M.Tech Dissertation

on

GAP ANALYSIS ON HAZARD IDENTIFICATION, RISK ASSESSMENT & DETERMINING CONTROL OF BOLERO PRODUCTION UNIT

Submitted by

Md. Tanveer Alam

R080213036

In partial fulfillment for the award of the degree of

Master of Technology

in

Health, Safety and Environment

Under the guidance of

Dr. N. A. Siddiqui

Prasanjit Mondal

DEPARTMENT OF HEALTH, SAFETY, FIRE AND ENVIRONMENT
COLLEGE OF ENGINEERING STUDIES
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
DEHARADUN

2015

UNIVERSITY OF PETROLEUM AND ENERRGY STUDIES, DEHRADUN

BONAFIDE CERTIFICATE

Certified this titled "Gap Analysis on Hazard identification, Risk Assessment & Determining Control of Bolero Production Unit" is the bonafide work of **Md. Tanveer Alam (R080213036)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

GUIDE

DR. N. A. Siddiqui

(Head & Associate Professor)
Department of HSE
UPES, Dehradun

Prasanjit Mondal

(Asst. Professor)
Department of HSE
UPES, Dehradun

Company Certificate

Mahindra

Mahindra & Mahindra Ltd.
Automotive Sector,
Sector - 5, Integrated Industrial Estate,
SIDCUL Haridwar (Uttarakhand) - 249 403

Tel : (01334) 239181, 82, 83
Fax (01334) 239184

11th April, 2015

To Whom It May Concern

This is to certify that **Md. Tanveer Alam** S/o Md Shakil Azam, University of Petroleum & Energy Studies, Dehradun, has successfully completed Industrial Training from **14th January 2015** to **11th April 2015.**

He has completed his project **Gap Analysis on Hazard Identification, Risk Assessment & Determining Control of Bolero PU**
Under the guidance of Project guide Mr. Amrinder Sandhu – Deputy Manager – Admin.
His Rating about Project is **Excellent.**

During this period we found him Sincere, Enthusiastic, & Hardworking.

We wish him all the best for his future assignments.

Thanking you,

For MAHINDRA & MAHINDRA LIMITED

11/04/15

Pooja Verma
Manager - HR

Regd. Office: Gateway Building Apollo Bunder, Mumbai-400 001.
CIN NO : L65990MH1945PLC004558
www.mahindra.com
Tel +91(22)22021031
Fax +91(22)22875485

Declaration

I, Md.Tanveer Alam hereby declare that the project work entitled "**Gap Analysis on Hazard identification, Risk Assessment & Determining Control of Bolero Production Unit"** is a bonafide work done by me under the guidance and supervision of **Mr. A. P. S. Sandhu**, Deputy Manager - S, OH &E, Mahindra & Mahindra Ltd. Haridwar. The work has not formed part of any earlier studies for the award of degree fellowship.

Md. Tanveer Alam
(Roll no.-R080213036)
Date: 21/04/2015

Acknowledgement

I thank and praise **GOD ALMIGHTY** who has been an unfailing source of strength and inspiration for the grace he has showered upon me in the completion of this project work.

To start with we would like to thank my institute, University of Petroleum And Energy Studies, for providing me this opportunity. I would also like to thank my Head of the department & my college guide **Dr. Nihal Anwar Siddiqui** for his encouraging words and deeds through this project.

I express my sincere gratitude to my industry mentor **Mr. A.P.S. Sandhu**, Deputy Manager - S, OH &E, Mahindra & Mahindra Ltd. Haridwar for his valuable guidance, continuous support and co-operation throughout my project, without which the present work would not have been possible.

I would like to express my deep sense of gratitude and respect to my co-guide **Mr. Prasanjit Mondal,** Faculty in Department HSE, UPES for the efforts he have taken in guiding me through every phase of my project.

I would like to thank **Mrs. Pooja Verma**, Manager-HR, Mahindra & Mahindra Ltd. Haridwar for her kind permission to carry on my project work and her cooperation.

I also wish to acknowledge **Mr. Sanjeev Chahar**, Safety Officer, Mahindra & Mahindra Ltd. Haridwar for giving his valuable time to me in order to complete the project.

Last but not the least I would also like to thanks to entire staff and employees of Mahindra & Mahindra Ltd. Haridwar, for the constant support and help in the successful completion of project. Finally, yet importantly I would like to express my heartfelt thanks to all faculties & my friends for their help and enthusiastic encouragement for the successful completion of this project.

Md. Tanveer Alam

Abstract

Hazard Identification is a proactive process to identify hazards and eliminate or minimize/reduce the risk of injury/illness to workers and damage to property, equipment and the environment. It allows us to shows our commitment towards a making of healthy and safe workplace. So, we must identify hazards and potential hazards in the workplace in order to be able to take action to eliminate/minimize or control them.

It is a step by step process to guide us to an effective hazard identification, assessment and controls system. The steps include:

- Hazard Assessment: identifying the hazards and potential hazards, determining the risks and the risk rating associated to the hazard based on:
    - Probability and
    - Severity
- Hazard control-controlling the hazards and the risks associated with the hazard. First try to eliminate the risk. If this is not possible, the risk should be minimized using substitution, modifications, isolation or engineering controls. Back-up controls such as personal protective equipment should only be used as a last option.
- Providing information, education, training and supervision on the hazards, risks and controls for employees affected by the hazards.
- Review of the hazard assessment and control process to maintain their effectiveness.

Keywords: Environment, Hazard, Safety, Health, Risk assessment

Table of Contents

List of Figures

List of Tables

List of Abbreviations

CAPA	Corrective and Preventive Action
ISO	International Organization for Standardization
MR	Management Representative
OH&S	Occupational Health & Safety
OHSAS	Occupational Health & Safety assessment series
EHS	Environment, Health and Safety
IMS	Integrated management system
NMPL	Neel metal product limited
M&M	Mahindra & Mahindra
DH	Department head
CP	Chicago Pneumatic
TCF	Trim Chassis and Final
MAPS	Mahindra advanced production system
WRAP	Warranty Reduction Action Plan
FAI	Final acceptance inspection
CAI	Customer acceptance inspection
PU	Production Unit
DMR	Department management representative
RFI	Ready for final inspection

Chapter-1
Introduction

1.1. General

For any industry to be successful, it has become essential to identify the Hazards, to assess the associated risks and to bring the risks to tolerable level. Recognizing this, Mahindra & Mahindra Ltd. Haridwar is continuously putting efforts for controlling the risks which are arising from various Hazards such that loss to Human life and property is negligible or zero. Its continuous best efforts to identify the Hazards and to bring the risk levels to tolerable level in the organization are recognized by several Government and safety regulating bodies.

In plants, hazards and risk are identified time to time by using modern techniques. Mahindra & Mahindra Ltd. Haridwar is OHSAS –18001 certified company. So in all departments /section risk and hazards are finding out by proper risk assessments. During this severity at various levels matched with probability level. And find out the case of intolerable, substantial, moderate and tolerable risk. Accordingly control measures at the place checked. Documentation done and records are maintained.

Now as Mahindra & Mahindra Ltd. Haridwar is OHSAS –18001 certified company, in all sections/plants proper hazard and risk assessment procedures and documentation done. Time to time, plant/section updates of this done and audited by other sectional persons. And again compliance incorporated.

Mahindra & Mahindra, Haridwar has two main production units one for Bolero Unit, & Other for Three Wheelers & Scorpio. The Three wheeler & Scorpio production unit is named as Sub One Ton Unit where assembly of Alfa, Gio and Champion & Scorpio is carried out.

The Chassis, Engine, Body & Other parts are coming from Nasik Plant & NMPL for the assembly in the respective production units and the assembled products are quality checked at each stage and customer assurance is ensured through FAI & CAI.

1.2 Aim of Project

Updation of HIRA for Identification of Occupational Hazards, assessment of risks and determination of necessary control measures to reduce the risks of injury and ill health in Assembly of Bolero in Mahindra & Mahindra Ltd. Haridwar.

1.3 Objectives of Project

- To understand the concept of risk assessment in Bolero Production Unit of M&M Haridwar.
- To be able to identify occupational health and safety hazards associated with each activities & sub activities in Assembly of Bolero.
- To use quantitative methodology of risk assessment to access hazards identified for each of the sub activity in Assembly of Bolero
- To recommend practical control measures for hazards identified for activities in Bolero Production Unit.

1.4 About the Company

Mahindra & Mahindra Limited (M&M) is an Indian multinational automobile manufacturing corporation headquartered in Mumbai, Maharashtra, India. It is one of the largest vehicle manufacturers by production in India and the largest seller of tractors across the world. It is a part of Mahindra Group, an Indian conglomerate. It was ranked as the 10th most trusted brand in India, by The Brand Trust Report, India Study 2014.

Mahindra & Mahindra Haridwar situated in SIDCUL Industrial Estate, is one of the assembly hubs for Mahindra Automotive sector that assembles SUVS (Bolero & Scorpio) & Three Wheelers (Alfa, Gio & Champion).

Mahindra & Mahindra, Haridwar has a dedicated team for Plant Engineering, Production, Quality, Maintenance & Utility, Stores, Supply Chain Management, Human Resource, Fire & Safety, Administration & Infrastructure and Employees Relation to ensure first quality products to reaches its customers.

Mahindra & Mahindra, Haridwar has two main production units one for Bolero Unit, & Other for Three Wheelers & Scorpio. The Three wheeler & Scorpio production unit is named as Sub One Ton Unit where assembly of Alfa, Gio, Champion & Scorpio is carried out.

The Chassis, Engine, Body & Other parts are coming from Nasik Plant & NMPL for the assembly in the respective production units and the assembled products are quality checked at each stage and customer assurance is ensured through FAI & CAI

Chapter-2
Literature Survey

Grimaldi and Simonds (2014): Health and safety management is the elimination or reduction of hazards, which revolves around the 'identification of hazards, determination of their significance, evaluation of the available correctives, and selection of the optimal remedies'. Their work highlights two aspects of safety management: engineering with its focus on design and ongoing hazard control, and management with its focus on ensuring the application and durability of control principles. While hazard control, management responsibility and compliance with legislation are emphasized, there is also a focus on the unsafe acts and unsafe conditions.

Rahimi's (2013) : Prescription for 'strategic safety management', a framework for integrating safety, health and environmental issues into long-range planning, and for developing a continuous improvement culture built upon the principles of empowerment, leadership and self-managed work teams, 'a journey to deeply ingrained participative safety management.

Viner (2012): points to the subjective nature of the identification of causes and of the terms 'safe' and 'unsafe', and argues the collection of judgmental data about unsafe acts does not prove an unsafe act exists. He suggests a strong societal attitude which ascribes blame to the victim of accidental injury may have hampered the application of the scientific method to the field of accident causation.

Denton (2010): He commented, that the adoption of a safe person or safe place perspective will depend on the position taken on accident causation that is whether the cause is seen to relate primarily to employee behaviour or to poor design and lack of appropriate hazard control. The concern here is to further explore the human-centred Versus hazard-centred approaches as they inform the subject of system type, rather than to examine the range of accident causation theories or the extensive literature on individual differences relating to causation and on accident behaviour.

Heinrich's research (2009) on the role of the individual in accident causation was supported by a burgeoning literature in the then new field of industrial psychology. High accident rates manufacturing industry had provided the context for the early

research in industrial psychology, which featured competing theories of accident causation, on the one hand the role of environmental factors beyond the control of the individual and on the other, the particular characteristics of injured individuals.

Weindling, 2008; Braverman, 2006 :The influence of industrial psychology extended into the workplace in the early decades of this century, through the introduction of aptitude tests to predetermine the suitability of employees for particular jobs by assessing their 'accident proneness', as well as their 'intelligence', 'manual dexterity' and the degree to which they matched the desired 'profile' of management. With the objective of enhancing efficiency and productivity, these techniques sat comfortably alongside the scientific management techniques introduced by Taylor, Ford and others.

Petersen (2005): Another proponent of the behavioral approach, views the traditional legislative emphasis on physical hazards and technical controls as curtailing the opportunities to develop the behaviorist perspective in the United States. He believes the stage was set for the introduction of a 'psychology of safety management era', which would extend Heinrich's principles into new methods for influencing the behaviour of people, but the initiative was delayed by the introduction of the *Occupational Safety and Health Act 1970*, which he terms the 'OSHA era'. Petersen comments disparagingly on the resulting emphasis on legislated management responsibility to control physical working conditions, and the new focus on compliance with legislation and documentation for government inspection.

Chapter-3
Assembly Process

3.1. Process Detail

The body shells (Painted) are received on trollies from Nasik and NMPL & these are checked for defects if defects found they are rectified and then store feeds them at trim line for the further operations. The subsequent operations are as follows:

3.1.1. Trim Line-

Trim line comprises of stages which include one buy- off stage. Here the body shell undergoes various trimming activities and is ready for the final assy.

Further the body shell fully trimmed is loaded on Gantry and transferred to Main line.

3.1.2. Engine Line-

Engine preparation done in the Engine docking area, where gear box with clutch & other accessories are assembled on engine. Whole assembly is transferred on trolley/pallet. Then it is transferred and assembled on Main line.

3.1.3. Main Line-

Main line consists of two sub lines they are Chassis preparation line and other is slack conveyor line. Chassis preparation line consists of three stages and Slack conveyor line consists of nine stations.

Assembled engine is dropped on chassis through hoist on conveyor. Trimmed body shell is dropped on main line where entire union of body & chassis is completed & vehicle is made ready for FAI (Final acceptance inspection) area.

The main assy line works on the concept of SELF CERTIFICATION by means of Travel card in each vehicle. The operator fills the travel card on each individual stage this certifying the final quality of the job. Buy off at each line ensures right quality passed on the next line.

3.1.4. FAI (Final Acceptance Inspection)-

Vehicle comes for FAI after roll down from mainline conveyor & the operations followed are:-

In FAI stationary inspection is being done & found concerns are rectified in rework area then, 100 % Endline.

3.1.5. CAI (Customer Acceptance Inspection)-

Vehicle comes for CAI after FAI. In CAI 100% road inspection (functionally) is done & Concerns highlighted in CAI are rectified in either mechanically.

3.1.6. WRAP (Warranty Reduction Action Plan)-

Vehicles comes for WRAP inspection here field related failures are rechecked and inspection in line with field.

The Figure 3.1 shows the layout of Bolero PU, which describe the detail procedure involved in assembly of Bolero. Bolero PU consists of Trim line, Chassis line, Engine line, Main line & FAI.CAI & WRAP unit located outside of Bolero PU.

3.2. Plant Layout

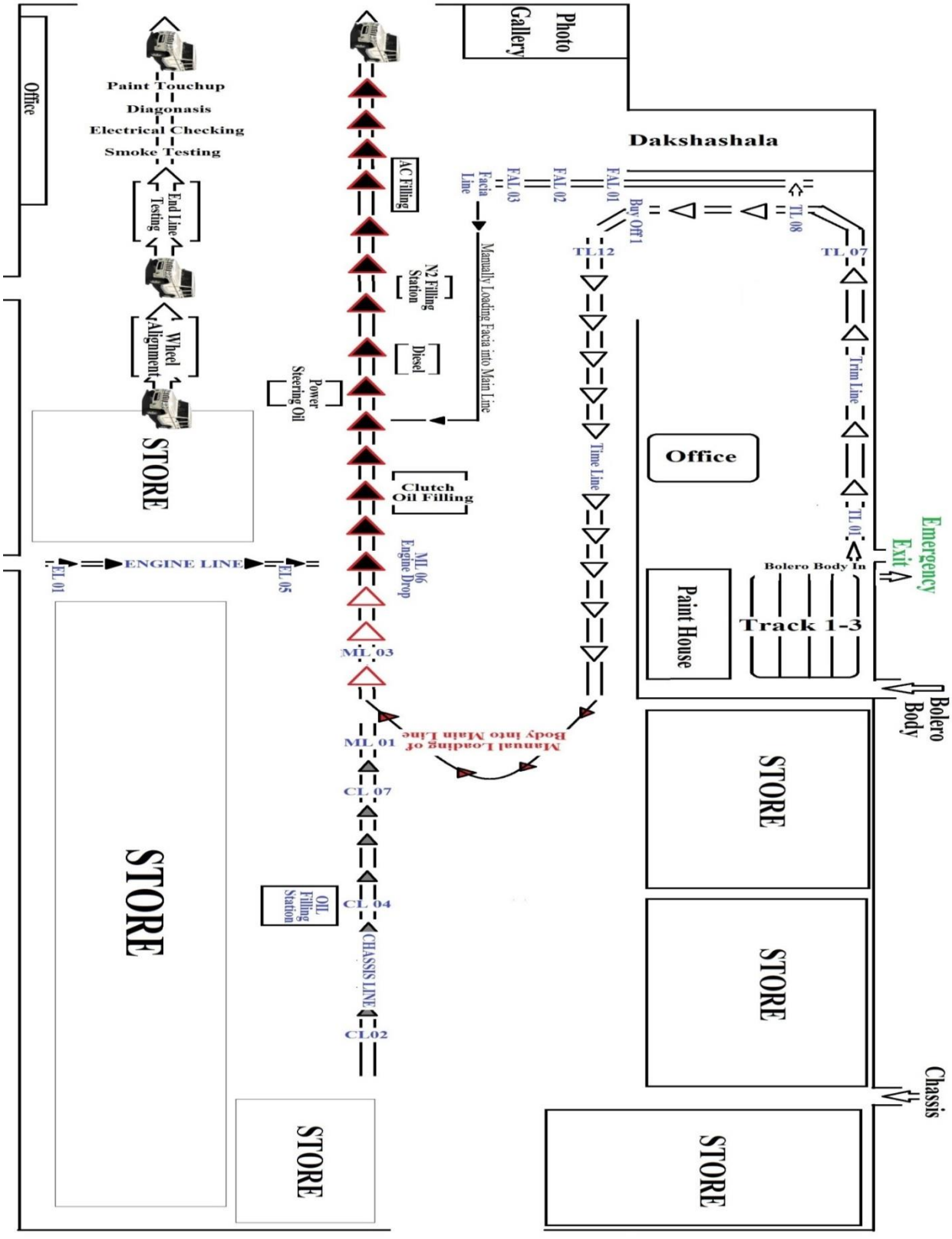

Figure 3.1. Plant layout

3.3. Steps Involved in Assembly Process of Bolero:

The Assembling Process involved in assembly of BOLERO is shows in figure 3.2 & explained in the following steps:

Step 1: The assembly of Bolero starts with manual loading of the Painted body on to the shop floor that is received on trollies from NMPL & NASIK. The painted body received from NMPL & NASIK first stored in Bolero body yard where dust is cleaned & body paint is checked & then transferred to BOLERO PU.

Step 2: In this step, body is transferred to TRIM LINE which consists of 26 stations/stages with one buy- off stage where Body Fitments and Accessories like IP harness, Speaker, Latch, Roof felt, Glass, AC, Seat, Carpet, wiper motor etc. are fitted into the body by the operator using guns in accordance to the SOP's developed for each of the fitments.

At each buy off stage operator fills travel card after manual checking of work done, this certifying that right quality passed on the next line.

Step 3: In this step Facia is separated to Body at Station TL-07 & then transferred to Facia line which consists of 4 stations where different Fitments & Accessories like vaccum modulator, Condenser, Fuel filter etc. are fitted.

Step 4: Here the Chassis is received into the shop floor and is loaded on to a stand using a forklift where different Fitments & Accessories like Stub Axle, Fuel tank, Leaf spring, Differential oil filling etc. are fitted to Chassis.

Step 5: Engine Docking is done in the ENGINE LINE which consists of 6 stations where the assembly of engine, with Power stg. Pump, gearbox, clutch plate etc. & other accessories are fitted on the conveyor.

Step 6: The fully prepared chassis and engine are assembled at MAIN LINE, station ML- 04 by using a trolley & hoist-lift arrangement & the assembly moved to next station for further process. The main line consists of 20 stations/stages, after that final line is start.

Step 7: The trimmed body which is prepared in Trim line is placed on assembled

chassis & engine at station ML-07 by using a trolley & hoist-lift arrangement & assembly moved to next station for further process.

Step 8: In main line, rear bumper, brake oil filling, tyre fitting, console fitting, power stg.oil filling, fender & bumper fitting, side foot step fitting etc.is done. The main assy line works on the concept of self-certification by means of Travel card in each vehicle where operator checked each and every part manually & checked job done by operator and then fills the travel card on each individual stage this certifying the final quality of the job. Buy off at each line ensures right quality passed on the next line.

Step 9: The facia which is prepared in facia line is placed on assembled at station ML-14 by using a trolley & hoist-lift arrangement & then final assembly moved to FINAL LINE for further process.

Step 10: The final line which is started after main line is consists of 8 stations where key learning, door setting, cladding fitting, AC filling, U/B inspection, stereo fitting, bonnet setting etc.is done on final assembly.

Step 11: In this step, wiper fitting, wheel alignment, light alignment, end line testing, smoke testing, Diagnosis, Paint touchup, final U/B inspection etc. is done of the vehicle.

Step 12: In the next bolero is moved to FAI (Final Acceptance Inspection) where Final Acceptance Inspection is carried out to ensure the quality of the vehicle against standard conditions.

Step 13: Once the vehicle pass through the FAI, the bolero is ready for the road test, which is carried out in Customer Acceptance Inspection (CAI) for final quality check to ensure customer assurance.

Step 14: Finally bolero moved to CAI to RFI & then parked in YARD for dispatch across different locations in the country.

3.4. Flow Chart for Assembly of Bolero:

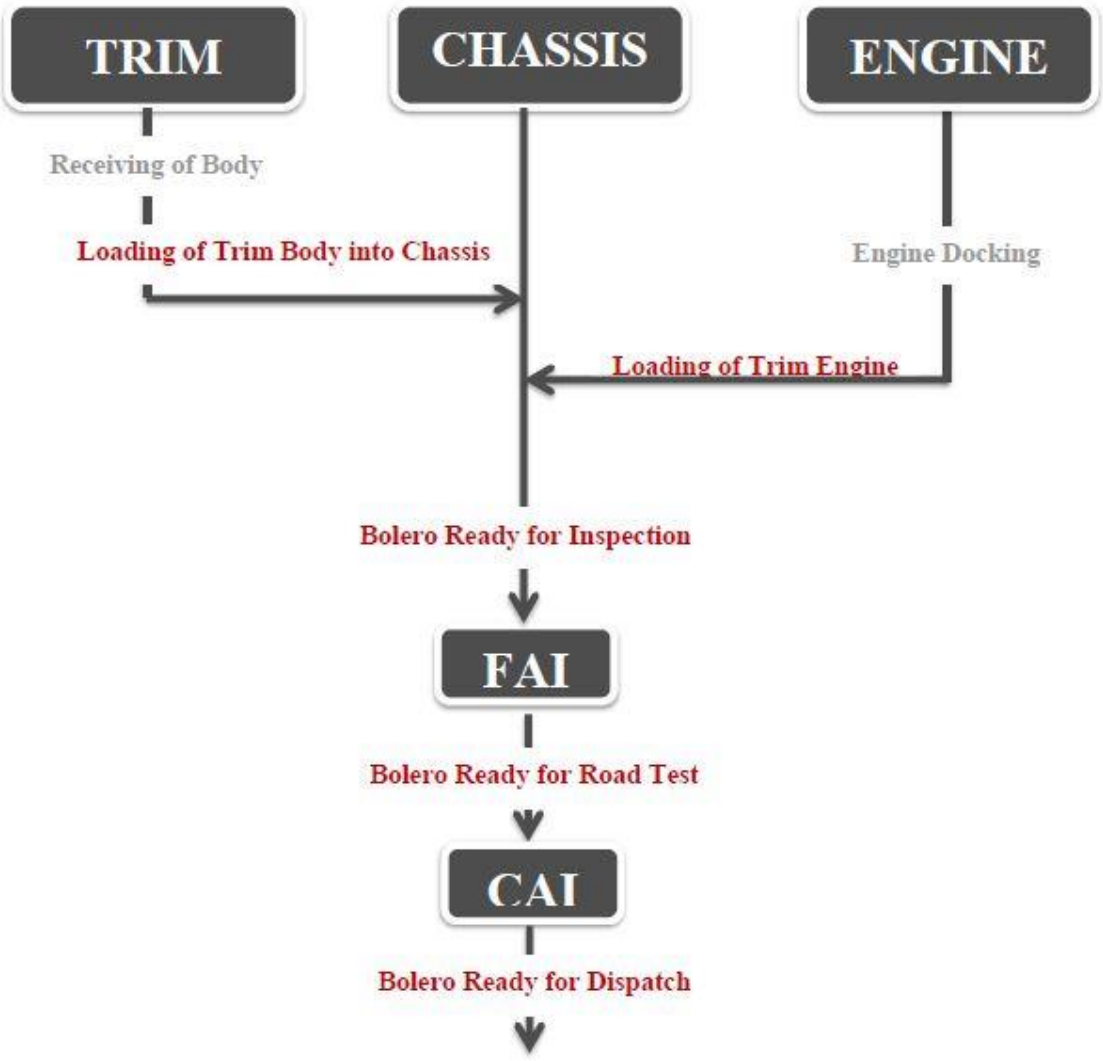

Figure 3.2. Flowchart for Assembly of Bolero

Chapter-4
Methodology

4.1. Hazard Identification

Planning for hazard identification- identify the OHS hazard/risks related to its activities, products and services through an initial OHS review. Make a sequential list of activities and sub-activities for each process of department/function. Identify process inputs & outputs for each sub-activity. Then identify & list OH&S hazard & related risks from each sub-activity.

While identifying occupational health & safety (OHS) hazards and risks during initial OHS review the, following input / factors shall be considered:

- Employee/contract personnel and likelihood of visitors' involvement.
- Routine and non-routine activities.
- Activities of all persons having access to the work place (including contractors and visitors)
- Human behaviours, capabilities and other human factors.
- Identified hazard originating outside the work place capable of adversely affecting the health and safety of persons under the control of the organization within the work place.
- Hazard created in the vicinity of the work place by work-related activities under the control of the organization.
- Infrastructure, equipment and material at the work place, whether provided by the organization or others.
- Changes or proposed changes in the organization, its activities, products, services or materials.
- Modifications to the OH&S management system, including temporary changes, and their impacts on operations, processes and activities.
- Any applicable legal obligations relating to risk assessment and implementation of necessary controls.
- The designs of work areas, processes, installations, machinery / equipment, operating procedure and work procedures and work organization, including their adaptation to human capabilities.

Carry out on-going project site assessment of all manufacturing / non-manufacturing facilities / office complex / substations / service offices / facilities, consultation with a cross section of employees, contractors and identify occupational health and safety (OHS) hazards and risks related to all activities and services. While identifying OHS risks considering shall be given to

- Electrical hazards
- Fire hazards –explosion/toxic gas release
- Mechanical hazards
- Physical hazards (including radiological hazards)
- Chemical hazards
- Biological hazards
- Ergonomics hazards
- Behavioural hazards

Accidental hazards (due to unsafe conditions & practices of the sub-stations / offices / services offices)

Consider the following other conditions while identifying occupational health and safety (OHS) hazards and associated risks:

Type (i.e. employee / contract / visitors) & number of persons likely to get affected due to hazards & related risks should be identified for evaluating of risk levels.

Routine (R): all activities which are performed as per planned intervals and schedules.

Non Routine (NR): all those activities which have to be performed as per emergency/sudden basis for e.g., breakdowns maintenance, etc.

Normal Conditions (N): This conforms to any prescribed standard or established control practices or procedures.

Abnormal Normal Conditions (AN): Any activity, process or services not complying with operational control procedure or system of standards are not in line with the intended purpose also include start-up/break-up condition.

Emergency Condition (E): any situation, which warrants involving emergency provision already contemplated and approved by management and related to potentially foreseeable emergency situation.

List out direct & indirect activities, related hazards & risk separately for better focus and controls.

Direct (D): OHS hazards, which organization can control itself.

Indirect (I): OHS hazards, over which organization can have transporter are influence upon, related to contractors/suppliers.

4.2. Risk Assessment

The risks assessment shall be conducted following a brainstorming session considering existing / present controls that are indicated in HIRA register. The risks assessment method includes applications of- quantitative criteria and qualitative criteria. The quantitative and qualitative criteria are described below:

4.2.1. The Quantative Risk Assessment :

Risks Priority Indicator/Number**:** combination of likelihood (L) of occurrence and severity (S) of the hazardous events occurring /might occur.

Likelihood (L): The probability of occurrence of the OHS hazards, as determined on the basis of the assessment of adequacy of risk control measures in place (technological / operational control/measurement & monitoring / competence)

Severity (S): The degree of harm on property, safety of human beings or health aspects.

NOTE: The above parameter i.e. likelihood and severity of OHS hazards occurred / might occur due to an activity are weighted as per guidance given in format (Table-4.1) attached below.

Table 4.1 for Likelihood of Occurrence

Scale	Categorization	Description
1	Highly Unlikely	Once in a year or more than a year
2	Unlikely	Once in a six months
3	Likely	Once in three months
4	Very Likely	Once in a month
5	Certain	More than once in a month

Table 4.2 for Severity

Scale	Categorization	Description
1	Minimum	First aid cases/superficial one/injury/minor cut/bruises/irritation from dust/momentarily discomfort, nuisance, irritation due to noise, dust and fumes, vapour and gases & frequent perspiration at work but exposure is minimal or $1/4^{th}$ of the average work. Scheduled at work station.
2	Moderate	Non-reportable/cut, wound/injury/burn/restricted work cases/head ache. Ill health due to dust & fumes, vapour and gases & temperature also discomfort and irritation due to noise at near by work place or interference in speech due to noise. Minor property damage. And exposure level than prescribed TLV (<20%).
3	Major	Reportable accident/lost time accident, hospitalization /laceration/burns/contusion/serious sprain/minor fracture/dermatitis/asthma/and work limited upper limb disorder. Moderate property damage. Exposure level above than prescribed TLV (>20% to <40%).
4	Serious	Amputation/permanent disorder/ill health /leading to permanent minor disability/multipurpose injury/deafness. Severe property damage. Exposure level above than prescribed (>40% to <50%).
5	Extremely Serious	Fatal injury/diseases leading to death. Annihilation /complete property destruction. Exposure level above than prescribed (>50% leading to chronic notifiable diseases.

The total score of an OHS risks is obtained on the basis of multiplication of the weightage factors of likelihood and severity. The total weightage is considered for risks classifications & determining controls.

Figure 4.2- Risk Matrix

Severity → / Likelihood ↓	Minimum (1)	Moderate (2)	Major (3)	Serious (4)	Extremely Serious (5)
Highly Unlikely (1)	Very Low (1)	Very Low (2)	Low (3)	Low (4)	Medium (5)
Unlikely (2)	Very Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Likely (3)	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Very Likely (4)	Low (4)	Medium (8)	High (12)	High (16)	Very High (20)
Certain (5)	Medium (5)	High (10)	High (15)	Very High (20)	Very High (25)

b) The following qualitative criteria should be applied to all hazards & risks irrespective of quantitative criteria for evaluation of hazards & risks and if applicable should treated as overriding for classification of risks. These includes-

Legislative Concern (LC): Applicable compliance requirement to national /state / district / area of operations related legal requirement and other requirement including customer requirement to each identified & listed OH&S hazard / risks to be identified. This identification & evaluation to be updated periodically or as & when any new or changes to existing legal requirement and other requirement are issued / received.

Interested Party Concerns (IPC): Person or group inside or outside the work place concerned with or affected by the OH&S performance of an organization.

Internal interested party concerns collected through internal reactive communications / safety committee & management reviews to be periodically updated.

Chronic Effect (CE): Any possible OHS hazard / risk with recognized irreversible health impact due to sustained long term exposure.

Domino Effect (DE): operations and processes which can trigger / multiply the risks those are of increasing magnitude and can create potential emergency conditions.

Possible Emergency Situations (E): Any potential situation which can require application of on-site emergency preparedness & response plan or having the potential to destruct the occupational health, safety of personnel involved & or production activities / services.

Above overriding criteria should be applied to all the risks identified & being evaluated.

If any of the above overriding criteria is applicable, the risk should be classified at least as "Medium" irrespective of lower risk rating.

4.3. OHS Risk Classification

The OHS risks shall be classified as follow based on quantitative criteria as per TABLE-4.1 & 4.2 and based on qualitative assessment as per 4.2:

Very Low: Risk is acceptable. No additional controls / actions are necessary; however requirement of operational controls / PPEs may be established.

Low: Risk is acceptable. Activities can operate with operational controls, PPEs & administrative controls. Consideration may be given to a more cost effective solutions or improvements to reduce the risks. Monitoring may be defined to ensure that the controls are maintained.

Medium: Risk is acceptable subject to Engg. Controls / operational control procedures / PPEs /OEP / Measurement & monitoring plan as necessary are ensured for effectiveness of risk monitoring & control.

Risks may be prioritized for objectives & targets supported with related management program for further improvement to reduce the risk.

High: Risks is not acceptable & work may not be started until risks are closely supervised / monitored & controlled with OCPs, PPEs / signage's / warnings, awareness training.

Risks shall also be prioritized for time bound objectives / targets & management program for risks elimination / substitution / reduction.

Very High: Risk is not acceptable & work cannot be started until risk is reduced to at least "Medium" level & controlled / monitored. If it is not possible to reduce risk even with unlimited resources, work has to remain prohibited.

4.4. Determining Risk Control / Measure

a) Based on the OHS risk classification in column-10 of HIRA register, risk evaluated to medium & above class shall be considered for following additional controls in the given sequence and risk to be re-assessed for residual risk.

- Elimination,

- Substitution,
- Engineering controls,
- Signage / warnings and / or administrative controls,
- PPEs
- Any other-e.g. emergency preparedness & response plan etc.

The risk control measures shall be identified and may include following:

- New technology / modification in technology / physical improvements / substitution of equipment / chemicals
- Development / strengthening of safe work procedure
- Obvious operational control such as, signage, prohibitory notices, caution, notice etc. / standing instruction
- Emergency preparedness and response plan
- Use of PPEs
- Training and competence improvement
- Task observation / contractor's control mechanism
- Strengthening of inspections and supervision system
- Monitoring and measurement, including ill health monitoring
- Any other as relevant

4.5. Hazard & Risk Assessment with Relevant Control Measure

It shall be communicated to all concerned personnel involved in activities / sub-activities & also personnel having access to workplaces.

Communications may be ensured through:

- Training
- OCPs.
- Signage's / posters
- Handouts / booklets
- Department SH&E gallery
- Dept. safety committee meetings
- Any other relevant forum

4.6. Updation of HIRA Register

Management of change: New or modification proposed in the processes, process materials, products, production equipment or other facilities / infrastructures shall be assessed for hazards & risk prior to implementation at planning stage and based on the risk assessment required control measures shall be analysed for feasibility / convenience of implementation & cost effectiveness of control etc. and proposed changes may be reviewed / updated considering this.

Hazard / risks & related control measures initially analysed at planning stage shall be re-assessed on actual implementation of changes & actual required control measure shall be established effectively.

This management of change process shall be implemented & records shall be maintained as per (MOC Procedure & format) for every change.

The changes in HIRA & related control measures shall be discussed & communicated to all concerned personnel.

HIRA register shall be reviewed & updated as & when there is any incident happens, changes in applicable legal & other requirement, changes in the layout, processes, input / process material, modification in existing products or introduction of new product, changes in equipment & machinery etc. prior to implementation.

Otherwise register shall be reviewed at least once in a year for the changes in risk level due to any other reason.

The results of the assessment shall be prioritized for setting OHS objectives / targets & management programs, & additional control measures may be established as mentioned above in 4.1.

4.7. Checking Corrective and Preventive Action

MR HOD / PU manager shall ensure the effective implementation of the above procedure and in case of deviation he shall take appropriate corrective and preventive action. The record of deviation and reason shall be maintained. He shall interact with core team member once in quarter to ensure timely update of register of OHS hazards and risks.

4.8. Gap Analysis

4.8.1. Procedure for Gap Analysis on HIRA for Bolero:

The HIRA procedure that has been adopted to determine the hazards & its risk value for Activities & Sub Activities in Assembly of Bolero is enlisted below:

Step 1:- Study of Existing HIRA for the assembly of Bolero

Step 2:- Identification of new or missing activities & sub activities in the existing HIRA

Step 3:- Determination of Hazards associated in each of the new activities and verification of hazards mentioned in the existing HIRA

Step 4:- Evaluation of Hazards on Qualitative Criteria's for each of the new Activities & review for the existing activities

Step 5:- Determination of Existing Control Measures for Hazards in each of the New Activities identified & verifying for the enlisted activities in the previous HIRA

Step 6:- Determination of Probability & Severity of Hazards for the new Activities & reviewing for the existing activity

Step 7:- Calculation of Risk & Risk Classification for Hazards in each of the new Activities & review for the risk rating for the existing hazards in latest HIRA

Step 8:- Determination of Addition Control Measures or Recommended Actions for Hazards in each of the new Activities in Assembly of Bolero

Step 9:- Final Updating of HIRA Document for Hazards in the Assembly of Bolero

4.8.2. HIRA Flow chart

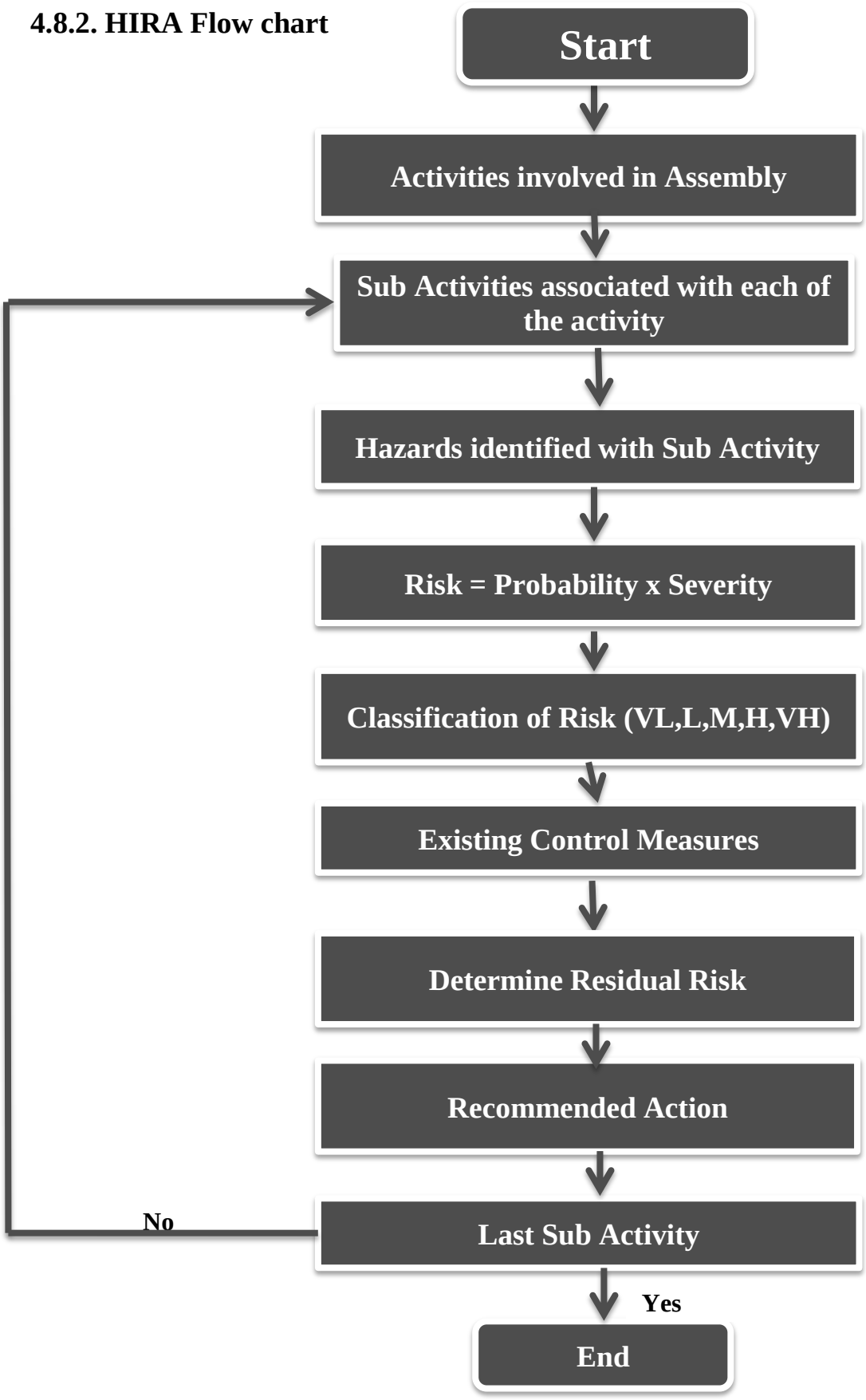

Figure 4.8. HIRA Flowchart

Step 1:-Study of Existing HIRA for the assembly of Bolero

- Study of the assembly process of Bolero.
- Study the terms given in the existing HIRA Document in accordance to the Latest L1 Manual Section 10_HIRA 2.02 of the company.

Step 2:- Identification of new or missing activities & sub activities in the existing HIRA

- Identify the major activities & sections involved in assembly of Bolero.
- Interaction with operators to identify each of the sub activities involved in each of the activities noted.
- Cross check with the activities given in the existing HIRA to determine new activities.
- Classify the new activities into Routine & Non Routine Activity in accordance to the Latest L1 Manual Section 10_HIRA 2.02 of the company.
- Determine the type of people involved such as Employees, Contactor or Visitors based on the definition given in the Latest L1 Manual Section 10_HIRA 2.02 of the company.
- Draft the list based on the sequence of activities involved in assembly of Bolero

Examples:

Sl No.	Section	Activity/Sub-Activity	R/NR	E/C/ V
1	Trim line	Bolero body receiving from bolero body yard & checking	R	E/C
2	Chassis line	Steering gear box oil filling	R	E
3	Facia line	Head lamp grommet fitment	R	E
4	Engine line	Sealant application on bell housing	R	E
5	FAI, CAI,YARD	Vehicle movement	R	E/C

Step 3:- Determination of Hazards associated in each of the new activities and verification of hazards mentioned in the existing HIRA

- Interaction with operators to identify the hazards associated with each of the sub activities.
- Visual Identification of Hazards in each of work stations.
- Determine all possible health effects or type of injury associated with the identified hazards
- Determine whether the hazards associated is Normal, Abnormal or Emergency condition based on the definition given in the Latest L1 Manual Section 10_HIRA 2.02 of the company.
- Updating the hazards with its conditions on the draft sheet against the corresponding activities.

Examples:

Sl No.	Sub Activity	Nature/ Type of Occupational Hazards	Type of Risk	N/AB/ E
1	Bolero body receiving from bolero body yard & checking	Cut due to sharp edge of body, manual handling risk	Hand injury/finger cut, back pain	N
2	Steering gear box oil filling	Spillage	Fire, slip hazard	E
3	Head lamp grommet fitment	Cut due to sharp edge	Finger/hand injury	N
4	Sealant application on bell housing	Fall of sealant on eyes	Eye injury	N
5	Vehicle movement	Unsafe driving	Accident	N

Step 4:- Evaluation of Hazards on Qualitative Criteria's for each of the new Activities & review for the existing activities

- Evaluate the hazards on Qualitative criterions such as **LEGISLATIVE CONCERN (LC) , INTERESTED PARTY CONCERNS (IPC), CHRONIC EFFECT**

(CE), DOMINO EFFECT (DE), POSSIBLE EMERGENCY SITUATIONS (E) accordance to the definitions given in the Latest L1 Manual Section 10_HIRA 2.02 of the company.

- Update the draft sheet with the qualitative assessment data

Examples:

Sl No.	Sub Activity	LC	IPC	CE	DE	E
1	Bolero body receiving from bolero body yard & checking	-	-	-	-	-
2	Steering gear box oil filling	-	-	-	-	-
3	Head lamp grommet fitment	-	-	-	-	-
4	Sealant application on bell housing	-	-	-	-	-
5	Vehicle movement	-	-	-	-	-

Step 5:- Determination of Existing Control Measures for Hazards in each of the New Activities identified & verifying for the enlisted activities in the previous HIRA

- Interaction with the operators to identify the existing control measures in place for the hazards involved assembly of bolero.
- Visual Inspection to identify the existing control measures employed to reduce the risk.
- Update the draft sheet with existing control measure for the associated hazards.

Example:

Sl No.	Sub Activity	Existing Controls
1	Bolero body receiving from bolero body yard & checking	Double hand gloves, hand sleeve
2	Steering gear box oil filling	SOP, Fire extinguisher, spill control tray
3	Head lamp grommet fitment	Double hand gloves, hand sleeve

4	Sealant application on bell housing	Goggles
5	Vehicle movement	Trained persons; Authorized Drivers, Speed limit; speed breaker; instruction displayed on path

Step 6:- Determination of Probability & Severity of Hazards for the new Activities & reviewing for the existing activity

- Formation of a team to evaluate the Probability & Severity for hazards.
- Team should constitute 3-4 members including Operators, Manager & Safety Officer.
- Based on the previous company data's such as Accident Reports & Near Miss Reports the team formed should assign probability and severity values for each of the hazards identified in the list in reference to the Annexure I in the Latest L1 Manual Section 10_HIRA 2.02 of the company.
- Updating of Severity & Probability of hazards into the draft sheet to the corresponding hazard.

Table for Likelihood of Occurrence:

Scale	Categorization	Description
1	Highly Unlikely	Once in a year or more than a year
2	Unlikely	Once in a six months
3	Likely	Once in three months
4	Very Likely	Once in a month
5	Certain	More than once in a month

Table for Severity:

Scale	Categorization	Description
1	Minimum	First aid cases/superficial one/injury/minor cut/bruises/irritation from dust/momentarily discomfort, nuisance, irritation due to noise, dust and fumes, vapour and gases & frequent perspiration at work but exposure is minimal or 1/4th of the average work. Scheduled at work station.
2	Moderate	Non-reportable/cut, wound/injury/burn/restricted work cases/head ache. Ill health due to dust & fumes, vapour and gases & temperature also discomfort and irritation due to noise at near by work place or interference in speech due to noise. Minor property damage. And exposure level than prescribed TLV (<20%).
3	Major	Reportable accident/lost time accident, hospitalization /laceration/burns/contusion/serious sprain/minor fracture/dermatitis/asthma/and work limited upper limb disorder. Moderate property damage. Exposure level above than prescribed TLV (>20% to <40%).
4	Serious	Amputation/permanent disorder/ill health /leading to permanent minor disability/multipurpose injury/deafness. Severe property damage. Exposure level above than prescribed (>40% to <50%).
5	Extremely Serious	Fatal injury/diseases leading to death. Annihilation /complete property destruction. Exposure level above than prescribed (>50% leading to chronic notifiable diseases.

Examples:

Sl No.	Sub Activity	Nature/ Type of Occupational Hazards	Likelihood of Occurrence	Severity
1	Bolero body receiving from bolero body yard & checking	Cut due to sharp edge of body, manual handling risk	1	1
2	Steering gear box oil filling	Spillage	1	3
3	Head lamp grommet fitment	Cut due to sharp edge	1	1
4	Sealant application on bell housing	Fall of sealant on eyes	1	2

5	Vehicle movement	Unsafe driving	3	2

Step 7:- Calculation of Risk & Risk Classification for Hazards in each of the new Activities & review for the risk rating for the existing hazards in latest HIRA

- Determine the value of risk using the formula "Risk = Likelihood of Occurrence x Severity".
- Determine the Risk Classifications (Very Low, Low, Medium, High, Very High) for the hazards in reference to the Annexure II in the Latest L1 Manual Section 10_HIRA 2.02 of the company.
- Update the list with the Risk value & Risk Classification associated with the hazard.

Risk Matrix:

Severity → Likelihood ↓	Minimum (1)	Moderate (2)	Major (3)	Serious (4)	Extremely Serious (5)
Highly Unlikely (1)	Very Low (1)	Very Low (2)	Low (3)	Low (4)	Medium (5)
Unlikely (2)	Very Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Likely (3)	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Very Likely (4)	Low (4)	Medium (8)	High (12)	High (16)	Very High (20)
Certain (5)	Medium (5)	High (10)	High (15)	Very High (20)	Very High (25)

Examples:

Sl No.	Sub Activity	Likelihood of Occurrence	Severity	Risk	Risk Classification
1	Bolero body receiving from bolero body yard & checking	1	1	1	VL
2	Steering gear box oil filling	1	3	3	L
3	Head lamp grommet fitment	1	1	1	VL
4	Sealant application on bell housing	1	2	2	VL
5	Vehicle movement	3	2	6	M

Step 8:- Determination of Addition Control Measures or Recommended Actions for Hazards in each of the new Activities in Assembly of Bolero

- Determine the gap involved in existing controls of hazards.
- Determining the list of prioritised risks that need to be mitigated at the earliest.
- Discussion in the team for the different control measure to be developed for the hazards to reduce the risk value from unacceptable to acceptable levels.

Hierarchy of Risk Control:

- Elimination,
- Substitution,
- Engineering controls,
- Administrative controls,
- PPEs,
- Emergency preparedness & response plan

- Update the draft sheet with the additional control measures proposed by the expert team.

Step 9:- Final Updating of HIRA Document for Hazards in the Assembly of Bolero

- Document the draft list and sheets into a document for the final HIRA.
- Update the Document No., Rev No.and Date for the HIRA document.
- Submit the Updated HIRA Document to the Concern Person.

Chapter-5

Results and Discussion

5.1 HIRA WORKSHEET

5.2 Observation & Discussion

On the application of HIRA on Bolero PU of Mahindra & Mahindra, we could identify and control the top priority risk that is involved in the Assembly process in Bolero:

Major issues identified are as follows:-

- Noise induced while using tools & tackles such as CP Guns, CP Screwdrivers, CP wrench etc. for tightening of screws.
- Slipping of vehicles in end line testing & CAI.
- Ergonomics Issues due to manual assembly
- Limitation of working space
- Illumination issues identified in the work stations.
- Slipping of cargo body trolleys on slopes on loading to the shop floor.
- Falling of battery on legs while fixing on to the chassis
- Spillages of petrol & Diesel while filling, resulting in fire & slip hazard.
- Striking of Trolley on legs

5.3 Recommendations

On performing of HIRA on assembly of Bolero some of the recommendations/ future areas of improvements found are as follows:

Trim Line:

- At TL-0, the person involved in transfer of body from bolero body yard to Bolero PU should provide double thick gloves in place of normal cotton gloves to avoid cut injury.
- Emergency exit in the trim line has hydrant pipeline obstruction, so management should explore some technique/method for obstruction free emergency exit.
- At TL-05 (pillar bostic) , the person involved in this activity or any other places like in paint booth/bostic spray table where person involved in using of bostic or other chemicals should provide respirator in place of mask and in

place of cotton gloves should provide neoprene/nitrile gloves. They are also force to use of Goggles, Apron, and Hair cap.

- Display of safety signage's at prominent points of assembly
- SOP's & MSDS should be displayed at prominent places.
- Also provide health/hygiene related information to workers that after the use of these chemicals, before eating should wash both hands with soap and water to avoid direct ingestion of chemicals into body.
- At TL-07, the person involved in facia opening and lifting, working below hoist & lift should motivate/force the use of safety helmet.
- After TL 11, many of stations have illumination issues, so more no.of horizontal light be provide to rectify illumination issue & to prevent fatigueness & tiredness among worker.
- Any activity which involved more ergonomics issue should modify/change.

Facia Line:

- In facia line there is also illumination issues especially in evening/night, winter or in rainy season, so more no. of horizontal light be provided to rectify illumination issues.

Chassis Line:

- The person involved in transfer of chassis to line should provide thick gloves in place of normal gloves to avoid cut injury.
- Chassis line involved more noise, so every person working in chassis line to be provided ear plug & they should motivate/force the use of ear plug.
- At CL 03 & CL 05, where oil filling is done, there should be spillage control like periodic cleaning/spill control tray to avoid slip & fire hazard. And also worker should motivate the use of goggles and apron.
- Leaf spring F/T which is done by manually, it has more weight, so it should be changed like automatic or semi-automatic which can be done by hoist and lift arrangement to prevent fall/ergonomics related hazard.

Engine Line:

- More no. of horizontal light should be provided to rectify illumination issues.

Main Line:

- The person involved in body/facia/engine drop, should motivate/force the use of safety helmet.
- Illumination issues also found in some of station in main line (eg.ML-18, 19), so extra light is provided to eliminate illumination problem.
- Number punching which is created more noise, management should explore some technique to reduce noise, because this process affects all people working near it.
- The stations (ML-11, 17) where oil filling is done, there should be spillage control like periodic cleaning/spill control tray to avoid slip & fire hazard. And also worker should motivate the use of goggles and apron.
- The person working under pit at any station should motivate/force the use of goggles & safety helmet.

FAI:

- Control of oil spillage to prevent slip hazard.

General:

- The rubber mat should provide at each electrical control panel to avoid electric shock.
- Proper segregation of biodegradable, non- biodegradable & hazardous waste at source, transfer to scrap yard & its disposal.
- There should be provision of Banks man to guide forklift truck and other vehicle in the plant premises to avoid accident & there should be speed limit of forklift truck operating in plant premises.
- The walkways in the plant premises should be free of any type of obstruction for safe movement of man, material & vehicle.
- The driver who is involved in transfer of vehicle from one station to another station or testing of vehicle should be given proper training & instruction to avoid collision to other vehicle & accident.

Chapter-6
Summary and Conclusion

6.1. Summary

Hazards Identification & Risk Assessment is a widely used tool to account for all of foreseeable hazards whether they are accidental events or worst case scenarios. Not only does it provide an elaborate outlook on the hazards that occur in the industry, but it also accounts for the control and recovery measures in order to mitigate the hazards so caused, which will help the organization in following ways:

- A record of the HIRA procedures and results can be kept for future reference and updating purposes.
- Helps to identify the occupational health and safety (OHS) hazard and the associated risk of activities & sub activities in the plant on the account of the Routine & Non Routine task
- Helps in setting of OHS objectives and target and also operational control based on risk assessment as above including training, measurement, monitoring and other requirement.
- Helps in prioritizing the hazard & risk for all Routine & Non Routine activities on an account of time bounded objectives/target for risk elimination/substitution/reduction.

6.2. Conclusion

- At TL-0, the person involved in transfer of body from bolero body yard to Bolero PU should provide double thick gloves in place of normal cotton gloves to avoid cut injury.
- Emergency exit in the trim line has hydrant pipeline obstruction, so management should explore some technique/method for obstruction free emergency exit.
- Display of safety signage's at prominent points of assembly
- SOP's & MSDS should be displayed at prominent places.
- The person involved in transfer of chassis to line should provide thick gloves in place of normal gloves to avoid cut injury.

- Chassis line involved more noise, so every person working in chassis line to be provided ear plug & they should motivate/force the use of ear plug.
- At CL 03 & CL 05, where oil filling is done, there should be spillage control like periodic cleaning/spill control tray to avoid slip & fire hazard. And also worker should motivate the use of goggles and apron.
- Leaf spring F/T which is done by manually, it has more weight, so it should be changed like automatic or semi-automatic which can be done by hoist and lift arrangement to prevent fall/ergonomics related hazard.
- Number punching which is created more noise, management should explore some technique to reduce noise, because this process affects all people working near it.
- The stations (ML-11, 17) where oil filling is done, there should be spillage control like periodic cleaning/spill control tray to avoid slip & fire hazard. And also worker should motivate the use of goggles and apron.
- The person working under pit at any station should motivate/force the use of goggles & safety helmet.
- The rubber mat should provide at each electrical control panel to avoid electric shock.
- Proper segregation of biodegradable, non- biodegradable & hazardous waste at source, transfer to scrap yard & its disposal.
- There should be provision of Banks man to guide forklift truck and other vehicle in the plant premises to avoid accident & there should be speed limit of forklift truck operating in plant premises.
- The walkways in the plant premises should be free of any type of obstruction for safe movement of man, material & vehicle.
- The driver who is involved in transfer of vehicle from one station to another station or testing of vehicle should be given proper training & instruction to avoid collision to other vehicle & accident.

References

Latest L1 Manual Section 10_HIRA 2.02 of Mahindra & Mahindra, Haridwar.

Beers, A. (1990) "Model Plan to Implement a Systematic Safety Program in the Workplace" in Professional Safety, September, pp 26-29.

Cohen, A., Smith, B. and Cohen, H. (1975) Safety Program Practices in High vs Low Accident Rate Companies - An Interim Report, National Institute of Occupational Safety and Health, Publication No 75-185, Cincinatti.

Stanevich, R. and Stanevich, R. (1989) "Guidelines for an Occupational Safety and Health Program", in AAOHN Journal, Vol 37, No 6, pp 205-214.

Cohen, A. (1977) "Factors in Successful Occupational Safety Programs" in Journal of Safety Research, Vol 9, pp168-178.

Coyle, J. and Leopold, J. (1981) "Health and Safety Committees - How Effective Are They?", in Occupational Safety and Health, November, pp 20-22.

Wood, K. (1981) "Occupational Health and Safety Management - Industrial Plants: Safety Engineering" in Chissick, S. Derricott, R. (eds.) Occupational Health and Safety Management, John Wiley and Sons, U.K, pp 247-282.

Crutchfield, C. (1981) "Managing Occupational Safety and Health Programs - An Overview" in Amercian Industrial Hygiene Association Journal, Vol. 42 (3) pp 226-228.

Dawson, S., Poynter, P., Stevens, D., (1987) "How to Secure an Effective Health and Safety Program at Work" in Professional Safety, January, pp 32-47.

Else, D. (1994) "Integrating Occupational Health and Safety into Tomorrow's Learning Organisation" in Belts to Bytes conference proceedings, WorkCover, Adelaide, pp 21-25.