# ERGONOMICS STUDY ON FURNACE OPERATION

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**Abstract**

**This research focuses on conducting an ergonomic study to optimize the operation of furnaces in industrial settings with the aim of improving worker performance, safety, and overall well-being. Furnace operation involves a range of physical and cognitive tasks that, when not properly designed, can lead to musculoskeletal disorders, fatigue, and decreased productivity among workers. The study employs a multidisciplinary approach, integrating principles of ergonomics, human factors engineering, and occupational health to evaluate and enhance the working conditions of furnace operators. Data will be collected through a combination of direct observations, surveys, and biomechanical assessments to identify ergonomic stressors and challenges faced by workers during furnace operation. The collected data are then analyzed using ergonomic assessment tools such as the Rapid Upper Limb Assessment (RULA). The findings of this study will contribute valuable insights for designing ergonomic interventions and implementing best practices to enhance furnace operation. Recommendations will be provided to improve the overall ergonomic design of workstations, implement training programs, and introduce technological solutions to mitigate potential health risks and enhance the efficiency and well-being of furnace operators.**

**Key words – Ergonomic, Furnace, Field Observation, Data collection, RULA, MSD**

## INTRODUCTION

In Industrial settings, furnace operation plays a pivotal role in various manufacturing processes, contributing significantly to the production of goods ranging from metals to chemicals. The efficient functioning of furnaces not only ensures optimal production but also impacts the overall well-being and productivity of the operators responsible for their control. As industries strive for increased efficiency and operator safety, conducting an ergonomic study on furnace operation becomes imperative.

Ergonomics, often referred to as the science of designing work environments to fit the capabilities and limitations of the human body, is crucial in ensuring a harmonious relationship between workers and their tools. In the context of furnace operation, understanding and optimizing the ergonomic factors involved can lead to improvements in operator comfort, performance, and safety.

This study aims to investigate the ergonomic aspects of furnace operation, considering factors such as workspace design, control interfaces, physical demands, and cognitive workload. By evaluating and enhancing these elements, the objective is to create an environment that not only maximizes operational efficiency but also prioritizes the well-being of the operators.

The importance of this study lies in its potential to address common challenges faced by furnace operators, including prolonged periods of standing, repetitive tasks, exposure to high temperatures, and complex control systems. A well-designed ergonomic intervention has the potential not only to reduce the risk of musculoskeletal disorders but also to enhance overall job satisfaction, leading to increased productivity and decreased downtime due to operator fatigue or discomfort.

In the subsequent sections of this study, we will delve into specific ergonomic considerations for furnace operation, utilizing a multidisciplinary approach that combines insights from engineering, human factors, and occupational health. By identifying key areas for improvement and proposing practical solutions, this research aspires to contribute to the advancement of both operational efficiency and occupational well-being in industries relying on furnace-based processes. Ultimately, the findings of this study aim to serve as a foundation for the development of guidelines and best practices that can be applied across

diverse industrial settings, fostering a safer and more productive working environment for furnace operators.

## LITERATURE SURVEY

1) The effects of ergonomic intervention on the musculoskeletal complaints and fatigue experienced by workers in the traditional metal casting industry

Wahyu Susihono , I.Putu Gede Adiatmika - The evaluation was carried out using questionnaires based on musculoskeletal complaints and fatigue. Meanwhile, an assessment of musculoskeletal complaints and fatigue was conducted one month before the ergonomic intervention, and then during follow-ups at one and eight months after the ergonomic intervention. This research aimed to evaluate the effects of ergonomic intervention on the musculoskeletal complaints and fatigue experienced by workers of the traditional metal casting industry that manually pour molten metal into molds.

2) An Ergonomic Evaluation of Work Place in Steel and Power Industry - A Case Study

Dr. Kottala Sriyogi - This paper is carried out by conducting the questionnaire method along the workers to evaluate the ergonomic in the work place to calculate stress and load. The main objective of this paper is to evaluate the working conditions of the plant from an ergonomics perspective and recommended feasible solutions to management for implementation. The investigation was done by a questionnaire survey as well as by observations in the workplace as a single case study

3) Musculoskeletal disorders and ergonomic risk factors in foundry workers

Asif Qureshi, K. Manivannan, Vivek Khanzode and Sourabh Kulkarn - The modified Nordic questionnaire is adopted to explore the prevalence of MSDs and associated critical ergonomic risk factor among the workers. The present study aims to identify activity-specific risk factors associated with musculoskeletal disorders (MSDs) among workers from small-scale foundries

4) Musculoskeletal Disorder Risk Assessment in small scale forging Industry by using RULA Method

Jaspreet Singh, Harvinder Lal, Gautam Kocher - In this paper Rapid Upper Limb Assessment (RULA) is used to evaluate the Musculoskeletal Disorder. The present study was aimed to evaluate the musculoskeletal disorder (MSD) of workers engaged in small scale forging industries. Study was conducted on 102 workers of a forging industry using the posture analysis tool RULA Method. Combined with a heavy physical workload, they result in a high frequency of work-related musculoskeletal disorders.

5) Analyzing musculoskeletal risk prevalence among workers in developing countries: an analysis of small-scale cast-iron foundries in India

Krishan kumar kataria, suman Kant, Milap sharma - The techniques used included the Nordic Musculoskeletal Questionnaire (NMQ), anthropometric measures, work postures analysis based on digital human modeling (DHM), Rapid Upper Limb Assessment/RULA and Biomechanics Single Action Analysis/BSAA ergonomic assessment tools. As processes are mainly labor intensive, workers employed in the metal casting sector are often at risk of MSDs. The main objective of this study is to investigate the exposure of work-related musculoskeletal symptoms prevalent among male workers employed in small scale gray cast-iron foundries of India.

## NEED FOR STUDY

**Worker Safety:** Ergonomics focuses on designing workspaces and tasks to fit the capabilities and limitations of the human body. In the case of an induction furnace, which involves manual handling of materials and operating machinery, addressing ergonomic considerations is crucial to minimize the risk of musculoskeletal disorders, fatigue, and other injuries.

**Efficiency and Productivity:** Ergonomically designed workstations can enhance worker efficiency and productivity. This is particularly relevant in industries that use induction furnaces, where repetitive tasks and prolonged periods of standing or sitting can lead to discomfort and reduced performance. Improving the ergonomics of workstations can contribute to better workflow and higher productivity.

**Reduced Worker Fatigue:** Operating an induction furnace can be physically demanding. Ergonomic design aims to reduce physical strain on workers, helping to prevent fatigue and potential long-term health issues. Fatigue can impact concentration, reaction times, and overall job performance, so addressing ergonomic factors is important for maintaining a healthy and alert workforce.

**Prevention of Injuries:** Musculoskeletal disorders, such as strains and sprains, can result from poor ergonomic design in workplaces. By considering ergonomics in the design and layout of induction furnace workspaces, the likelihood of injuries can be minimized. This not only benefits the health and well-being of workers but also reduces the financial burden on employers associated with medical costs and potential legal liabilities.

**Compliance with Regulations:** Many countries have regulations and standards related to workplace ergonomics. Ensuring compliance with these regulations is not only a legal requirement but also an ethical responsibility. Adhering to ergonomic principles in the design and operation of induction furnaces helps companies maintain a safe and healthy work environment for their employees.

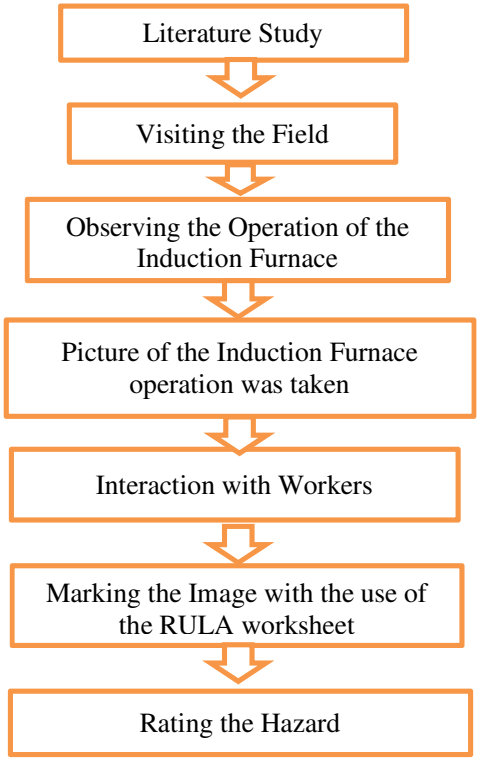
**Employee Satisfaction and Retention**: A well-designed and ergonomic workspace contributes to overall job satisfaction. When employees feel comfortable and supported in their work environment, it can positively impact morale and retention rates. Conversely, a poorly designed workspace that neglects ergonomic principles may lead to dissatisfaction and increased turnover.

## METHODOLOGY

RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. The RULA ergonomic assessment tool considers biomechanical and postural load requirements of job tasks/demands on the neck, trunk and upper extremities.

A single page worksheet is used to evaluate required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist, and section B for the neck and trunk. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.

The RULA was designed for easy use without need for an advanced degree in ergonomics or expensive equipment. Using the RULA worksheet, the evaluator will assign a score for each of the following body regions: upper arm, lower arm, wrist, neck, trunk, and legs. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.




## RESULT AND DISSCUSSION

This study is used to identify the ergonomic hazard arised during the operation of the Induction Furnace . The Study is conducted in different Induction Furnace. The study assessed by the help of the RULA( Rapid Upper Limb Assessment ). The below table shows how to calculate the RULA ( Rapid Upper Limb Assessment).The RULA worksheet is calculatede in different position of the Induction Furnace operators.

| Score | Level of MSD Risk |
|---|---|
| 1-2 | Negligible Risk |
| 3-4 | Low risk |
| 5-6 | Medium risk |
| 6+ | Very high risk |

From the above table mentioned points are used to identify the risk of the operators working in the Induction Furnace.

| S. No | POSTURE | SCORE |
|---|---|---|
| 1 | Subject 1 | 6 |
| 2 | Subject 2 | 6 |
| 3 | Subject 3 | 4 |
| 4 | Subject 4 | 4 |
| 5 | Subject 5 | 6 |
| 6 | Subject 6 | 4 |
| 7 | Subject 7 | 4 |
| 8 | Subject 8 | 6 |
| 9 | Subject 9 | 4 |
| 10 | Subject 10 | 4 |
| 11 | Subject 11 | 4 |
| 12 | Subject 12 | 6 |

## REFERENCE

[1] H.M.M.M. Jayawickrama, M. Dharmawardana, A.K. Kulatunga, K.G.S.P. Karunarathna, S.A.U. Osadith , Enhancement of productivity of traditional brass manufacturing industry using sustainable manufacturing concept; 13th global conference on sustainable manufacturing, GCSM 2015; binh du'o'ng new city; Viet Nam, . Procedia CIRP. 40 (2015) 562–567, 2016.

[2] E.M. Capodaglio, Participatory ergonomics for the reduction of musculoskeletal exposure of maintenance workers, Int. J. Occup. Saf. Ergon. (2020).

[3] Lynas, D. and Burgess-Limerick, R. (2013), "Participatory ergonomics case study: coal handling train crew operations", Ergonomics Australia, 10(1),1-11

[4] Mohsin, S., Khan, I.A.: Ergonomic Evaluation of a CNC lathe environment using EEPP. In: International Conference on HWWE, Mechanical Engineering Department, AMU, Aligarh (2017)

[5] Armstrong, T.J., Marshall, M.M., Martin, B.J., Foulke, J.A., Grieshaber, D.C. and Malone, G. (2002) 'Exposure to forceful exertions and vibration in a foundry', International Journal of Industrial Ergonomics, Vol. 30, No. 3, pp.163–179.

[6] Cheng, H.Y.K., Cheng, C.Y. and Ju, Y.Y. (2013) 'Work-related musculoskeletal disorders and ergonomic risk factors in early intervention educators', Applied Ergonomics, Vol. 44, No. 1, pp.134–141, Elsevier Ltd.

[7] Choobineh, A., Motamedzade, M., Kazemi, M., Moghimbeigi, A. and Pahlavian, A.H. (2011) 'The impact of ergonomics intervention on psychosocial factors and musculoskeletal symptoms among office workers', International Journal of Industrial Ergonomics, Vol. 41, No. 6, pp.671–676.

[8] Choobineh, A., Tabatabaee, S.H. and Behzadi, M. (2009) 'Musculoskeletal problems among workers of an Iranian sugar-producing factory', International Journal of Occupational Safety and Ergonomics, Vol. 15, No. 4, pp.419–424.

[9] Fredericks, T.K., Kumar, A.R. and Karim, S. (2008) 'An ergonomic evaluation of a manual metal pouring operation', International Journal of Industrial Ergonomics, Vol. 38, No. 2, pp.182–192.

[10] Ilangkumaran, M., Karthikeyan, M., Ramachandran, T., Boopathiraja, M. and Kirubakaran, B. (2014) 'Risk analysis and warning rate of hot environment for foundry industry using hybrid MCDM technique', Safety Science, Vol. 72, No. 2, pp.133–143.

[11] V. Soyseth, H.L Johnsen, J. Kongerud, Johny, Respiratory hazards of metal smelting. Curr. Opin. Pulm. Med., 19 (2) 158-162 doi: