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A Total Ergonomics Model for integration of health, safety and work to improve productivity of thermal Power Plants

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Abstract: *This paper presents a outline for development of integrated health, safety and work in complex critical systems of thermal power plant. In this paper operation and maintenance department of a thermal power plant was chosen as the case of our study. First, to achieve objectives, an integrated approach based on total ergonomics factors was developed. Second, it was applied to the thermal power plant and the advantages of total ergonomics approach were discussed. Third, the impacts of total ergonomics factors on local factors were examined through non-parametric statistical analysis. It is shown that total ergonomics model is much more beneficial than conventional approach. It should be noted that the traditional ergonomics methodology is not capable of locating the findings of total ergonomics model. The aspect of this study is the employment of a total system approach based on integration of the conventional ergonomics factors with factors.*

Key word: *Safety. Total system design, Environmental protection, Power plants, Human performance, Ergonomic, Macro ergonomics*

I. Introduction

The systematic process of designing for human use purpose is to provide a systematic and deliberate method for solving human factors issues in the most cost effective way. Analyses are conducted, solutions are implemented, Results are measured and follow-up actions taken, and Systems are affected. Productivity improvements for thermal power plants using Ergonomic point of view is categorized in as noise, Temperature, Lighting, Working Postures, Safety, Workers Productivity and Occupational Health, Equipment Design[1]. A design process can be described as a systematic series of actions that are under taken design a system or project [2].

The industrial challenge is to create an national interface among human operators, machine and managerial structures. In reality, managerial errors are often the basis causes of human errors and man-machine failures (3). Hence, the interface systems must be matched with operators' capabilities (4,5). In addition, there is a need for an integrated design between operators, machines, management and organization (6,7).

The need for productivity improvement arises due to the intimate link between productivity and economic growth; Economic growth has implications for resource use in general and for use of technology in particulars [8]. Productivity growth is critical for ensuring sustained increase in the production and services [9].

II. Methodologies

The systematic procedure for ergonomic point is to perform productivity needs analysis which gives an overview of current working condition of the company identifies the key productivity measures for the plant and forms the basis for the detailed work of production efficiency. Working need analysis which is constructed followed a plant tour and interviews/workshops with senior management to ascertain the current level of adoption of lean tools within the processes. Technological factor which gives perception and control philosophy (manual and automation), type of technology, system safely, market maintainability, national tradition and resource etc. and Anthropological factors which gives environmental and physiological characteristics, body sizes, level of skills education and knowledge attitudes and preferences. Training needs analysis (TNA) assesses the level of understanding and application of the same tools by the workforce. Idea generation and concept developments that are scenario, driven discussion design decision group focus groups

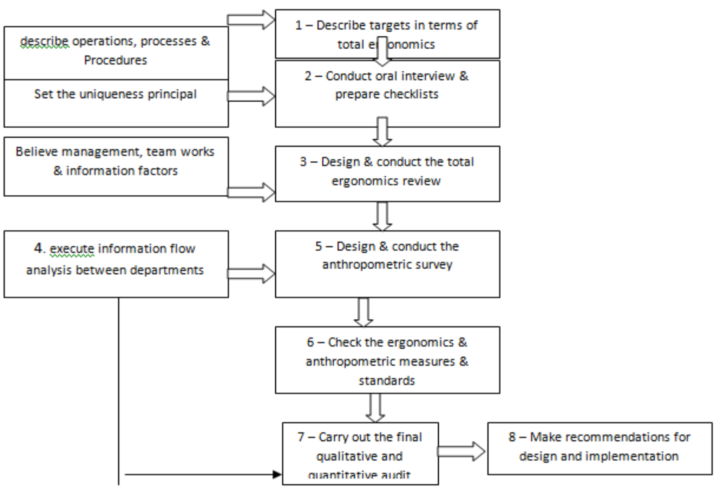

Fig. 1: The general steps required to achieve a total ergonomics model.

2.1Posture of employee during work

Calculated for each In this study work all the employees doing this operations were in the age group of 20 to 25 years with minimum tow year experience including training period and 450 people's interviews were conducted with a sample of plant's engineers and designers of which 417 completed and returned and obtain their description of the design process and use of ergonomics information. Risk priority numbers (RPN) were work elements based on posture and force for each major muscle group and the average was taken as the RPN for the effort intensity for the work. The major muscle groups considered were Back, Knees & ankles neck, Shoulders, Arms & wrists, Fingers and thumbs. The duration of continuous effort was recorded for each steps and RPN calculated based on the period of continuous effort. In calculating the total RNs for each work,. Weight age was given to the three parameters, based on their potential as risk factors for CTDs. Prioritization of works is carried out according to the total RPNs scored. The process of thermal power plant is identified as the work with maximum risk for cumulative Trauma Disorders according to the hazard rating scale-and RPNs of 8 & above, improvements to be taken up.

2.2Safety in Thermal Power Plants:

In this work 150 people were asked to fill out a structure questionnaire in connection with an accident investigation of thermal power plant. 125 subject returned the questionnaire for a response rate of 77%. The non responses percentage was 33%. The subject consists of 40 accident victim, 35 eyewitness, 10 worker's safety representative, 15 foreman, 05 manager, 15 safety officer, 05 groups neglected to mention groups to which they belongs, total number was 125. The subject estimated the effect of 24 measures on both productivity and safety. They rated each measure on a five-point scale so that values – 2 and 1 described a negative effect of a measure and value+1and + 2 a positive effect. The subjects chose the value zero if they felt that the measure had neither a positive nor a negative effect.

2.3Workers Productivity, Occupational Health

The work was conducted in 10 thermal power plant representing in urban, suburban and rural area. The number of thermal power plants in urban, suburban and rural area are 03(30%). 04(40%), 03 (30%) respectively. Investigate ergonomics, worker productivity and OHS in industries involved development of a checklist that included questions regarding: 91) demography of the company, (i) productivity and safety issues, (ii) ergonomic issues, (iii) environmental factors, and (iv) organizational and management issues. The demography of the companies included 10 questions such as number of workers, type of industry, if targets are set and percentage of targets achieved. Regarding productivity and safety issues, managers were asked 10 questions about worker productivity, quality of work, absenteeism and number of injuries. The ergonomic issues included 10 questions regarding worker's complaints on health and safety such as back pain, upper-body pain, fatigue, stress, manual material handling and motivation and training.

In this work 150 people were asked to fill out a structure questionnaire in connection with an accident investigation of thermal power plant. 120 subjects returned the questionnaire for a response rate of 80%. The non response percentage was 20%. The subject consist of 60 worker's safety representative, 20 foreman, 10 manager, 30 safety officer, total number was 120. The subjects estimated the effect of 10 measures on both productivity and safety. They rated each measure on a five-point scale so that values -2 and -1 described a negative effect of a measure and values + 1and + 2 a positive effect. The subjects chose the value zero if they felt that the measure had neither a positive nor a negative effect.

2.4 Noise in Thermal Power Plant

This work is conducted in three thermal power plants representing suburban locality. Noise is measure at selected stations in the different departments of the three plants using a precision sound level meter. Noise is measure with meter set on a network as well as the different octave bands. Noise data is recorded in brief. A random sample of 1050 male workers was selected from the different departments in the three surveyed plants of which 900 completed and returned. Out of 80 questionnaires about 20% were not returned and the rest incomplete. These (80) questionnaires were almost equally diapered within the 21 surveyed location. The questionnaire was designed to assess the socioeconomic characteristics of the individuals (age, marital status, occupation, education, and income) and individual's attitudes towards noise pollution.

2.5 Temperature Experimental Procedures

Temperature is measured at selected stations in the different departments of the three plants using a precision thermometer. Fifty healthy men participated in the research. The physical characteristic is summarized. The exposure time of each experiment was 3 hours. Firs, all subjects were exposed in climates with equal air, globe and radiant temperature. The subjects are examined at 7 "reference climates", where the temperature ranged from 27 to 55^{o}C. In subsequent experiments, minimum air temperature was 27^{o}C. Each step was combined with stepwise elevated radiant temperatures until the physiological reactions were at least equal or greater than those at the corresponding reference climate. Similar experiments were performed with variations of air velocity, physical work load and cloth is. The workers seemed to be related to the work environment (i.e. Plant Climate) due to high heat and high air ambient temperature, excessive noise dusts, dusts and noise level seeded to the worker. Heat load due to summer climate (Outside factory = 42^{o}C) and working near the boiler furnace (45^{o}C to 50^{o}C) affected operators by allowing less ability to work for a specific time. Additional heat was radiated by sunshine into the factory environment through tin roofed sheds

III. Results And Discussion:

3.1Working Posture: Intensity of Effort:

Risk priority numbers or RPNs were calculated for each work element, based on posture and force for each major muscle group of thermal power plants and the average was taken as the RPN for the effort intensity for the work in table 3.9. The major muscle groups considered were Back, Knees & ankles, neck, Shoulders, Arms & wrists, figures and thumbs the work, Using the Rodger's risk rating scale for each work step, prioritization of the work steps was done (risk scores or RPN of 8 & above) and improvement to be taken up, were finalized in consultation of engineers and team leaders as shown in table 3.10.

Table 3.9 Risk Priority Number of Each Work

SN	Activity	Risk Rating
1	Read the actual metal temperature of HP casing	4
2	Check the operational mode of HP & LP bypass value manual and auto.	6
3	Check the temperature control loop of the HP bypass station.	8
4	Ensure that the evacuating valves CR/105 & CR/106 and valves across NRVS in reheat lines are closed.	5
5	Check HP bypass valve and raise the steam pressure of boiler to design value.	9
6	Check the bypass valve of MSV & ESV.	4
7	Check steam pressure	5
8	Check drain system	6
9	Note down various metal temperatures	6
10	Bring the control of LP bypass valve on manual mode.	4
11	Manually closed the HP bypass valve.	7
12	Check that the eccentricity and different expansion system.	4
13	Check ESV inlet valve and CV of HP & IP turbine	4
14	Check bypass valve of MSV	4
15	Listen the turbine rubbing at 500m. Check the vibration of various bearing.	4
16	Check the speed to 300 rpm and hold the turbine for 5 minutes with a view to carry out inspection and listening soaking.	4
17	Ensure that the main centrifugal oil pumps are in ready position.	9
18	Synchronize the set load.	4
19	The raising of steam parameter and loading.	4

Table 3.10 Work Requiring Attention and improvements

SN	Work requiring attention	Improvement suggested
1	Office work station	Office workstation in adjustable height
2	Check drain system and note down various metal temperature	Height of adjustable platform to reduced twisting and bending and twisting can be avoided
3	Check the operation mode of H.P. Value	Redesign so that bending and twisting can be avoided
4	Pick up more than 3 kg weight from the rack above the shoulder level	Redesign the rack so that above shoulder operations are eliminated.
5	Operation mode of HP & LP valve manual and auto.	Redesign the height to avoid twisting and bending.
6	Temperature & Pressure measurement of HP bypass station.	Redesign of height to avoid twisting and bending.
7	Centrifugal oil ump reading	Redesign the height of pressure and temperature & soil level to reduced bending and back pain.

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