In the Name of Allah the Almighty

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

DEPARTMENT OF TECHNCAL AND VOCATIONAL ENGINEERING (TVE)

STUDY OF ELECTRIC POWER SAFETY: BANGLADESH WOVEN GARMENTS INDUSTRIES PERSPECTIVE.

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF FOR THE DEGREE OF MASTERE OF SCIENCE IN TECHNICAL AND VOCATIONAL EDUCATION IN ELECTRICAL AND ELECTRONIC ENGINEERING (MScTE)

Prepared By

K. M. MD. GOLAM RABBANI 133601
AUDU IBRAHIM BABA 133608

Under the Supervision of

Mr. Kazi Obaidul Awal, Part Time Teacher, EEE Department

and Former Chief Engineer, Bangladesh Atomic Energy Commission

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING (EEE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
GAZIPUR, DHAKA, BANGLADESH

OCTOBER 2014, SESSION 2013-2014

In the Name of Allah the Almighty

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

DEPARTMENT OF TECHNCAL AND VOCATIONAL ENGINEERING (TVE)

STUDY OF ELECTRIC POWER SAFETY: BANGLADESH WOVEN GARMENTS INDUSTRIES PERSPECTIVE.

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF FOR THE DEGREE OF MASTERE OF SCIENCE IN TECHNICAL AND VOCATIONAL EDUCATION IN ELECTRICAL AND ELECTRONIC ENGINEERING (M.Sc.TE)

Prepared By

K. M. MD. GOLAM RABBANI 133601
AUDU IBRAHIM BABA 133608

Under the Supervision of

Mr. Kazi Obaidul Awal, Part Time Teacher, EEE Department

and Former Chief Engineer, Bangladesh Atomic Energy Commission

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING (EEE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
GAZIPUR, DHAKA, BANGLADESH

OCTOBER 2014, SESSION 2013-2014

DECLARATION

We hereby declare that this report has not been submitted elsewhere for obtaining any degree or diploma or certificate or for publication and as such be accepted as fulfilling the requirement for the degree of Master of Science in Technical Education (M. Sc TE, Electrical).

Signatures:

K. M. MD. Golam Rabbani Student No. 133601

Audu Ibrahim Baba Student No.133608

Countersigned:

Kazi Obaudul Awal,
Special Study Supervisor
Department of EEE, IUT

Approved by:

Prof. Dr. Md. Shahid Ullah,
Head, Department of EEE, IUT

Prof. Dr. Che Kum Clement
Head, Department of TVE, IUT

Dedicated To

Honorable Teachers of Islamic University of Technology;

Garment Workers, Who are Working Day and Night for Earning

Valuable Foreign Currency to Boost Country's Economy and

Social Up-liftment; and to

Those Who Dedicated Themselves for Civil Defense and to Save Others

Acknowledgment

We thank Allah the Almighty for providing them an opportunity and ability to complete this study.

We would like to express their deep feeling of gratitude and appreciation to **Prof. Dr. M. Imtiaz Hossain**, Vice-Chancellor, Islamic University of Technology (IUT) for granting them scholarship and permit them to enroll in the M.Sc. course of IUT. Our deep thanks and gratefulness to **Prof. Dr. Md. Shahid Ullah**, Head of EEE department for his suggestions, assistance and support.

We also express our deep appreciation, thanks and gratefulness to **Mr. Kazi Obaidul Awal** currently Part Time Teacher, Former Assistant Professor (EEE, IUT) and Retired Chief Engineer, Bangladesh Atomic Energy Commission for his suggestions, guidance, supervision, encouragement and patience during the preparation of study and writing this thesis.

We also acknowledge our deep thanks to the Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and the owners and staffs of the woven garment industries that we visited for their help during the visits for power safety related data collection for this thesis. Our deep respect and thanks are also due to high officials of Bangladesh Fire Service and Civil Defense Directorate (BFSCDD) for providing power safety related data and advices.

The researchers also wish to express their thanks to the **staffs of the electrical workshops and other staff members** of IUT for their valuable help and co-operation during preparation of this thesis.

K. M. MD. GOLAM RABBANI

AUDU IBRAHIM BABA

Preface

Bangladesh is a developing country. The country with an area 147,570 km^2, 153.6 million populations is the most density populated. It is, as such, essential to enhance employment opportunities as well as exports. Garments industry sector is the most rapidly expanding sector of Bangladesh. It provides job opportunity to more then 4 (four) millions of workers, primarily women. The sector indirectly supports an additional 23 million people. The sector exports about US$ 22 billion worth of products which is about 76% of country's total export. As such it is the most important contributor to the GDP growth and the overall economy of the country. The trend is expected to remain the same in the coming decades due the country and global realities.

Garment industries are mainly of two types: one is woven garment industries and another is knitwear garment industries. Annual exports amount to about US$ 14.5 billion from woven garment industries and the rest US$ 11.5 billion from the knitwear garments. So far as the numbers of workers are concerned, about 80% workers are employed in woven garment industries and the rest 20% at knitwear garments.

All garment industries require safe and quality power supply for smooth operation of the industries and for the production of quality goods and services. The electric power supply has associated risks; which may cause, due to weak design or faults –injuries, fatalities and fire. The consequent fire may cause havocs resulting serious damage to goods, machinery, and even the structures of the buildings. Fire also causes injuries and deaths to the workers and or occupants of the industries.

Safety and security of about 3 million worker's life of the woven garment industries are, therefore, dependent on the standard of power supply systems of the industries. In Bangladesh the number of minor and major accidents leading to deaths and injuries in the garment industries are quite frequent. This is unacceptable both from national and international industrial safety standards. In this context the recent accidents in Tazreen (24-11-2012) and Rana Plaza, Savar (24-04-2012) may be recalled. Tazreen accident resulted 112 deaths and 125 were injuries and in Rana Plaza 1132 died, and 332 missing, the injured workers, an estimated 1,800 were taken to the hospital. 339 workers were severely injured, and had to undergo major operations and long-term treatment for severe head injuries, pelvic fractures, and backbone injuries. Some of the workers who were released from the hospital within a few weeks are still unable to return to garment work and others will never work again. The accidents caused both national and international concerns. The international import agencies as well as the foreign governments are now imposing pressures on Bangladesh Government to improve safety standards in the garment industries.

The principal reasons for the accidents and fires are: faulty or weak design of power systems (without following safety codes and standards as required by law and regulations),

design incorporated safety and protection systems, lack of routine and proper maintenance of the systems, weak emergency response and disaster management plans etc.

It is essential and very important to minimize the risks of accidents and fatalities within internationally acceptable limits to save the lives of millions of workers and also to overcome foreign embargo for smooth growth of the industry and for the socio-economic betterment of the nation through realizing the acceptable standard of electric power safety. For this, comprehensive and in depth study and analyses of the safety and quality of power supply systems of the garment industries is essential. Such study is not possible within the time, scope and resource of this special study course.

The study, however, made an attempt to find out the key elements or issues of the power safety study by developing a data sheet and get practical exposures through field inspections and visits of only a number of representative types of woven sector garment industries and also the concerned authorities: Bangladesh Garment Manufacturing and Exports Association (BGMEA) and Fire Service and Civil Defence Directorate of Bangladesh (FSCDDB). Efforts have also been made to collect relevant data and information from the available books, publications, media, newspapers and websites.

Three large study groups namely: The Accord, The Alliance, and Bangladesh University of Engineering and Technology (BUET). They have been carrying out studies on the same issue for a considerable period. The Accord, a platform of 150 retailers and brands mainly from Europe, has so far carried out inspections of 850 factories of 1626. The Alliance, a platform of 27 US-based apparel retailers and brands, inspected 609 out of 626 factories. Meanwhile, BUET has completed inspection at 266 factories out of around 2,000 factories, according to the TIB study. The final reports are yet to be published. Attempts have also been made to contact these study groups but without much success.

The study presents the data sheet prepared for the study, selection criteria of the industrial visits and the outcome of the visits. Efforts have also been made to summarise and analyse the finding s of the visits. Finally recommendations have been included.

Finally the subject is very important from the national and international perspectives. The special study only made an attempt to have some idea on existing status of power related safety issues and a possible roadmap to improve the power safety in the garment industries which have been presented in the report. Government and relevant authorities should give due importance and do all the needful to ensure the desired standards of safety of the workers of the garment industries for the smooth and safe development of the sector as well for the sustenance of the desired growth of the country’s economy.

Contents

ABBREVIATIONS

A	: Ampere
ABS	: Air Break Switch
AC	: Alternating Current.
ACB	: Air Circuit Breaker
ACR	: Auto Circuit Re-closer
ADP	: Annual Development Plan
Ah	: Ampere-hour
ANSI	: American National Standards Institute.
BCCSAP	: Bangladesh Climate Change Strategy & Action Plan
BD	: Bangladesh
BGMEA	: Bangladesh Garment Manufacturers and Exporters Association
BNBC	: Bangladesh National Building Code
BPDB	: Bangladesh Power Development Board
BUET	: Bangladesh University of Engineering and Technology
CB	: Circuit Breaker
CEDAW	: Committee on Elimination of Discrimination Against Women
CFR	: Code of Federal Regulations.
CNG	: Compressed Natural Gas
CPR	: **C**ardiopulmonary resuscitation.
CSO	: Civil Society Organization
CSR	: Corporate Social Responsibility
CT	: Current Transformer
DC	: Direct Current.
DESCO	: Dhaka Electric Supply Company
DFSCDB	: Directorate of Fire Service and Civil Defense Bangladesh
DPDC	: Dhaka Power Distribution Company
ES&L	: Energy Standards & Labeling
EU	: European Union
FSP	: Facility Safety Plan.
FYP	: Five year Plan
GCRI	: Global Climate Risk Index
GDP	: Gross Domestic Product
GEF	: Global Environment Facility
GFCI	: Ground-fault circuit interrupter.
GNI	: Gross National Income
GoB	: Government of Bangladesh
GOs	: Government Organizations
Govt	: Government
HDI	: Human Development Index
HT	: High Tension
HV	: High Voltage
IEEE	: International Electrical and Electronics Engineering.
ILO	: International Labor Organization
IMF	: International Monetary Fund
IUT	: International University of Technology
IWS	: Integration Work Sheet
KW	: Kilo Watt
LA	: Lightning Arrestor

LDC	: Least Developed Country
LED	: Light Emitting Diode
LT	: Law Tension
LV	: Law Voltage
MDGs	: Millennium Development Goals
MIC	: Middle Income Country
MW	: Mega Watt
NEC	: National Electric Code
NEC	: National Electrical Code.
NEMA	: National Electrical Manufacturers Association.
NFPA	: National Fire Protection Association.
OCB	: Oil Circuit Breaker
OIC	: The Organization of the Islamic Conference
OJT	: On-the-job training.
OSH	: Occupational Safety and Health
OSHA	: Occupational Safety and Health Administration.
PF	: Power Factor
PPE	: Personal protective equipment.
PT	: Potential Transformer
PVC	: Poly Vinyl Chloride
REB	: Rural Electrification Board
RMG	: Ready Made Garments
USA	: United State of America
V	: Voltage
WHO	: World Health Organization
WZPDC	: West Zone Power Distribution Company

1

Introduction

Garment industry is by far the largest industrial sector of Bangladesh which contributes about 76% of the total exports of Bangladesh and employs about four million of workers mostly women. Power safety is very important for the safety of the industrial workers as well as for the smooth functioning of the industry. Because of the time limit and resource constraints, efforts have been made to study and identify present power safety status and some key power related issues which deserve attention of the policy makers and the management to improve and strengthen power safety.

Key terms related to power safety and woven garment industries have been defined and highlighted in Chapter -2.

Geo-economic and historical back ground of Bangladesh and present status and growth trend of woven garment industries have been presented in Chapter -3. The chapter also highlights power safety and protection requirements by international and national codes, standards and laws.

Chapter -4 presents need and importance of electricity for the industry. The chapter also highlights the power related safety issues.

A data sheet has been prepared to collect power safety related important data. The data sheet includes general information of the industry to be visited, description and status of the power supply system, protection system, intensity of illumination, regulatory compliance, other power related safety issues, emergency response plan, workers' awareness, accident compensation and liabilities, general remarks etc. Information related to the development of data sheet is presented in Chapter – 5.

Data and information received during the visits of the woven garment industries and some related organizations/authorities e. g. Bangladesh Garments Manufacturers and Exporters' Association and Bangladesh Fire Service and Civil Defense Directorate have been presented in Chapter-6.

Findings and analyses of the data received from the visits have been presented in Chapter -7.

Recommendations and conclusions of the study have been presented in Chapter -8 and Chapter -9 respectively.

2

Key Terminologies

This section provides an alphabetical list of the terms used in and applicable to this Project and Thesis of the Power System Safety, Bangladesh Woven Garments Industry Perspective. The following terms and acronyms are used in this document and the supporting appendices.

ACCESSORY: A device associated with current using equipment or with the wiring of an installation; for example, a switch, a plug, a socket outlet, a lamp holder, or a ceiling rose. ALIVE: See LIVE.

APPARATUS: Apparatus means Energy Efficient Apparatus. Electrical apparatus including all machines, appliances and fittings in which conductors are used or of which they form a part.

APPLIANCE: Appliance means Energy Efficient Appliance, An item of electric current using equipment other than a luminaries or an independent motor.

ELECTRICAL EQUIPMENT: A general term for material, fittings, devices, appliances, fixtures, apparatus, and the like that are used as a part of or in connection with an electrical installation. The term applies to both power-generation equipment and electronics equipment.

ELECTRICAL HAZARD: Any situation in which an employee or any conductive tool or object in contact with the employee could contact or approach closer than the safe clearance distance of any live part or other energized conductor, Any situation in which electrical equipment is likely to cause a fire because of defective components or design. Examples of electrical hazards include inadequate working clearance while working on energized circuits, exposed energized parts; electrical equipment inadequately guarded or enclosed electrical equipment in an unsafe environment, and unsafe electrical equipment. Generally, electrical equipment that is not in compliance with OSHA regulations or NEC standards presents a potential hazard.

BDB: Branch- Distribution Board located in the same floor of a building and connected to one of the **SDBs** in the same floor:

BRANCH CIRCUIT, APPLIANCE: A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such branch circuits do not have any permanently connected lighting fixtures except those that are integral parts of the appliances themselves.

BRANCH CIRCUIT, GENERAL PURPOSE: A branch circuit that supplies a number of outlets for lighting and/or appliance.

BRANCH CIRCUIT, INDIVIDUAL: A branch circuit that supplies only one utilization equipment.

BUNCHED: Cables are said to be bunched when two or more are either contained within a single conduit, duct, ducting, or trunking or, if not enclosed, are not separated from each other.

CABLE: PVC insulated copper cables having copper cross section of 1 mm2 and above. A length of single insulated conductor (solid or stranded), or two or more such conductors, each provided with its own insulation. The insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

CELING ROSE: A ceiling rose is used for terminating the point wiring for a Light or a Fan in the ceiling. It has brass terminals in which incoming cables are terminated using brass screws on the terminals and the outgoing flexible cables get connection through the screw connections.

CIRCUIT: An assembly of electrical equipment supplied from the same origin and protected against over current by the same protective device.

SUB CIRCUIT, FINAL CIRCUIT: An outgoing circuit connected to one way of a distribution board or a fuse board and intended to supply electrical energy, to one or more points, to current using appliances without the intervention of a further distribution fuse board other than a one-way board. It includes all branches and extensions derived from that particular way in the distribution board or fuse board.

CIRCUIT BREAKER: A device used to break a circuit during over current or short circuit condition. An LV Circuit Breaker is used in a low voltage distribution system and an HV Circuit Breaker is used in a high voltage distribution system.

CORD, FLEXIBLE CABLE: A flexible cable having large number of strands of conductors of small cross-sectional area with a soft PVC insulation. Two flexible cords twisted together may be termed as twin flexible cord. However, some flexible cords are made following the style of a twin core PVC insulated copper cables but much soft and flexible.

CUTOUT: Any appliance for automatically interrupting the transmission of energy through a conductor when the current rises above some predetermined value. A cutout contains a part for holding either fuse wire (rectangular cross section type) or a part for holding tubular fuse (cylindrical body rectangular cross section type). (see Fuse)

DB: Distribution Board. This may be the box where the main incoming cable enters and terminates from the main service feed connection. The SDBs get feed from a DB.

DEMAND FACTOR: The ratio of the maximum demand of a system, or part of a system, to the total connected load of the system or the part of the system under consideration.

DUCT: A closed passageway formed underground or in a structure and intended to receive one or more cables which may be drawn in.

EARTH: The conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

EARTH ELECTRODE: A metal plate, pipe or other conductor electrically connected to the general mass of the earth.

EARTH LEAD WIRE: The final conductor by which the connection to the earth electrode is made.

EARTH CONTINUITY CONDUCTOR (ECC): The conductor, including any clamp, connecting to the earthing lead or to each other, those parts of an installation which are required to be earthed. It may be in whole or in part the metal conduit or the metal sheath or armour of the cables, or the special continuity conductor of a cable or flexible cord incorporating such a conductor. ECCs of appropriate size must run from an MDB to it's DBs, from a DB to its corresponding SDBs, from an SDB to the Switch Boards under this SDB, from an SDB to the BDBs if there are any, from a BDB to the Switch Boards under this BDB, from an SDB or a BDB to the Sockets under this SDB or BDB.
EDB: Emergency Distribution Board. This may be the box where the main incoming cable from the Emergency or Standby Generator Panel enters and. The ESDBs get feed from a EDB.

EFDB: Emergency Floo**r** Distribution Board located in each of the floors of a multistoried building. The EDBs get feed from EFDB.

Electrical Worker: An electrical worker is a person trained, qualified, and authorized to work on electrical equipment. He/she is usually hired specifically for this purpose.

ENGINEER-IN-CHARGE: An engineer responsible for implementation /execution of the work of a building or a project. Such an engineer is expected to have significant knowledge in Electrical Engineering, Electrical Construction, Measurement, Codes and Practices of such work and availability of different materials needed for the construction.

Facility Power: Main disconnects, panel boards, switches, and associated wiring are considered facility/building power and are typically less than 600 V ac. These systems are designed and installed to operate facilities in these buildings (i.e., lighting, heating, air conditioning, or standby power supply and circuitry).

FDB: Floo**r** Distribution Board located in each of the floors of a multistoried building. The DBs get feed from FDB.

FUSE: A device that, by the fusion of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted when the current through it exceeds a given value for a sufficient time. Fuse is generally made of fusible wires of appropriate ratings which is either mounted inside glass tubes or porcelain tubes or on a two terminal cutout.

FUSE SWITCH: A composite unit, comprising a switch with the fuse contained in, or mounted on, the moving member of the switch.

GROUNDED: Connected to earth or to some conducting body that serves in place of the earth, physically and intentionally connected to the earth through a ground connection of sufficient low impedance and with sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazard to connected equipment or persons. (See ungrounded.)

INSULATION: Suitable non-conducting material, enclosing, surrounding or supporting a conductor, Usually PVC, polymer, specially treated rubber.

LABELED: Equipment or materials to which a label, symbol, and other identifying mark has been applied by an NRTL.

LIGHTING FITTING: A device for supporting or containing a lamp or lamps (for example, fluorescent or incandescent) together with any holder, shade, or reflector; for example, a bracket, a pendant with ceiling rose, or a portable unit.

LIVE: Electrically charged so as to have a potential different from that of earth, also known as **ALIVE.**

LUMINAIRE: A complete light fitting consisting of lamp, holder, starting gears, reflectors, housing and mounting accessories.

LT / LV and HT/ HV: LT or LV in this document indicates 230 Volt single phase and 400 volt 3 phase. HT or HV in this document indicates 11KV Line to line 3 phase system.

MDB: Main Distribution Board. This is the distribution box where the main incoming cable enters and terminates from the main service feed connection of a large building. The FDBs get feed from MDB.

OVER CURRENT: A current exceeding the rated current. For conductors, the rated value is the nominal current carrying capacity.

PANEL BOARD: A single panel or a group of panel units designed for assembly in the form of a single panel including buses, automatic over current devices, and with or without switches for the control of light, heat, or power circuits, designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.

PLUG: A device carrying metallic contacts in the form of pins, intended for engagement with corresponding socket contacts and arranged for attachment to a flexible cord or cable. A plug may contain tubular fuse inside it although some plugs do not contain fuse.

POINT (in wiring): A termination of the fixed wiring intended for the connection of current using equipment e.g., a Light, a fan, an exhaust fan.

QUALIFIED-PERSON: A person who has been determined by his/her supervisor to have the skills, knowledge, and abilities to safely perform the work to which he/she is assigned. Qualifications may include a recognized degree, certificate, or professional standing--through extensive knowledge, training, and experience--or that one has

successfully demonstrated the ability to resolve problems relating to the subject matter or work to the satisfaction of his/her supervisor.

SAFETY WATCH: A person specifically assigned to stand by (within visible and audible range of workers) and continually monitor equipment and personnel for safety.

SDB: Sub-Distribution Board located in the same floor of a building and connected to the DB**.** The BDBs get feed from SDB.

SERVICE: The conductors and equipment required for delivering energy from the electric supply system to the wiring system of the premises served.

SWITCH: A manually operated device for closing and opening or for changing the connection of a circuit. A 5A SPST switch is used for the control of a Light or Fan point. A 5A SPDT switch is also used for the control of a Light or Fan point.

SWITCHBOARD: An assemblage of switchgear with or without instruments; the term, however, does not apply to a group of local switches on a final sub-circuit where each switch has its own insulating base.

SWITCHGEAR: Main switches, cutouts/fuses, conductors and other apparatus in connection therewith, used for the purpose of controlling or protecting electrical circuits or machines or other current using appliances.

TEMPORARY WIRING: Electrical wiring that is temporarily installed for a limited time to complete a specific task (e.g., construction of a new facility or performance of R&D work). Temporary wiring methods shall apply sound engineering practices to ensure adequate electrical safety of temporary wiring installations. Temporary wiring shall conform to the requirements in Section 3.5 of this document, Article 305 of the NEC, and the respective subparts of 29 CFR 1910 and 29 CFR 1926.

UNGROUNDED: A condition having no physical connection or continuity with earth ground, A condition of insulation or isolation. (See grounded.)

UTILITY POWER: Utility, transmission, and distribution of electrical power systems typically above 600 V ac (i.e., substations, vaults, transformers, and switch gear) prior to the final point of transformation and distribution. These electrical systems and equipment then furnish electrical power to buildings and facilities through an electric service entrance. Qualified Plant Engineering personnel (or their designees) are the only individuals authorized to work on these high-voltage systems.

WORK SUPERVISOR: The person responsible for supervising and directing the work and ensuring the health and safety of workers. Specific responsibilities include:

- Understanding potential hazards of the work.
- Ensuring that an employee is qualified by knowledge, training, and experience; that he/she has successfully demonstrated the ability to safely complete the work; and that the employee is authorized to perform the work.

- Having a complete understanding and the ability to reach agreement with the qualified person about the work to be performed, the sequence in which it should be done, and the potential and present hazards involved--having outlined those hazards and/or limitations of tasks to the extent considered necessary to ensure the worker's health and safety.

3

Bangladesh Woven Garment Industry

3.1 Bangladesh

The official name of Bangladesh is People's Republic of Bangladesh; it is a delta in South Asia, Bangladesh shares large borders with India and a small southern strip with Myanmar. Bangladesh is home to the Ganges, the Brahmaputra and the Meghna rivers, and networks of smaller rivers and canals.

A growing economy with a GNI per capita income of US $480, Bangladesh's GDP growth rate from 1990 to 2006 was 3.0. Bangladesh has made significant strides forward in recent years and improved its human development indicators in spite of overpopulation, frequent natural disasters and widespread poverty. It is now placed at 140 in the UNDP 2007 Human Development Index. Much of the economy is rural and agricultural based. Major exports include jute, woven garments, knitwear, seafood and leather. 41% of the population lives on less than $1 a day, 84% of the population lives on less than $2 a day. Disparities in income opportunities between urban and rural areas are widening. However, the situation of urban poor is no better than rural poor; in some cases it is worse. Population 155 million and land area -147,570 sq km, capital city is - Dhaka

The GNI per capita (US$) 480, health expenditure (% of gov expenditure) 7, education expenditure (% of gov expenditure) 17, defense and security expenditure (% of gov expenditure) 10, phones per 100 people 13.6, internet use per 100 population 0.2, % working children (between ages 5-14 yrs.) 7, official development assistance (% of GNI) 2, debt service (% of exports, goods and services) 5,

Modern History

The area which is now Bangladesh has a rich historical and cultural past, the product of there pleated influx of varied peoples, bringing with them the Dravidian, Indo-Aryan, and Mongol-Mughul, Arab, Persian, Turkic, and European cultures. About 1200 A.D., Muslim invaders under Sufi influence, supplanted Hindu and Buddhist dynasties, and converted most of the population of the eastern areas of Bengal to Islam. Since then, Islam has played a crucial role in the region's history and politics. In the16th century, Bengal was absorbed into the Mughul Empire. Portuguese traders and missionaries reached Bengal in the latter part of the 15th century. They were followed by representatives of the Dutch, the French, and the British East India Companies. During the 18th and 19thcenturies, especially after the defeat of the French in 1757, the British gradually extended their commercial contacts and administrative control beyond Calcutta into the remainder of Bengal up to 1947. In June1947, the UK declared it would grant full dominion status to two successor states India and Pakistan. Due to frictions between West Pakistan and East Pakistan army of Pakistan's contingent in the East. By the time Pakistan's forces surrendered on December 16, 1971, India had taken numerous prisoners and gained control of a large area of East Pakistan, which is now Bangladesh.

A map of Bangladesh is attached as **Annex I**

3.2 Garment Industry

Large-scale production of readymade garments (RMG) in organized factories is a relatively new phenomenon in Bangladesh. Until early sixties, the ready-made garment (RMG) industry of Bangladesh started in the late 1970s and became a prominent player in the economy within a short period of time. The Ready-Made Garments Sector Taken as a whole, the textile industry is Bangladesh's number-one export earner, accounting for approximately 80percent of the countries. The garment industry of Bangladesh has been the key export division and a main source of foreign exchange for the last 25 years. At present the country problems and prospect of garments industry in Bangladesh and the supportive policy regime/ current state of affair. Sl Reg. No. Garments Company garment address contact person garments product; 101: 3288: AFTEX LIMITED: Bhai Bhai Plaza(6th Floor), B-29, Khilkhet Bazar, Dhaka-1229Represents the export oriented garment manufacturers and exporters of Bangladesh profile member list and event announcements, the challenges of globalization prospects of the readymade garments (RMG) industry of Bangladesh. The Bangladesh garment industry: Challenges of The 21st century essay the Bangladesh garment industry: challenges of the 21st Century. Category: social issues garments industry in Bangladesh: Like other 3rd world countries Bangladesh is a developing country. Her economic development depends firstly on agriculture.

THE GARMENT INDUSTRY OF BANGLADESH

Introduction: The garment industry has played a pioneering role in the development of industrial Shafiqul Islam, a 20-year-old garment worker in Savar, Bangladesh, was about to finish his shift at 1 a.m. He handed a stack of sweaters to his manager and was National Wage Board proposes a tiered and phased approach to wage rises the national wage board could not come to a consensus on wage rises during a 7 hour long History. The history of the ready-made garments sector in Bangladesh is a fairly recent one. Nonetheless it is a rich and varied tale. The recent struggle Asia-Pacific Trade and Investment Review Vol.3, No. 1, June 2007 3 ABSTRACT the ready-made garment (RMG) industry of Bangladesh started in the late overview. We are launching the London chapter of DP with the theme of workers and their life in the garments industry of Bangladesh. Many British companies, including problems of garments industry in Bangladesh, The ready made garments industry of Bangladesh has expanded dramatically over the last three decades. – The history of INTRODUCTION the shift from a rural/agro based economy to an urban/industrial economy is an essential part of the process of economic development. Although first draft rises of readymade garments industry in Bangladesh: entrepreneurial ingenuity or public policy by Mohammed Ali Rashid professor of economics Islam Garments Ltd. A group of industries House # 21 Baridhara, Road # 10, Dhaka-1212, Bangladesh Phone #880-2-8816179, 8827770, 608280 The garment industries in Mexico and Bangladesh face an uncertain future, according to a recent report published in Textile Outlook International. Although Bangladesh is not developed in industry, it has been enriched in garment industries in the recent past years. In the field of industrialization Bangladesh search engine, Bangladesh business directory Mills Industries News Media Beauty Parlour and all sorts of under garments for

Journal of International Women's Stus Vol. 11 #1 November 2009 289The ready-made garments industry in Bangladesh: A means to reducing gender-based social However, the association never mentions or attest that they represent the woven garments portion of the total garments industry in Bangladesh, since they serve both woven Garments Company list of Bangladesh. Knit, Woven, Sweater, Apparel Home | Overview of Garment Industry | List of Garment Product |List of Garment Company | In late May and through June this year, there has been a wave of fierce class struggle in the Bangladesh garment industry. To illustrate the scale of events: around10 Ghulam Kamal, Pratima Paul-Majumder, Khalilur Rahman, Economically Active Children in the Garment Industry in Bangladesh, (Dhaka: Associates for Community and Bangladesh and exports have accelerated significantly overtime. The country currently produces about $5 million annual export of garments. Change in production in Joynal Abdin the Federation of Bangladesh Chambers of Commerce and Industry (FBCCI) January 1, 2008 Abstract: Bangladeshi Garment Industry is the largest industrial the garment industry in Bangladesh became the main export sector and a major source of Foreign exchange starting in 1980, and exported about $5 billion USD in 2002.Overview of Bangladesh garment industry, Garments Company Information of Bangladesh. Mainly Knit, Woven, Sweater, Apparel, Fashion Products. Sl Reg. No. Garments Company Garment Address Key Personnel Garments Product; 91: 1797: ADSALE GARMENTS LTD.S-21/A, Noorjahan Road, Mohammadpur, and Dhaka, Bangladesh.

Development at a Glance

The growth feature of export in RMG sectors of Bangladesh during last 30 years from 1984-85 to 2012-2013 financial year are as follows:

Export Trend of RMG US$ Millions

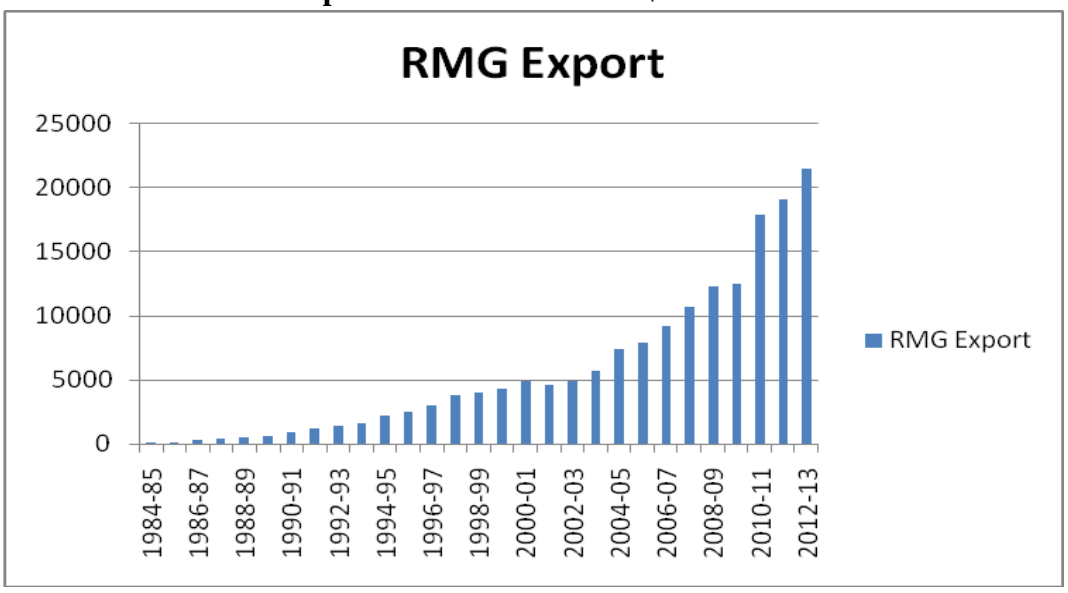

Fig-3.1, Growth feature of export in RMG sectors of Bangladesh

Comparative growth feature of export RMG verses total export of Bangladesh during last 30 years from 1984-85 to 2012-2013 financial year are shown below:

Export RMG VS Total Export US$ Millions.

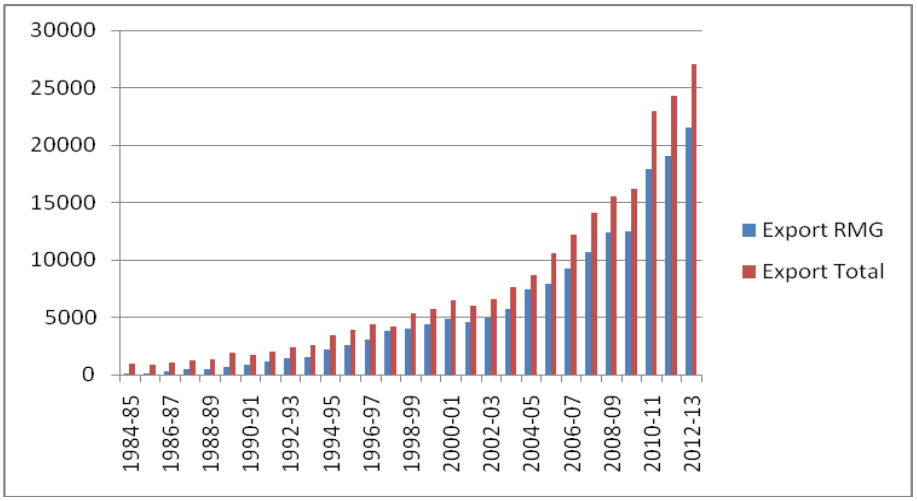

Fig-3.2 Comparative growth feature of export RMG verses total export of Bangladesh

Development of garment factories in Bangladesh during last 30 years from 1984-85 to 2012-2013 financial year are shown below:

Total Number of Garment Factory

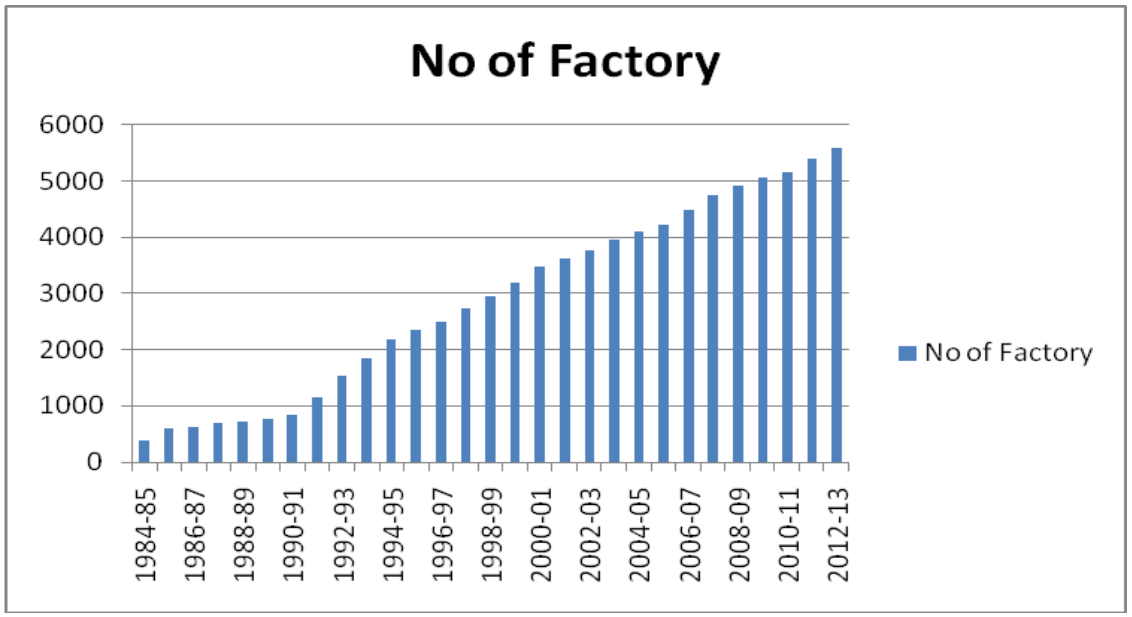

Fig-3.3 Development of Garment Factory in Bangladesh.

Development employment opportunities in Bangladesh through garment industries during last 30 years from 1984-85 to 2012-2013 financial year are shown below:

Total Number of Employees at Garment Factory

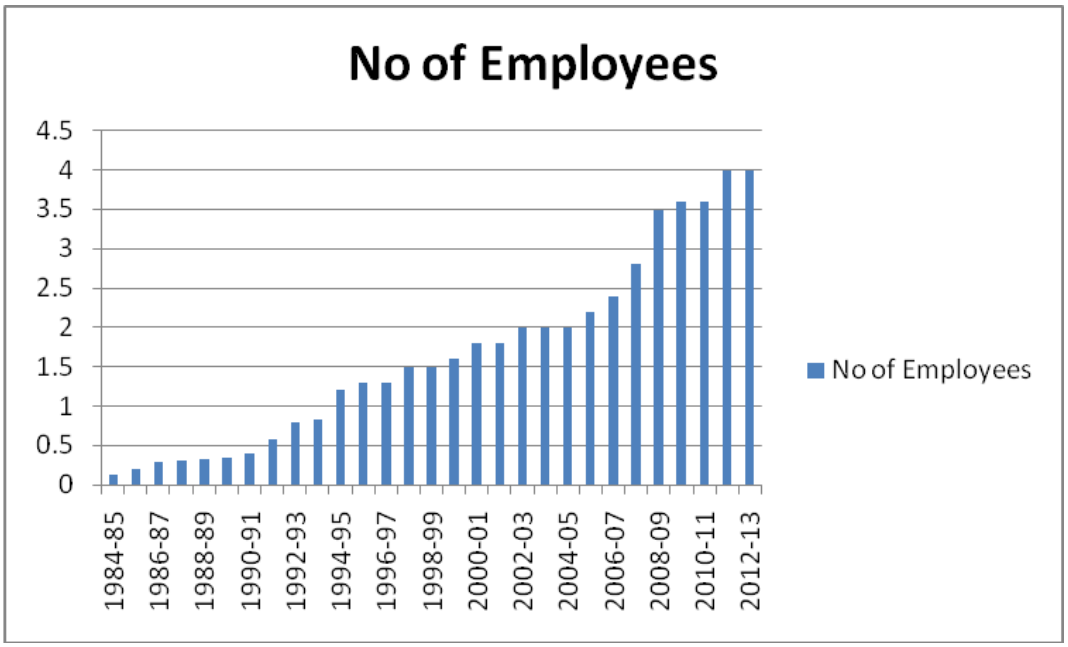

Fig-3.4 Development of Employment Opportunities in Bangladesh.

3.3 Woven Garments Industry

Within the 5600, ready made garment industries, there are mainly two of types, one is woven garment industries and another is knitwear Garment Industries. Annual exports amount to about US$ 14.5 billion from woven garment industries and the rest US$ 11.5 billion from the knitwear garments. So far as the numbers of workers are concerned, about 80% workers are employed in woven garment industries and the rest 20% at knitwear garments. Majority of those are woman.

All garment industries are dependent on the safe and quality power supply for smooth operation of the industries and desired production of goods and services. The electric power supply has associated risks which may cause, due to weak design or faults - fatalities and fire. The consequent fire may cause havocs causing serious damage to goods, machinery, and even the structures of the buildings causing even more injuries and deaths to the workers and or occupants of the industries.

The safety, security of about 3 million worker's life of the woven garment industries are, therefore, dependent on the power supply system of the industries. In Bangladesh the number

of minor and major accidents leading to deaths and injuries in the garment industries are quite frequent. This is unacceptable both from local and industrial standards. Recent accidents in Tazreen (24-11-2012) and Rana Plaza (24-04-2013) caused national and international concerns. The international import agencies as well as the foreign governments are now imposing pressure on Bangladesh Government to improve safety standards in garment industries.

The principal reasons for accidents and fire are: faulty or weak design of power systems (without following safety codes and standards as required by law and regulations), design incorporated safety and protection systems, lack of routine and proper maintenance of the systems, weak emergency response and disaster management plans etc.

It is essential and very important to minimize the risks of accidents and fatalities within internationally acceptable limits to save the lives of millions of workers and also to overcome foreign embargo for smooth growth of the industry and for the socio-economic betterment of the nation through realizing the electric power safety. For this, comprehensive and in depth study and analyses of the safety and quality of power supply system is essential. Such study is not possible within the time, scope and resource of this special study course.

The study, however, made an attempt to find out the key elements of the power safety study by developing a data sheet and get practical exposures through field inspections and visits of only woven sector of the Bangladesh Garment Industries.

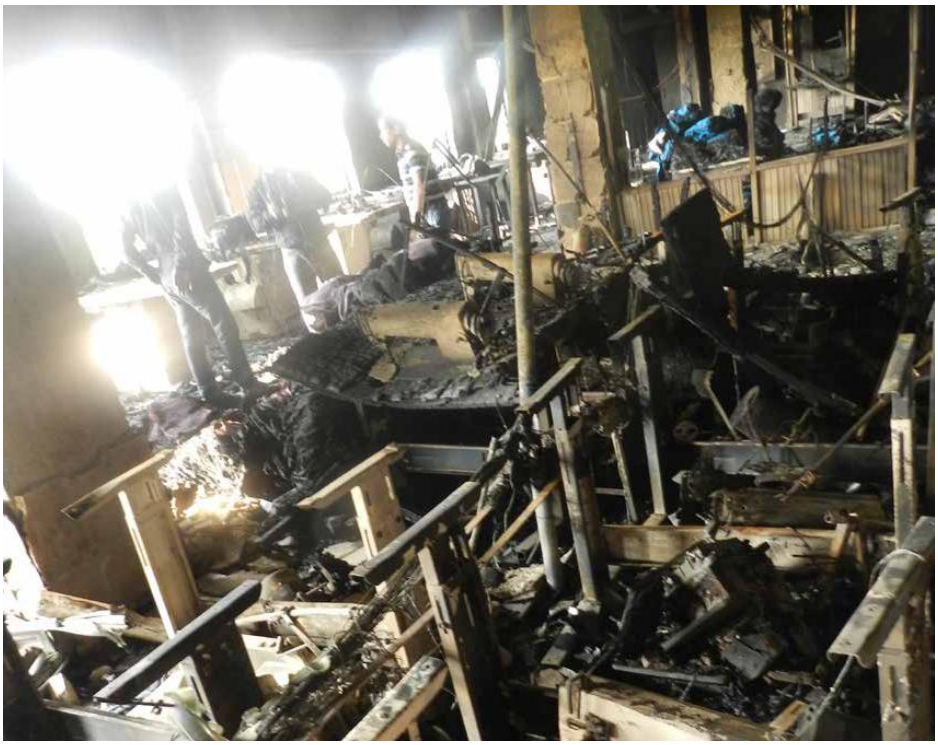

Fig 3.5 Inside Tazreen Fashions, the Day After the Factory Fire

Fig 3.6 Rana Plaza building collapse, April 24, 2013.

3.4 Safety and Protection

Safety and protection is most important continue preventive processes which start at the beginning and continue up to end of any work and project.

3.4.1 National Requirements

Every Nation have recognize some particular rules and regulation to save there people and assets from various type of accident and disaster. To face such problem and batter effort of the people Bangladesh have such rules and regulation that is known as Bangladesh National Building Code. To power system safety purpose it is require to study Bangladesh National Building Code 2011 “Electrical and Electronic Engineering Services for Buildings” Some key concept of this are given below;

Aim of this section of Codes of Electrical and Electronic Engineering Installations in Buildings

The aim of the codes for Electrical and Electronic Engineering Services for Buildings presented in this section is to ensure that the related installation work becomes perfect safe for the persons residing in and around the building. The term safe means safe for the persons and safe for the properties.

The codes in this section have been presented to set minimum standards for Electrical and Electronic Engineering Installation sin Residential Buildings, Multistoried Apartment Buildings, Commercial Buildings, Office Buildings, Rail Stations, Airport Buildings, Factory Buildings, Ware houses, Jetties, Container Yards, Other Yards, Parking lots and similar

places. All the system sand equipment intended for the supply of normal power and stand by power to all these places are covered by these codes. Electrical and Electronic Engineering Installations include Lighting and Illumination, Fans Cooling/Heating system, Normal and Standby power supply system, Supply system for the Lifts, Telecommunications Systems, Data Communication Systems, Fire Alarm System, CCTV monitoring System, Cable Television Distribution System, Electronic Access Control System, Burglar Alarm System.

Electrical wiring/cabling form a major part in the above mentioned installation works. Electrical wiring/cabling must be reasonably safe to persons and property. Installations, alteration, or extension of Electrical wiring/cabling systems conforming to the provisions of this codes hall be deemed to be reasonably safe to persons and property.

Guiding Sources of the Codes of Electrical and Electronic Engineering Installations Significant Modification, Up gradation and Additions of the Previous Electrical Engineering Section of BNBC of 2011 have been incorporated in this updated version.

While making changes and additions, the following documents/regulations/codes have been taken as reference/guiding sources:

a) Bangladesh Electricity Act.
b) IEE wiring Regulation (17thedition) BS: 76712008 including all parts.
c) British Standards (BS).

In addition to these, the following documents/ regulations/ codes have also been taken as references as required:

a) National Building code of India –2005.
b) Building code of Pakistan–latest version.
c) National Electrical Code of USA with necessary modifications for Bangladesh.
d) International Electro-technical Commission (IEC) standards for International Standards for all electrical, electronic and related technologies as applicable to Bangladesh.
e) ISO50001 standard for Energy management System.
f) International Electro-technical Commission(IEC) specifies the standards related to energy production and distribution, electronics, magnetics and electro-magnetics, electro-acoustics, multimedia and telecommunication, as well as associated general disciplines such as terminology and symbols, electro-magnetic compatibility, measurement and performance, dependability, design and development, safety and the environment.
g) Verb and Deutscher Elektro techniker (Association of German Electrical Engineers) (VDE). However, efforts have been be given to accept a significant part of rules and practices mentioned in IEE wiring Regulation (17th edition) BS:76712008 including all parts with necessary modifications for our system and suitable for our country.

While preparing this document the following standards and practices are kept in mind.

a) For having safe domestic electrical systems, domestic electrical installations shall be designed and installed according to the "fundamental principles" given in British

Standard BS7671 Chapter13. These are similar to the fundamental principles defined in international standard IEC60364-1. It is necessary to apply British Standard BS7671 (the "Wiring Regulations"), including carrying out adequate inspection and testing to this standard of the completed works.

i. To meet the above mentioned requirements the following rules and guidance shall be followed.
ii. The rules of the IEE wiring regulations (BS7671), colloquially referred to as "the regs" (BS7671:2008, 17th Edition).;
iii. The rules of an equivalent standard approved by a member of the European Economic Area (e.g., DIN/VDE0100);

b) Guidance given in installation manuals that are consistent with BS7671, such as the IEE On-Site Guide and IEE Guidance Notes Nos 1 to7.

c) Installations in commercial and industrial premises must satisfy there quarrymen's set in Electricity at Work Regulations 1989(UK) and must follow recognized standards and practices, such as BS7671" Wiring Regulations".

A part from these, some modifications had to be made considering the weather and other local conditions, practices and previous experiences in this country.

Designing an Electrical and Electronic Engineering Installations in Buildings and related structures

The codes presented in this section are not meant to provide adequate information to design Electrical and Electronic Engineering Installations and Systems in Buildings and related structures. These should not be taken to be adequate or complete for the efficient design work of installations.

Such design work, the required features, detailed technical specifications, schedule of items etc., should be obtained through the services of an engineer adequately qualified in this area. Energy efficient appliances should be considered during electrical designing.

3.4.2 International Requirements

European Union et al (2013), stated that the following are the internal requirements we regard to garment industries;

"1. Last year's accidents in the garment and textile industry in Bangladesh, in particular the Rana Plaza collapse tragedy one year ago, are a probing reconfirmation of the necessity to raise social and environmental awareness and performance in international trade. Also the ongoing fuelling of conflicts through sourcing of minerals from conflict-affected area's and the persistent signals of human rights violations in the supply chain of coal show that there is still a long way to go. There is therefore an urgent need to promote responsible business conduct all over the world, and in particular in the garment and textile industry as well as in the extractive sector. Joint international action by governments, companies and civil society is necessary to deal with matters such as responsible supply chain management, human rights, child labour and environment. Moreover, since international production, trade and investments are increasingly organized within so-called global value chains, finding an answer to issues related to globalization is necessary. France and The Netherlands are dedicated to foster a more balanced globalization-policy in the European Union by: raising awareness of the OECD Guidelines for Multinational Enterprises by companies that operate abroad, promoting sustainable trade, ecological transition, and advocating for sustainable development in emerging and developing countries. We are convinced that this will strengthen the competitiveness of European companies in the long run. In the run-up to the European elections, France and the Netherlands want to highlight that European trade policy, and policy in favor of the internationalization of business should embody social and environmental progress and values.

2. France and the Netherlands fully support measures proposed in order to enhance responsible business conduct in the textile-garment supply chain which could also apply in other sectors:

-Rana Plaza, Tazreen and other dramatic industrial accidents show notably the complexity of identifying responsibility within the supply chain. The OECD Guidelines help companies forward by setting out the principles and standards for responsible business conduct.

-France and the Netherlands encourage other countries to sign up to the OECD Guidelines, especially those hosting extractive, textile and agricultural activities and involved in international trade.

-France and the Netherlands welcome the recent report of the French National Contact Point on the implementation of the OECD Guidelines in the textile and clothing sector. This report sets up key recommendations to help companies in the textile sector. Risk assessment, Risk management, Strengthening Auditing, Mapping the supply chain, Remediate, Responsibility sharing, Transparency, Stakeholder consultation and Respect for fundamental social rights, highlighted by the NCP, constitute the pillars for Responsible Business Conduct, in conformity with the OECD Guidelines.

-France and the Netherlands invite companies to use this guide as a reference and call upon companies to take the next step forward to implement the recommendations. Sharing of experiences and working together towards solving supply chain issues is essential. The Dutch textile sector Plan of Action, drafted in consultation with Dutch civil society, could

serve as a reference for private sector initiatives on organizing companies, stakeholders and government. The Dutch textile sector included in their Plan of Action a risk analysis of the supply chain and identifies priority issues like purchasing practices, due diligence, child labour, freedom of association, building safety and recycling.

-Because companies have a key contribution to sustainable development, our two countries address these recommendations primarily to companies. However, they are also relevant for local Governments in order to improve business climate, governance and enjoyment of social rights. France and the Netherlands call for international cooperation across borders to increase the effect of the agreed activities and leverage in producing countries.

-France and the Netherlands fully support the OECD proactive agenda to promote the OECD Guidelines as sector level: textile, extractive, financial and agricultural sectors. In this context, France and the Netherlands would like the OECD and OECD National Contact Points to use this Report as reference for a specific guidance on the implementation of the OECD Guidelines in the textile-garment sector.

3. France and the Netherlands call for continuous efforts to improve labour conditions in Bangladesh

-France and the Netherlands support the EU-Government of Bangladesh-ILO-USA Sustainability Compact and the ILO's actions and Better Work initiative in Bangladesh to enhance social and labour conditions in Bangladesh. These include ongoing efforts concerning labour inspectorate, safety training programs, reintegration of Rana Plaza victims, support for trade unions and implementation of the new labour law.

-Our countries call for the role of the ILO to coordinate and align the different inspection programs for fire and building safety in the garment sector -the Accord, the Alliance, Better Work and the Government of Bangladesh National Action Plan -and to uphold a harmonized inspection standard.

-France and the Netherlands congratulate the signatories of the ACCORD of May 13th 2013 to improve fire and building safety and security in the garment factories in Bangladesh for their initiative of historical importance. Never before sourcing companies have united on this scale to take their responsibility in the supply chain in one country. Our countries consider the Accord an effective tool to improve security at work. They urge all European textile companies active in or trading with Bangladesh to sign up to this ACCORD.

-The 24th of April will mark the commemoration of one year after Rana Plaza. France and the Netherlands invite the European Commission to report on the Sustainability Compact's progress at the Foreign Affairs Council on May 8th 2014.

-France and the Netherlands call for continued efforts of the international community, multinational companies, Bangladesh factories management, civil society, ILO, EU and the Bangladesh Government to improve labour conditions in the textile and garment industry in Bangladesh.

4. Call for Responsible business conduct in the coal supply chain: need for international cooperation and business commitment

-The real risks of human rights violations in the supply chain of coal, poor labour conditions as well as environmental degradation at the mining sites all over the world is well reported. This call for adequate due diligence measures to identify and mitigate these risks within the supply chain, and also to remediate for potential negative impacts. France and the Netherlands remind the need for the sourcing energy companies to use their influence within their supply chain accordingly in order to follow up on OECD recommendations. The recently established Better coal initiative joined by most of the

European energy utilities could contribute to it.

-Our two countries consider the Better coal Initiative as a useful tool towards a more responsible supply chain in the coal industry. The corporate joined efforts and increased leverage towards the mining companies could help raising the level playing field in the European market for energy.

-France and the Netherlands encourage the OECD to give attention to the supply chain of coal within the OECD proactive agenda project concerning stakeholder engagement in the extractive sector.

5. Social and environmental standards in trade agreements: a common ambition to hold standards up high

High social and environmental standards are key elements of the competitiveness of our European industries. The link between trade, the protection of the environment and social matters, is not adequately addressed nowadays within international trade. Therefore France and The Netherlands would like to give ample attention to high social and environmental standards in bilateral and regional trade agreements to strengthen these standards within the European free trade agreements (FTAs). The two countries will put forward some proposals designed to reinforce social and environmental standards within these trade agreements:

-They encourage to enhance the cooperation with international organizations, such as the ILO, the OECD or UNEP, in order for these bodies, to participate more actively in the elaboration and the monitoring activities of social and environmental standards within FTAs.

-Furthermore, our two countries consider that civil society should assume a prominent role when it comes to the monitoring of social and environmental standards. Members of the civil society should continue to be able to submit concerns, at all times, so as to draw government's attention on existing rule violations by third parties.

-France and the Netherlands consider that greater attention should be paid to social and environmental standards in free trade agreements, so as to attach an equivalent importance to these provisions to economic provisions of the agreements. They will examine proposals to increase the level of commitments in the "trade and sustainable development chapters" of the EU

-Our two countries believe that it is in their common interest to better address what is at stake from a social and environmental point of view when it comes to the negotiation of trade agreements. Amongst others, the possible impact of trade agreements on third countries should be carefully assessed. They therefore encourage to the EU Commission to further improve and make a better use of the existing sustainable impact assessments.

-France and the Netherlands believe that states have a great role to play as regards the promotion of responsible global supply chains. They therefore promote corporate social responsibility initiatives and work towards and inclusion of Corporate Social Responsibility aspects within European trade agreements.

France and the Netherlands appeal to the European Commission to hold these standards up high, in line with ILO conventions on core labor rights and multilateral environment agreement and encourage negotiators to keep a high level of ambition for the ongoing negotiations, and especially the Transatlantic Trade and Investment Partnership (TTIP).

6. France and the Netherlands want to strengthen social and environmental standards in official development aid. Our two countries invite the World Bank to raise the level of its social and environmental standards in the reform of its public procurement rules and to reinforce the supervision of procurement execution.

7. France and the Netherlands support the initiative taken in ISO to develop a new international standard on responsible procurement.

8. France and the Netherlands welcome the solution found by the Council and the European Parliament in the trilogue on the Non-Financial Reporting Directive. They fully support the mandatory requirement on certain large listed companies and financial institutions to publicly disclose information on their policies with respect to human rights, environmental, social and employee matters, anti-corruption and bribery matters and represents an important step in the transition to a sustainable global economy by enhancing the transparency of non-financial information of European companies. They regret that the text does not include in its scope large unlisted companies, as the activities of these companies may also have a substantial impact in the social and environmental field or in the field of human rights, but welcome the possibility of revisiting these issues when the directive will be reviewed. They wish that this directive will be adopted by the European Parliament before the end of its term.

9. France and the Netherlands are fully supportive and will play on active role at the OECD informal ministerial meeting on June 26th that will take place back to back with the second Global Forum for Responsible Business Conduct. They wish that Ministers adopt an ambitious declaration of the 46 countries adhering to the OECD Guidelines along the lines just presented and beyond.”

4

Power Safety

4.1 Importance of Electricity

Electrical Power is most essential for our daily life. Especially for industrial production system it is heart of the industry. Electricity demand is increasing day by day. To fulfill that demand Ministry of Power, Energy and Mineral Resources, Government of the Peoples Republic of the Bangladesh declared as follows:-

"Bangladesh, with its 152 million people in a land mass of 147,570 sq km, has shown tremendous growth in recent years. A booming economic growth, rapid urbanization and increased industrialization and development have increased the country's demand for electricity. Presently, 62% of the total population (including renewable energy) has access to electricity and per capita generation is 321 kWh, which is very low compared to other developing countries.

Recognizing the fact the present government has prioritized the power sector right from its election manifesto. As per the manifesto, electricity generation in the country was supposed to be 5000 MW by the year 2011 and 7000 MW by 2013. The government has been successful in meeting these targets and has even been able to achieve higher level of precedents. The government aims to generate in additional 15,000 MW electricity, within 2016 under short, medium and long term plan. This target is much higher than the one stated in the election manifesto.

Assessing the current state of electricity in Bangladesh, this web page disseminates on how to develop and communicate various strategies and plans and implement moderate growth in demand through increased efficiency. It also investigates on how to combine environmental goals into planning and operation and tries to find ways on how to ensure sufficient supply wherever and whenever it is required, as well as on how to handle various other challenges in the power sector.

The government has further extended its vision targeting the upcoming years up to 2030 and prepared the Power System Master Plan 2010 (PSMP). This plan states that in 2030 the demand of power would be around 34,000 MW while the generation capacity would be about 39,000 MW.

Presently, the generation capacity is nearly 9,713 MW (September, 2013) which implies that much endeavor is required to achieve the goal. Considering the country's future energy security, the government has rightly given due importance on renewable energy, energy efficiency as well as energy conservation."

4.2 Accidents Due to Electric Power

Due to use of electrical power systems without proper protective devises, less quality fittings, lacking of proper control devices, low quality appliances, equipments, machineries are most common cause of accident. That may cause of death, burn by fatal electrical shock, electric fire, arc and cause of injury. On the other hand violation of safety rules and regulations at electrical installation or wiring works' as well as deviation of proper safety training, and operational training also the causes of those types of accidents. On the point of view to find out present status of electric power supply system of the industries, weakness, probable risk and the necessary management and regulatory action required to improve the overall safety standards to save undesired fatality of the workers and damage of industries a data sheet/questioner are developed for the study.

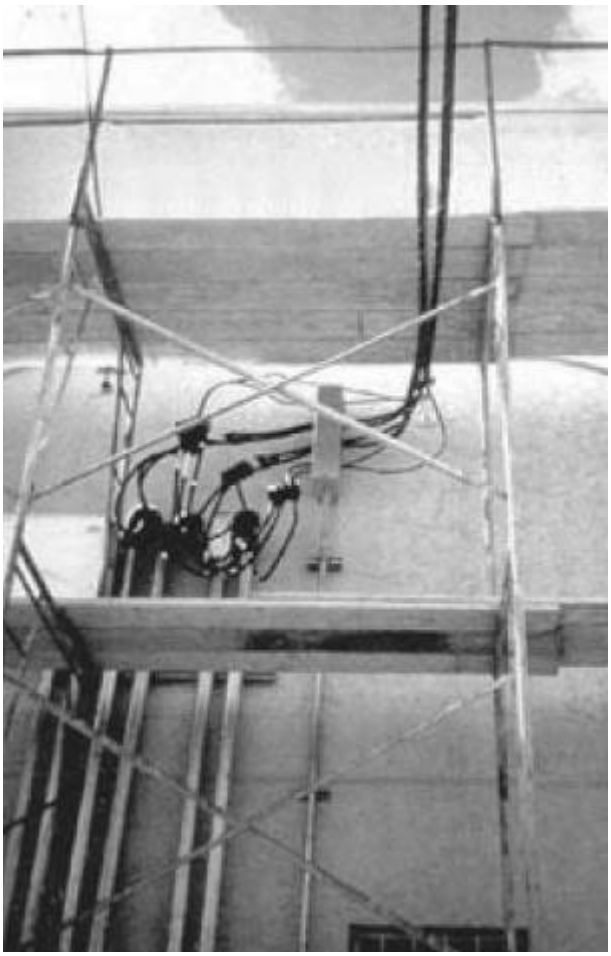

Fig 4.1 There is a Hazard of Shock or Electrocution: Scaffold and Platform are Less Than 10 Feet Away from the Power Lines.

Overall brief study of electrical safety may be seen at **Annex-III.**

5

Data Sheet Development

Electricity is nature's most versatile form of energy. Electrical power lights our homes, streets, offices and factories. The power of electricity can be dangerous if it is not used correctly. Electrical energy can damage property and ignite fires. It can also hurt and even kill. Electricity is an integral part of today's modern world, and sometimes it is easy to forget just how dangerous it can be. Given the correct circumstances, it can kill. But it can also shock you painfully, damage sensitive equipment, and ignite combustible materials (Electrical Safety Foundation, OSHA 2013).

Deaths Electrocutions rank *fourth* (9%) in causes of industrial fatalities (behind traffic, at violence and construction). The National Safety council estimates 600 people die every year of electrical causes. Most of these accidents involve low voltage (600 volts or less). Roughly 3,600 disabling electrical contact injuries occur every year in the United States, along with another 4,000 non-disabling injuries. Greater understanding of safety concepts and the process of safety leads to better communications. Sound safety practices can help minimize electrical hazards and cut down the risk of accidents (EHS Safety Training 2013). The hazard of electricity cannot be eliminated, but it can be controlled through education and engineering. The more you understand about electrical energy, the safer you will be at work and home (Potter et al 2007).

With those reason data sheet was develop to ascertained information or knowledge and ideas on power safety e.g. .Power supply and protection, Level of intensity illumination, Regulatory Requirement, other Safety Related Issued, Workers Awareness, Emergency Response Plan, Accident compensation and liability .Effort were also carried out to assess the Past, Present and future trend of development of Industrial Power Safety.

According to the objective of study electric power safety: Bangladesh Woven Garments Industries Perspective proposed data sheet/questioner cover following area of sample of woven garments industries.

1. General Information provide name of the industry, location/address, contact, number of employees, building specification, date of operation, area, number of floor, working space, number of shift, and annual gross sale.

2. Power Supply System includes source of power, sectioned load, supply voltage, type of service drop, connection, connected load, peak demand, demand factor, earthing type, type of substation, HT & LT switch gear, pf correction, transformer, it's protection, alternative power supply, emergency power, and captive generation.

3. Power Supply and Protection includes type of wiring, earth lead wire, and power supply protection.

4. Intensity of Illumination includes luminance of different area of the industry.

5. Regulatory Requirement provides condition of clearance for industry from licensing board, other regulatory board, and update drawing/design.

6. Others Safety Related Issues include lightening protection, central control, emergency stop button, quick exit symbol and identified path, fire safety, earthquakes.

7. Emergency Response Plan shows existence, training, and condition of drills.

8. Worker Awareness includes workers training on operational health and safety, interview for feedback.

9. Accident Compensation and Liability shows the policy of insurance, accident liability fund etc.

10. Overview and General Remarks provide require comment of industry.

Complete Data Sheet developed for the study and had been used during the industrial visits is attached as **Annex II** of the study report.

6

Visits of Industries and Related Organizations

6.1. Visits of Industries and Statuary Bodies

One of the most essential parts of this study is data collection from different woven garment industries. To get a valid and reliable outcome from this study it is essential to collect primary data, but the data collection from the existing garment factories is one of the most difficult aspects of this research, because the garment factories are reluctant to allow visit by external visitors, especially to the outsiders wanting to investigate the safety related with power system, fire and other safety performance. According to the types of building there are three categories first per-designed, second converted, and third rental. On the other hand as per policy of business or relation with buyer there are two types of industries, (i) direct contract with foreign buyers, and (ii) sub-contract.

Data sheet mentioned in the preceding chapter (**Annex-II**) were used for data and power related information collection during the industrial visits.

Questionnaires were used to obtain the data from the random selection respondent. Both open-ended and close-ended Questionnaires were used to ascertain data, open-ended questionnaires call for a free response in the respondents own words.

Although the visit of a particular industry were informed about the impending visit a day before given that there are a large number of factories within the jurisdiction of each visit, it was assumed that it would not be possible to leak the information ahead of time to all the industries, or even if it leaked, all the industries will not take actions given lack of precision about the visit. The industries were also informed that the result or findings were for academic purpose only and the information given would remain confidential.

BGMEA is the statutory association of the of garments manufacturing and exporters industries and agencies. They work for the betterment of their industries, business, and employees. So researcher interested to take data about their activities for improvement of safety of the garments industries to improve safety and emergency and reduce damage and fatalities and injuries. Visit of BGMEA as such was essential to get general information and trend of development on the power safety as per require of the industries of Bangladesh. Accordingly BGMEA was visited on 23 July 2014.

Directorate of Fire Service & Civil Defense Bangladesh (DFSCDB) is a government organization for civil defense and fire service. They work on safety and prevention for civilians, industries, business, residents, institutes and organizations from any type of

accident and natural disaster. So researcher interested to take data about their activities for improvement of safety issues of the garments industries. Especially electrical power system related causes of accidents, to improve safety and emergency and reduce and recovery of damage and injuries. Visit of DFSCDB as such was essential to get general information and trend of development on the power safety as per require of the industries of Bangladesh. Accordingly DFSCDB was visited on 7 September 2014.

6.2 Outcome of the Visits

6.2.1 Aliza Fashion Ltd (Aliza Trouser, Aliza Blazer I and Aliza Blazer II).

6.2.1.1 General Information

Aliza Fashion Ltd (Aliza Trouser, Aliza Blazer I & II), is predesigned industry at chaydana National University, Gazipur. It has sub-section, i.e. Aliza trouser and Aliza blazer I & II respectively. In trousers side, the industry has 400 male and 1000 numbers of female as production staff and 80 male and 20 female as office staff.

It has building specification:

- Building is found pre-designed.
- Total Area of industry=26000 sft.
- Number of floor=7.
- Space=18000 sft.
- Number of working shift=1.
- Annual Gross sale= $ 480000 Tk. 385500000/=

* In Aliza blazer I & II Are found same building, and other specifications, but numbers of workers for each of those two units are 500 male and 900 number of female as production Staff and 85 male, 15 female as office staff for each unit.

6.2.1.2 Power System

In close-end questionnaire use to obtained data, which shows that REB were used for power supply, with sanctioned load of 350 KW and supply voltage of 33 KV.

Finding view industrial services drop connection was underground using 3 cores, belted type armored cable size of 95mm^2, with connection load of 350kw/unit (out of 2500 KVA central) as peak demand and for 'Earth' found system grounding for the efficiency at the operation system. But the rising point of 33 KV underground cables' is found uncovered.

Main substation 33/11 KV, 2.5 MVA outdoor type, and other is indoor type 11/0.4 KV, 2.5 MVA, CT, PT, HT panel board and safe grounding were also available in switch gear. Transformers 2500 KVA rated were found used with adequate protection but isolator in low-tension (0.4 KV) side were not, over current protection, short circuit protection, LT bus, LT

breaker and LT panel board were function as it is. Emergency power shows that IPS with capacity of 10KVA solar supply were use, captive generation of diesel type of generator which as a rate of 500KVA, 400 Volt rated voltage located at outdoor for each and every unit of industries but manual control with adequate generator protection. There are capacitor bank connected with output of supply line, but due to shortage of cable some installed units of capacitor bank are not connected with generators' output.

6.2.1.3 Power Supply and Protection

In such section three types of wiring system for power supply are namely concealed circuit, surface circuit and tranking system. Adequate power supply protection device are available in the industry but Electricity Licensing and Control Board (ELCB) comment is not available for worker safety.

6.2.1.4 Intensity of Illumination

Intensity of illumination in the industry is found less then standard of Bangladesh National Building Code (BNBC).

6.2.1.5 Regulatory Requirement

The industry may able to fulfill necessary regulatory requirement, but require supporting paper, update drawing and design are not available.

6.2.1.6 Other Safety Issues

Other safety related issues were found poor, as earthquake instruction chart, earthquake drill, central control room and emergency stop button are not available.

6.2.1.7 Emergency Response Plan

Emergency response plan may they have but necessary documents are not much enough available.

6.2.1.8 Worker Awareness

Worker awareness is found good, they have active safety program which executed through a safety committee. But necessary document are not available.

6.2.1.9 Accident Compensation and Liability

There they have factory insurance but no document about worker life insurance. There they have no accident liability fund. But authority said they pay as per requirement. For death case BGMEA pay TK. 1,00,000/= per head.

6.2.1.10 Overview and General Remarks

The industry does not have available maintenance_schedule, safety chart, precaution notice and first aids instruction chart.
Detailed description of the findings are taken from, visit 1- Data collection format number 01, visit 2- Data collection format number 02, and visit 3-Data collection format number 03.

6.2.4 Pusan Bangladesh Ltd

6.2.4.1 General Information

Pusan Bangladesh Ltd was located at 98, chaydana, Gazipur. It was designed and constructed in 1998, and begin operation in 2001. With the following specification:

- Building is found Rental.
- Total area of the industry: 2000 sft
- Number of floor: 7
- Space: 14000 sft
- Annual Gross sale: $ 900000 TK. 6500000/=

The industry has Number of production staff, 40 male and 235 female, while office staff are 35 male and 8 female.

6.2.4.2 Power System

In close-end questionnaire use to obtained data, which shows that REB, were used as power supply source which has sanctioned load of 100 KW with supply voltage of 0.4 KV. Underground service drop were used with 100 KW connected load, 3 qua-duplex cable size, 105 KW peak demand.

There are only one LT breaker is found of LT protection, but the problem of isolator, over current protection, short circuit protection LT Bus, and LT panel board are all not available in low tension. The location of main LT breaker is in a congested and narrow space.
Emergency power shows that IPS with capacity of 5KVA were use, captive Generation of Diesel type of generator which as a rate of 150KVA, 400 Volt Rated voltage located at indoor (ground floor). Operation and control are manual with poor Generator protection. There are no capacitor bank connected with output of supply line, and generator.

6.2.4.3 Power Supply and Protection

In such section three types of wiring system for power supply are namely concealed circuit, surface circuit and Duct wiring system with earth continuity conductor, but as it is a rental building height of each floor about 3 m and used duct just wire laying on the floor and covered by channel of steel sheet. Adequate power supply protection device are available in the industry but ELCB were comment is not available for worker safety.

6.2.4.4 Intensity of Illumination

Intensity of illumination in the industry is found less then standard of BNBC.

6.2.4.5 Regulatory Requirement

The industry may not able to fulfill necessary regulatory requirement, on the other hand they have no supporting paper on regulatory requirement. Update drawing and design are not available.

6.2.4.6 Other Safety Issues

Other safety related issues were found too poor, as earthquake instruction chart, earthquake drill, central control room and emergency stop button are not available.

6.2.4.7 Emergency Response Plan

Emergency response plan may they have but necessary documents are not available.

6.2.4.8 Worker Awareness

Worker awareness is found satisfactory, may they have active safety program which executed through a safety committee. But necessary document are not available.

6.2.4.9 Accident Compensation and Liability

There they have factory insurance but no document about worker life insurance. There they have no accident liability fund. But authority said they pay as per requirement. For death case BGMEA pay TK. 1,00,000/= per head.

6.2.4.10 Overview and General Remarks

There they have no available maintenance schedule, safety chart, precaution notice, first aids instruction chart. As it is a large industry, but there are on electrical engineer and on safety officer, as well as number of electrician are not enough as there area of works.
Detail description of the findings are taken from, visit 4- Data collection format number 04.

6.2.5 S. S. Seiatrid Ltd

6.2.5.1 General Information

S.S. Seiatrid Ltd, was located at Bat thata Road, Board Bazar, Gazipur. The industry has 15 male and 145 number of female as production Staff and 10 male, 5 female as office staff. With converted type of building which it was constructed in 2012 and begins to operated in 2014.

The building has following specification:

- Industry Building is found rental.
- Total Area of industry = 6000 sft.
- Number of floor = 1.
- Space = 12000 sft.
- Number of working shift = 2.
- Annual Gross sale = $ 16,50,000 Tk 1230,00,000/-

6.2.5.2 Power System

In close-end questionnaire use to obtained data, which shows that REB, were used as power supply source which has sanctioned load of 100 KW with supply voltage of 0.4 KV. Underground service drop were used with 100 KW connected load, 3 qua-duplex cable size, 105 KW peak demand.

There are only one LT breaker is found of LT protection, but the problem of isolator, over current protection, short circuit protection LT Bus, and LT panel board are all not available for low tension line. The location of main LT breaker is in a narrow space.
No emergency power available. There is captive generation of diesel type of generator which as a rate of 100KVA, 400 Volt rated voltage located at indoor (ground floor). Operation and control are manual with poor Generator protection. There are no capacitor bank connected with output of supply line, and generator.

6.2.5.3 Power Supply and Protection

In such section two types of wiring system for power supply are namely concealed circuit, and tanking wiring system with earth continuity conductor, but as it is a rental building height of each floor about 3 m and used tanking are not maintained safe height and use just channel of steel sheet. Adequate power supply protection device are available in the industry but ELCB were comment is not available for worker safety.

6.2.5.4 Intensity of Illumination

Intensity of Illumination in the industry is found too less then standard of BNBC.

6.2.5.5 Finding Related to Regulatory Requirement

The industry may not able to fulfill necessary regulatory requirement, on the other hand they have no supporting paper on regulatory requirement. Update drawing and design are not available.

6.2.5.6 Other Safety Issues

Other safety related issues were found very poor, fire extinguishers, fire and smoke detector fire alarm, fire drill, earthquake instruction chart, earthquake drill, central control room and emergency stop button are not available.

6.2.5.7 Emergency Response Plan

Emergency response plan may they have but necessary documents are not available.

6.2.5.8 Worker Awareness

Worker awareness is not satisfactory, May they have no active safety program and safety committee. Such type document are not available.

6.2.5.9 Accident Compensation and Liability

There they have no any insurance. There they have no accident liability fund. But authority said they pay as per requirement. For death case BGMEA pay TK. 1,00,000/= per head.

6.2.5.10 Overview and General Remarks

There they have no available maintenance_schedule, safety chart, precaution notice, first aids instruction chart, fire extinguishers, fire and smoke detector fire alarm, fire drill, earthquake instruction chart, earthquake drill, central control room and emergency stop button. It is a sub-contract industry, and there are on electrical engineer and no safety officer, as well as number of electrician are not enough as there area of works.
Detail description of the findings are taken from, visit 5- Data collection format number 05.

6.2.6 Omega Fashion Ltd

6.2.6.1 General Information

Omega Fashion Ltd, was located at Din Muhammad Market Board Bazar, Gazipur. The industry has 46 male and 360 number of female as production Staff and 36 male, 5 female as office staff. With rent type of building which it was constructed in 2004 and begins to operated in 2005.

The building has following specification:

- Building of the industry is rental.
- Total area of industry = 12000 sft.
- Number of floor = 3 out of 6.
- Space = 12000 sft.
- Number of working shift = 1.
- Annual gross sale = $ 36,00,000 Tk. 288000,000/=

6.2.6.2 Power System.

In close-end questionnaire use to obtained data, which shows that REB, were used as power supply source which has sanctioned load of 200 KW with supply voltage of 0.4 KV. Underground service drop were used with 150 KW connected load, 3 qua-duplex cable size, 150 KW peak demand.

There are only one LT breaker is found of LT protection, but the problem of isolator, over current protection, short circuit protection LT Bus, and LT panel board are all not available in low tension. The location of main LT breaker is in a congested and narrow space.
No emergency power available, captive generation of diesel type of generator which as a rate of 175KVA, 400 Volt Rated voltage located at indoor (ground floor). Operation and control are manual with poor generator protection. There are no capacitor bank connected with output of supply line, and generator.

6.2.6.3 Power Supply and Protection

In such section three types of wiring system for power supply are namely concealed circuit, surface circuit and Duct wiring system with earth continuity conductor, but as it is a rental building height of each floor about 3 m and used duct just wire laying in an wooden box. Adequate power supply protection device are available in the industry but ELCB were comment is not available for worker safety.

6.2.6.4 Intensity of Illumination

Intensity of illumination in the industry is found too lower then the standard of BNBC.

6.2.6.5 Regulatory Requirement

The industry may be able to fulfill necessary regulatory requirement, on the other hand they have no supporting paper on regulatory requirement. Update drawing and design are not available.

6.2.6.6 Other Safety Issues

Other safety related issues were found too poor, as earthquake instruction chart, earthquake drill, central control room and emergency stop button are not available.

6.2.6.7 Emergency Response Plan

Emergency response plan may not they have, and seems necessary documents are not available.

6.2.6.8 Worker Awareness

Worker awareness is found poor, May they have no active safety program which executed through a safety committee. And necessary document are not available.

6.2.6.9 Accident Compensation and Liability

There they have no document about worker life insurance. There they have no accident liability fund. But authority said they pay as per requirement. For death case BGMEA pay TK. 1,00,000/= per head.

6.2.6.10 Overview and General Remarks

There they have no available maintenance_schedule, safety chart, precaution notice, first aids instruction chart. As it is a large industry, but there are on electrical engineer and on safety officer, as well as number of electrician are not enough as there area of works.

Detailed description of the findings are taken from, visit 6- Data collection format number 06.

6.2.7 Powertex Fashions Ltd

6.2.7.1 General Information

Powertex fashions Ltd, located at Mansur plaza Board Bazar, Gazipur. The industry has 250 male and 900 number of female as production Staff and 50 male, 20 female as office staff. With rent type of building which it was constructed in 2003 and begins to operated in February 2004.

The building has following specification:

- Industry building is found as rental.
- Total area of industry = 14000 sft.
- Number of floor = 4 out of 6.
- Space = 14000 sft.
- Number of working shift = 1.
- Annual gross sale = $ 28,80,000 Tk. 2304,00,000/=

6.2.7.2 Power System

In close-end questionnaire use to obtained data, which shows that REB, were used as power supply source which has sanctioned load of 250 KW with supply voltage of 0.4 KV. Underground service drop were used with 250 KW connected load, 3 qua-duplex cable size, 250 KW peak demand.

There are only one LT breaker is found of LT protection, but the problem of isolator, over current protection, short circuit protection LT Bus, and LT panel board are all not available in low tension. The location of main LT breaker is in a congested and narrow space.
No emergency power available, captive generation of diesel type of generator which as a rate of 375KVA, 400 Volt Rated voltage located at outside of the building. Operation and control are manual with poor Generator protection. There are no capacitor bank connected with output of supply line, and generator.

6.2.7.3 Power Supply and Protection

In such section three types of wiring system for power supply are namely concealed circuit, and tranking wiring system with earth continuity conductor, but as it is a rental building height of each floor about 3 m and used tranking tray as channel of steel sheet. Adequate power supply protection device are available in the industry but ELCB were comment is not available for worker safety.

6.2.7.4 Intensity of Illumination

Intensity of illumination in the industry is found too lower then the standard of BNBC.

6.2.7.5 Regulatory Requirement

The industry may be able to fulfill necessary regulatory requirement, on the other hand they have no supporting paper on regulatory requirement. Update drawing and design are not available.

6.2.7.6 Other Safety Issues

Other safety related issues were found poor, as earthquake instruction chart, earthquake drill, central control room and emergency stop button are not available.

6.2.7.7 Emergency Response Plan

Emergency response plan may they have, but seems necessary documents are not available.

6.2.7.8 Worker Awareness

Worker awareness is found poor, May they have namely active safety program which executed through a safety committee, But necessary document are not available.

6.2.7.9 Accident Compensation and Liability

There they have no document about worker life insurance. There they have no accident liability fund. But authority said they pay as per requirement. For death case BGMEA pay TK. 1,00,000/= per head.

6.2.7.10 Overview and General Remarks

There they have no available maintenance_schedule, safety chart, precaution notice, first aids instruction chart. As it is a large industry, but there is one electrical supervisor and on safety officer, as well as number of electrician are not enough as there area of works.

Detailed description of the findings are taken from, visit 7- Data collection format number 07.

6.2.8 BGMEA

Bangladesh Garments Manufacturers and Exporters Association (BGMEA) is the height Association of the providers of garments manufacturing and exporters. They work for the

betterment of their industries, business, and employees. So researcher interested to take data about their activities for improvement of safety of the garments industries to improve safety and emergency and reduce damage and fatalities and injuries. On that issue finding are as follows:-

Location of Bangladesh Garments Manufacturing and Exporter Association (BGMEA) is BGMEA complex. 23/1 Panthapath Link Road Karwan Bazer, Dhaka-1215.

There found that they have a fire safety section and engineering section. There is no separate electrical engineering section. So they are just carrying fire and other accidents report. Because of shortage of technical/engineering staff they have no action plane about electrical safety. According to the statement of engineer in charge found that there is no electrical safety advice for garments industries from BGMEA. They just say to maintain Bangladesh building code, but no follow-up on that issue. Due to the shortage of staff they are unable to observe the existing safety condition of various garments industries around the country.

But they inform that there are three organization named ACCORD (AJ Hights, Level-12 Badda, Dhaka), ALLIANCE (BTI Celebration point 6th floor plot no 385, road no 113/A Gulshan-2 Dhaka), and IOL through BUET works on various safety issue of garments industries.

ACCORD – is carrying out survey and studies in 850 Industries;
ALLIANCE – is carrying out survey and studies in 609 Industries; and
ILO – is carrying out survey and studies in 266 Industries..

The study groups not yet submit any report on that issue; they are now collecting data from garments industries.

6.2.9 Directorate of Fire Service & Civil Defense Bangladesh

Directorate of Fire Service & Civil Defense Bangladesh (DFSCDB) is a government organization for civil defense and fire service. They work on safety and prevention for civilians, industries, business, residents, institutes and organizations from any type of accident and natural disaster. So researcher interested to take data about their activities for improvement of safety issues of the garments industries. Especially electrical power system related accidents and fire. Their works to improve safety, emergency and reduce damage and fatalities and injuries. On those issues finding are as follows-

Location of Fire Service & Civil Defense Bangladesh headquarter is 38-46 Kazi Alauddin Road, Dhaka - 1000.

There found that they have lots information about fire and other accident as well as safety related data. There is no separate electrical engineering section. So they carefully provide services in order to fire fighting and other civil defense due to any types of accident, earthquake, flood, cyclone, tornado etc. They recorded all data as they found. But due to of shortage of electrical engineering staff they have no separate action plane about electrical safety. They just have little bit look after for giving permit to various industries, buildings and other infrastructure under the fire safety roles. But maintaining Bangladesh building code for any building construction, it is mater of metropolitan or municipal authorities, and electrical power safety depends upon power supply authorities and Electrical licensing board. But they have follow-up on those issues, as well as they conducted various categories of safety training program, fire drill etc. Shortage of manpower and firefighting equipment and traffic jam those are height problem of this organization. On the other hand the population of different cities of the country increase 50 time during previous 20 years and number of industries increase about 100 time within this period, but comparatively number of fire station average two time only. However, that's but it is found that Fire Service & Civil Defense Bangladesh is height industrious organization of Bangladesh. The Directorate provides last five years' information about fire including cause. The information are shown in Table – 6.1 presented below:-

Table -6.1
Statistics of Last Five Years' Fire in Bangladesh and Causes

SL NO	**Cause of fire**	**Number of Accident and Years**				
		2009	2010	2011	2012	2013
1	Electrical fault	4520	5188	5693	5123	5469
2	Fire of burner, stove, Oven etc	2787	3361	3854	3589	3744
3	Burning piece of Cigarette	1401	2231	2245	2215	2660
4	Unknown	1073	910	794	597	894
5	Use of open lamps	643	757	774	658	596
6	Hot Ash/fuel	512	511	653	719	696
7	Child play with fire	255	311	426	374	489
8	Friction of machineries parts	231	325	251	305	306
	Total	11422	13594	14690	13580	14854

There are 253 number of fire occur at different garments industries from 01-01-2013 to 31-12-13, death 8, injured 9, amount of loss TK 190,26,61,384/=.
The Directorate also informed about the involvements of three organization named ACCORD (AJ Hights, Level-12 Badda, Dhaka), ALLIANCE (BTI Celebration point 6th floor plot no 385, road no 113/A Gulshan-2 Dhaka), and ILO through BUET works on various safety issue of garments industries.

ACCORD – is carrying out survey and studies in 850 Industries;
ALLIANCE – is carrying out survey and studies in 609 Industries; and
ILO – is carrying out survey and studies in 266 Industries..

The study groups not yet submit any report on that issue; they are now collecting data from garments industries.

7

Findings and Analysis

This chapter deals with summary of all findings and analysis which obtained from the industrial visit with the objective to accomplished this study.

7.1 Findings Related to Close Ended Questionnaire

The industries have many KVA supply power rates, depending on size and type of the garment industries. Most lager industries have the following rating sanctioned load of 2.5MVA and supply voltage of 33KV.The rating KVA of medium and small industries has the following rating sanctioned load ranging from 250 kW, to 150 kW supply voltage of 11KV or 400V.

Findings show +++ industries services drop connection was underground using 3 cores, wire type with cable size of 95mmHT, and Earth type systems grounding for the efficiency at the operation system.

Substations are indoor type, CT, PT, HT panel Board and safe grounding were also available in switch gear of most industries. Transformer 5MVA (33/11kV), 500kVA, 250KVA (11/.4kV) Rated were used with adequate protection but isolator in low-tension were not in some garment industries, over current protection, short circuit protection, LT Bus, LT Breaker and LT Panel Board were function as it is. Emergency power shows that IPs with capacity of 10KVA solar supply were use in large industries, captive Generation of Diesel type of generator which as a rate of 500KVA, 375kVA, 175kVA, 150kVA, and 100kVA, 400 Rated voltage located at outdoor are widely use in all industries but with manual control with adequate generator protection.

7.2 Findings Related to Other Safety Issues

Findings in other safety related issues show - that *lighting protection, quick exit symbol and identified path, fire alarm bell, smoke detector, emergency path/stairs, fire extinguisher and fire drill* were all effectively function for the enhancement of the industries. The response shows that lack of earthquake safety, plan/instruction chart for earthquake emergency, frequency of earthquake drills were also factors that affect the electrical safety of the garment industry. Workers awareness concerning training on how to use fire equipments and producers on how to operate them was also giving to the workers with accident compensation scheme (insurance) were provided.

7.3 Finding Related to Open-ended Questionnaires

Finding shows that, some garment industries lacks of substation and transformer protection. Captive generation was Diesel type 150KVA, rated voltage of 400 which are located inside of the building ground floor of industries with manual/auto control system.

In regulatory requirements concerning license or electric licensing board, clearances of other regulatory board were not given answers from some industries but others have. Update of available of original electrical system design and drawings were not available to some industries. Emergency path/stairs are not enough for the operation of the industries with manual fire alarm bell control. Fire detector and smoke detector and drills were not provided in some industries, with no emergency response plan documents.

Finding shows that, there is not ongoing preventive health program to educate employees in safety levels of noise, exposures and effects of noise on their health and use personnel protection, as shown in some data collection format sheets.

7.4 Analysis of Close-ended Questionnaires

Findings of the information received during the visits of the selected woven garment industries based on close-ended questionnaires are presented in Table -7.1 below:-

Table - 7.1

Percentile Analysis of Close-ended Questionnaires

.

SL NO	Statement	Rating		Acceptable Results	Remarks
		Yes	No		
1	Building pre-designed	3	4	43%	According to the findings results of close ended questionnaires it seams that average acceptance of standard about 19% only.
2	Available documents of Regulatory Requirement	0	7	0%	
3	Electrical Drawing	3	4	43%	
4	P.F correction	3	4	43%	
5	Emergency power	3	4	43%	
6	Central control room	0	7	0%	
7	Emergency safety button	0	7	0%	
8	Safety plan and drill for Earthquake	0	7	0%	
9	Accident compensation and liability fund	0	7	0%	

7.5 Analysis of Open-ended Questionnaires

Findings of the information received during the visits of the selected woven garment industries based on open-ended questionnaires are presented in Table -7.2 below:-

Table - 7.2

Percentile Analysis of Open-ended Questionnaires.

SL NO	**Statement**	**Rating**			**Standard Results**	**Remarks**
		Standard	**Below standard**	**Too Low**		
1	Building floor height	3	0	4	43%	According to the findings results of open ended questionnaires it seams that average acceptance of standard about 11% only.
2	Service drop	3	0	4	43%	
3	LT Protection	0	3	4	0%	
4	Generator location	3	1	3	43%	
5	Power supply safety and protection	0	3	4	0%	
6	Intensity of illumination	0	3	4	0%	
7	Others safety issues	0	3	4	0%	
8	Emergency response plan	0	3	4	0%	
9	Worker awareness worker	0	0	7	0%	
10	Worker awareness Management	0	3	4	0%	
11	Number of electrical engineer	X	X	3	0%	
12	Number of electrician	X	3	4	0%	

7.6 BGMEA

Through visiting BGMEA found that they have a fire safety section and just a nominal engineering section. There is no separate electrical engineering section. So they are just collect fire and other accidents report. Because of shortage of technical/engineering staff they have no action plane about electrical safety. According to the statement of engineer in charge found that there is no electrical safety advice for garments industries from BGMEA. They just say to maintain Bangladesh building code, but no follow-up on that issue. Due to the shortage of technical/engineering staff they are unable to observe the existing safety condition of various garments industries around the country.

7.7 DFSCDB

During the visit of Directorate of Fire Service and Civil Defense of Bangladesh (DFSCDB) it was found that the directorate has lots information about fire and other accidents as well as safety related data. There is no separate electrical engineering section. So they carefully provide services in order to fire fighting and other civil defense due to any types of accident, earthquake, flood, cyclone, tornado etc. They recorded all data as they found. But due to of shortage of electrical engineering staff they have no separate action plane about electrical safety. They just have little bit look after for giving permit to various industries, buildings and other infrastructure under the fire safety roles.

But maintaining Bangladesh building code for any building construction, it is mater of metropolitan or municipal authorities, and electrical power safety depends upon power supply authorities and Electrical licensing board. But they have follow-up on those issues, as well as they conducted various categories of safety training program, fire drill etc. Shortage of manpower and firefighting equipment and traffic jam those are height problem of this organization.

On the other hand the population of different cities of the country increase 50 time during previous 20 years and number of industries increase about 100 time within this period, but comparatively number of fire station average two time only. However, that's but it is found that Fire Service & Civil Defense Bangladesh is height industrious organization of Bangladesh.

Summarily it is found that from 2009 to 2013 (last five years) 38.15% cause of fire (25993 out 68140) around the country due to electrical fault.

7.8 Summary of the Findings

There are about five thousand and five hundred garment industries. Only seven representative woven garment industries were visited as most are reluctant to allow visits, particularly in providing power safety related data and information. Industries were approached for the visits and data collection with a request letter (Annex – IV) issued by the project supervisor. Data were collected based on the data sheet (Annex- II) developed for the study.

The industries receive power supply through the request and approval from the power supply authorities/companies like Bangladesh Power Development Board (BPDB), Rural Electricity Board (REB), Dhaka Electric Supply Co. (DESCO) etc.

Since power supply is not uninterrupted, some of the industries have also captive generations.

The summary of the findings received from the visits described in the preceding subsections are presented in Table – 7.3 below:-

Table - 7.3

Percentile Findings on Various Power Safety Related Questions of the Data Sheet.

Sl. No	Power Safety Related Questions	Findings
i.	Building floor height	~57% less than standard
ii.	Service droop	~57% not satisfactory
iii.	Connected Load condition	~57% more than demand
iv.	Earthing	~57% low quality
v.	LT Circuit breaker	~75% below standard
vi.	Earth leakage circuit breaker	100% nil
vii.	Generator location	43% below standard
viii.	Regulatory requirements	~100% unsatisfactory
ix.	Electrical drawing	~57% not available
x.	P.F. correction	~57% not available
xi.	Power supply safety	~57% below standard
xii.	Emergency power	~57% not available
xiii.	Central control room	~100% nil
xiv.	Emergency safety button	~100% nil
xv.	Intensity of illumination	~57% below standard
xvi.	Safety plan and earthquake drill	~100% unsatisfactory
xvii.	Accident compensation and Liability fund	~100% nil
xviii.	Emergency response plan	~100% unsatisfactory
xix.	Worker awareness	~100% unsatisfactory
xx.	Number of electrical engineer	~85% not available
xxi.	Number of electrician	~70% short
xxii.	Insulation condition of wire	~50% unsatisfactory
xxiii.	Earth wire condition	~70% unsatisfactory
xxiv.	Rate of periodical maintenance	~100% nil
xxv.	Rate of periodical regulatory inspection	100% nil
xxvi.	Level of knowledge about electrical safety	~85% very poor
xxvii.	Day care center	100% nil

8

Recommendations

8.1. Weaknesses and Flaws

The study revealed a number of causes and weaknesses that initiate electric power related accidents, fires, injuries and deaths. The summary of the weaknesses are shown in section 7.8 of the preceding chapter. Besides, applicable codes and standards are not properly followed in the power system design and installations. Routine checks and maintenances are also not pursued or practiced in majority of the garment industries. Safety and fire training of the workers and routine pursuance of the emergency drills are also absent in majority of the industries, particularly those industries which work on subcontract basis or operate in rental buildings. The concerned authorities and agencies must have to give due attention to these weaknesses and flaws and rectify these so that rate of injuries and deaths are within acceptable limits.

8.2. Recommendations to Appropriate Authorities

On the basis of the findings of the study, kind attentions of the Power Supply Authorities (BPDB, REB, DESCO, Power Supply Cos,), Bangladesh Garment Manufacturers and Exporters' Association (BGMEA) and Government Authorities are drawn on the on the power safety related issues with the hope that due and appropriate actions will be taken to improve the power related safety of the four million, mostly women, garment workers who are contributing about 75% of the hard earned foreign currency for the economic and social upliftment of Bangladesh so that in future injuries and deaths are reduced to within internationally acceptable limits. The recommendations to the concerned bodies, agencies and authorities are submitted in the following subsections-

8.2.1. Power Supply Authorities:

i) Ensure that the approved power load matches with power demand of the industry concerned;

ii) Ensure supply and installations of appropriate power safety and protection devices including isolators, circuit breakers, earth leakage circuit breakers, power factor correction devices, appropriate metering as per applicable codes and standards at the supply end of all industries;

iii) Complete all consumers' wirings of the primary side as per specifications under direct supervision of the authorities concerned;
.

iv) Conduct routine inspections of consumer's primary wirings and test sensitivity of protection systems and devices of the power supply; and

v) Appoint appropriate number of inspectors to ensure the aforesaid tasks effectively.

8.2.2. BGMEA:

i) Ensure garment industries' shifting from rental buildings or located in city, towns, in lanes or by- lanes to predesigned buildings located at appropriate sites or at least to discourage new garment industries to function at such places;

ii) Ensure that the power system design and maintenance have been done and are carried out as per applicable national and international codes and standards;

iii) Ensure that the industries provide appropriate training and create awareness of the workers on safety issues and emergency response plans and also maintain routine drills;

iv) Ensure that the industries maintain the records of the original power system designs and the subsequent changes and also of the routine maintenance and overhauling;

v) Ensure that the industries comply the safety related applicable state and international laws, conventions and protocols;

vi) Ensure the availability of adequate number of qualified engineers and technicians in BGMEA as well as in the garment industries to do the aforesaid jobs effectively and efficiently;

vii) Collaborate with the government, engineering/technical universities and ILO/WHO to make batter plan of action and strategies and implement those for improved safety and management of the industries;

viii) Ensure establishment of appropriate first aid and day care center for all garments industries;

ix) Give due considerations on the findings of the more comprehensive studies now being carried out by Alliance, Accord and ILO, mentioned in section 6.2.9 of the report;

x) Lighting intensity of the garment industries do comply with the Bangladesh Building Code recommendations; and

xi) Create appropriate workers' liability fund so that proper compensations can be provided to the victims of the accidents and disasters.

8.2.3 Government Authorities:

i) Enforce appropriate laws and regulations to ensure imp;

ii) Develop or promote appropriate power safety codes and standards compatible with local realities and international standards;

iii) Ensure that the Electricity Licensing Board and or Energy Regulatory Commission have adequate quality manpower and facilities to enforce the power system design,

implementation and maintenance of the garment industries are carried out as per the laws and applicable codes and standards;

iv) Ensure that the industries create appropriate insurance and liability fund to take care of the workers' due interest and welfare;

v) Establish new fire stations to ensure quick and affective emergency response during accidents, fires and industrial disasters;

vi) Consider on the findings of the more comprehensive studies now being carried out by Alliance, Accord and ILO, mentioned in section 6.2.9 of the report and take appropriate steps necessary to improve safety;

vii) Develop/adopt applicable safety codes and standards to improve the safety of the workers of the garment industries and groom adequate number of engineers and technical persons to enforce these standards and codes in the industries.

9

Conclusions

More than five thousand garment industries, employing about four million workers, mostly women, are operating in Bangladesh. The industries earn about 76% of the total foreign currency which help economic and social upliftement of the country.

The industries as well as the safety and protection of the workers of these industries, as such, demand due attention of the concerned authorities, agencies and regulators so that appropriate measures are taken to ensure the safety and protection of the workers as well as smooth functions of the industries without being affected by fires, damages or disasters.

A large number of the industry operates in rental buildings located in city, town on the by lanes. There are also a considerable number of industries which operate on subcontracts.

The power supply systems of the industries particularly those operating on rental buildings and or operate on subcontract are weak and flawed and do not comply with applicable safety codes and standards. Appropriate protection systems are also missing. Records of electrical system design drawings and subsequent modifications are missing in most industries.

There are weakness in enforcing the codes, standards and regulatory requirements of the power supply systems of the garment industries. Effective measures have to be taken by the concerned authorities, agencies and government to remove such weakness and flaws. Appropriate laws, codes, standards, guides have to developed and enforced. Adequate qualified engineers and technical persons have to be groomed to enforce the standards codes and standards efficiently and effectively.

Most of the industries as such are risk prone. The industries do not have appropriate insurance or liability funds to ensure the compensation in case of occurrence of worker’s injury and deaths due to accidents and disasters in the industries.

The industries also either do not have appropriate emergency response plans or do not conduct emergency drills on routine basis. Appropriate measures have to be taken by the industries, BGMEA and government to address these weaknesses.

The study was not comprehensive due lack of time and resources. It only made efforts to identify the key issues and highlight these issues. Much more comprehensive studies are currently being carrying out by Alliance, Accord and ILO. The BGMEA, concerned authorities and government should consider the findings of these studies and take appropriate actions so the safety and protection of the garment industries are improved to the internationally acceptable standards and the damages, injuries and deaths are limited to acceptable levels.

10
References

- Housing & Building Research institute, Bangladesh standard and testing institute. Bangladesh National Building Code-1993. ISBN 984-30-0086-2.
- Housing & Building Research institute, Bangladesh standard and testing institute. Bangladesh national building code-2012. Part 8.
- Group schneider, Low voltage distribution catalogue 1997/98.
- Short Course on "Electricity- the Most Preferred Form of Energy: Need, Accessibility, Affordability and Sustainability", Islamic University of Technology, Board Bazar, Bangladesh, 20-24 December 2008. Lecture sheet and presentation.
- Charles A Schuler & william L. Mc namce, Industrial electronics & robotics, Copy right 1986 ISBN-0-07-100302-9
- A.K Sawhney & Puneet Sawhney, A Course in Electrical and Electronics Measurement & Instrument, Edition-2002.
- Bangladesh fire service and civil defence, Special Journal March 2012.
- J. Anthony Capon, Elementary Statistics. ISBN 0-534-08784-1.
- J. O. Paddock & R. A. W. Galvin. Electrical Installation Technology and practice Reprinted 1977.
- K. M. Md. Gloam Rabbani. An Ideal Electrical Interview Knowledge 1st Edition 2001.
- Anwani. Basic Electrical Engineering. Eleventh Edition 1984.
- M. L. Ghosh Electrical Trade Theory. The Tata McGarw-Hill Publishing Company 1984.
- S. R. Chakkrabarti. Electrical Wiring Estimating and Costing 4th Revised and Enlarged Edition 1981.
- Muhammed H. Rashid. Power Electronics. Third Edition 2004.
- http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml
- Charles F. Dalziel, *Deleterious Effects of Electric Shock*, International Labour Office Meeting of Experts on Electrical Accidents and Related Matter (October 1961)
- IEEE 450-IEEE, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.
- Consumer Product Safety Commission Document # 16
- Consumer Product Safety Commission Document # 524
- Roswell W. Ard. Home Wiring Inspection July/August, 1985 p. 35-40.
- Federal Pacific Electric (FPE) Electrical Hazards Website
- http://www.inspect-ny.com/appointment.htm.
- http://www.inspect-ny.com/fpe/fpepanel.htm
- http://www.wilsontech.org/executesearch.cfm?search=electricl
- http://www.bgmea.com.bd/beta/uploads/pages/2011_McKinsey_Bangladesh_Case_Study.pdf
- http://www.fbcci-bd.org/fbcci/others/Major%20Economic%20indicators%202010-11.pdf
- http://www.epb.gov.bd/details.php?page=11
- Export Promotion Bureau Bangladesh Ministry of Commerce;
- Liana Foxvog, Judy Gearhart, Samantha Maher, Liz Parker, Ben Vanpeperstraete, Ineke Zeldenrust, Still Waiting, Six months after history's deadliest apparel industry disaster, workers continue to fight for reparations

Annex-I

Map of Bangladesh

Annex II

DATA COLLECTION FORMAT

Electric Power Safety: Bangladesh Woven Garments Industries Perspective.

Date:- … … … …

Sl No:- … … …

1. General Information

1.1 Name of Industry : ……

1.2 Location/Address : ……

……..

…….……..

Website : ……..

Email : ……

Fax : ……

Phone : ……

1.3 Number of Employee *a) Production Staff a) Male ..... b) Female.....

****b) Office Staff a) Male ..... b) Female.....**

1.4 Building a) Pre-designed ☐ b) Converted ☐ c) Rental ☐

i) Period of Designed/Construction : ……

1.5 Date of Operation : ……

1.6 Total Area of the Industry : ……

1.6.1 Number of Floor : ……

1.6.2 Space : ……

1.7 Number of Working Shift : ……

1.8 Annual Gross Sale : $……TK……

2. Power Supply System

2.1 Power Supply

2.1.1 Source of Power : BPDB/REB/DESA/DESCO/Other (.....)

2.1.2 Sanctioned Load : …… KW/KVA

2.1.3 Supply Voltage a) 400 V ☐ b) 11KV ☐ c) 33 KV ☐

*** Production Staff: Persons those are manually involved with production e.g. workers, operators etc.**

**** Office Staff: Persons those are involve with management e.g. manager, supervisor, clerk, messengers, security etc.**

2.2 Service Drop

2.2.1 Connection **a) Overhead ☐ b) Under Ground ☐**

2.2.2 Over Head Protection : ……

2.2.3 Wire/Cable types/Size : ……

2.2.4 Connected Load : ……... KW

a) Lighting Load …….... KW

b) Machinery Load …….... KW

c) Others Load …….... KW

Total …….... KW

2.2.5 Peak Demand : ……... KW

2.2.6 Demand Factor : $\frac{\text{Peak Demand}}{\text{Connected Load}}$ ……...

2.2.7 Earthing Type : .....

2.3 Substation

2.3.1 Types/Location **a) Outdoor ☐ b) Indoor ☐**

2.3.2 High Tension

2.3.2.1 HT Switch Gear

i) Isolator .....

ii) Circuit Breaker .....

iii) CT & PT ***a)*** **Yes ☐** ***b)*** **No ☐**

iv) HT Panel Board ***a)*** **Yes ☐** ***b)*** **No ☐**

v) Safe Grounding ***a)*** **Yes ☐** ***b)*** **No ☐**

2.3.2.2 P.F. Correction (Capacitor Bank/Synchronous Converter)

a) Yes ☐ b) No ☐

If Yes i) Capacity .....

ii) Comments .....

2.3.2.3 Transformer

i) Rated KVA .....

ii) Rated Voltage KV .....

iii) Control a) Auto ☐ b) Manual ☐

iv) Transformer Protection: .....

2.3.3 Low-Tension

i) Isolator a) Yes ☐ b) No ☐
ii) Over Current Protection a) Yes ☐ b) No ☐
iii) Short Circuit Protection a) Yes ☐ b) No ☐
iv) LT Bus a) Yes ☐ b) No ☐
v) LT Breaker a) Yes ☐ b) No ☐
vi) LT Panel Board a) Yes ☐ b) No ☐
Comments.....

2.3.4 Alternative Power Supply

2.3.4.1 Emergency Power

i) UPS a) Yes ☐ b) No ☐ **Capacity…… KVA**
ii) IPS a) Yes ☐ b) No ☐ **Capacity…… KVA**
iii) Breakup Generator a) Yes ☐ b) No ☐ **Capacity…….. KVA**
Type (Fuel) .....

2.3.4.2 Captive Generation

a) Yes ☐ b) No ☐

i) Type of Generator (Fuel) .....
ii) Rated KVA .....
iii) Rated Voltage .....
iv) Location .....
v) Control a) Auto ☐ b) Manual ☐
vi) Generator Protection : .....

3. Power Supply and Protection

3.1 Power Supply (Wiring)

3.1.1 Types of Wiring a) Concealed Conduit ☐ b) Surface Conduit ☐
c) Tranking ☐ d) Duct ☐
3.1.2 Earth Lead Wire a) Yes ☐ b) No ☐ **Comments.....**
3.1.3 Earth Continuity Conductor a) Yes ☐ b) No ☐ **Comments.....**

3.2. Power Supply (Protection)

3.2.1 MCB **Comments.....**
3.2.2 MDB **Comments.....**
3.2.3 SDB **Comments.....**
3.2.4 ELCB **Comments.....**
3.2.5 Switches **Comments.....**
3.2.6 Socket **Comments.....**

4. Intensity of Illumination

Area or Activity	Recommended luminance (lux) *	Existing luminance (lux)	Remarks
Corridors	**90**		
Stairs	**150**		
Receiving, sorting, washing, drying, ironing (calendering) and dispatch	**200**		
Stock parts productions	**450**		
Matching-up	**450**		
Cutting, sewing			
Light	**300**		
Medium	**450**		
Dark	**700**		
Inspection			
Light	**450**		
Medium	**1000**		
Dark	**1500**		
Hand tailoring			
Light	**450**		
Medium	**1000**		
Dark	**1500**		
Pressing	**300**		

***Bangladesh National Building Code 2011, Table 8.1.10**

5. Regulatory Requirement

5.1 Clearance of Electric Licensing Board **a) Yes** ☐ **b) No** ☐

5.2 Clearance of Other Regulatory Board **a) Yes** ☐ **b) No** ☐

5.3 Availability of Electrical System Design & Drawing

a) Yes ☐ **b) No** ☐

5.4 Any Update **a) Yes** ☐ **b) No** ☐

If Yes: Availability of Updated Design & Drawing

a) Yes ☐ **b) No** ☐

6. Others Safety Related Issues

6.1 Lightning Protection **a) Yes** ☐ **b) No** ☐ **i) Comments.....**

6.2 Central Control Room **a) Yes** ☐ **b) No** ☐ **i) Comments.....**

6.3 Emergency Stop Button **a) Yes** ☐ **b) No** ☐ **i) Comments.....**

6.4 Quick Exit Symbol and Identified Path **a) Yes** ☐ **b) No** ☐

i) Comments.....

6.5 Emergency Pass/Stairs **a) Yes ☐** **b) No ☐** **i) Comments.....**

6.6 Fire Safety

i). Fire Alarm Bell **a) Yes ☐** **b) No ☐** **i) Comments.....**

ii) Fire Detector **a) Yes ☐** **b) No ☐** **i) Comments.....**

iii) Smoke Detector **a) Yes ☐** **b) No ☐** **i) Comments.....**

iv) Fire Extinguishers **a) Yes ☐** **b) No ☐** **i) Comments.....**

v) Fire Drill **a) Yes ☐** **b) No ☐** **i) Comments.....**

6.7 Earthquake

6.7.1 Safety Works/Instruction Chart during an Earthquake.

a) Yes ☐ **b) No ☐** **i) Comments.....**

6.7.2 Conduct Earthquake Drills

a) Yes ☐ **b) No ☐** **i) Comments.....**

Period : .....

7. Emergency Response Plan

7.1 Existence **a) Yes ☐** **b) No ☐** **i) Comments.....**

7.2 Training of Workers **a) Yes ☐** **b) No ☐** **i) Comments.....**

7.3 Frequency of Drills Emergency Response Plan.....

8. Worker Awareness

8.1 Staff (Workers)

8.1.1 Workers Training on Operational Health and Safety.

a) Yes ☐ **b) No ☐** **i) Comments.....**

8.1.2 Do you have any participation at fire drill within last six month?

a) Yes ☐ **b) No ☐** **i) Comments.....**

8.1.3 Do you have training on use of fire extinguisher or fire evacuation procedures?

a) Yes ☐ **b) No ☐** **i) Comments.....**

8.2 Staff (Management)

8.2.1 Do you have an active safety and health program in operation that includes general safety and health program elements as well as the management of hazards specific to your work site?

8.2.2 Do you have safety committee or group made of management and labour representatives that meets regularly and report in writing on its activities?

8.2.3 Is there a training program to instruct employees on safety methods of machine operation?

8.2.4 Is there an ongoing preventive health program to educate employees in safety levels of noise, exposures and effects of noise on their health and use of personal protection?

9. Accident Compensation and Liability fund

9.1 Insurance **a) Yes ☐** **b) No ☐** **i) Comments.....**

9.2 Accident Liability Fund **a) Yes ☐** **b) No ☐** **i) Comments.....**

i) Disability Tk..... **ii) Death Tk.....**

10. Overview and General Remarks

Annex III

STUDY OF ELECTRICAL SAFETY

1.1 Introduction

This document contains general requirements for all Laboratory work involving the use of electrical equipment and systems. Appendix A contains terms and definitions and Appendix B, the effects of electrical energy on humans. All managers, designers, users, installers, and others who service or operate electrical equipment--including those used for research and development (R&D)--shall comply with these requirements.

More specific information about electrical work can be found in Document 16.2, "Work and Design Controls for Electrical Equipment," and Document 16.3, "LLNL Authority Having Jurisdiction Requirements for Approving Electrical Equipment, Installation, and Work," in the ***Environment, Safety, and Health (ES&H) Manual***. In addition, Laboratory programs may consult the Electrical Safety Advisory Board (ESAB) for further guidance on electrical work. The ESAB was chartered on February 20, 2012, and is the Laboratory's technical resource for electrical safety issues. The Board comprises a chair and several members from the Hazards Control Department, Electronics Engineering, Scientific Programs, and Plant Engineering who are knowledgeable in electrical safety. The chair is a member of the Safety Programs Division and is appointed by the Hazards Control Department Head. The other members are nominated by the chair and approved by the Hazards Control Department Head.

1.2 Hazards

Electricity is used in many different ways at LLNL. Each application has its own combination of hazards and environmental aspects that includes the potential of electric shock, fire, and burns. Thus, it is essential for all employees, including supplemental labor and subcontractor employees, to be aware of the hazards and environmental aspects associated with electrical work and use appropriate protective methods to minimize the risk of an injury or accident.

Appendix B contains more detailed information about the effects of electrical energy on humans.

1.3 Controls for Electrical Work and Electrical Equipment

1.3.1 General

Only qualified and authorized individuals are permitted to perform electrical work at LLNL. A qualified person is one who has the required skills and knowledge to perform electrical work safely. Such individuals shall be aware of the hazards and environmental aspects associated with electrical work (see Appendix B for details) and the methods for reducing the risk of electrical accidents that can result from unsafe equipment, adverse environmental conditions, and unsafe acts.

Whenever possible, all circuits or equipment shall be de-energized before beginning any work. Work on energized circuits shall only be performed by authorized workers, as described in Document 16.2. In addition, these workers shall use

- Proper design, fabrication, installation, and documentation techniques.
- Proper operational and maintenance procedures.
- Electrical equipment approved by a nationally recognized testing laboratory (NRTL).
- Proper personal protective equipment (PPE).

In support of Lab-wide electrical safety, management shall take a proactive approach when dealing with the root causes of employees' concerns, near-misses, and incidents or accidents involving electrical hazards.

1.3.2 Electrical Equipment Conditions of Approval and Use

All electrical equipment, components, and conductors should be listed, labeled, and approved by an NRTL for their intended purpose. Custom-made and installed equipment can be approved for use, by the Electrical Authority Having Jurisdiction (AHJ), if built according to specific standards (e.g., Underwriters Laboratories [UL] 508 or one of the ANSI C series standards). Appropriate documentation for such equipment shall be maintained on file.

When building, repairing, or modifying electrical systems, NRTL-approved equipment shall be used if available. Non-NRTL-approved equipment (e.g., shop-made extension cords) shall be built in accordance with an approved design, as specified in Document 16.3.

Document 17.1, "Explosives," in the ES&H Manual provides specific guidance for explosives work and for work in explosives areas. Assure an Explosives Safety Engineer has reviewed the process prior to starting work in explosives facilities or areas.

1.3.3 Work on Electrical Components and Systems

Any live electrical parts shall be positively de-energized when working on or near electrical circuits, equipment, or systems. Circuits and equipment shall be considered energized until isolated, locked out and tagged, and verified with an appropriate testing device as described in Document 12.6, "LLNL Lockout/Tag out Program," in the *ES&H Manual*. Where it is possible for the circuits to be energized by another source, or where capacitive and/or inductive devices (including cables) may retain or build up a charge, circuits shall be grounded and shorted. Exceptions to this paragraph may be permitted when the requirements in Document 16.2 are fulfilled.

Additionally, the following precautions shall be observed to improve ES&H in the workplace:

- Follow LLNL-established procedures (see Table 3 of Appendix A in Document 16.2).

- Identify and report to your supervisor potential electrical hazards or unexpected occurrences or incidents (i.e., discharges or arcs when applying grounds to circuits thought to be de-energized), including near misses.
- Anticipate potential electrical problems, hazards, and environmental aspects.
- Do not rush to finish a job; never bypass approved procedures.
- Plan and analyze for ES&H during each step of any electrical work.
- Keep accurate records (e.g. system one-line drawings, panel schedules, etc.) for electrical or electronic systems.
- Have significant ES&H-related work [e.g., work requiring a Safety Plan (SP)] independently verified.
- Use properly rated test equipment and verifies its condition and operation before and after use.
- Know applicable emergency procedures.

1.3.4 Clearances and Illumination for Electrical Enclosures

A clear working space shall be maintained in the front, back, and on each side of all electrical enclosures and around electrical equipment for safe operation and to permit access for maintenance and alteration. Refer to the documents listed in this section as required. (NOTE: The National Electrical Code (NEC) is available from the Technical Information Department (TID) Library and the Plant Engineering Library. You may also contact the Hazards Control Department for additional information about the NEC):

- NEC Article 110-26, "Spaces about electrical equipment, (600 volts or less)."
- NEC Article 110-32, "Work space about equipment (over 600 volts)."
- NEC Article 110-33, "Entrance and access to work space."
- NEC Article 110-34, "Work space and guarding (over 600 volts)."
- Document 16.2.

In addition to the NEC, the IES Lighting Handbook (latest edition) specifies the following requirements for electrical equipment:

- Adequate illumination shall be provided for all working spaces around electrical equipment.
- The control switches for light circuits shall be positioned away from exposed energized circuits and other potential electrical hazards.

1.3.5 Temporary Wiring

Construction Power and Lighting: Temporary wiring for electric power and lighting is permitted during periods of construction, remodeling, maintenance, repair, or demolition of equipment or structures and during emergencies. Temporary wiring does not mean a "reduced" level of safety or quality, as this wiring must still conform to certain criteria for electrical work.

Temporary wiring shall have a temporary wiring tag attached to it with the following information:

- Review/approval and signature of the facility manager, area supervisor, lead experimenter, construction inspector, or Plant Engineering Electrician Shop supervisor and the signature of the appropriate ES&H Team industrial safety representative.
- The reason for the temporary wiring (i.e., emergency, construction, test, and/or research and development).
- Installation date.
- Name, phone number, and pager number (if applicable) of the person installing the temporary wiring tag.

1.3.5.1 In addition, temporary wiring

- Shall be approved or identified as suitable for installation and installed in accordance with the rules prescribed in the current edition of the NEC and 29 CFR 1910 and 1926.
- Shall be protected from accidental damage.
- Shall be removed as soon as the prescribed activity is completed. It shall not be used as a substitute for permanent wiring.
- Shall be color coded in accordance with Plant Engineering or Electronic Engineering standards.
- May be used during an "off-shift working hour" emergency. On the day of installation, a temporary wiring tag shall be completed and attached to the wiring so that it is readily visible. Approvals for the wiring tag shall be obtained on the first regular workday after the emergency.

Switches or other means shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. All lamps used for temporary illumination shall have a suitable fixture or lamp holder with a guard to prevent damage or accidental contact with energized parts.

Experiments: Temporary wiring may be used for experimental and developmental equipment. There is no time limit on how long the wiring can remain in place, except that it shall be removed upon completion of the experiment. Temporary wiring tags are not required

for temporary wiring within experimental systems. However, they are required for the power feeder to the power distribution points of experimental systems. The wiring tag on these systems shall contain the same information as previously described.

1.3.6 Extension Cords/Multiple Outlet Boxes/Flexible Cords and Cables

Extension Cords: Observe the following precautions when using extension cords. Note that extension cords for normal office use do not require a temporary wiring tag.

- Use only three-wire extension cords and cables that conform to the rating, grounding, and non-interchangeability stated in NEC Article 210-7 (Receptacles and Cord Connectors).

- Check extension cords before use to ensure they are adequate for the intended purpose. Plug high-current equipment (e.g., space heaters, hot plates, and coffee pots) directly into a wall receptacle whenever possible.

- Use only one extension cord for lamps, appliances, or other equipment in conjunction with the power supply cord. Laboratory practice prohibits the use of multiple extension cords (daisy chaining) that will increase resistance in an electrical circuit, which in turn will increase heating of conductors, receptacles, and plugs.

- Inspect extension cords for damage before placing them in service and daily during use. Only qualified and authorized persons can repair extension cords; this shall be done in a manner approved by the manufacturer. Replace damaged cords with ones listed by an NRTL. Contact the ES&H Team for guidance, if necessary.

- For receptacles connected to circuits with different voltages, frequencies, or current (ac or dc) on the same premises, use a design such that the attachment plugs on the circuits are not interchangeable (see Section 3.7 for details). All extension cords shall be listed or labeled by an NRTL.

Only high-visibility orange or yellow extension cords shall be used outdoors and with portable or integral ground-fault circuit interrupters (GFCIs).

Multiple Outlet Boxes: Observe the following precautions when using multiple outlet boxes:

- Each multiple outlet box shall be plugged into a wall receptacle. Use of one outlet box to provide power to one or more outlet boxes is not permitted.

- Outlet boxes shall not be used to provide power to space heaters, hot plates, coffee pots, or other high-current loads. These types of appliances have caused outlet boxes to burn up.

Note that multiple outlet boxes used in offices, as well as those used to provide surge protection for computers; do not require a temporary wiring tag.

Flexible Cords and Cables: Flexible cords and cables shall comply with the requirements in NEC Article 400 (Flexible Cords and Cables). They shall not be

- Used as a substitute for fixed wiring of a structure.
- Attached to building surfaces.
- Routed through holes in walls, ceilings, or floors; or through doorways, windows, or similar openings.
- Concealed behind building walls, ceilings, or floors.
- Wired with a plug or connector that does not have dead-front construction or strain relief. "Dead-front construction" is defined as electrical equipment built so that it is "without live parts exposed to a person on the operations side of the equipment."
- Placed where they could present a trip or fall hazard.
- Used when the cord insulation is damaged, cracked, or spliced; or when the ground pin is missing from the end of the male cord plug.
- Installed in raceways, except as otherwise permitted by the NEC.

Individual conductors of a flexible cord or cable shall not be smaller than those listed in Table 400-5(A) and (B) of NEC Article 400.

Article 240-4 of the NEC (Protection of Flexible Cords and Fixture Wires) states that flexible cords, including extension cords, shall be protected against over current in accordance with their amperage ratings (see Tables 400-5(A) and 400-5(B)). NEC Article 400-14 states that flexible cords and cables inserted through holes in covers, outlet boxes, or similar enclosures shall be protected by bushings or fittings.

1.3.7 Power Plugs and Receptacles

The Laboratory uses many different voltages, frequencies, and current (ac or dc) in power systems and equipment. Thus, it is essential to ensure that such equipment cannot be inadvertently connected to the wrong power source. For specific purposes, voltage, current ratings, use a plug or receptacle that fully complies with the requirements in ANSI C73. See the configuration chart (from ANSI C73) in the NFPA National Electrical Code Handbook for information about general-purpose locking and non locking plugs and connectors. Use of the National Electrical Manufacturers Association (NEMA) connectors may not be appropriate for all research and development applications. Contact Electronics Engineering Specifications and Standards Group for guidance, if necessary.

1.3.8 Ground-Fault Circuit Interrupters

Ground-fault circuit interrupters-either circuit breakers or portable ground-fault interrupting receptacles-shall be used for

- All 125-V single-phase, 15-A and 20-A receptacles within 6 feet of a sink or installed outdoors.
- Temporary wiring outdoors.

- Wherever employees will be using electrical equipment around water or in damp environments.

Unlike fuses or standard circuit breakers, which are designed to protect equipment from over current, GFCIs are designed to protect personnel from serious injury or death.

Article 305-6 of the NEC (Ground-Fault Protection for Personnel) requires GFCI protection of all 125 V, single phase, 15, 20, and 30-Amp receptacles that are associated with temporary wiring on construction sites. LLNL requires the use of GFCIs for any type of construction work to ensure personnel protection, even if the receptacle is part of the permanent wiring of the building.

Laboratory practice is to provide its employees and subcontractors with at least the same level of protection from electric shock as they would have in their own homes. NEC Article 210-8 (Ground-Fault Circuit-Interrupter Protection for Personnel) specifies that GFCIs shall be installed in the following locations:

- Dwellings where 125-V single-phase, 15-A and 20-A receptacles are installed outdoors.
- Bathrooms, garages, and crawl spaces at or below grade.
- Unfinished basements.
- Where receptacles on countertop surfaces are within 6 ft of a sink.

Thus, all the aforementioned areas within LLNL shall have receptacles with GFCI protection.

Exceptions to these requirements are;

- Laboratory areas where receptacles are required (other than on counter tops) to supply power to specific equipment (i.e., receptacles dedicated to refrigerators or other heavy equipment).
- Line filters and other power supply components in many electronic instruments. These instruments draw sufficient capacitive current to trip a GFCI and therefore are not designed to be connected to GFCI-protected circuits. They also shall not be installed in wet or damp locations.

1.3.9 Portable Electrical Tools, Equipment, and Instruments

Portable electrical equipment or tools shall always be inspected to identify defects; defective equipment shall be removed from service immediately. Portable electrical equipment shall be connected to a portable GFCI (or a circuit that contains a GFCI) when used outdoors, in damp locations, in any unsafe environment, or for indoor or outdoor construction. Ordinarily, the casings for portable electrical equipment are grounded. If it is necessary to operate this type of equipment with other than grounded equipment casing, suitable barriers, guards, or shields shall be installed to protect personnel while working on or near the equipment. In addition, a safety procedure shall be written describing the controls for safe operation of the equipment.

Receptacles and flexible cords can be used to connect electrical appliances and equipment (e.g., fans, machine tools, and pumps) to power sources. Receptacles used on a two-wire, single-phase portable generator (or vehicle-mounted generator) with a rating of not more than 5 kW (where the circuit conductors are insulated from the frame and all other grounded surfaces) do not need to be GFCI protected.

1.3.10 Equipment Grounding

All electrical apparatus, equipment, and systems shall be grounded in accordance with NEC Article 250 (Grounding) and ANSI standards. The conductor used for grounding shall meet the following criteria:

- Be permanent and continuous.
- Facilitate operation of the circuit's protective devices.
- Have sufficiently low impedance to limit the voltage to ground to a safe level at all frequencies and fault-current conditions anticipated.
- Have the capacity (size and rating) to safely conduct any fault current that may be imposed on it for the time required for protective device operation.

Guidelines for proper grounding of programmatic equipment and systems can be found in the Electronics Engineering Department ***Grounding Guidelines: Practical Examples for Power Systems at LLNL*** (UCID-19752).

1.3.11 Static Electricity

A static charge is an imbalance of electrons on objects (matter) that can build up on all matter and transfer from one object to another by conduction or induction. The discharge of static electricity can cause shock or a fire or explosion. Although this type of shock is painful, it is not normally physically hazardous and therefore is not considered reportable as an electric shock. It should be noted, however, that injuries may result from reaction to the shock (i.e., by a person rapidly pulling his/her hand away from a metal object and hitting an elbow against a wall or cabinet).

Equipment and Personnel Guidelines: When working with electrical equipment, employees shall follow the guidelines below for their own protection and that of the equipment;

- Grounding of the metal parts or enclosures will continuously discharge static. Therefore, wrist straps and other connections used to ground employees shall be solidly grounded where static-safe workstations are used for semiconductor, electronic, or explosive work. Grounding prevents the wrist strap from becoming a shock hazard in the event of a short circuit from a voltage to the wrist-strap conductor.
- Bonding will equalize the potential between two adjacent noncurrent-carrying metal parts or enclosures. Thus, only approved or listed grounding clamps are acceptable for static bonding and grounding. Alligator clamps are not acceptable.

- Dust is attracted to the face of the video display terminal because of a static charge of approximately 25,000 V. Therefore, never clean the glass face of a computer monitor while the computer is on. When a person touches the screen with a finger, the charge in the portion of the screen touched discharges through the finger with a tiny spark. Electric current does not normally flow through glass, so only the charge on that part of the screen the finger touches is discharged. When cleaning a monitor, however, the entire glass is wet and the charge on the entire screen will discharge to a finger or hand causing a much more painful shock.

- Never allow any electrical-powered office equipment to become wet while it is turned on, and never turn on any electronic equipment when it is wet. Even when a computer is turned off for a few minutes, it is best not to touch the monitor's CRT while handling or using other electronic equipment-including the telephone. Wet or dry, a person may receive an electric shock similar to one that can be received by touching a metallic object when vacuuming, machining a dielectric, or walking across carpeting in leather shoes.

NFPA Regulations for Fire and Lightning: NFPA 77 (Static Electricity) contains requirements for reducing the fire hazard of static electricity. Lightning, an example of static electricity, is covered in NFPA 780 (Lightning Protection Code). This document gives lightning protection requirements for ordinary facilities and for facilities containing flammable vapors, gases, or liquids.

Flammable Vapor: A flammable vapor source can be ignited by static electricity if the following conditions exist simultaneously:

- Generation of a static charge imbalance.

- Static charge accumulation.

- Flammable atmosphere.

- A spark with significant ignition energy or temperature.

Liquids: Electrostatic charges can be generated by the movement of liquid through pipes, funnels, pumps, filters, or by free-flowing through air. Static charges generated by flowing liquids can be reduced or eliminated by bonding or grounding, or both; by lowering the flow rate; or by reducing the amount of misting, spraying, free-fall, and splashing of the liquid. Pay particular attention to situations where the liquid stream may impinge on a connection to a capacitor, high-voltage bushing, or cable terminal. Static charge from the liquid can store hazardous quantities of electrical energy in a capacitor over time. This hazard is most likely to occur when filling electronic apparatus tanks with insulating oil.

1.3.12 Personal Protective Equipment

Personal protective equipment is required when installing, examining, adjusting, servicing, fabricating, testing, or maintaining electrical equipment. The work supervisor shall provide employees with the appropriate PPE, and shall ensure that the equipment is used properly. Alternatively, employees may contact the area ES&H Team for assistance in selecting the appropriate PPE for the operation. Protective footwear; hard hats; and insulated, nonmetallic-

framed safety glasses shall meet the requirements of ANSI Z41, ANSI Z87.1, and ANSI Z89.2 (see Table 4 below).

Rubber-insulated (nonconductive) protective equipment shall be visually inspected at the beginning of each workday before use and after performing work that can cause damage to PPE. This inspection shall include an air test of the gloves used. Hot sticks, grounds, aerial-lift equipment and booms, hot rope, and hot ladders shall also be visually inspected.

1.3.13 Reviews and Inspections

Major modifications to new and existing facilities and projects may be inspected by the DOE (or authorized designee) to verify compliance with codes and standards in effect on the day that such work is approved by a final design review. If the modification involves a hazard to life, equipment, environment, or property, current ES&H requirements shall be reviewed and used to mitigate the hazard and negative environmental impact.

Table 4. ASTM/ANSI standards for PPE.

Protective equipment or apparel	ASTM standard	ANSI standard
Rubber, insulating gloves	**D 120**	**--**
Rubber, insulating matting	**D 178**	**--**
Rubber, insulating blankets	**D 1048**	**--**
Rubber, insulating covers	**D 1049**	**--**
Rubber, insulating line hose	**D 1050**	**--**
Rubber, insulating sleeves	**D 1051**	**--**
Protective foot wear	**--**	**Z41**
Eye and face protection	**--**	**Z87.1**
Nonconductive hard hats (helmets)	**--**	**Z89.2**
Leather protectors for rubber insulating gloves	**F 696**	**--**

1.3.14 Emergency Assistance and Rescue

Anyone who witnesses or discovers a serious electric shock that results in any of the conditions listed below, at the Livermore site or at Site 300 shall immediately call the Fire Department Emergency Rescue (dial 911) (from a cell-phone, call 925-447-6880).

- Obvious serious injury (e.g., loss of consciousness, significant trauma).
- Altered mental status (e.g., confusion, slow/slurred speech).
- Other obvious injury (e.g., laceration, muscle strain, burn).
- Ensure that all potential sources of energy are safe and in a neutral state, if you are qualified.
- Initiate cardiopulmonary resuscitation (CPR), if appropriate. (Only trained personnel should perform this task.)
- Notify the victim's supervisor and the appropriate ES&H Team as soon as possible. (The victim's supervisor and the Hazards Control Department will want to determine what caused the electric shock.)

Refer to Document 10.1, "Occupational Medical Program," in the ***ES&H Manual*** for additional information.

1.3.15 Minor Shocks

All other electric shock victims shall be taken to the Health Services Department for evaluation so that potentially damaging effects can be detected early and treated properly. It should be noted that such effects may not be immediately recognized and can appear later (see Appendix B for details). Do not let the shock victim drive himself to the Health Services Department.

- Notify the victim's supervisor and the appropriate ES&H Team as soon as possible. (The victim's supervisor and the Hazards Control Department will want to determine what caused the electric shock.)

1.3.16 Analysis of Electrical Incidents

Serious and potentially lethal incidents, including near misses that could result in a serious or potentially lethal shock, shall undergo an incident analysis in accordance with Document 4.5, "Incidents--Notification, Analysis, and Reporting," in the ***ES&H Manual***. This analysis shall be determined by facility or program management and the responsible ES&H Team.

- Properly secure the area once the victim is under care, leaving items and equipment in the same position as much as possible. Try to remember the original position of items that may have been moved during response to the accident.
- Record the time, date, and location of the accident; the name of the victim and any witnesses; who was notified; the voltage and current; the contact parts of the body; what equipment or system was being serviced; and the shock reaction and duration of the shock.

1.3.17 Specific Training

Electrical Workers: Employees who perform electrical work shall be trained to recognize the hazards associated with their work environment and use appropriate procedures and protective equipment to minimize the risk of an accident or injury. The payroll supervisor provides trained electrical workers. Work supervisors shall verify the qualifications and training of all electrical workers before they are permitted to perform electrical work. Training shall be conducted and documented in accordance with Document 40.1, "LLNL Training Program Manual," in the ***ES&H Manual*** and the Directorate Training Implementation Plan.

Employee training shall be documented with respect to the specific equipment and tasks for which the employee is qualified. Much of the experience required for an employee to be considered qualified is specific to the equipment and tasks involved. On-the-job training is always a necessary component of a qualification program. Classroom training, including courses offered by the Hazards Control Department, is a useful way to ensure that employees share a common level of basic knowledge on which to build specific on-the-job training. Additionally, employees can gain knowledge and experience about how to perform their jobs safely and properly by taking courses offered by universities and trade schools or through apprenticeships, on-the-job training (OJT), or other formalized training. The depth of training and how training is provided shall be determined by the hazards and environmental aspects associated with the employee's respective tasks.

Electrical workers shall be trained in and familiar with the following subject areas:

- The safety-related work practices required by 29 CFR 1910, Subparts J and S; and 29 CFR 1926, Subparts K and V (see Sections 5.0 and 6.3 for details).
- Techniques necessary to de-energize electrical systems, identify live parts of equipment, and determine the nominal voltage of exposed live parts and clearance distances specified in Document 16.2.
- Procedures for locking out and tagging energized electrical circuits and equipment safely. Document 12.6 contains specific details.
- Other subjects, such as
    - Standard for Electrical Safety in the Workplace (NFPA 70E).
    - National Electrical Code (NFPA 70).
    - National Electrical Safety Code (ANSI/IEEE C2).
    - Use of personal protective grounds (29 CFR 1926.954(e)).
    - Use of testing and measuring equipment (29 CFR 1910.334(c)).
    - Safety plans and work authorization documents [Integration Work Sheets (IWS) and Facility Safety Plans (FSPs)].
    - Use and care of personal protective equipment (29 CFR 1910.335(a)).

- ❖ Hazard categories and personnel requirements.
- ❖ The requirements of this document.

The Hazards Control Department offers the following courses to fulfill some of these requirements:

***. HS5210-W, "Capacitor Safety Orientation."**

*. HS5220-W, "Electrical Safety Awareness."

*. HS5230-W, "High-Voltage Safety in Research."

*. HS5245-CBT, "Lockout and Tag."

*. HS5245-RW, "Lockout and Tag -- Refresher."

*. HS5250, "Working on Energized R&D Equipment."

Refresher training for electrical workers are required at intervals listed in the course catalog, and shall include a formal review of current regulations and safety practices.

Electrical workers should take HS1625, "Careplus CPR."

Non electrical Workers; The Occupational Safety and Health Administration requires training for non electrical workers whose job assignments require them to be close to exposed parts of electrical circuits operating at 50 V or more. The Hazards Control Department offers the following course for this purpose:

- HS5220-W, "Electrical Safety Awareness."

1.3.18 Supplementary Training

In addition to the courses the Hazards Control Department offers, both electrical and non electrical workers whose job assignment requires them to work close to exposed electrical circuits operating at 50 V or more to ground (in accordance 29 CFR 1910.332) should receive supplementary training in the following subject areas:

- ❖ The proper handling of portable tools and appliance cords.
- ❖ Procedures for resetting over current protective devices.
- ❖ Techniques for approaching distances to overhead conductors.
- ❖ The meaning of electrical safety warnings and barriers.
- ❖ Electrical hazards associated with water.
- ❖ The proper response to electric shock.

For additional training requirements, see the LLNL Training Program Manual and the Directorate Training Implementation Plan.

1.3.19 Responsibilities

All workers and organizations shall refer to Document 2.1, "General Worker Responsibilities and Integrated Safety Management," in the ***ES&H Manual*** for a list of general responsibilities. This section describes specific responsibilities of LLNL organizations and workers who have key ES&H roles. The responsibilities of individuals with regard to electrical work are listed below each title.

1.3.19.1 Employees

- Only perform the tasks for which you are qualified.
- Understand the basic principles of electricity and electrical safety.
- Follow applicable OSHA requirements.
- Use the proper tools and required PPE.
- Request additional training to avoid working beyond your level of qualification or comfort.
- Comply with the requirements set forth by the DOE, OSHA, and LLNL.

1.3.19.2 Work Supervisors

- Ensure employees
  - Comply with the requirements set forth by the DOE, OSHA, LLNL, and other regulatory agencies.
  - Have the appropriate PPE available and use them properly.
  - Are adequately qualified to perform their jobs.
- Determine the work each employee is qualified to perform and make work assignments accordingly.

1.3.19.3 Electrical Safety Advisory Board

- Provide support primarily through the ES&H Teams, which are the initial point-of-contact for all ES&H issues raised by Programs or individuals.
- Identify electrical ES&H hazards and make recommendations for resolution.
- Provide support to program line management responsible for analyzing electrical accidents and incidents.
- Evaluate electrical accidents and incidents to determine trends.

- Develop, review, and approve electrical safety training programs.

- Interact on a continual basis with groups (e.g., ES&H Working Group and subcommittees, Directorate safety committees and councils, the ES&H Teams) charged with providing a safe work environment for employees. This interaction may include conducting electrical safety presentations and providing a forum (e.g., written or electronic communication or meetings) for the exchange of ideas and information.

- Inform management and employees of lessons learned from electrical accidents and incidents.

- Participate in DOE electrical safety programs (e.g., DOE and EFCOG Electrical Safety Committees).

1.3.20 Work Smart Standards

29 CFR 1910, Subpart S, ***Electrical***, (1910.301 to 1910.399), January 1999. (B56)
29 CFR 1910, Subpart H, ***Hazardous Materials***, (1910.101 to 1910.120), January 1999. (B55)
29 CFR 1910, Subpart J, ***General Environmental Controls***, (1910.141 to 1910.147 App A) (Section 1910.147, "The control of hazardous energy lockout/tag out," specifically applies). January 1999. (B68)
29 CFR 1910.269, ***Electric Power Generation, Transmission, and Distribution,*** January 1999. (B78)
29 CFR 1910 Subpart I, ***Personal Protective Equipment*** as of July 1, 2000, but not including 29 CFR 1910.139 (1910.132-1910.138; specifically 29 CFR 1910.137, ***Electrical Protective Devices.***) (B20)
29 CFR 1926, Subpart K, ***Electrical***, (1926.400 to 1926.449), January 1999. (B79)
DOE M 440.1-1, ***DOE Explosives Safety Manual***, (including DOE Explosives Safety Committee approved changes through May 2005). (B52) NFPA 70, National Electrical Code. (B57)

Annex – IV/1

Date: ……., 2014

To Whom It May Concern

Subject: <u>Electric Power Safety – Bangladesh Woven Garments Industry Perspective</u>

Garment industry sector is the most rapidly expanding industrial sector of Bangladesh. It provides jobs to more than four millions of workers, primarily women. The sector exports about US $ 26 billion which is more than 76 % of country's total exports. It is, as such, the most important contributor to the GDP growth and the overall economy of the country. The trend is expected to remain the same in the coming decades due the country and the global realities.

Safe and quality electric power system is the key for maintaining the desired growth rate of garment sector as well as to ensure the safety of the workers and the facilities. The power system safety depends on the proper design and installation as per applicable regulations, codes, guides and standards; and the subsequent quality management of the system.

Mr. K. M. Md. Golam Rabbani and Mr. Audu Ibrahim Baba - two first year M. Sc. TE students of Islamic University of Technology (IUT) are carrying out, under the guidance of the undersigned - a Special Study on the aforesaid subject. The study starts from January 2014 and will end in September this year. The study, I conceive, is very important in ensuring the safety of the garment workers as well as for the smooth development of the industry and the economy.

I would, therefore, request you to kindly provide necessary information and assistance to enable Mr. Rabbani and Mr. Baba to visit garment industries, power related installations and talk with the concerned persons to pursue the study on the power safety efficiently and effectively.

Thanking you in anticipation.

Sincerely yours,

Sd/-

(Kazi Obaidul Awal)

Currently Part Time Teacher and

Former Assistant Professor, EEE Department and

Retired Chief Engineer, Bangladesh Atomic Energy Commission

Annex- IV/2

Date: 23 July, 2014

Mr. Ehsan –Ul Fatah, Secretary General

Bangladesh Garments Manufacturer and Exporter's Association (BGMEA), Dhaka

Subject: Electric Power Safety – Bangladesh Woven Garments Industry Perspective

Dear Mr. Fattah,

Bangladesh garment industry sector provides jobs to more than four millions of workers, primarily women. The sector exports about US $ 24 billion worth of goods which is about 75% of country's total exports. The sector, as such, is the most important contributor to the GDP as well as the overall economy of the country.

Safe and quality '*electric power system'* is the key for maintaining the desired growth rate of garment sector and to ensure the safety of the industries and the workers. The power system safety standards in garment industries usually lack international standards (ILO, WHO etc). Accidents and fire often cause deaths and losses in the sector. The Rana Plaza disaster, worst in the recent history, caused 1129 deaths and 2515 injuries on 13th May, 2013. The root of many accidents is: fire originated from the faulty power system. I understand the BGMEA is working hard to improve the safety of the garment industries to improve safety and emergency and reduce damage and fatalities and injuries. BGMEA, I believe, also has good records and documents/publications on the subject, access to these will help the study.

Mr. K. M. Md. Golam Rabbani and Mr. Audu Ibrahim Baba - two first year M. Sc. TE students of Islamic University of Technology (IUT) are carrying out, under the guidance of the undersigned - a Special Study on the aforesaid subject. The study started in January 2014 and will end in September this year. The study, I conceive, is very important from Bangladesh.

I would, therefore, request you to kindly provide available data/information and assistance, and if necessary advise/suggestions to Mr. Rabbani and Mr. Baba enabling them to complete the study effectively and efficiently. Thanking you in anticipation.

Sincerely yours,

Sd/-

(Kazi Obaidul Awal)

Currently Part Time Teacher and

Former Assistant Professor, EEE Department and

Retired Chief Engineer, Bangladesh Atomic Energy Commission

Annex – IV/3

Date: 23 July, 2014

Directorate General

Bangladesh Fire Service and Civil Defense Directorate, Dhaka

Subject: Electric Power Safety – Bangladesh Woven Garments Industry Perspective

Dear Sir,

Bangladesh garment industry sector provides jobs to more than four millions of workers, primarily women. The sector exports about US $ 24 billion worth of goods which is about 75% of country's total exports. The sector, as such, is the most important contributor to the GDP as well as the overall economy of the country.

Safe and quality '*electric power system'* is the key for maintaining the desired growth rate of garment sector and to ensure the safety of the industries and the workers. The power system safety standards in garment industries usually lack international standards (ILO, WHO etc). Accidents and fire often cause deaths and losses in the sector. The Rana Plaza disaster, worst in the recent history, caused 1129 deaths and 2515 injuries on 13th May, 2013. The root of many accidents is: fire originated from the faulty power system. The FSCD has major role in fire prevention as well in improving emergency response by regularly organizing fire and emergency response drill. I understand the Directorate has good records and documents/publications on the subject.

Mr. K. M. Md. Golam Rabbani and Mr. Audu Ibrahim Baba - two first year M. Sc. TE students of IUT are carrying out, under the guidance of the undersigned - a special study on the aforesaid subject. The study started in January 2014 and will end in September this year. The study, I conceive, is very important from Bangladesh perspective.

May I, therefore, request you to kindly provide available data/information and assistance to Mr. Rabbani and Mr. Baba to complete the study effectively. Thanking you in anticipation.

Sincerely yours,

Sd/-

(Kazi Obaidul Awal)

Currently Part Time Teacher and

Former Assistant Professor, EEE Department and

Retired Chief Engineer, Bangladesh Atomic Energy Commission

List of the Tables

List of the Figure