Master of Advanced Engineering Management

A Study of Safety, Health & Environment in BOC Bangladesh Limited

By

Mizanur Rahman Bhuiyan

This thesis has been submitted in partial fulfillment of the requirement for the degree of Master of Advanced Engineering Management (AEM).

Department of Industrial and Production Engineering (IPE)
Bangladesh University of Engineering and Technology (BUET),
Dhaka-1000, Bangladesh

February 2007

The thesis titled " **A Study of Safety, Health & Environment in BOC Bangladesh Limited**" submitted by Mizanur Rahman Bhuiyan. Roll No 040408120P, Session April 2004 has been accepted as satisfactory towards partial fulfillment of the requirement for the degree of Master of Advanced Engineering Management on February 28, 2007

Board of Examiners

Dr. A. K. M. Masud — Chairman (Supervisor)
Associate Professor
Department of Industrial & Production Engineering
Bangladesh University of Engineering & Technology

Dr. M. Ahsan Akhtar Hasin — Member
Professor
Department of Industrial & Production Engineering
Bangladesh University of Engineering & Technology

Dr. Abdullahil Azeem — Member
Assistant Professor
Department of Industrial & Production Engineering
Bangladesh University of Engineering & Technology

Declaration

It is hereby declared that this thesis paper or any part of it has not been submitted elsewhere for the award of any degree or diploma.

Mizanur Rahman Bhuiyan

Table of Contents

Acknowledgement

This study would not have been possible without the support and guidance of my project supervisor Dr. A K M Masud, Associate Professor, Department of IPE, BUET. I would like to take this opportunity to sincerely thank him for his valuable advice, constant support and encouragement in completing the project.

My sincerest gratitude to all the individuals of BOC Bangladesh Ltd. who directly or indirectly helped me out in many instances through giving their precious time for interview, who were always there to provide support, ideas, their constructive criticism towards my study.

I would also like to thank my respected teachers of the department, classmates, friends and family members who directly or indirectly gave me encouragement and support in completing my job

Abstract

Safety, Health and Environment in workplaces play a vital role in creating a healthy working condition. In addition every business has legal responsibilities to ensure safety for its stakeholders. Poor health & safety leads to illness and accident which in turns incurs significant amount of cost. Any manufacturing unit has to follow general safety as well as engineering safety for the improvement of the quality of working life of its employee General safety as well as engineering safety at BOC Bangladesh Limited has been observed carefully. Major vulnerable areas to be concerned as safety point of views have been identified as the areas of transport operations, manual handling and process operations. Transport related accident could be reduced to a tolerable limit by introducing AVLS (Automatic Vehicle Location System). By introducing semi-automatic painting machine manual handling related accident can be prevented. It will also help reduce occupational illness. High pressure filling hose of perfect design will reduce hose failures.

CHAPTER-1: INTRODUCTION

1.1 Introduction

Every business has legal responsibilities to ensure the health and safety of its employees and other people affected by the business activities, such as customers, contractors and suppliers. It is also obliged to meet legal requirements designed to protect the environment. But the right approach isn't just about doing the minimum required to comply with the legal requirements. It can also benefit the business.

Poor health and safety lead to illness and accidents and significant costs for any business. Effective health, safety and environmental practices pay for themselves. They also improve the reputation with customers, the local community and own employees.

The Safety, Health & Environment system of BOC Bangladesh Limited has been studied. It has been tried to find out the root causes of accidents that occurred during recent years in BOC Bangladesh Limited. Most vulnerable operations managed by BOCB where there exist potential hazards are Transport operations, different processes operations, manual handling etc. I have analyzed a few accidents that had occurred in the previous years. To reduce the recurrence of same nature of accidents, some methodologies have also been proposed

BOC is committed to managing a safe, secure and healthy working environment. There is no higher priority for BOC than the safety of its employees, customers, suppliers, local communities, and the protection of the physical environment in which it operates.

BOC aims to have a world class safety record in which:

- Safety is a pre-requisite to any business it undertakes
- Commitment to zero tolerance of any form of accidents/incidents
- Considering safety as the most important key performance indicator

BOC also understands that world class safety is only possible if the whole organization embraces the safety ideologies and programs of the group. All BOC employees are required to know what is expected of them, to support the program. and where appropriate. show leadership in embedding the safety ideologies.

The responsibilities of implementing such a huge program lies with the local SHE department. In striving to achieve this goal the department works towards complying all relevant legal requirements. local industry standards, codes, requirements etc. Not just that SHE strives to exceed the minimum requirement and attain the bench mark position in this aspect. Furthermore it is the responsibility of SHE to [1]:

- Maintain a safe and environmentally sound workplace in all locations by effectively managing the risks arising from business activities, products and services through the application of BOC and industry best operating practices.
- Continually review operations and processes, creating and maintaining appropriate programs and support structures to bring about continuous improvement in performance
- Place a duty of care on all company officers and managers and hold them accountable for safety. health and environmental performance against agreed key performance indicators (KPIs)
- Ensure functional competence of all employees through on-going training, development, communication and appraisal programs
- Work with and encourages suppliers and contractors to conduct their business with BOC in a safe and environmentally responsible manner
- Learn from incidents and share the lessons learned with employees, customers, contractors and other bodies as appropriate to ensure it is never repeated in future

BOC believes all employees have a part to play in ensuring a safe working environment, environmental protection, business improvement in line with SHE objectives and support for the local community where it operates. BOC employees are urged to bring any undermining or unsafe practices to the attention of their supervisor, their local safety committee, SHE representatives.

1.2 Objective of the Thesis/Project

BOC is committed to world class safety. To achieve world class safety, BOC has different type of safety programs in place. For general safety, BOCB follows NOSA (National Occupational Safety Association). NOSA is a South African organization. For engineering safety, BOCB follows IMSS (Integrated Management System & Standards) & Engineering Audit etc.

The prime objectives of this project are:

- Study of Safety, Health & Environment (SHE) in BOCB
- Identification of the areas where there are potential hazards that may lead to accident/incident
- Analysis of accident/Incident in BOCB during recent years
- Suggestion to reduce/prevent recurrence of accidents in BOCB

CHAPTER 2: COMPANY PROFILE OF BOC BANGLADESH LTD.

2.1 Introduction

The BOC Group, a global industrial gas company, is listed on the London and New York stock exchanges and registered in England. It employs around 43,000 people globally, operates in more than 60 countries.

For more than a century BOC has been contributing to advancement in many industries and aspects of everyday life, including health care, steel-making, refining, chemical processing, environmental protection, wastewater treatment, welding and cutting, food processing and distribution, glass production, electronics etc.

BOC products play a vital role in applications as diverse as purifying water, producing microchips, treating hospital patients and manufacturing cars. BOC's presence can be found almost everywhere - from deep-level mining to outer space, in factories, laboratories, farms and garages in more than 60 countries throughout the globe.

2.2 Group Profile:

The BOC group began its business life over a century back as the Brin's Oxygen Company. The company was incorporated in England in 1886 and adopted its present name on 1st March 1982.

With manufacturing operations in some 60 countries and sales in many others, BOC works in a complex, demanding environment characterized by the rich ethnic and cultural diversity of its people.

Global Sales % per region

Table 2.1: Market share of BOC

Region	%
Europe	27%
Asia Pacific	31%
Africa	13%
Americas	29%
Total	100%

2.3 BOC Bangladesh Limited

BOC Bangladesh Limited, an affiliate of the BOC Group Plc. is one of the leading multinationals operating in Bangladesh. The BOC Group Plc owns 60% of its share. The other significant shareholding groups include the Investment Corporation of Bangladesh (ICB)-21%, Bangladesh Shilpa Rin Sangstha (BSRS)-1.2%, Sadharan Bima Corporation 1.3%, and general public-16.5%.

In Bangladesh, 'BOC' has been present for over 50 years with continuous expansion in operations and business. With a modest appearance at the beginning, BOC's products are now part and parcel of all the industrial and economic activities of the country.

As a pioneer multinational company in the gases business, BOC Bangladesh limited has 3 major locations/installations at Tejgaon, Rupganj, and Shitalpur. It has around 25 sales centers scattered throughout the country. The Company is currently capable of producing about 80 tones of liquid ASU gases per day and 13 thousand MT of welding electrodes per year. Its product folio and services include liquid and gaseous oxygen and nitrogen, argon, acetylene, carbon dioxide, dry ice, refrigerant gases, lamp gas and other gas mixtures, medical oxygen, nitrous oxide, Entonox, medical equipment and accessories, welding electrodes, gas and arc welding equipment and accessories, welding training and services.

Through embedding ACTS (Accountability, Collaboration, Transparency and Stretch) BOC Bangladesh has a strong in-built culture with work values reinforced and developed over the years which are reflected in the performance of its employees.

The corporate vision of BOC may be mentioned below:

"We shall be recognized as the leader in all the business sectors in which we compete in Bangladesh

Our success will be built on our absolute dedication to the satisfaction of our customers, through constant innovation, operational efficiency, cost effectiveness and the talents of our people.

We shall always apply high standards of integrity and responsibility in our activities."

2.4 Organizational Structure of BOCB

BOC Bangladesh comprises of the following departments:

- Welding Business
- Gases Sales
- Gases Operations & Engineering
- Finance & Accounts
- Human Resource & Administration
- Business Assurance
- Supply Management
- Information Management or IT
- SHEQ department

BOC Bangladesh considers the first two departments as its business function, i.e. Marketing & Operations. The rest of the departments are considered as enabling function i.e functions that provide all the necessary support and services to the business functions for them to complete their core objectives

Brief descriptions of these departments are given below:

2.4.1 Welding Business:

Welding product namely Mild Steel electrodes is the major bread earner for BOC Bangladesh. It contributes around 60% of the company's total revenue. Competition is stiff in this segment, not only from local manufacturers, but also in the form of imported electrodes.

The Company is currently capable of producing about 13 thousand MT of welding electrodes per year. Its product folio and services include welding electrodes, gas and arc welding equipment and accessories, welding training and services. At present BOCB owns and operates state of the art plants in Rupganj. Moreover, Welding business received ISO 9002 certification in 1996. A distribution agreement has been signed with world class welding Company, the Lincoln of USA.

BOCB's main advantage in this business segment is its wide distribution network that allows it to send its products to all corners of the market as well as its goodwill which is very important, considering that all other brands sell at a significantly lower price. BOCB has been able to sustain as the market leader through its quality product line and highly effective distribution network. Main products of welding business have been listed below:

- Mid Steel & Cast Iron Electrodes
- Low Hydrogen/Low Alloy Electrodes
- Stainless Steel & Bronze Electrodes
- Arc Welding Equipment & Accessories
- Spot Welding Machines
- MIG Welding Equipment

2.4.2 Gases Business

BOC Bangladesh is a truly market driven & customer-focused company. This basically means that BOCB's core business is concentrated through cylinder gases and associated equipment and specialized services, both industrial and medical.

The list of gaseous products of BOC Bangladesh Ltd. is given below:

- Compressed Oxygen
- Liquid Oxygen
- Compressed Nitrogen
- Liquid Nitrogen
- Dissolved Acetylene
- Carbon Dioxide
- Dry Ice
- Argon
- Lamp Gases
- LPG
- Refrigerant Gases
- Hydrogen
- Compressed Helium
- Liquid Helium
- Sulphurhexafluoride (SF_6)
- Sulphur dioxide
- Special gases & gas mixtures

Gases are one of the core products of BOC Bangladesh Ltd. A significant contribution to the total business comes from ASU gases and Dissolved Acetylene.
The biggest market of gaseous products is in Chittagong and customers are ship breaking and scrap cutting industries

Competition within the gases industry is mainly local, but is quite significant for BOCB. Local competition has the advantage of low overheads, minimum safety standards, but BOCB counters them through higher-grade product and consistency in quality and quantity.

2.4.3 Medical & Special Product Business

The Medical Product Division of BOC Bangladesh Ltd. provides Medical Gases and Equipment also promoting liquid medical Oxygen and many other health care products. Although small compared to the industrial segment the medical segment is highly profitable for BOC Bangladesh. BOCB is still known today as the organization that produces and sells life saving medical oxygen.

BOCB is also the local agents of some of the worlds leading medical equipment manufacturers e.g. Datex Ohmeda, Tyco Healthcare, Fisher & Paykel etc. BOCB's medical product line includes but is not limited to the following:

- Medical Oxygen
- Nitrous Oxide
- Entonox
- Sterilizing Gases
- Medical Gases Cylinders
- Anesthesia Machines
- Anesthesia Ventilators
- ICU/CCU Ventilators
- ICU/CCU Monitoring System
- Infusion/Syringe Pump
- Pulse Oxy-meter
- Nerve Stimulator
- Blood Gas Analyzer
- Electrolyte Analyzer
- Infant Warmer
- Photo therapy Units

CHAPTER 3: GENERAL SAFETY

3.1 Introduction

BOC Bangladesh Limited use NOSA as a tools for maintaining general Safety, Health and Environment. The term NOSA stands for National Occupational Safety Association. Its corporate office is in South Africa. It is providing a comprehensive range of services and products in Occupational Safety and Health Management for all industry and commerce.

Successful organizations are to ensure that they make optimal use of all their resources minimizing waste, reducing unnecessary losses for example:

- machine down time,
- accident & Incident control

Health & Safety areas are broad and have marked impact on overall productivity and profitability results.

NOSA provides through its Five Star System, the expertise knowledge and skill necessary to integrate health & safety environment & loss control into a total program

3.2 Purposes of NOSA

- To provide dynamic, proactive and cost effective consultative services in the fields of Loss Prevention, Occupational Safety and Health.
- To strive for excellence in customer service by motivated employees.
- To guide, educate and train all people in the techniques of Occupational Accident and disease Prevention.
- To create a work environment, which is conductive to encouraging employees to participate in decisions, that directly affects their daily working lives **[2]**.

According to NOSA –" We are committed to providing –

- Quality products and services
- Outstanding customer service
- Quality in everything we do"

3.3 NOSA MBO 5 Star: Safety and Health Management System

This system has 5 sections with 73 elements. The sections along with their objectives are listed in the following table.

Table 3.1: Section of NOSA

Section	Description of the Section	Objective of the section is to
1	Premises and housekeeping	Implement and manage a system to effectively control those aspects which relate to premises and house keeping which, if unattended, could or may give rise to unsafe conditions which result in accidents causing injury to personnel and /or damage to property (machinery, materials etc.)
2	Mechanical, Electrical and Personal Safeguarding	Implement and manage a system to effectively control those aspects which relate to the use of machinery and electrical equipment and the provision and usage of personal protective equipment so that injuries and losses are eliminated or minimized.
3	Fire Protection and Prevention	Implement and manage a system to effectively control the equipment and procedures necessary for fire protection and prevention.

4	Accident Recording and Investigation	Implement and manage a system to effectively control the reporting, recording and investigation of accidents and incidents and implementation of preventive measures to ensure that recurrence of similar incident is prevented or minimized.
5	Safety Organization	Implement and manage a system to effectively control the employment and placement, training, delegation of duties to and involvement of personnel in the program so that personal and job factors which gives rise to unsafe acts and/or conditions are identified and that steps be taken to eliminate or minimize these in order to prevent injury or damage causing accidents.

BOC follows the NOSA MBO 5 Star Safety and Health Management System. Safety auditors of BOC/NOSA follow the Grading, Audit & Survey Rough Notes of this system to inspect and audit safety programs.

Grading is classified as follows [2]:

Table 3.2: NOSA Grading System

No. of Stars	Grading %
5 Star: Excellent	≥91
4 Star: Very Good	≥75
3 Star: Good	≥61
2 Star: Average	≥51
1 Star : Fair	≥40

3.3.1 NOSA Section-1: Premises & House Keeping

This section of NOSA gives guidance on good house keeping. Good house keeping fulfils some very important functions:

- It prevents injury as passages & work places are free from superfluous material
- Space is saved
- It saves time taken up by the search for goods

The effect of good house keeping is obvious. The work place and the working environment improve which in turn inspire the workers to work more effectively and production increases. The accident rate is usually lowered with good house keeping.

NOSA uses different checklists to check the condition of the factory premises. These checklists give clear understanding of how to maintain the premises. Two checklists have been attached here [2]:

TABLE 3.3: PLANT AMENITIES & SANITATION

SURVEY OF FACILITIES

PLANT AMENITIES AND SANITATION

SITE_____

Location: write where located gate. oxy.plant, WTC,Rest house etc.	Latrines	Urinals	W/basin	Shower	Canteen	Kitchen

Persons on site:

Category	Numbers
Management	
Office	
Workers	

Survey Conducted by :

Signature :

Date :

Table 3.4 : Hygiene Inspectors Checklist

HYGIENE INSPECTOR'S CHECKLIST

SITE:_____

Name of Inspector_____

Check Items	Remarks	Action
Change Rooms		
Are lockers provided for each persons?		
Are lockers clean & tidy?		
Are floors clean & tidy?		
Are food items stored in lockers?		
Are shower facilities provided?		
Toilet Block		
Are floors, toilets and urinals kept clean and disinfected?		
Is water wastage prevented?		
Are wash basin provided and supplied with soap?		
Are clean towels provided?		
Are toilet facilities inspected regularly by representatives?		
Are cleaning team appointed and provided with equipment?		
Canteen		
Is sufficient seating provided?		
Are floors tables chairs clean?		
Are refuse bins provided?		
Are clean towels provided ?		
Are soap provided near wash basins?		
Are clean cool hygienic drinking water provided?		
Kitchen		
Are cooking utensils clean and stored in a safe manner?		
Are floors clean and slip free?		
Is kitchen disinfected regularly to control. rodents, insects ?		
Are caps apron/overalls supplied and worn?		
Are leak-proof refuse bins with lead supplied and kept clean?		
Is kitchen fly-proof?		
Are first facilities & fire protection provided?		
Is ventilation adequate ? Does the extractor work?		
Date of Checking & Signature of Hygiene Inspector→	Date:	Signature:

Key areas of this section have been briefly described below.

3.3.1.1 Refuse Bins

- To be placed at correct location where refuses are generated
- Must have lids which can easily be opened
- Bins as well as the location where placed to be numbered to ensure that after cleaning it comes to the same location

3.3.1.2 Lighting

- The main requirement for Industrial Lighting is sufficient amount of high quality light on all levels.
- Standard of illumination has been set for different type of work, which need to be followed and monitored from time to time.
- Emergency lighting to be provided which should have an illumination level of at least 0.3 lux on floor surface

3.3.1.3 Ventilation

- open windows
- built in window fans or exhaust fans
- air conditioner with exhaust system
- should be well designed to provide air change as per requirement
- to be inspected and maintained regularly

3.3.1.4 Storage

- Adequate Ventilation is necessary but the openings to be protected to limit the entrance of birds & thieves
- lighting to be between the shelves so that materials can be easily seen

- full height to be utilised

All stacking in store or in a storing area should always comply with the following eight requirement:

1. The base on which the stacking is done should be solid and even

2. No stock may be higher than 3 times the width of the narrowest base of the stock unless exception is obtained from the site manager

3. Stocks to be bonded and linked

4. under no circumstances should stacking be done in walk-ways, passages or roadways

5 Under no circumstances should stacks obstructs fire fighting equipment, , lighting. ventilation equipment, electrical switching devices, emergency exits or symbolic safety signs

6. Where there is danger of stack collapsing , it should be immediately dismantled, starting from top

7. Stacks should only be mounted using the right equipment

8. Stacks should only be dismantled from top to the bottom

3.3.1.5 Color Codes

- Uniform colour codes to be applied throughout the company
- colour code boards to be placed prominently- only display those codes used on specific area where board is placed, display all at central place

- maintain the colour, as soon as these start getting fade repaint.
- demarcation on floor for walk-ways, equipment e.g. fire fighting, switch-gears etc. different contours / levels to be kept always painted
- there should be strict control over the keep clear areas

To establish uniformity in color identification and coding of:

- plant
- pipelines
- equipment
- moving machine parts and
- housekeeping items
- in order to allow a speedy recognition of different objects and to warn workers of hazards and to enhance appearance.
- Uniform color code to be used throughout the company
- Color keyboards to be displayed
- workers to have knowledge of color codes

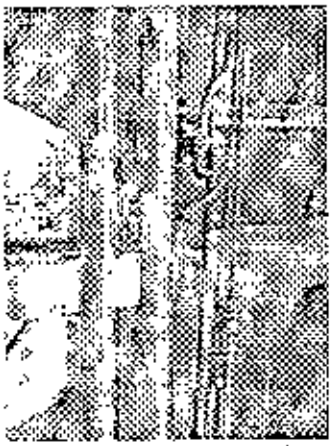
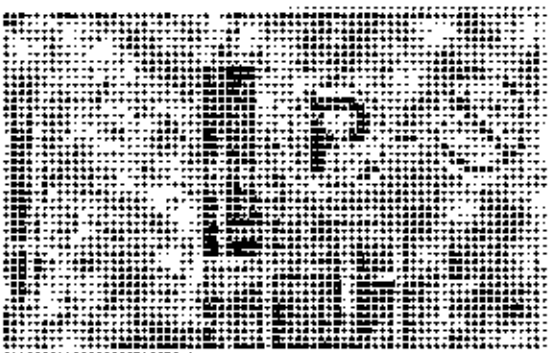


Figure 3.1: Color Coding

3.3.1.6 Symbolic Signs

- Take a layout of site, determine activities, decide on Notices and sign requirement.
- Place the symbolic signs, traffic signs, & notices at relevant places
- Provide a key board at prominent place / s
- Train the workforce in the meaning of the signs
- Follow standard international design & size of the signs.
- Signs to be maintained properly



3.3.2 NOSA Section-2: Mechanical, Electrical and Personal

This section gives a clear guidance on how to keep the personnel safe from being injured either by mechanical or by electrical equipment. Different Elements of this section have been discussed below:

3.3.2.1 Hand and power driven portable tools

Clear guidance on safe use of hand and power driven tools has been given in this section. The policy of managing hand and power driven tools included following:

- standard of equipment purchased
- frequency of inspection
- accountability
- training

- maintenance
- writing off procedures
- storage and replacement practices
- application and use of hand tools

Inspection of tools is needed regularly to keep them safe for use. Specific checklist is used for this purpose. A sample check list for this purpose has been shown as below:

Table 3.5 : Inspection checklist for hand tools

Site : _____

Holder of the Tools:	**Inspection Date:**	
Department/Section:	**Inspected By:**	
Chisels	**✖ cross**	**✓ tick**
Heads safe-ended or dressed	☐	☐
Cutting edges sharp and square	☐	☐
Files		
Tangs protected with handles	☐	☐
Teeth Sharp and clean	☐	☐
Hammers		
Handle unbroken and clean	☐	☐
Face of head smooth not mushroomed	☐	☐
Screwdrivers		
Handle smooth and clean	☐	☐
Bits sharp and square	☐	☐
Wrenches		
Jaws sharp not spread	☐	☐
Right type for the job	☐	☐
Any other Tools(write name below)	**✖ cross if bad**	**✓tick if okay**
1	☐	☐

3.3.2.2 Lifting gear and records:

Lifting gear can generally be describes as mechanical apparatus used to raise, lower or transport heavy loads for limited distances. As per NOSA, all lifting gears should comply with the following:

- it should be maintained in a safe working condition and so stabilized and used as to ensure its complete safety
- equipment should be securely attached with its support
- equipment should have positive stops or limit switches
- it should be provide with a brake to prevent downward travel when raising action is halted
- The safe working load and identification of equipment must be clearly marked on each part of the equipment

3.3.2.3 Ladder

Safe use of ladders is very vital in any factory. Ladders are frequently used for various types of jobs. Fail to comply with standards may lead to accident of the user of ladder. In NOSA, a very clear guidance has been described. Ladder may be classified as fixed as well as portable.

- For fixed ladder, rungs must not be more than 400 mm apart
- Ladders more than 5 meter long, should be provided with a back support cage
- Ladders more than 8 meters long should be provided with rest platforms every 8 meters
- Fixed ladders should regularly be inspected for rust at all joints
- For mobile should be inspected regularly since these are exposed to excessive handling
- Wooden ladder should never be painted since paint can hide any crack in the wood
- Only one person may be on a ladder at a given time
- Always use both hand when climbing up or down a ladder
- Never leave any tools on a ladder as it can lead to accident

Table 3.6 : Portable Ladder card [2]
Site_____

Location		Identification No:			
Name of Person Authorised to inspect		Type of Ladder			
No.	**Item**	**Condition**	**Condition**	**Condition**	**Condition**
1	**STRAIGHT LADDER**				
1.1	Loose rungs(move by hand)				
1.2	Loose nails, screws, bolts etc.				
1.3	Loose mounting brackets etc.				
1.4	Cracked, broken, split stays				
1.5	Splinter on stays or rungs				
1.6	Cracks in metal stays				
1.7	Bent metal stays or rungs				
1.8	Damaged/worn, non- slip device				
1.9	Wobbly				
2	**STEP LADDER**				
2.1	Wobbly				
2.2	Loose/bent hinge spreaders				
2.3	Stop on spreaders broken				
2.4	Loose hinges				
3	**EXTENSION LADDER**				
3.1	Defective extension locks				
3.2	Defective rope pulley				
3.3	Deterioration of rope				
4	**GENERAL**				
4.1	Painting of Wooden Ladder				
4.2	Identification No: faded				
4.3	Storage proper				
5	**Remarks Item No:**				
6	**Remedial Item No:**				
7	**Signature**				
8	**Date of inspection**				

3.3.2.4 Machine Guarding:

- **M** aximum positive protection
- **A** ccess to danger zone prevented during operation
- **C** orrosion and fire resistant and can easily be repaired
- **H** azard such as splinters and pinch points should not be created by the guard

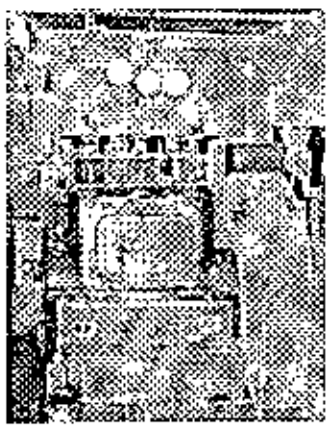


Figure 3.3 : Machine Guard

- **I** nspection by government official (factories Inspector)- the guard should comply
- **N** ot weakening structure and be permanent part of the equipment
- **E** fficient operation of the machine must not be affected
- **S** trong enough to withstand normal wear and tear

3.3.2.5 Lock out & Tag out:

- identify the hazard(s) associated with the work to be undertaken
- obtain a permit to work
- notify personnel within the area that work is to be carried out on the equipment
- lockout the equipment
- place warning sign(s) on the equipment
- carry out zero potential test(s) - operate start stop switch at least twice
- replace guards, tools and parts
- remove tools, clean area
- notify personnel in that area

- notify supervisor, sign off work permit
- ensure equipment is switched off
- Open the lock

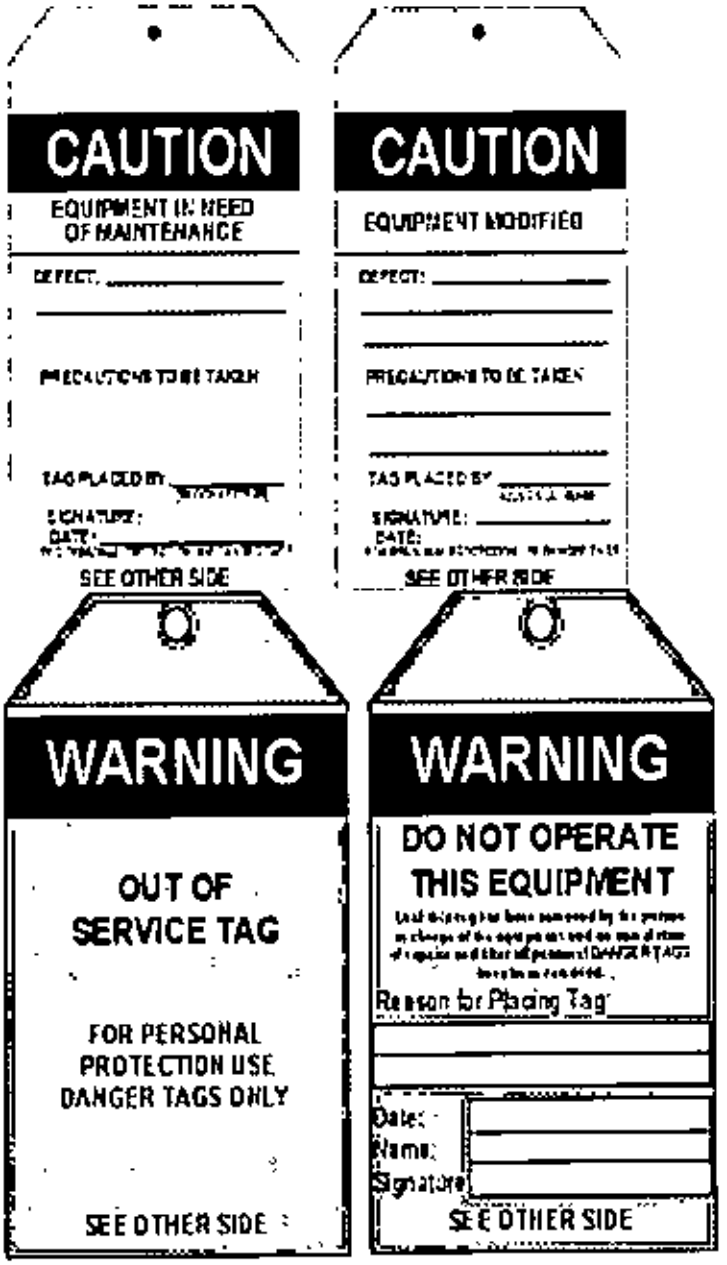


Figure 3.4: Logout & Tag out

3.3.2.6 Personal Protective Eqnipment (PPE):

- Survey to determine the type of PPE to be used for the various operations
- Proper Personal Protective Equipment of approved specification to be selected after discussion with the users & purchased
- Necessary PPE to be issued to the respective employees. They should sign for receipt thereof.
- Employee should be adequately instructed/ trained on the correct use and maintenance of the PPE issued
- Wearing of PPE to be enforced
- Regular inspection to be conducted

Figure 3.5: An operator wearing PPE

3.3.3 NOSA Section-3: Fire Protection & Prevention

3.3.3.1 Ignition Sources

- Electricity 25%
- Cigarettes 20%
- Friction 10%
- Overheated material 08%
- Open Flames 07%
- Static discharge 01%
- Unknown Factors 01%
- Hot surfaces 08%

3.3.3.2 Anatomy of fire

The chemistry of fire is related to the various properties and composition of materials that determine the risk and course of fire. It need three things to get fire shown as below:

- Ignition source
- Oxygen
- Combustible material

3.3.3.3 Classification of Fire

- Class "A" Fires: Ordinary combustibles where large quantities of water are required to lower temperature (slow-burning, such as wood, paper, and rags).
- Class "B" Fires: Flammable liquids, gasoline, oil, paints, greases, etc., where a blanketing or smothering action is more effective (quick flash)
- Class "C" Fires: Electrical equipment where electrical non-conductivity of the extinguishing media is absolutely necessary
- Class "D" Fires: Combustible metals such as magnesium, zinc, calcium, zirconium, lithium, sodium, and potassium. These require specialised techniques and extinguishing agents.

3.3.3.4 Fire Extinguishers

- Correct type of extinguishers to be provided suitable for the location
- locations to be close to the fire hazard but not so close that as to be damaged or cut off from use due to a fire
- quantity as per recommendation of local authority but not less than one 4.5 kg dry powder in 2000 ft^2 4 times extra for higher risk areas

Figure 3.6: A fire Extinguisher

3.3.3.5 Emergency Planning:

- Written Emergency Action Plan suitable for the site should be available. Each site has its own emergency plan depending on the hazards associated with the site
- Emergency team to be formed
- Emergency drills to be conducted
- Emergency control centre to be established and emergency equipment to be made available
- an alternate control centre to be in place

3.3.3.6 Implementation of the plan

- Raise Fire Alarm to initiate Fire Fighting Activities & site evacuation activities
- Inform site senior person and attempt to contain the emergency by use of Fire Extinguishing Equipment or product isolation
- The site senior person assess the extent of incident and potential, if Major he will assume the role of Works Incident Controller until relieved and initiate the emergency shutdown and isolation procedure
- Declare the incident as MAJOR and inform Works Main Controller

3.3.4 NOSA Section-4: Accident Recording and Investigation

This section deals with accident/incident recording and investigation, injury/disease recording, analysis of incident/accident etc.

3.3.4.1 Accident/Incident Recording & Investigation

- All injuries major, serious, minor or even that requires first aid only, to be reported, recorded and investigated.
- Investigator to be appointed and trained
- Safety Representative of the Area where incident occurred to be in the team
- NOSA standard forms to be used

3.3.4.2 Accident/Incident category-Category 1-Major

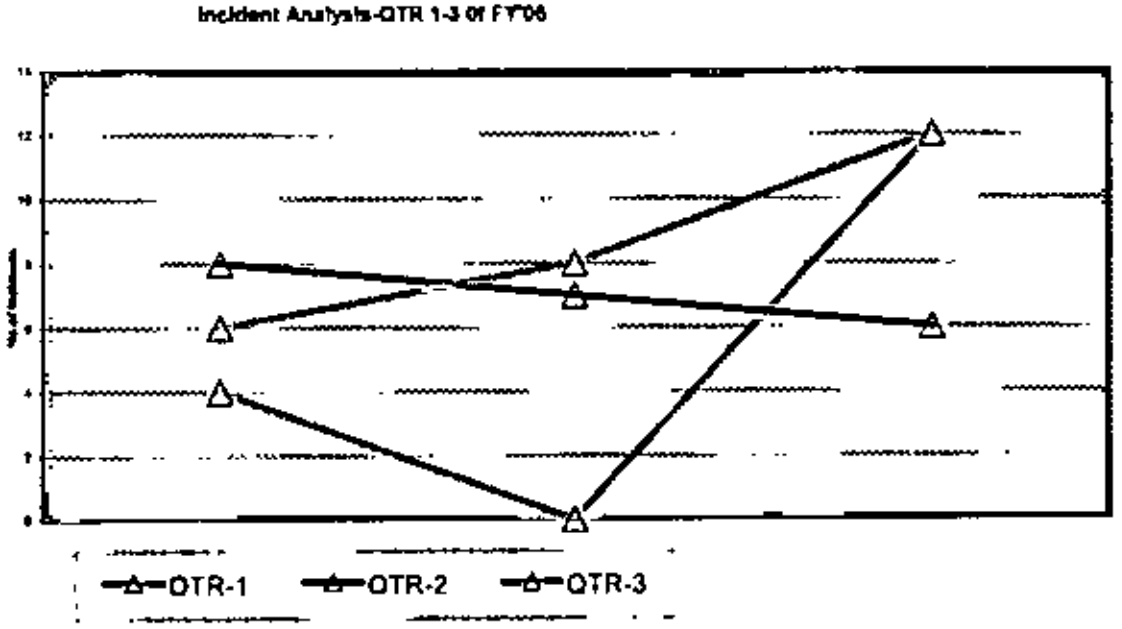
- fatality (employee, contractor or third party; on or off site)
- severe or major injury (permanent or expected total disability), including major burns
- off-site release with significant detrimental effects (large evacuation or environmental effects)
- financial loss greater than £500k (property damage or interruption)
- major transportation accident
- significant media attention (national coverage or crisis communication)

3.3.4.3 Accident/Incident category-Category 2-Serious

- lost time injury or severe injury without permanent disability
- on-site release contained with assistance
- off-site release with only minor detrimental effects
- statutory offence
- financial loss between £10k and £500k
- media attention (local coverage)

3.3.4.4 Accident/Incident category-Category 3-Minor

- first aid or medical attention required
- on-site release immediately



- financial loss between £1k and £10k

Figure 3.7: Accident/Incident Analysis (BOCB)

Table 3.7: Incident Analysis FY-05-06

	Incident Analysis up to September-06 (FY-05-06)				
Incident Types	Manual Handling	Process	Transport	Customer	Total Incidents
No of Incidents	11	11	40	6	68
	Incident Analysis up to September-06 (FY-05-06)				
	Manual Handling	Process	Transport	Customer	Total Incidents
October '05	0	0	2	0	4
November '05	0	0	0	0	0
December '05	1	3	5	0	12
January '06	2	0	3	0	8
February '06	0	0	5	0	7
March '06	2	1	2	1	6
April '06	0	1	2	0	6
May '06	3	1	3	0	8
June '06	2	1	5	1	12
July'06	0	3	5	1	11
August'06	0	0	6	1	8
September'06	1	1	2	2	6
Total Incidents:	11	11	40	6	68

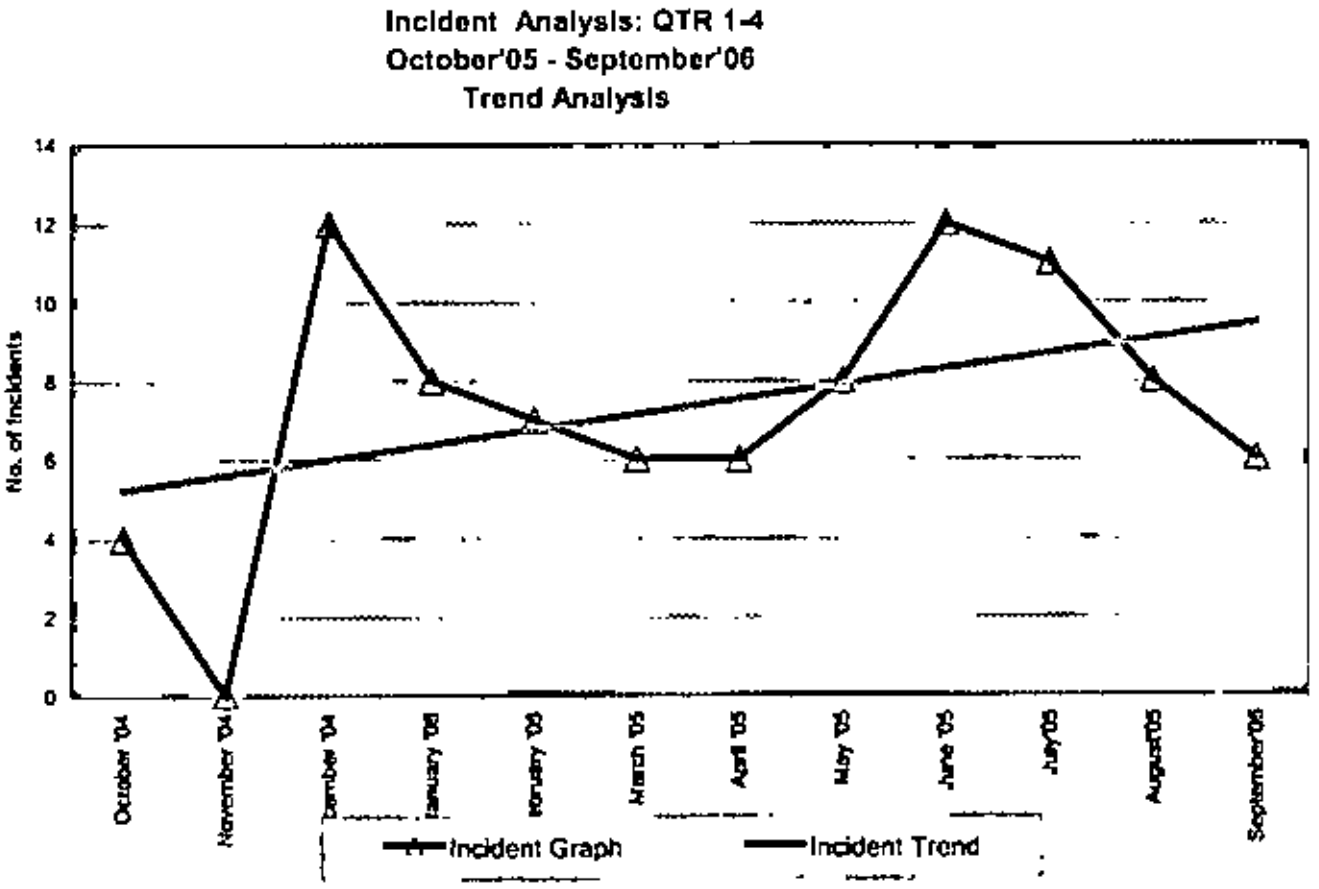


Figure 3.8: Incident Analysis

3.3.5 NOSA Section-5: Safety Organization

To perform all the safety related activities at a site, a safety organization work to achieve a goal of zero accident. A senior manager responsible for this site leads this organization. He gives appointment of several persons to perform the duties.

3.3.5.1 Duties of Safety Representatives

- To ensure that all the elements of the Site Safety Policy issued for the site are fully followed and necessary records are kept for the above said areas for which he/she is responsible as a Safety Representative.

To carry out monthly inspections and submit report to the Safety Co-ordinator which will be discussed at the Safety Committee Meetings.

- To attend Safety Committee Meetings

3.3.5.2 Duties of Accident/Incident Investigator

- Investigate any incident or accident along with the safety representative of the area by inspecting the scene and interview everyone involved or who witnessed it.
- Make notes and sketches and check systems
- Identify the direct cause as well as the basic cause
- Check the existing steps in the procedure
- Evaluate and correct the standards
- Review all other similar situations
- Notify all necessary persons of recommendation
- Record findings and report to Safety Committee

3.3.5.3 Duties of First Aid Coordinator

- To maintain the legal content of all first-aid box
- To ensure that a percentage of staff complement are trained in first aid each year and that the first aider certificates are valid.
- To form & co-ordinate the first aid team and train the team to react to all emergencies

3.3.5.4 Duties of Portable Electrical Equipment Inspector:

- To ensure that all portable equipment used by this company is numbered and placed on register.
- To inspect all the equipment registered above and to record all finding in the above-mentioned register.
- To ensure that all unsafe equipment tagged as defective ,is repaired if it is under your control or reported to the person responsible for the maintenance.

- To ensure that all single phase wall plugs are connected to an earth leakage relay (when fitted) and that the trip out limit is 15-30 mA. This to be tested every 6 months and results entered into the register.

3.3.5.5 Duties of Hygiene Coordinator:

- To maintain the occupational hygiene program according to NOSA MBO system.
- To carry out monthly inspections of all canteens, kitchens, ablutions and rest room facilities
- To control the cleaning of facilities by our cleaners and contract cleaners.

3.3.5.6 Duties of Housekeeping Inspector:

- To ensure that the standard & procedure set for the element / item for which you have been appointed as an Inspector are fully followed and necessary records are kept by the person entrusted for the above said item.

- To carry out monthly inspections and submit report to the Safety Co-ordinator which will be discussed at the Safety Committee Meetings.

3.3.5.7 Duties of Fire Coordinator

- To maintain the fire prevention program to an optimum level including checking of all fire fighting equipment monthly and ensuring that the equipment are in working order(the respective representatives are responsible for any maintenance/upkeep)
- To identify all fire risks and taking action to eliminate or reduce these.
- To form & co-ordinate the fire team and train the team for all emergencies.
- To register all fire fighting equipment with serial numbers.
- To keep liaison with local fire department.

3.3.5.8 Permit to Work

- Must be issued for all hazardous and non-routine work
- permit issuer to be clearly identified and name displayed with specimen signature
- issuer & others must have full knowledge of hazards associated with operations
- under no circumstances can a work permit extend across shifts

3.3.5.9 Work Permit Process

- Permit Issuer- must be of supervisory level, trained , competent and must be appointed by senior line manager,
- permit Acceptor can be BOC or CONTRACTOR
- Higher Authority, must ensure that safe condition have been created
- standby person

3.3.5.10 Permit Issuer

The following guidelines apply to appointment of the Permit Issuer:

- The Permit Issuer is appointed by the appropriate senior line manager.
- A list of persons qualified to issue permits and the limits of their authority must be posted at the permit issuing office.
- Management should ensure that sufficient staff are authorized to issue permits so that there is adequate coverage at all times.
- Permit Issuer must be at supervisory level or above.

To be qualified for appointment as Permit Issuer, the person concerned must:

- have the necessary qualifications and experience.
- have undergone appropriate training to evaluate potential hazards
- existing in a given situation, and the actions required to safeguard
- personnel and equipment.
- be trained and competent in Permit Issue and Supervision of Work

- Limit to authorization

The authorization must be limited to areas over which the Permit Issuer has direct control of the working conditions and potential hazards.

3.3.5.11 Permit Acceptor

Guidelines for appointment:

- can be a BOC Gases employee or a designated contractor.
- is appointed by the appropriate engineering or line manager.

Relationship to other workers:

- The Permit Acceptor must be in line control and responsible for carrying out the work described in the work permit.
- The Permit Acceptor and other workers reporting to the Permit Acceptor carry out the work.

A sample planning checklist as well as a blanked permit to work form has been shown in the following two pages. By using the panning checklist, it is very easy to find out the requirement of a permit to work. Once it is established that a permit to work is required for carrying out a specific task, permit to work form is completed & permit acceptor is briefed well regarding the safety issues. Once the work is completed, the acceptor hand back the permit to work to permit issuer.

Permit No. _____

PERMIT TO WORK

1. Name of Department/Contractor _____
   No. of workers _____

2. Plan involved _____
   Work Area _____
   Work to be done _____

3. PRECAUTIONS

a) Atmospheric Check Frequency of Test: Start of Work ☐ Continuous ☐

	Time	Result	Time	Result	Time	Result	Time	Result	Time	Result
% Oxygen										
Explosive level										
Others										

b) Mechanical Isolation Yes ☐ No ☐
Isolated at _____

c) Electrical Isolation Yes ☐ No ☐
Isolated at _____

d) Hot Work
Gas/Electric Welding/Brazing Yes ☐ No ☐
Electrical Power Tools Yes ☐ No ☐
Specify Others _____

e) Supporting Certificates
i) Certificate for Lifting & Excavation ☐

f) Other Precautions
1) _____
2) _____
3) _____
4) _____

4. PERMIT TO WORK ISSUE AND RENEWAL
Permit Acceptor: I understandthe precautions to be taken and will instruct all concerned accordingly.

Issued from		Permit Issuer		Permit Acceptor		Workers	
Date	Time	Print Name	Signature	Print Name	Signature	Print Name	Signature
Valid To							
Date	Time						

5. HANDBACK
☐ The work is complete. The plant/equipment is safe and serviceable
☐ The work is not complete. This Permit is cancelled.

Date	Time	Permit Issuer		Permit Acceptor		Workers	
		Print Name	Signature	Print Name	Signature	Print Name	Signature

Serial No: _____

PLANNING CHECKLIST

HAZARD IDENTIFICATION

Hazard	Yes	No	Hazard	Yes	No
Confined Spaces	☐	☐	Flammable Gases/Liquids	☐	☐
Oxygen Deficiency	☐	☐	Electrical Equipment	☐	☐
Oxygen Enrichment	☐	☐	Work on Pipework	☐	☐
Corrosive/Toxic Gases	☐	☐	Hot Work/Flame	☐	☐
High Pressures	☐	☐	Ladders/Elevated Work	☐	☐
Steam/High Temperature	☐	☐	Moving Machinery/Crane	☐	☐
Cryogenic Temperature	☐	☐	Traffic	☐	☐

Additional Hazards

SAFETY PRECAUTIONS

Safety Precautions	Yes	No	Safety Precautions	Yes	No
Atmospheric Analysis	☐	☐	Depressurising	☐	☐
Oxygen	☐	☐	Temperature Normalisation	☐	☐
Flammable Gas	☐	☐	Area Isolated/Barriers	☐	☐
Toxic Gas	☐	☐	Warning Notices Posted	☐	☐
Ignition Sources Eliminated	☐	☐	Fire Extinguishers	☐	☐
Inert Gas Purging	☐	☐	Fire Hose	☐	☐
Forced Ventilation	☐	☐	Traffic Control	☐	☐
Fresh Air Supply	☐	☐	Hazardous Material Removal	☐	☐
Physical Isolation	☐	☐	Standby Man Available	☐	☐
Electrical Isolation	☐	☐	Lifeline	☐	☐

Additional Precautions

PERSONAL PROTECTIVE EQUIPMENT

PPE Required	Yes	No	PPE Required	Yes	No
Helmet	☐	☐	Gloves	☐	☐
Visor/Safety Spectacles	☐	☐	Safety Footwear	☐	☐
Ear Protectors	☐	☐	Protective Clothing	☐	☐
Breathing Apparatus	☐	☐	Safety Harness	☐	☐

Additional PPE Required

CERTIFICATES REQUIRED

	Yes	No		Yes	No
Atmospheric Analysis	☐	☐	Excavation and Lifting	☐	☐

AUTHORISATION

Activity	Yes	No		
Site Inspected	☐	☐	Name	
Procedure Agreed	☐	☐	Signature	
			Date	

KEEP COPY WITH WORK PERMIT
RETAIN ORIGINAL ON FILE

CHAPTER 4: ENGINEERING SAFETY

4.1 Introduction

NOSA deals with general safety For maintaining process safety as well as transport safety, BOC follows different tools that take care of all the processes. In BOCB there are several operational processes as below [3]:

- Transport Operations (TRO)
- Acetylene Production (ACE)
- CO2 Production (CO2)
- N2O Production (NTO)
- Air Separation Plant (ASU)
- Industrial Gases Compression (IND)
- Cylinder Maintenance (CMT)
- Customer Engineering Services (CES)
- Medical Gases Production (MED)
- Liquefied Petroleum Gases (LPG)

A lot of measures are in place to ensure engineering safety. These are as follows:

- IMSS (Integrated Management System and Standards)
- Engineering Audit
- Project Safety Review (PSR)
- Engineering Management of Change (EMOC)

4.2 Integrated Management System and Standards (IMSS)

- It is an entire knowledge management, training and assessment tool that has been created by BOC for BOC [3]
- Captures and stores knowledge about each specific site and process

- Enables BOC operators to access up-to-date knowledge required to run their business safely and effectively
- Provides an integrated standards, training and audit system
- Provides a tool to support continuous improvement and operational excellence
- Ensures that standards and procedures are the same throughout the group (can compare like with like).
- Ensures that training is done consistently and employees are competent in their job.
- Less effort & cost than manual/paper systems.
- Reduces the effort needed to audit and improves the quality of audits.
- Reduces the overall time and avoids duplication of effort on producing training material and work instructions.
- Can implement new projects faster and easier.
- Provides useful information for planning.

The prime aim of IMSS is to train the operators on different processes, which he operates. For example a person operating an Acetylene plant is trained thoroughly on how to run the plant safely, what are the standards to run this plant etc. A Training Need Analysis (TNA) is prepared for each group of people doing same type of job. A sample TNS looks like below:

Table 4.1: Training Need Analysis

ACE Training Needs Analysis

			Target Audience						
Number	Title	Scope	Filling Area	Generating Area	Inspection Area	Team Leader	Supervisor/ Manager	Maintenance	First Aid
ACE-01	The Dissolved Acetylene Process								
ACE-01-01	What is Acetylene	Global	●	●	●	●	●	●	
ACE-01-02	Dissolved Acetylene Production Process	Global	●	●	●	●	●	●	
ACE-01-03	Producing Dissolved Acetylene from Petrochemical Processes	Global	●	●	●	●	●	●	
ACE-01-04	Acetylene Operations - Hazards and Safety	Global	●	●	●	●	●	●	●

ACE-01-05	Lessons From Losses	Global	●	●	●	●	●	●	
ACE-01-06	General Emergency Procedures	Site	●	●	●	●	●	●	
ACE-01-07	Global Management Reporting and KPI's	Global				●	●		
ACE-01-08	National Management Reporting and KPI's	National							
ACE-01-09	About this Site	Site	●	●	●	●	●	●	
ACE-01-10	Acetylene Emergency Guidelines	Global	●	●	●	●	●	●	
ACE-02	**Supplying Calcium Carbide to the Generator**								
ACE-02-01	About Calcium Carbide	Global		●		●	●	●	
ACE-02-02	First Aid for Calcium Carbide Exposure	Global		●		●	●		●
ACE-02-03	Receiving and Storing Calcium Carbide	Global		●		●	●		
ACE-02-04	Calcium Carbide Fires	Global		●		●	●		
ACE-02-05	Calcium Carbide Spils	Global		●		●	●		
ACE-02-06	Dealing with Defective Calcium Carbide Containers	Site		●		●			
ACE-02-07	About Transferring Calcium Carbide to the Generator from Drums	Global		●		●	●		
ACE-02-08	About Transferring Calcium Carbide to the Generator from Bulk Containers	Global		●		●			
ACE-02-09	Emergency Procedures for Hot Drums	Global		●		●	●		
ACE-02-10	Purging Calcium Carbide Bulk Containers	Site		●		●			
ACE-02-11	Transferring Calcium Carbide to the Generator from Drums	Site		●		●			
ACE-02-12	Transferring Calcium Carbide to the Generator from Bulk Containers	Site		●		●			
ACE-02-13	About Handling Empty Calcium Carbide Drums	Global		●		●	●		
ACE-02-14	About Handling Empty Calcium Carbide Bulk Containers	Site		●		●			
ACE-02-15	Disposing of Empty Calcium Carbide Drums	Site		●		●	●		
ACE-02-16	Disposing/Maintaining Empty Calcium Carbide Bulk Containers	Site		●		●			
ACE-02-17	Emergency Procedures for Transferring Calcium Carbide	Site		●		●	●		
ACE-02-18	Dalmec Manipulator Troubleshooting and Maintenance	Site		●		●	●		
ACE-02-19	Ozone Dust Collector Operation	Site		●		●	●		
ACE-02-20	Maintaining the Ozone Dust Collector	Site		●		●	●		
ACE-03	**Generating Acetylene**								
ACE-03-01	About the Acetylene Generator	Global		●		●	●		
ACE-03-02	About ALDA Generators	Global		●		●	●		
ACE-03-03	About REXARC Generators	Global		●		●	●		
ACE-03-04	About AGA Generators	Global							
ACE-03-05	About Air Liquide Generators	Global							

ACE-03-06	Operating the Acetylene Generator	Site							
ACE-03-07	Cleaning the Acetylene Generator	Site		●		●			
ACE-03-08	Maintaining the Acetylene Generator	Site		●		●			
ACE-03-09	Emergency Procedures when Operating the Generator	Site		●		●	●		
ACE-03-10	Purging the Gasholders	Site		●		●			
ACE-04	**Carbide Lime Treatment**								
ACE-04-01	About Carbide Lime	Global		●		●			
ACE-04-02	First Aid for Carbide Lime Exposure	Global							●
ACE-04-03	Emergency Response to Carbide Lime Incidents	Global		●		●	●		
ACE-04-04	About Carbide Lime Treatment Plants	Global		●		●	●		
ACE-04-05	About Disposing of Carbide Lime	Global		●		●	●		
ACE-04-06	Operating the Carbide Lime Treatment Plant	Site		●		●			
ACE-04-07	Carbide Lime Spills	Global		●		●	●		
ACE-04-08	Determine Acetylene Content in Carbide Slurry	Global				●	●		
ACE-05	**Purifying, Compressing and Drying**								
ACE-05-01	About the Acetylene Purification Process	Global	●			●	●	●	
ACE-05-02	Operating a Scrubber/Purifier	Site	●			●			
ACE-05-03	Maintaining a Scrubber/Purifier	Site	●			●			
ACE-05-04	Emergency Procedures when Operating the Scrubber/Purifier	Site	●			●	●		
ACE-05-05	About Compression of Acetylene	Global	●			●	●		
ACE-05-06	Operating an Acetylene Compressor	Site	●			●			
ACE-05-07	Maintaining an Acetylene Compressor	Site	●			●			
ACE-05-08	Emergency Procedures when Operating the Compressor	Site	●			●	●		
ACE-05-09	About the Acetylene Drying Process	Global	●			●	●		
ACE-05-10	Operating Low Pressure Acetylene Driers	Site							
ACE-05-11	Maintining Low Pressure Acetylene Driers	Site							
ACE-05-12	Emergency Procedures when Operating the Low Pressure Drier	Site							
ACE-05-13	Operating High Pressure Acetylene Driers	Site	●			●			
ACE-05-14	Maintining High Pressure Acetylene Driers	Site	●			●			
ACE-05-15	Emergency Procedures when Operating the High Pressure Drier	Site	●			●	●		
ACE-05-16	Operating an Additional Acetylene Compressor	Site	●			●			

As per TNA, each person has be trained on different chapters allocated for him. This is a vigorous process. Every body takes theory as well as practical training. After completion of a chapter, the learner has to sit for an examination. BOC uses computer to take examination. A world known learning management system Traccess is used by BOC worldwide. Once a person is trained on his job, the probability of any process related accident reduces drastically

Similarly each process contains different chapters which cover the safe operating procedures of this specific process. BOC has a very strong Intranet where all this chapters are kept. Anyhody having the access of this Intranet can easily use these chapters as a tool to update himself.

4.3 Engineering Audit

Audit is done to provide management with a reliable and positive means for identifying and assessing risks within:

- operations
- engineering
- management systems, in order to effectively manage non-compliances and support continual improvement

IMSS Engineering Audit is a systematic evaluation of all operating sites against the standards specified in IMSS using standard questions contained in Audit Manager. Audit Manager is a web based auditing tools. Where deficiencies against the standards or hazards are identified then they are risk assessed and appropriate actions assigned.

Audit team member, typically from other sites, who are trained and competent in both auditing skills and the operations activity.

This technique is used to ensure that the site is operating and that all plant and equipment is in compliance with IMSS

4.3.1 Reasons for Audits

Audits are scheduled for various reasons, including:

- as directed in the Line of Business plan
- sudden increases in number or type of accidents
- task observations consistently showing substandard practices and/or conditions are apparent
- special request by line management
- past audit results
- high risk operations or processes
- company acquisition
- as a commissioning handover / acceptance check.
- as an input to the risk assessment, HAZOP or design processes.

4.3.2 Principles of Auditing

An audit is an inspection or examination of a facility or process, conducted to determine the level of compliance with relevant standards. In a BOC plant, for example, equipment and operating procedures might be examined and compared to existing Best Operating Practice, employee safety rules, product quality specifications, and environmental regulations. Based on the risk matrix shown below, BOC rates the hazards:

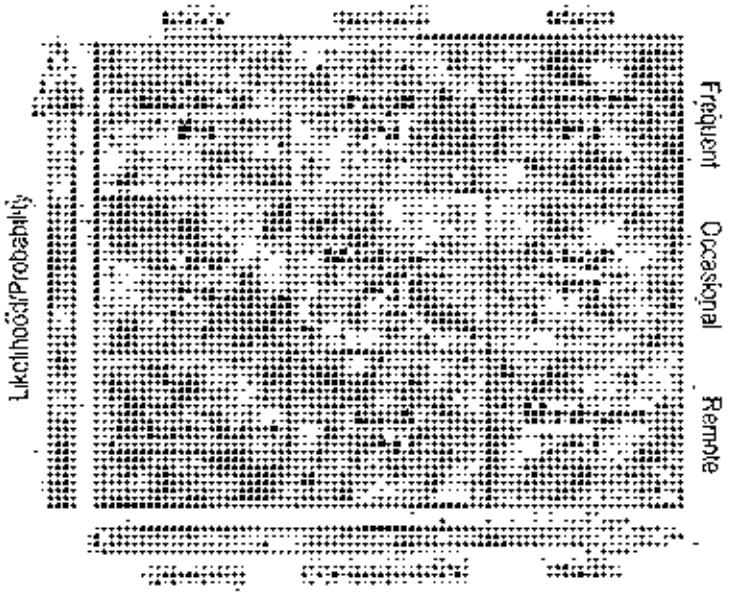


Figure 4.1: Risk Matrix

4.3.3 Priority Risk Ratings

A risk rating is a letter/number combination – P1, P2, P3 and P4 – assigned to a hazard to indicate a priority and level of risk to BOC [4]

The following headings briefly define each of the four ratings and offer examples.

4.3.3.1: P1: Severe Risk

A severe risk is defined as a situation where there is potential for a substantial loss to occur at any time, for example activities, situations or processes that may result in:

- off-specification product being supplied to the customer.
- major adverse impact on the environment.
- unsafe working conditions with immediate risk to employees.

Examples:

Examples of P1 hazards would include:

- a safety valve that clearly would not function
- use of a plate 2 mm (.080 in.) thick, in use as a bursting disc
- use of materials not compatible with the gas (for example, copper in wet acetylene service)
- frosted mild steel pipework from a cryogenic supply without any low temperature protection
- random sampling shows medical air in excess of 23% oxygen

4.3.3.2: P2 High Risk

High risk defined A situation where only one additional wrong action, or change in circumstance, is needed to create

the potential for a substantial loss. This includes the failure to implement a system element or widespread areas of non-compliance to a system element requirement.

Examples

Examples of P2 hazards would include.

- use of wet acetylene in dry acetylene service

• a non-approved type of bursting disc where the rated pressure is unknown

• a mild steel pipeline fed from a cryogenic supply via a vaporiser without low temperature protection.

4.3.3.3: P3 Medium Risk

A situation where an action is necessary to achieve compliance with BOC and/or local standards, but the non-compliance is not considered an immediate hazard. This includes isolated failures to comply with procedural requirements.

Examples:

Examples of P3 hazards would include:

• inadequate purge on tanker filling hoses

• seal on door to air filter house damaged

• critical instrument not tagged with set and trip points

• inadequate labelling of pipework.

4.3.3.4 P4: Low Risk or Best Operating Practice (BOP) Opportunity

A recommendation that, at the time of the audit, has little or no potential to cause loss This includes minor instances of non-compliance with procedural requirements.

BOP Opportunity This classification can be used to progress towards world class operations. When a site is not operating to best operating practice (BOP), as defined in IMSS, then an auditor may raise a P4 action. This action should highlight an improvement, which could be made, at the site's discretion, to improve the operation at that site and to reduce further the loss potential

4.3.3.5 Audit Findings

Audit issues (P1, P2, P3 & P4) must be resolved within specific duration of time:

- P1 Issue- must be solved within one month of audit closure
- P2 Issue-must be solved within six month of audit closure
- P3-issue must be solved within one year of audit closure

Hence by conducting engineering audit, BOC eliminate the process hazards.

Auditors use standard worksheet to evaluate the process under audit. Each process has standard audit sheets. Each audit sheet contains a set of questionnaire Specific guidance is found in the IMSS for each question. An audit sheet is shown below:

Auditor Worksheet

Audit Manager

Audit No: 13489 **Location** Narayanganj **Audit Description** New Audit

Audit Date. 17-Sep-2005 **Auditor** Mizan,& Khabi **Audit:** Internal Audit

BOC IND Industrial Cylinder Site Operations - 01 Hazards and Safety 0.5 Hour(s) to complete

Question		RP	Type/ Reference	Priority Rating	Comments
2	IND-01 ; Are the mechanical properties of storage/pipework/equipment that contains cryogenic liquid/liquefied gas compatible with the low temperature encountered. Reference : IND-02-01	1	Equipment IND-02-01		
3	IND-01 : Are storage/charged cylinders handled in accordance with approved procedures? Reference : IND-02-01	1	Operations IND-02-01		
4	IND-01 ; Other issues - Equipment	3	Equipment Not specified		
5	IND-01 ; Other issues - Operations	3	Operations Not specified		
6	IND-01 ; Other issues - Systems	3	Systems Not specified		

4.4 Project Safety Review (PSR)

Overview

The Project Safety Review (PSR) is a team-based, audit process, with a review meeting scheduled during each project stage The initial stage of a PSR aims to identify, or anticipate, the most significant hazards that might be encountered on the project so that a suitable safety strategy can be developed. As the project progresses. later reviews focus on [5] :

- identifying and addressing the hazards that are most important at that current stage
- ensuring that hazards identified earlier in the project have been actioned as planned and

- continuing to anticipate the hazards that may appear in future stages. The outcome from this process is a higher degree of confidence that all design, construction, environmental and operational hazards have been identified and their consequences minimised or eliminated.

The PSR process uses a question list to help identify possible hazards.
Actions to eliminate or mitigate these hazards are then identified and these actions are followed up during ongoing project progress meetings.

4.4.1 PSR Objectives

The key objectives for having and using a PSR process are to:

- ensure that design and review processes are being used on projects to identify and so address all Safety, Health and Environment (SH&E) hazards and thus minimise the level of risk exposure on the project.
- ensure that all aspects and consequences of a particular project have been considered. This includes both:
- the impact of the new or changed facilities upon the existing plant and it's neighborhood, as well as,
- all the transient conditions that will exist on the new plant, either during construction or operation.
- provide a framework for ensuring compliance with the BOC Group Policy on Safety, Health and Environmental Management and the national legislation in the countries where we operate.
- improve safety communications on projects, by giving all the groups that participate in PSRs a clear understanding of their specific responsibilities and actions.
- provide consistency in addressing SH&E issues, on-site and off-site, for all new projects and for modifications/ additions to existing sites.
- give a basis for structured, qualitative auditing of project execution performance in addressing SH&E issues.
- have a consistent but flexible process to cover large and small projects, involving any technology.
- provide important information to management on identified and residual risks.

4.5 Engineering Management of Change (EMOC)

Overview:

Changes to process, process control, equipment, technology, procedures and facilities can introduce new hazards and a formal approval procedure is required to properly control changes that could result in injury or loss. The formal approval procedure is known as Engineering Management of Change (EMOC).

Changes or modifications requiring approval will normally arise from one of the following [6]:

- Projects and other works initiated by site Engineering or Management.
- Modifications arising from maintenance staff during their work on plant, equipment or process.
- Audits, including self, external, quality, etc.
- Corrective Action Requests.
- Process reviews.
- Risk assessments.

The MOC procedure is intended to:

- Control changes or modifications that could be hazardous.
- Ensure changes are reviewed and authorised by a technically competent person.
- Prevent changes from introducing unacceptable hazards to personnel, the environment or safe operation of the plant/process/equipment.
- Develop an audit trail through appropriate documentation
- Ensure all operating procedures, maintenance records, training and drawing records are accurate and up to date.

Following is a list of principles upon which the procedures in this chapter are based:

- All changes whether assessed as minor (insignificant change or correction), emergency (urgent) or major shall be formally recorded at the operating unit level in the MOC log or register.
- A minimum of two signatures shall endorse the status of any actual or proposed change. This includes the person proposing or performing the change and the Change Approval Authority or the Nominated Technically Competent Person.
- The MOC system should incorporate a support mechanism for telephone authorisation followed by written confirmation (for example, email, fax memo, etc.), within 12 hours for any emergency change proposed. Such support shall be consistent with requirements of the category of change in question.
- No change shall be implemented without an entry in the MOC log or register and appropriate authorisation required by that category of change.
- Follow-up procedures, approvals and closeout of actual or proposed changes must be completed for all defined categories of change.
- All changes must be signed off as approved by a nominated Change Approval Authority.
- Document update methods appropriate to the category of change shall be in place.
- Update and review of records shall take place by local and line management and by auditor and functional resources as scheduled or if required.
- All changes must have an appropriate safety, health and environmental review.
- Follow-up monitoring and auditing.

CHAPTER 5: SAFETY RELATED PROBLEMS IN BOCB & THEIR SOLUTIONS

5.1 Introduction:

If we analyze the accident/incident statistics, we will easily see that major areas where there is much potential to an accident be occurred are as follows:

- Transport
- Manual handling
- Process related
- Unsafe condition
- Unsafe act

Accident/incident that occurred during last financial year in BOCB have been studied. Table below shows the statistics:

Table 5.1: Accident/Incident Statistics

	Incident Analysis up to September-06 (FY-05-06)				
Incident Types	Manual Handling	Process	Transport	Customer	Total Incidents
No of Incidents	11	11	40	6	68

	Incident Analysis up to September-06 (FY-05-06)				
	Manual Handling	Process	Transport	Customer	Total Incidents
October '05	0	0	2	0	4
November '05	0	0	0	0	0
December '05	1	3	5	0	12
January '06	2	0	3	0	8
February '06	0	0	5	0	7
March '06	2	1	2	1	6
April '06	0	1	2	0	6
May '06	3	1	3	0	8
June '06	2	1	5	1	12
July'06	0	3	5	1	11
August'06	0	0	6	1	8
September'06	1	1	2	2	6
Total Incidents:	11	11	40	6	68

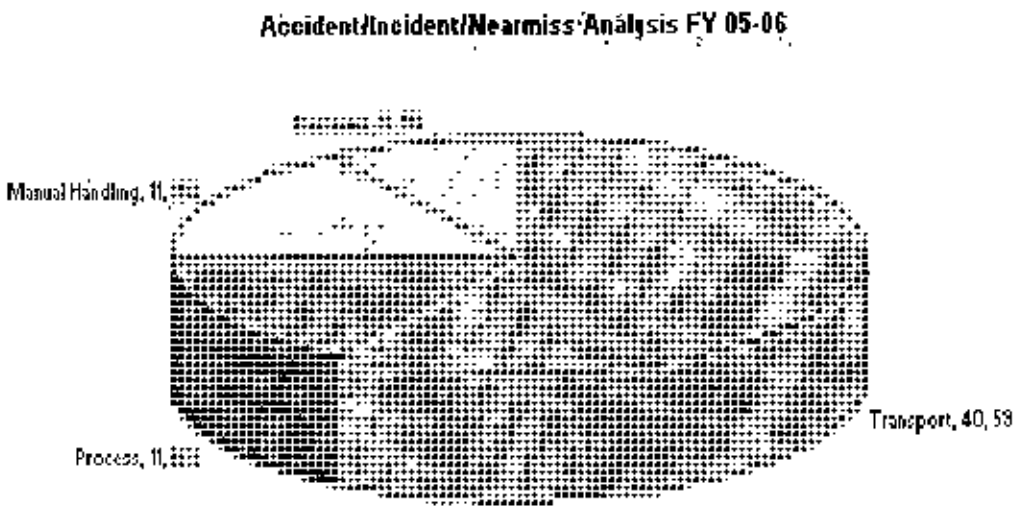


Figure 5.1: Accident/Incident Analysis FY 05-06

If we represent the data graphically, we will see that about 40% of the incident/accident are transport related. So transport is the most vulnerable area for BOCB in terms of safety. Other major areas of concern are:

- Manual Handling-11%
- Process related-11%

If we want to reduce accident in BOCB, we have to reduce accident in these areas. I have some specific recommendation to reduce such kind of accident.

5.2 Transport Related Accident:

5.2.1 Problem Description

BOC Bangladesh limited operates a pool of transports for its distribution activities. From the graphical representation shown above, we find that about 60% accident/incident that have taken place during last year came from transport operation. So if we can reduce transport related accident, total overall accident will be reduced drastically.

Asian development Bank carried out a survey on road accident/incident in South East Asia. As per ADB's report-2004, fatalities of 385000 occurred during 2004 in South East Asia. So transport operation is a vulnerable issue. So it is needless to say that we have to concentrate more in preventing road accident.

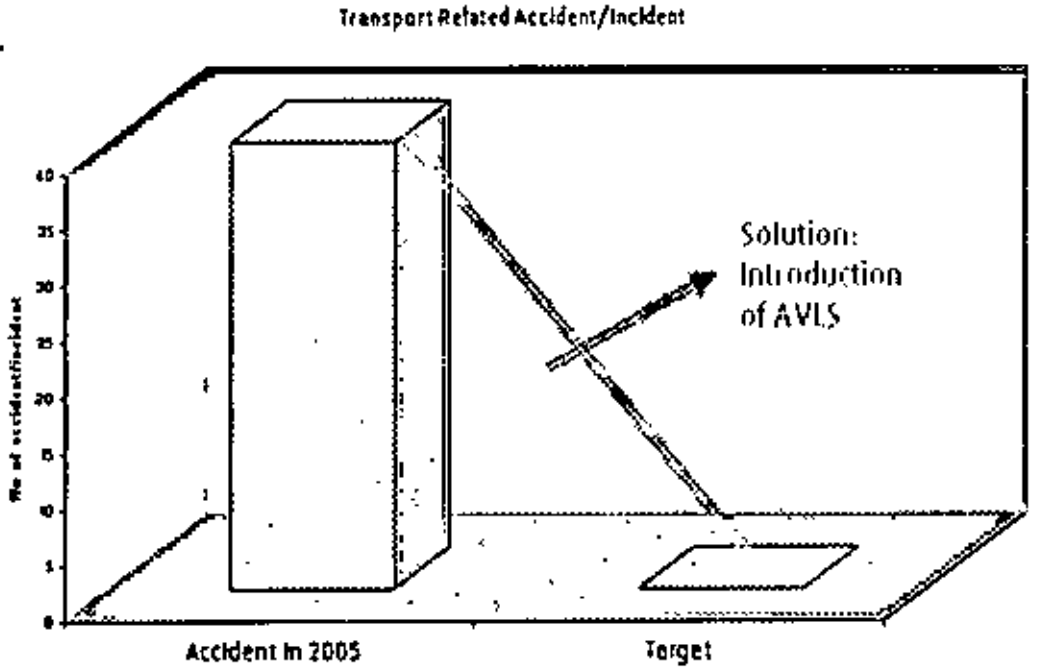


Figure 5.2: Transport Related Accident

5.2.2 Causes of Road Accident

After analyzing previous transport related accident/incident, it is found that in most of the case accident occurred due to:

- reckless driving
- over speeding
- harsh breaking etc
- route changing
- unauthorized parking

All of these accidents can be prevented if we can introduce a tool, which can monitor our vehicle closely. AVLS is a kind of tool, which can monitor any vehicle closely as such we can reduce transport related accident.

5.2.3 Solution (proposal to reduce road accident)

Our target is to reduce the road accident to zero. As I have mentioned that most of the accidents occurred due to reckless driving, over speeding, harsh breaking etc. These all are related to close monitoring of the driver as well as vehicle. It is true that once the drivers go out side of a factory they become absolutely free from close monitoring by supervisor. That leads them to become aggressive during driving.

If we can introduce a tool, which is very powerful in tracking the vehicle from remote, drivers will become more conscious. AVLS is such kind of a tool.

5.2.4 What is AVLS?

AVLS is Automatic Vehicle Location System, which if installed in a vehicle is capable of providing some real time information as listed below:

- Harsh-breaking
- Harsh acceleration
- Over-speeding
- Excessive Idling
- Un-authorized movement

This information can be received from anywhere in the world. All we need to install a very tiny device in the vehicle. This device gives all information needed by using satellite. We can monitor all information needed from our computer.

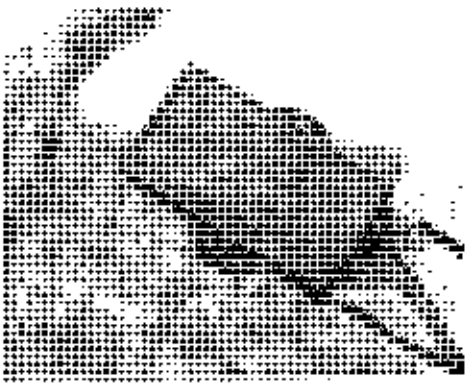


Figure 5.3: GPS/GSM Tracking Device

Pictures below represent how the system works:

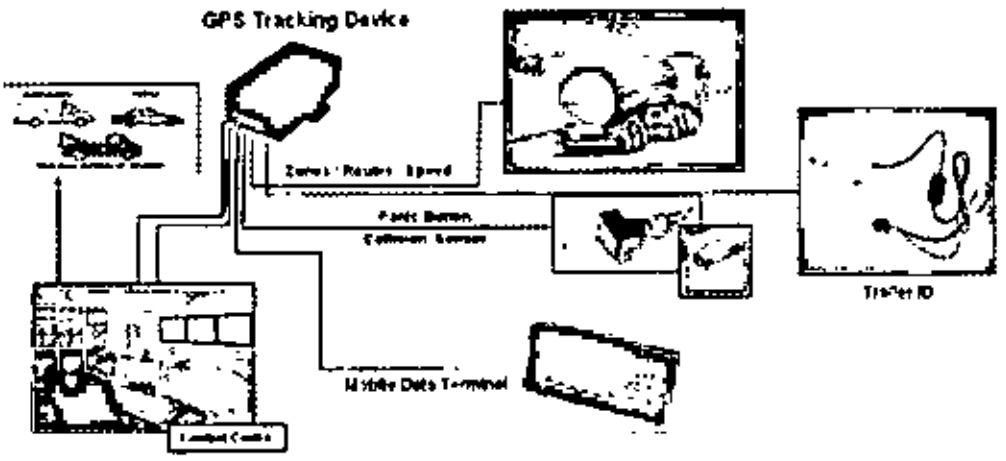


Figure 5.4: GPS/GSM Tracking System

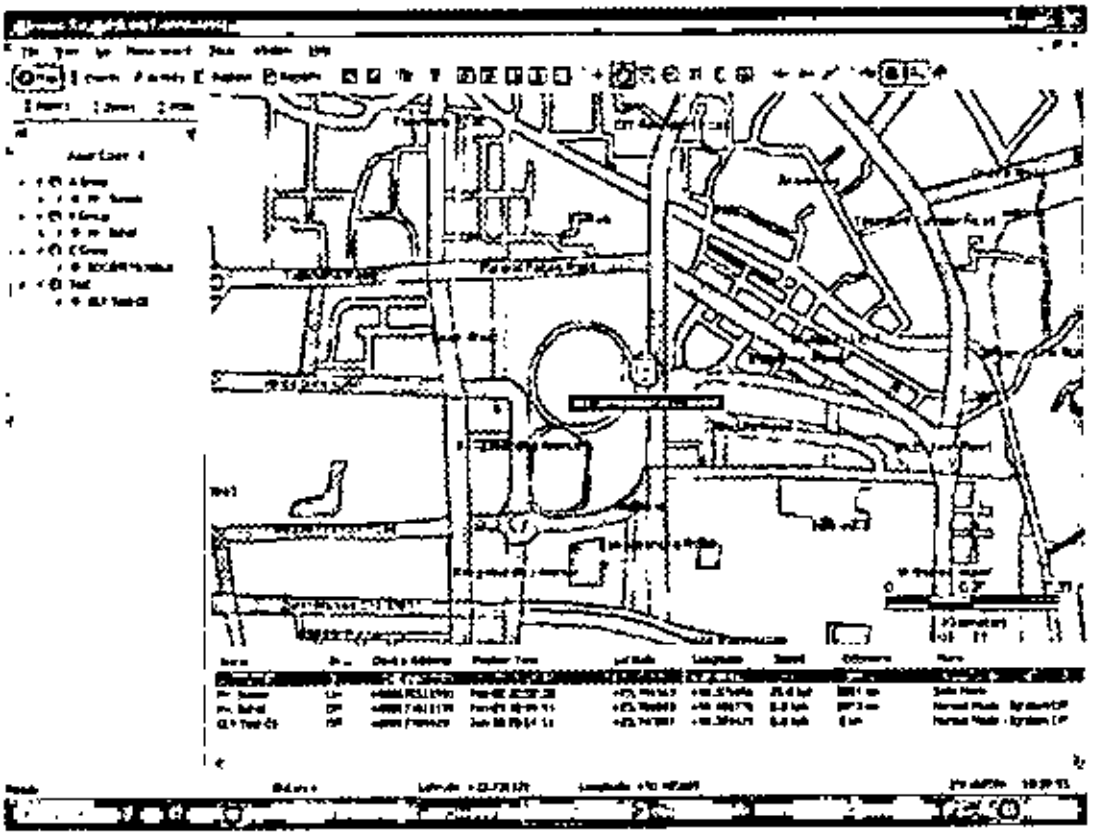


Figure 5.5: A Vehicle on Dhaka City Map

5.2.5 Benefits

- Reduce accident rate as drivers know that they are monitored
- Reduce fuel cost
- Real time tracking
- Perfect transport scheduling
- Reduction of operating cost
- High efficiency
- Unauthorized movement
- Provides some valuable reports
- Drivers profile
- Vehicle can be traced if theft

5.2.6 Cost Elements

During last financial year, a total number of forty accidents related to transport have been reported. Out of these forty accidents, no fatality occurred. But if we consider the loss of property, it is quite a big amount. Although no such calculation has been done to find out exact financial loss out of these accidents, we can easily visualize that the amount is huge. Quotation has been obtained from an AVLS provider, which has been shown below:

Table 5.2: Quotation for hardware

HARDWARE (IMPLEMENTATION & INSTALLATION) – (ONE TIME)

ITEMS	DESCRIPTION	QTY	UNIT PRICE(BDT)
1	**Sirius Lite** Tracking Device Installation with Panic Button *	1	**39, 000/-**
2	Cellular Network Card with GPRS Enabled	1	
3	Other electrical component devices to integration with **Sirius Lite** Tracking Device	1	
Total inclusive of Local Taxes and Levis (1 Unit Vehicle = One Time Installation and Configuration Charge)			**Tk. 39,000/-**

Table 5.3: Quotation software

SOFTAWRE (INSTALLATION & CONFIGURATION) – (ONE TIME)

ITEM	DESCRIPTION	QTY	UNIT PRICE (BDT)
1	Real-Time Vehicle Control System Server System Installation & Configuration the following servers: • *JMS Server* • *Sirius XP Server* • *Sirius XP Gate* • *Sirius XP Client* • *GSM Modem* • *Map License* * *Training for Server Management and Service Operation for 3 persons per location*	1	2,00,000/-
Total inclusive of local Taxes and Levis (Real-Time AVLS Monitoring Server for Single Sites)			Tk. 2,00,000/-

In word (Taka Two Lac Only)

Table 5.4: Quotation for service charge

SUBSCRIPTION, SERVICE & MAINTENANCE CHARGES – (MONTHLY BASIS)

ITEM	DESCRIPTION	QTY	UNIT PRICE (BDT)
1	Service Charge for unlimited Map Upgrade		1,000/-
2	Service charge for GLP firmware update	1	
3	Service Charge for Server Software Maintenance and Continuous Upgrade		
4	Subscription Charge for Cellular Network Card with SMS & GPRS facility	1	
5	Service Charge for GPS Service	1	
6	Service Charge for GLP Maintenance & Warranty	1	
Total inclusive of Local Taxes and Levis (1 Unit Vehicle – Monthly Charge)			Tk. 1,000/-

5.2.7:Cost per Month per Vehicle if AVLS is installed

BOCB has thirteen road tankers carrying hazardous gases. As per the quotation, if AVLS is installed on these thirteen vehicles, cost will be as follows:

Fixed Cost:

1 Installation & configuration of soft ware – BDT 200000 00 (as per quotation)

2 Hardware Installation- 39000 X 13 = BDT 507000.00 (as per quotation)

Total Fixed Cost (One Time) = BDT 707000.00 (1 + 2) which may be considered as total project cost.

Running Cost:

Running cost per month per vehicle is BDT 1000 00 only. So total running cost per annum is = 13 X 12 X 1000.00 = BDT 156000 00

Fuel Cost:

Table below shows the distance traveled & fuel consumption by all thirteen tankers during last BOCB financial year.

Table 5.5: Distance traveled & fuel consumption

Distance travel by tankers

TankerNo	Oct '05	Nov '05	Dec '05	Jan '06	Feb '06	Mar '06	Apr '06	May '06	Jun '06	Jul '06	Aug '06	Sep '06	Total
1311	1433	928	1072	464	750	558	1079	510	885	629	556	318	9212
11-0007	9027	10579	3615	1308	2845	3239	1636	1460	996	2043	1352	1606	39906
11-0030	1187	6556	9113	4747	3157	5405	5087	5885	6229	6917	11879	8211	74373
09-0013	8742	3702	3480	340	0	0	0	0	0	0	0	2086	18350
09-0014	10363	1252	3642	3642	5069	6077	5162	5339	5266	6551	5453	6677	64493
11-0005	6007	6329	7991	1386	2916	6595	4915	2277	5852	6592	13497	0	66357
11-0006	941	903	1400	704	215	1396	1555	546	3251	7711	7973	7271	33866
11-0028	12305	12379	1118	3551	2461	6392	4238	4951	3557	2452	5010	4490	62914
11-0029	12017	12003	9697	6838	6207	8518	7741	9458	7121	8142	6758	8125	101625
11-0014	5537	4468	0	0	0	0	0	110	1293	859	1675	995	15040
11-0033	0	0	5203	4968	5638	9603	9850	9686	8963	8404	14564	14521	81299
11-0036	0	0	2471	2471	5954	2249	6110	3019	409	512	2165	6349	31709
11-0121	12975	12339	8985	2118	5052	6967	8454	3601	8771	6590	6655	7356	89064
	80634	73438	57788	31537	40264	57029	55827	46851	52593	57402	77537	68108	699008

Fuel consumed by tankers

Tanker No	Oct '05	Nov '05	Dec '05	Jan '06	Feb '06	Mar '06	Apr '06	May '06	Jun '06	Jul '06	Aug '06	Sep '06	Total
1311	363	225	307	126	158	147	313	91	212	147	178	110	2379
11-0007	2489	2906	932	427	773	890	594	289	409	604	458	474	11147

11-0030	270	1504	2070	961	642	1153	1077	1236	1348	1188	2715	1922	19085
09-0013	1849	798	615	60	0	0	0	0	0	0	0	500	4022
09-0014	1979	288	737	704	929	1157	901	1049	1026	1253	1116	1301	12440
11-0005	1321	1588	1564	276	588	1350	1009	452	1238	1417	2831	0	13644
11-0006	261	250	400	199	65	352	406	140	820	1729	1695	1710	8027
11-0028	3774	3724	331	1068	774	1947	1325	1517	1139	762	1568	1449	19378
11-0029	3765	3674	2962	1799	1876	2594	2379	2959	2193	2454	2157	2526	31335
11-0014	1353	910	0	0	0	0	0	30	399	240	477	297	3706
11-0033	0	0	1620	1485	1712	2392	2928	2947	2741	2586	4556	4556	27527
11-0036	0	0	579	579	1436	525	1465	726	98	128	496	1549	7561
61-0121	3660	3474	2770	660	1456	2003	2367	1119	2510	1871	1878	2166	25944
	21084	19249	15087	8345	10419	14510	14764	12564	14133	14379	20127	18562	183218

From the data shown above:

Average monthly travelling by a tanker is 699008/(12*13)= 4480 Km

Average monthly fuel consumption by a tanker is 183218/ (12*13)=1175 Litre

Amount of fuel per Km per vehicle is 1175/4480 = 0.262 Litre

Cost of fuel per month per vehicle is 1175 * 33 = BDT 38775.00 (Diesel Cost per Litre is BDT 33.00)

If AVLS is installed, the movement of the vehicle can be monitored easily. Driver will not change the route that has been assigned to him. This will save fuel Also hard breaking and harsh acceleration consumes more fuel than normal Since AVLS will prevent hard breaking, harsh acceleration and unauthorized routing, it will definitely save fuel cost as well as maintenance cost.

If we consider 5% fuel saving due to avoiding hard braking, harsh acceleration and unauthorized route, the amount is 5% of 1175 Litre = 59 Litre which is BDT 1947.00 Per month per vehicle.

Total Cash inflows per year from this savings = 1947 X 13 X 12=BDT 303732.00

So annual net cash inflow =Cash inflows per year- annual running cost of AVLS

=BDT 303732.00-BDT 156000.00= BDT 147732.00

5.2.8: Net Present value Analysis of the Project

Under the net present value method, the present value of all cash inflows is compared to the present value of all cash outflows that are associated with a project. The difference between the present values of these cash flows, called the net present values, determines whether or not a project is acceptable.

In our case, if AVLS is installed, it will incur a total cost of BDT 707000.00. If we consider the life of the equipment as ten years, salvage values after ten years will be zero. Annual net cash inflows may be considered as the difference between annual savings and annual running cost. If we summarize:

Table 5.6: Project Summary

Initial Cost----------BDT 707000.00
Life of the project, years----------10
Annual net cash inflows----------BDT 147732.00
Salvage Value----------0
Required Rate of Return----------14%

Now it is to be justified whether or not BOCB should go for this project. Table below shows the NPV analysis of the project:

Table 5.7 Present Value Analysis

Item	Years	Amount of Cash, BDT/year	14% factor	PV of cash flows, BDT
Annual cost savings	1-10	147732	5.216* (by using table*8)	770570
Initial Investment	Now	(707000)	1	(707000)
			Difference	63570

According to the analysis, BOCB should go for the project, as the net present value of the project is positive. This positive value justifies the project.

5.3 Manual Handling Related Accident

5.3.1 Problem

Manual handling injury is one of the most common risks that will be encountered at home and work. Manual handling injuries can damage:

- the ability to continue work
- the quality of home life
- people's long term well-being

Everybody needs to take responsibility for reducing the chance of injury by manual handling. Manual handling injuries are commonly caused by [7]:

- moving excessive loads
- awkward movements of the body
- twisting
- over stretching
- excessive repetitive actions
- losing control of an object being moved
- placing part of the body where it can be cut or crushed

From the analysis of accident/incident shown previously, we see that about 11% accident was related to manual handling. Major volume of manual handling at BOCB includes:

- Cylinder churning
- Cylinder painting

These two jobs can be done in a better-organised way so as to avoid accident.

5.3.2 Manual Handling Related Accident-Cylinder Painting

Problem:

Manual handling risk assessment often identifies painting cylinders by hand as an issue because of the nature of the job. It requires stretching and twisting of the body while painting of a cylinder. Rotating a cylinder by hand during painting is always kept the painter in risk. Picture shown below demonstrates this:

A questionnaire has been prepared to find out the feed back from the painters about the difficulties they are facing while painting. This questionnaire contains seven questions, which are as below:

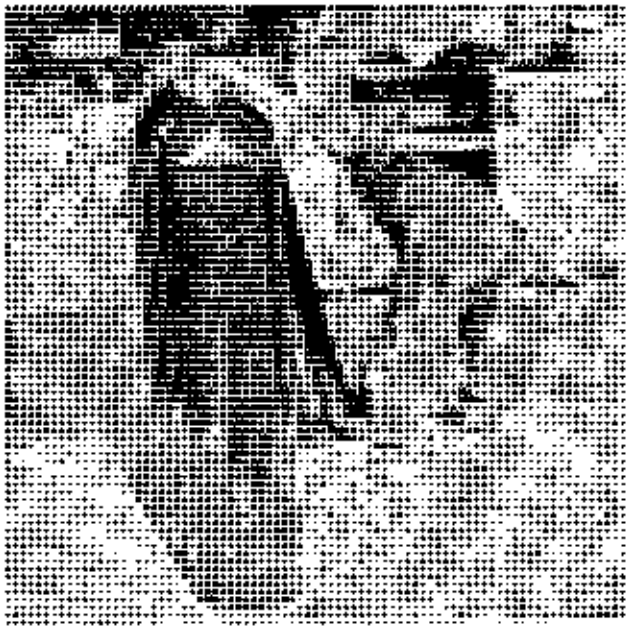


Figure5.6: Cylinder Painting-Manually

Ergonomics Survey on Painting Cylinder Manually

Employee Name: **Employee #**

Circle applicable answers or fill in:

1 Are you experiencing any discomfort?

YES/NO

2. Do you feel any pain on your backbone?

YES/NO

3. Does the fume of paint create problem while taking breath?

YES/NO

4. Do you feel stretch while rotating the cylinder?

YES/NO

5. Have you had any visit to doctor recently for any illness/ pain, which you think, is an outcome of your job?

YES/NO

6. Do you think that if the cylinder could be rotated automatically would give you an ease of painting?

YES/NO

7. Do you think that an adjustable painting roller can help you in relieving body stretch?

YES/NO

EMPLOYEE COMMENTS: _____

_____

_____

_____

_____

BY: (date)

COORDINATOR/EVALUATOR COMMENTS FROM OBSERVATION: _____

_____

This questionnaire has been given to five painters. Most of them have back pain. They are also facing problem of inhaling paint fume while painting. Some of them have visited doctor due to arm pain or back pain. They have appreciated the idea of introducing a semi-automatic painting machine.

Considering the risk involved in painting cylinders, a proposal of a semi-automatic painting machine has been proposed to BOCB. BOCB has agreed on the proposal.

Solution:

Drawing shown below is a simple machine to paint a cylinder.

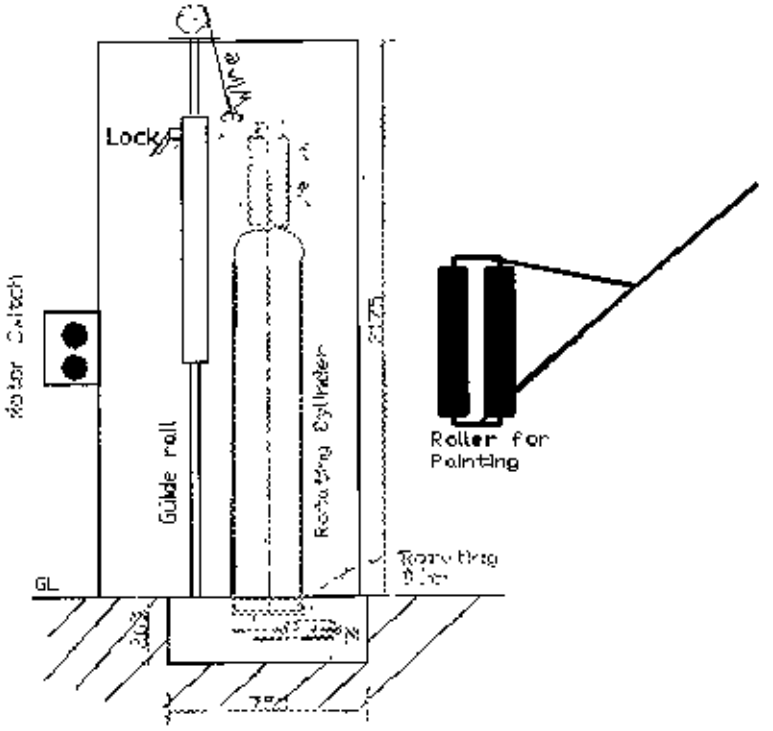


Figure 5.7: Cylinder Painting Machine-Semi-Automatic

The gas cylinder is placed on a rotating disc, which is driven by a geared motor placed underneath as shown in the figure. The speed of the motor is 75 rpm. A sleeve with ball

bearing runs on a guide rail and is balanced by a counter weight on the rear of the machine for easy handling of the machine.

This special type of painting brush (As shown in the drawing) needs to be used to paint the cylinder while it is rotating. With this painting equipment it will never necessary to bend the back or knees. At the same time the risk of inhaling the paint fumes will be reduced.

5.4 Process Related Accident-High Pressure Oxygen Filling Hose Failure:

5.4.1: Problem

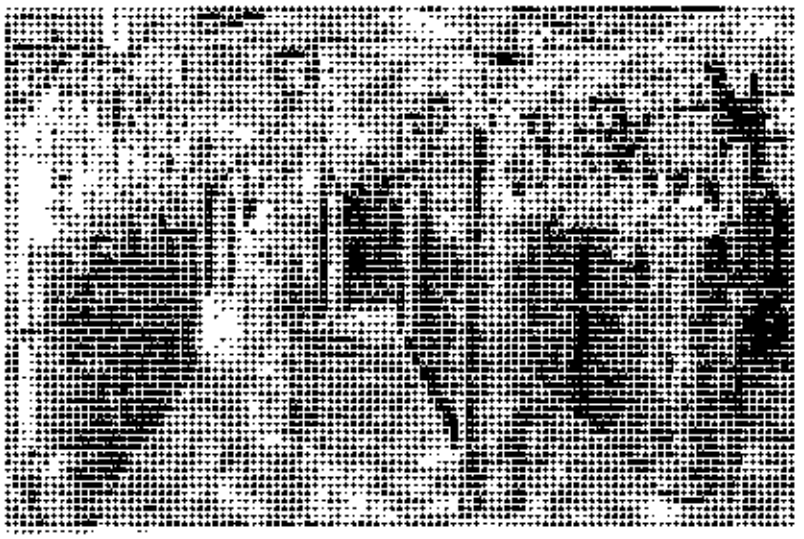


Figure5.8: Cylinder filling Arrangement

High pressure filling hose is one of the most vulnerable equipment in the filling system. A lot of accidents have been reported during recent years on filling hoses. I have studied some of these accidents and tried to analyze the cause of the accidents. Some of these accidents have been described here with probable causes & lesson learnt:

1. O Ring Ignition

Incident — An incident occurred in Sagorika compressing station involving an oxygen ignition caused by contamination of an o-ring on a filling connection.

Cause — The cause of the O ring ignition was that there was an absence of condition monitoring.

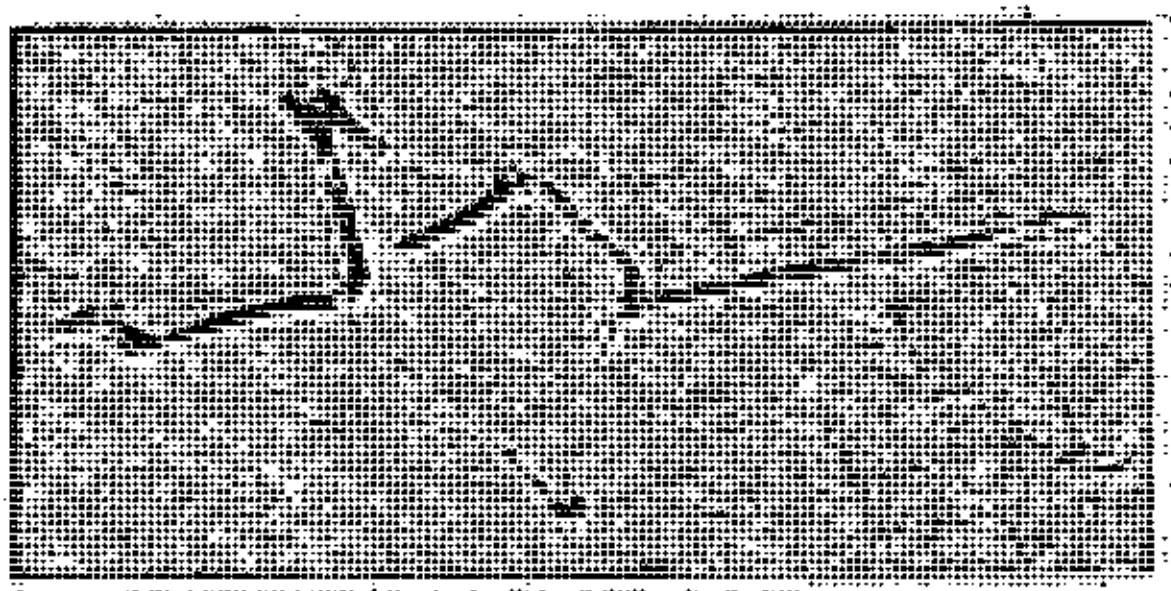
Lesson Learnt — The lessons learnt from this incident are:
Before use, check that O rings are undamaged and free from burrs or contamination.
Only use approved O rings that have been supplied in sealed bags from stores.

2. Ignition and Hose Failure due to Contaminated Valve

Incident — This incident occurred at Shitalpur Compressing Station. Oxygen cylinders had just been filled and the operator had just started shutting the first cylinder valve when the hose connecting the manifold to the vent/fill paperwork burst with a loud bang and subsequent sparking

Cause — The main cause of this incident was contamination on the cylinder valve.
The hose failure was a secondary event.

Lesson learnt — The lessons learnt from this incident is:
No connection should be made to a cylinder that is contaminated with any foreign material.



3. Hose Leakage

Incident	A leakage was found in a filling hose while filling at Rupgonj factory on 28/01/06. The hose was put in service just a day before of the accident. At the time of leaking the pressure of the system was 500 psig. The hose had been isolated immediately.
Cause	The causes of this incident were: Lack of inspection of the hose prior to put in service The hose was not hydraulically tested at BOCB facility before put in service
Lesson learnt	The lessons learnt from this incident are: Each hose must be checked thoroughly before put in service Each hose must be hydraulically tested before put in service

Figure 5.10: A Filling Hose with leakage

4. Contamination

Incident	On 25/07/05 at Sagorika compressing station, a filling hose under 1900 PSIG had been ruptured. A spark had been observed at the time of hose failure.
Cause	The main cause of this incident was contaminated filling hose/valve
Lesson learnt	Contaminated hoses/valve **must** not be allowed during filling operation

5.4.2 Solution

Heat Sink	Heat sink at both ends of a PTFE lined flexible hose will reduce the risk of hose ignition. Where rapid pressurization can occur in an oxygen system, leading to temperature increase at dead ends, heat sink will quickly dissipate the heat to surrounding. Considering the hose length & cylinder height, it is recommended that a high-pressure copper pipe of six-inch length should be used as heat sink.
Clean flexible hoses	Flexible hoses **must** be clean. Hoses should be delivered in individually sealed plastic packages. Hoses in service **must** be degreased periodically as per standard procedures.

Periodical inspection

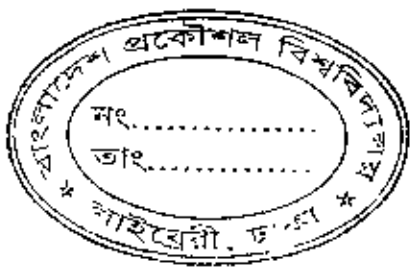
With constant usage, the mechanical properties of flexible hoses can be expected to deteriorate. Periodical inspection **must** be followed as per maintenance schedule/condition based monitoring. I have developed a maintenance schedule for periodical inspection of the hoses. This will reduce the likelihood of hose related accident.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

Industrial growth in production sector is increasing day by day in our country. In order to achieve healthy working environment, it is obvious that one should follow safety rules & regulations strictly. This will bring productivity as well. In developed countries, a lot of money is being spent on implementation of industrial safety. Even in our country some advanced organizations are spending a lot of money on implementation of safety. Because they know that safety brings back money for their organization.

Engineering safety as well as general safety of BOC Bangladesh limited has been studied carefully to know about industrial safety. House keeping, fire fighting etc has been considered as general safety. By following general safety, one can easily keep the organization tidy. In engineering safety, process related hazards are discussed. Mitigation process has also been described in this section.

Finally some proposals have been made to improve the safety as well as quality of working life of the operators. Since most of the accidents are transport related, it has been suggested BOCB to implement AVLS. It will help closely monitoring of the vehicle as well as driver. If the drivers know that they are being observed, they will be careful while driving. They will not violate the set rules and regulations. Painting machine will reduce the volume of manual work. This will also help the painters to prevent direct inhalation of paint fumes. It will save them from occupational health injury. Finally by implementing the guidelines given for maintaining high pressure filling hose will help to reduce hose related accident.



References

1. Perini, Rob, "How BOC is Managed" BOC Intranet, December 2001
2. "NOSA Five Star System" A publication by Samtrac, January 1996
3. Surman, D, "About BOC Global Technical Authority" BOC Intranet, December 2004
4. Flewitt, Jim & Cooper, Steve , "Auditing in BOC " BOC Intranet, June 1997
5. Holland, Grant & Hegarty, Neil, "Project Safety Reviews" BOC Intranet, February 2003
6. Lake, Jas & Currie, Dr. Jim , "Engineering Management of Change" BOC Intranet, June 2002
7. Blackwell, John, " Management of Manual handling & Repetitive Work" BOC Intranet, June 2005
8 Garrison, Ray H & Noreen, Eric W, " Managerial Accounting" M^{C}Graw-Hill, 2004-2005. Ninth Edition