HAZARD IDENTIFICATION & RISK MITIGATION IN REFRACTORY INDUSTRY

K.P.Anoop[#1], K. Mugundhan[#2], S. Kamalakannan[#3]

#1 PG Scholar, Department of Mechanical Engineering, Knowledge Institute of Technology, Tamilnadu, India.
#2, #3 Assistant professor, Department of Mechanical Engineering, Knowledge Institute of Technology, Tamilnadu, India.

#1 kpanoop80@gmail.com

Keywords—Risk Assessment, HIRA, Pareto Analysis and Risk Reduction…

1. ABSTRACT:

Hazard exists in every work situation in different forms and which requires identification, assessment and control to create a safe working environment. As the most important steps in risk managing process, hazard identification is always arguably the most important part in safety analysis effort that need to identify, control or conduct in close consultation with the people. “Hazard Identification and Risk Analysis (HIRA)” is a collective term that encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to employees, the public, or the environment are consistently controlled within the organization’s risk tolerance.

In this paper, Pareto analysis is used to prioritize the risk of the plant. It is an unique analysis technique used where many possible courses of action are competing for attention. In essence, the problem-solver estimates the benefit delivered by each action, then selects a number of the most effective actions that deliver a total benefit reasonably close to the maximal possible one.

Pareto analysis is a creative way of looking at causes of problems because it helps stimulate thinking and organize thoughts.

This technique helps to identify the top portion of causes that need to be addressed to resolve the majority of problems. Once the predominant causes are identified, can be used to identify the root causes of the problems. While it is common to refer to pareto as "80/20" rule, under the assumption that, in all situations, 20% of causes determine 80% of problems.

The application of the Pareto analysis in risk management allows management to focus on those risks that have priority and to tackle the most impact risk of the plant.

2. INTRODUCTION:

- Hazard Identification, Risk Assessment and Determining its Control is part of the OHSAS 18001:2007 standard in clause 4.3.1, which is the organization shall establish implement and maintain a procedure for ongoing hazard identification, risk assessment and determination of necessary controls.
- Hazard identification and risk assessment (HIRA) is a structured and systematic examination of a planned or existing process.

- After evaluating the plant risk, the risk are prioritized and control actions are taken for the top and prominent risks of the plant.
- In this project deals with the Hazard Identification and Risk Prioritization by HIRA methodology and its operation at Refractory Industry

3. NEED FOR THE STUDY

The need of the study is to identify the potential of implementing the environmental management system standards in line with ISO 14001;2015 and Occupational health and safety management system standards in line with BS OHSAS 18001:2007 , in a enterprise engaged in refractory activities. This study give a direction to these types of industries for implementing the best practices for attaining the environmental and health and safety improvements.

4. OBJECTIVES OF THE STUDY

Objective of the study is to assess the environmental aspects and the health and safety hazards in the process and to implement the effective steps for overcoming the issues for improvements. The improvements may be the reduction in pollution, saving of resources and for improving health and safety for the employees.

5. LITERATURE SURVEY

- **Azrah K, et al., 2015 published a paper on A Literature Review on Identification and assessment of hazard in the Refractory Brick Production Company** which says that In the refractory brick manufacturing industry, because of the high risks associated with the level of dust in the factory environment and thermal stress, a precise identification of industrial hazards is required as a part of safety analysis. The aim of this study was to introduce a preventive approach to risk identification and assessment in the refractory brick production line.

  In this paper, methods such as observation of factory operations, process analysis through the factory diagrams, and interviews with employees were used. In addition, the risk levels of the factory were investigated using the risk matrix. The results showed that 40.2% of the risks were caused by human errors. The installation of a secondary control valve in the transfer route of the glue vapors to the workplace, an alternative pressure control system, a secondary ventilation system, several fans near the furnace (redundancy), and a real-time phenol monitor are recommended. Moreover, regular analysis of safety, health, and environmental risks are some of the recommendations proposed to reduce the identified risk level.

- **Kotek Lubos et al., 2010** published a paper on **Risk and Hazard Analyses of the Industrial Furnaces – Safety of Electro heat Equipment** Paper is focused on the field of safety of electro heat equipment, specifically on the risk and hazard analyses of the industrial furnaces. Design and development of a new industrial furnace includes risk analysis. That machinery should be constructed with taking account of the results of the risk assessment process in such a way as to fulfil its function, and could be operated, adjusted and maintained without the person exposed to undue risk.

  Paper summarizes the current legislation, which is in the field of risk of electro heat furnaces. Paper describes process of hazard identification and risk assessment during the design and development phase and main pitfalls of that activity with orientation on possibility of creating of explosive or toxic atmospheres inside of furnace by hazardous substances emitted by heated work piece inside of the furnace.

  The issue of creation of explosive or toxic atmosphere in the furnace is not normatively incorporated yet, so the article outlines the procedure to estimate the concentration of emitted hazardous (toxic or explosive) substances in the furnace during heating. On the basis of risk assessment is necessary to propose reducing measures - technological mode of machinery and safety features of control and measurement systems.

- **Shengli Niu., 2010** published a paper on **Ergonomics and occupational safety and health: An ILO perspective** which says on the diseases and injuries caused by ergonomic factors and conditions protective and preventive provisions, ergonomic losses and their application have to be monitored. It is very difficult to estimate the magnitude of work-

related musculoskeletal disorders by compensation data as majority of workers will not claim for compensation. The data on people who are exposed to adverse ergonomic working conditions, exposure level, impact of preventive ergonomic measures and influence of protective ergonomic measures. Common factors and indicators are to be developed and should be standardized which helps in comparison of ergonomic condition among different sectors and localities. The symptoms of musculoskeletal disorders are most likely seen in those employees who are exposed to both psychosocial and physical risks. The higher rates of musculoskeletal disorders are reported among non-union and women workers. Guidelines for major work-related risk 10 factors like poor psychosocial work environment, repetitive work, vibration, static work and manual handling are needed.

- **Tom Gebel et al., 2009 published a paper: About hazard and risk assessment** which **says,** Hazard classification and labelling is the main and basic requirement for all industrial and consumer chemicals in the European Union, if they are not regulated under more specific legislation such as drugs, food ingredients or cosmetics. The first approach in hazard classification is hazard identification.
  Describing the hazardous properties of chemicals. Refinements in the classification criteria include the assessment of toxic potency (hazard characterization) where feasible and the possibility to set higher or lower specific concentration limits for classification. In the past only a minor portion of the classified chemicals underwent a risk assessment including exposure assessment and risk characterization.
  Risk assessment will become more frequent with the implementation of REACH. However, as risk assessment is rather labor-intensive even under REACH risk assessment will be performed in a targeted approach for a selected number of chemical substances while hazard classification and labelling will remain the basic approach for all chemicals .

- **Study of SheikAllavudeen.S, Sankar.S.P(2015).The authors study gives hazard ,risk and its control methods in foundry.**
  The author gives guidelines for Foundries types. Ferrous foundries produce steel and iron castings. Nonferrous. Foundries produce copper based alloys casting, aluminium-based alloys casting and other alloys. And gives a Foundry industry is considered to be a high risk area since it contains the hazardous operations. Assessing the risk and controlling the risk according to the aspects of occupational health and safety is very hard in foundry. The motive of this project is identifying the hazard and risk associated with the various steps involved in each process and taking all the possible measure to control the risk.an important role in the occupational environment and physical safety with material economy.

- **Study of KhairulAkmal Shamsuddin, MohdNorzaimiCheAni, Ahmad Kamal Ismail (2015).** This study gives aprocedure for hazard identification, risk assessment and determination of necessary controls.
  The authors proposed a hazard identification analysis in operation area, revealed potential hazards which are the physical hazard, radiation and chemical hazard. Found out the total risk level score without control was at medium level for all the activities except on hazard which on lower level. After the risk assessment taken place and all the necessary control measure were carried out all the activities have fallen into low risk level category..

6. METHODOLOGY

The methodology used is Hazard Identification and risk assessment and Pareto Analysis.

- HIRA Methodology consists in listing all the hazardous situations at every level of the organization that was established in the previous step (JOB, workstation or task), with the related risk means of control for each one.
- Rate the risk as per the HIRA methodology
- Prioritize risk using Pareto Analysis.

7. HIRA METHODOLOGY

- For the analysis of accidental risks, the standard method PXS (Probability X Severity) is followed:
- The scoring of the level of probability or severity must be made through discussion with concerned professionals, and it is especially based on data such as the knowledge of exposure to hazardous situations, the history of Health and Safety events for the type of considered JOB and the means of control implemented, together with their estimated level of reliability.
- Combined score of PXS is called as risk score or RPN (Risk Prioritization Number) and the possible risk numbers under the probable severity and probability is given in the Risk Grading Chart.
- RPN 0-16 is Green risk (acceptable risk)
- RPN 20-168 is Yellow risk
- RPN 210 above is Red risk and actions should be taken to reduce the risk to green or acceptable risk

7.1 SEVERITY

The severity S is calculated in this method by anticipating the possible effects of the impact of the hazard considered during his/her period of work into account.

- **Very high (Death):** May cause death by accident or serious occupational illness;
- **High (Permanent handicap):** May cause a permanent handicap following a serious accident or a serious occupational illness;
- **Medium (Lost time):** May cause a lost-time accident (LTA) or an occupational illness with lost-time, which makes the resumption of usual work temporarily impossible;
- **Low (Non-Lost time but with medical treatment):** May cause a non-lost-time accident (NLTA), an occupational illness without lost time or an injury requiring medical treatment;
- **Very low (Minor treatment):** May cause a slight injury or slight pain that requires first aid.

7.2 PROBABILITY

The probability P is calculated in this method by taking the time of exposure of the employee to the hazard considered during his/her period of work and possible frequency into account.

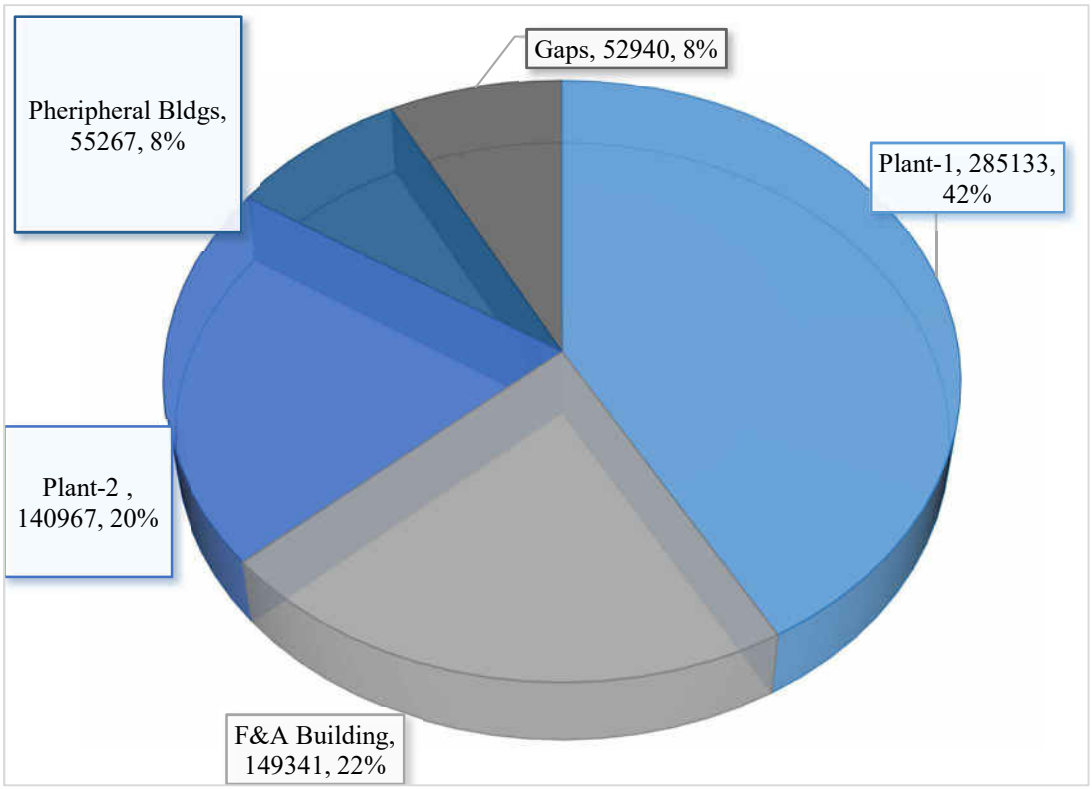
- **Very high**: This risk may occur every day or every week in usual work situations (an accident may occur several times per year);
- **High:** This risk may occur weekly or monthly in usual work situations (an accident may occur once or twice per year);
- **Medium:** Without being frequent, situations which are scored at this level may occur in special working conditions. Near accidents may have been reported (an accident may occur once every 2 years);
- **Low:** The risk has never appeared in any form but the analysis shows that it is possible and employees consider it possible (an accident may occur once every 5 years);
- **Very low:** Conditions which lead to the appearance of this risk are theoretically possible in the case of an improbable conjunction of special situations.

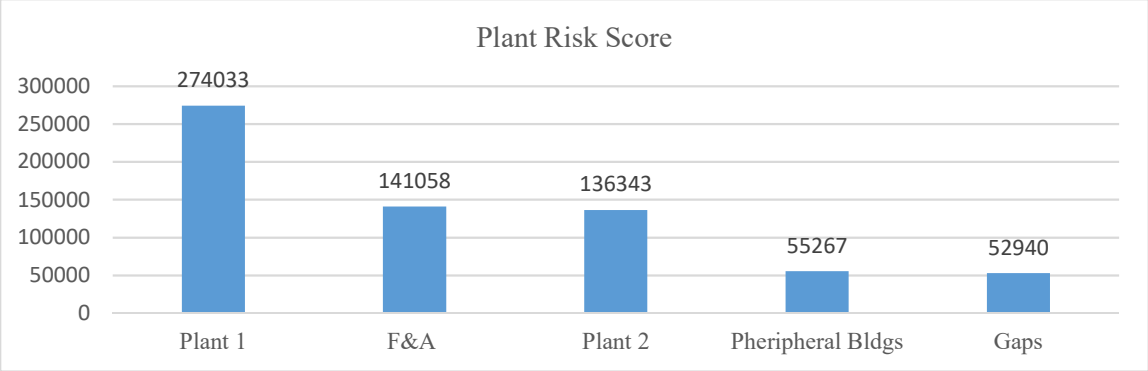
8. RISK GRADING

Severity		Probability: Very high (10)	High (8)	Medium (6)	Low (4)	Very low (1)
Very high (Death)	100	1000	800	600	400	100
High (Permanent handicap)	40	400	320	240	160	40
Medium (Lost time)	21	210	168	126	84	21
Low (Non-lost time but with medical treatment)	8	80	64	48	32	8
Very low (Minor treatment)	2	20	16	12	8	2

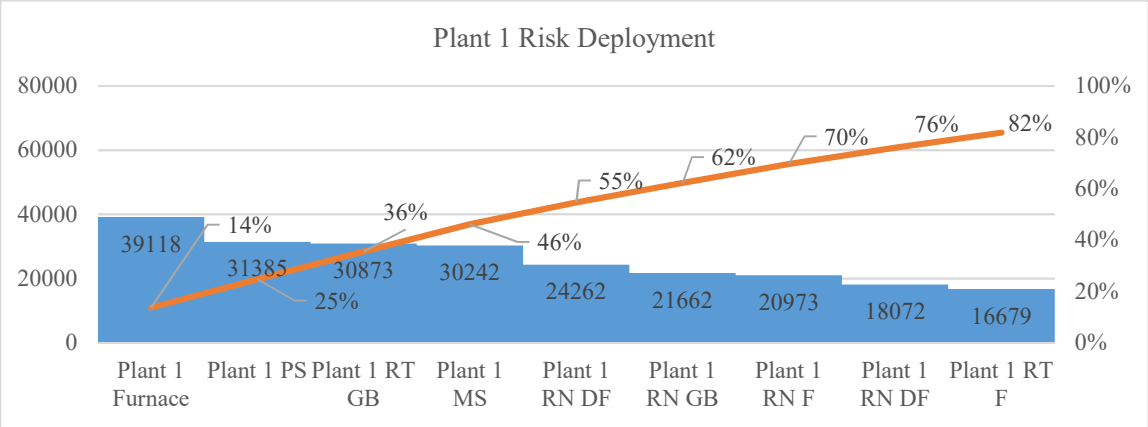
9. PROBLEM IDENTIFICATION & RISK PRIORITIZATION

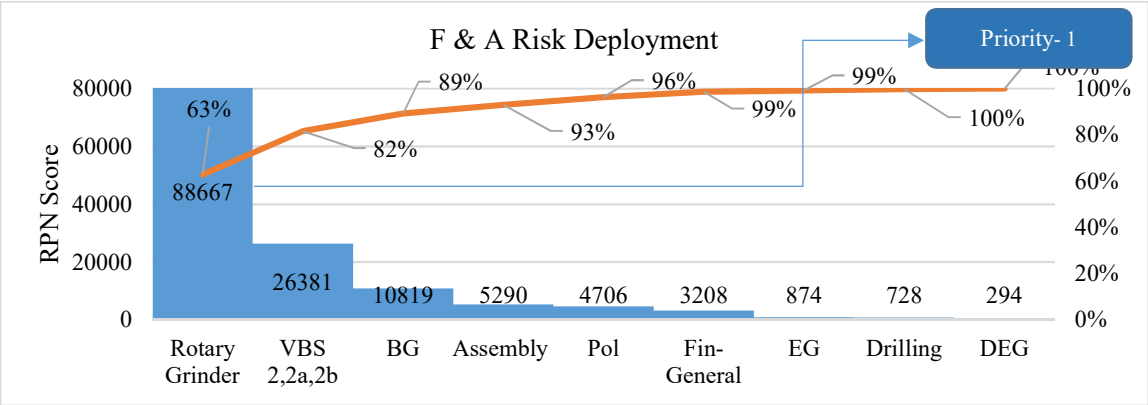
9.1 Over all Plant risk scores; The Risk assessment of the overall plant is evaluated and deployed on Plant Level.

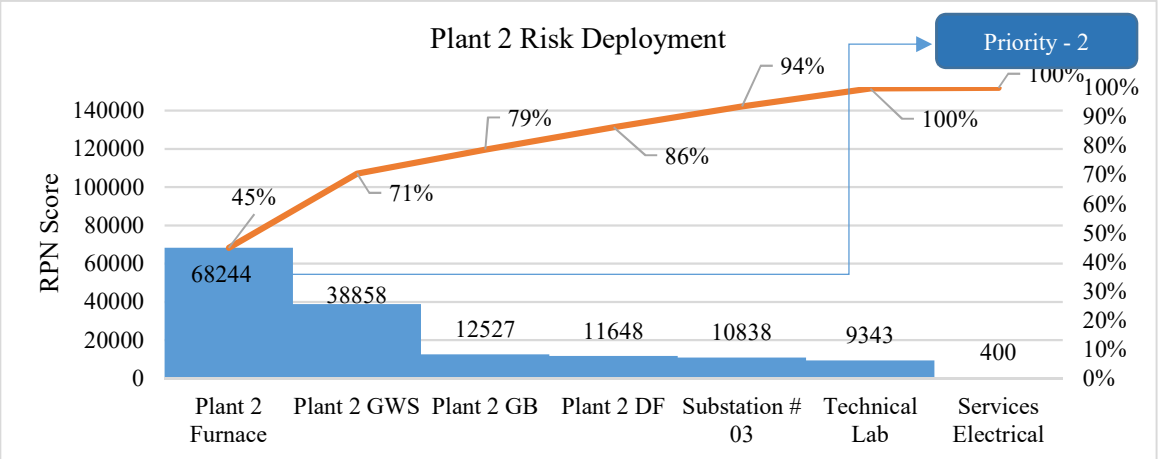




9.2 Over all Plant risk scores; The Risk assessment of the overall plant is evaluated and deployed on Department Level.







9.3 It is evident through the 2nd level of deployment and accordance to the risk prioritization **Plant 2 Furnace & Rotary Grinding process is contributing to 65% of risk at high priority area** and this project is taken to identify the hazards and to plan for corrective action and thereby to reduce the Risk Scores at both areas.

10. RISK MITIGATION AND RESULTS

10.1 F&A Risk Mitigation

F&A Risk Mitigation				
Sl No	**Hazards on Task Wise**	**Corrective Actions Initiated**	**Before Score**	**After Score**
1	Pit Manual Cleaning – Workers exposed to Finishing sludge – Exposure to finishing sludge.	Installation of Filter Press and manual cleaning is avoided	400	21
2	Pit cleaning – Manual Handling and ergonomic risks	Installation of Filter Press and manual process is eliminated	210	21
3	Accidental entry of operator/ operation during man inside and chance of injury	Door Provided with interlock and confined space systems	320	32
4	Slip/Fall of blocks	Fixtures provided for safe operation of Blocks	240	126
5	Slip of tool while changing of cutter and possible hand/finger injury	Impact Wrench provided.	168	8
6	Slip and trip hazard due to cleaning hose - Fall of person	Retractable drum with hose provided and no scattering of pipes on floor.	210	84
7	Unauthorised entry of operator/ operation during man inside - Rotating/Moving Parts – Risk of Injury	Schmersal Interlock with unique keys & RFID Provided.	400	40
8	Unauthorised entry/machine operation - Rotating/Moving Parts – Risk of Injury	Additional railings provided to restrict unauthorised entry.	210	40
9	Accidental Fall by operator into the pit – Fall of person	Telescopic handrail and additional barricade provided to avoid fall.	210	21

10.2 Plant-2 Furnace Risk Mitigation

Plant-2 Furnace Risk Mitigation				
Sl No	**Hazards on Task Wise**	**Corrective Actions Initiated**	**Before Score**	**After Score**
1	Furnace – Fusion & Pouring Spout platform interlocks – Rotating/Moving Parts – Risk of Injury	Interlocks provided with SCADA Systems, Rotating lamp with audio visual warning 10 secs prior to platform movement and Emergency key	400	40

2	Topping station dust level are high – Dust Exposure	Enclosures provided to contain the dust, Dust collector blower speed increased for better suction.	210	21
3	Manual cooling check by services team of the furnace over mobile ladder – Fall of person	Temperature sensors provided and Lights provided to safely check hot spots from ground level.	210	8
4	Unauthorised entry and risks in furnace operation through emergency back door. Hot process - Risk of Injury	Interlock provided with warning system enabled in furnace SCADA.	240	40
5	Spout changing – Fall of graphite boards	Platform provided to safely transfer graphite plates.	210	84
6	Spout Cleaning – Burn injury	Separate bin designed to collect hot crest from the spout.	240	126
7	Dust exposure from the dust collector cyclone separator bottom collection area.	Pneumatic gate provided and operated from the outside of enclosure and exposure is avoided.	400	40
8	Unauthorised entry or electrocution hazard while changing electrode.	Schmersal Interlock with unique keys & RFID Provided for the access ladder and its fool and mistake proof.	600	100

11. CONCLUSION;

- In this project, HIRA (Hazard Identification and Risk Assessment) methodology was analysed.
- HIRA revisited & done for the overall plant.
- Risk were prioritised and Pareto analysis was done to identify the top losses in the plant.
- Projects taken in this area to identify the hazards and corrective actions are taken to reduce the RPN Scores.
- Systematic way of risk identification, prioritization and eradication was applied and top risks was minimized.

12. REFERENCE;

(1) Azrah K, et al., 2015 published a paper on A Literature Review on Identification and assessment of hazard in the Refractory Brick Production Company

(2) Kotek Lubos et al., 2010 published a paper on Risk and Hazard Analyses of the Industrial Furnaces – Safety of Electro heat Equipment

(3) Shengli Niu., 2010 published a paper on Ergonomics and occupational safety and health: An ILO perspective

(4) Tom Gebel et al., 2009 published a paper: About hazard and risk assessment

(5) Study of SheikAllavudeen.S, Sankar.S.P(2015).The authors study gives hazard ,risk and its control methods in foundry.

(6) Study of KhairulAkmal Shamsuddin, Mohd Norzaimi CheAni, Ahmad Kamal Ismail (2015). This study gives aprocedure for hazard identification, risk assessment and determination of necessary controls.

(7) International standard ISO 14001;2015.

(8) BS OHSAS 18001;2007 standard.