cloth-masks, helmets and gloves for workers, especially who work in manual brick unloading, maintenance and housekeeping. When the airborne concentration is over the permissible limits, workers should wear special mask or semi-mask. The equipment should be selected, used, maintained, stored and periodically replaced. The sanitary facilities and other measures included providing washing and changing facilities. Showers as bathing facilities should be provided for workers.

Medical examination: The study indicated that among the proportion of workers complaining health problems, more number of FCBTK employees were associated with health problems. Among the number of workers who had health problems, gastrointestinal tract, skin related illnesses, respiratory complaints and genitourinary tract problems were more prevalent among FCBTK workers compared to VSBK workers. All these problems, however, cannot be attributable to brick technology. But, detailed blood pressure result analysis indicates that the FCBTK technology induces higher blood pressure complaints. The environmental monitoring data also definitively suggests prevalence of heat stress at FCBTK factories compared to VSBK factories.

Taking into consideration of medical and environmental findings the following inferences could be drawn:

1. The respirable dust pollution and level of heat stress was considerable at FCBTK technology of brick production.
2. The fire masters of FCBTK are at risk with respect to in high blood pressure and the prevalence rates of all stages of blood pressure were more compared to corresponding workers engaged in VSBK factories.
3. The green brick laying and red brick transport operations were associated with high dust concentration. The operations like green brick laying green brick carrying into trenches were unsafe practices; the fire masters were exposed to high amount of heat stress. In general the work practices were unsafe and prone to minor and major accidents in FCBTK factories.
4. The medical examination indicated that majority does not have health related problems. Among those who had problems, health problems complained by FCBTK employees was more compared to VSBK workers; however all the health complaints do not have occupational origin.
5. Many very young workers are observed engaged in work FCBTK factories, specially deployed in brick carrying work.

The study findings suggest the workers at VSBK factories were better organized; they were involved in work under roof and had a factory-like environment. The management

and the work pattern involved at VSBK technology were more organized. From the points of workplace hazards and pollution levels VSBK technology had lesser latent risks and hazards compared to FCBTK brick technology.

The study results and findings have indicated some advantages with respect to VSBK over FCBTK technology of brick production in Nepal. The following advantages are associated with VSBK technology.

Advantages of VSBK technology:

- The quality or work environment is better – lesser rate of dust and heat pollution
- There are better possibilities of instituting pollutant measures (engineering and administrative) control
- There is s scope to improvise work environment with respect to gas pollution
- The work-practices and hazards could be modulated to minimize employee exposure
- The workers have lesser health problems
- The work is more organized and the work-shift systems could be continued in all seasons without seasonal breaks – production could be better streamlined
- Since the number of workers per VSBK factory is relatively lesser, better safety and welfare measures could be planned.

Outcome Of The Study

The study provides authentic information about the status of existing work-environment, associated pollutants and work-safety – of VSBK as well as FCBTK Technology. The occupational health study had several benefits since it was a comprehensive, systematically planned and studied.

Some of the points of outcome are:

- Recognition of the inter- relationship of work environment and brick industry technology (FCBTK and VSBK) - accomplished by measuring and monitoring pollutant levels, compilation of knowledge, experience and quantitative data; evaluation of the of health and well being of employees and formulating of recommendations for addressing of problems and finally instituting control – development of corrective measures in order to eliminate or minimize existing occupational health and safety problems.

- The study facilitated observation and understanding actual work-practices involved in the entire job categories of brick production for the purpose of identifying the associated work-environmental stressors (physical, chemical and ergonomic) to which the employees were exposed during the course of work. It also facilitated preparation of adequate warning and precautions where dangers exist.

- Baseline scientific occupational health and safety information, for the first time is generated comprehensively from this scientific study. This would be of value to project authorities, planners and regulating authorities.

Limitations Of The Study

1. The numbers of workers at FCBTK was many folds more than those engaged in VSBK; also the sizes of the FCBTK factories were comparatively bigger.
2. The worker turnover was very high; a worker leaving a particular job and new workers taking over was common. Therefore the same set of workers in al the spells of the study could not be followed.
3. All workers in FCBTK factories engage in open-field operations and at VSBK the fire-masters operate inside the factories under roof.

CONSIDERING MANY OCCUPATIONAL HEALTH AND SAFETY ADVANTAGES ASSOCIATED WITH VSBK FACTORIES, THE VSBK TECHNOLOGY COULD WELL BE PROMOTED IN NEPAL.