

# FACTORS THAT INFLUENCE SAFETY PERFORMANCE & STRATEGIES FOR PROMOTION OF SAFETY CULTURE IN POWER PLANT

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**ABSTRACT** - Working in power plant is most critical in terms of its potentials for accidents due to the diversified nature of activities coupled with the contractor unskilled labour force. Maintaining safety management for contractor is a challenging task of any organization because of the high severity of injuries because of the presence of unskilled, illiterate and migratory workers having low safety awareness among workers make them more vulnerable to accidents. The year wise trending of safety indices value shows that total contract employees worked, near miss accident reported, safety activity number, have a direct association with the safety performance. Near miss accidents reporting system helps to prevent accidents by identifying reporting, analyzing & correcting the causes of near misses & safety promotional activities as a part of accident prevention programme resulted in improving safety awareness that depicts good safety culture of the organization and helps for further improvement. This paper describes the factors that influence safety performance & the innovative techniques for employee participation in different safety promotional and awareness programme that promote safety culture in the work place

**Keywords-** Safety Management, Safety Indices, Safety Awareness, Near Miss Accident, Contractor Worker, Safety Culture, Safety Budget, Safety Activity.

## 1. INTRODUCTION

The scenario of work places is constantly changing & influencing due to increased reliance on sub contractors & transient workers which create a serious challenge with regards to Industrial safety for an organization. All hazards & challenges of industrial safety in a power plant are well defined, properly recognized & understood by all regular employees of plant, but during shutdown & for major activities various contractor labor force employed to execute different types of work activities. These contractor workers transiently employed for one phase of project by some agency for a while and soon after completion of that phase move to other phase with some new contractor & so on, these contractors have to settle these temporary workers who are quite not appropriate for the job They do not recognize the risks involved & preventive measures

which they themselves have to take in order to safe guard them from different types of hazards. These contractor workers comprise of unskilled labors their lack of awareness of safety measures make them more vulnerable to accidents. Safety in a industry is based on the combination of three pillars- the person, their behavior & their environment. When all three pillars are combined forms a strong safety culture which is the base for accident prevention. For preventing the accidents implementation of right job for right person policy, strict supervision, proper procedure adherence & training is required.

## 2. DEFINITIONS-

- **Safety-** It is consider as freedom or protection from danger/ harm/ hazard & accident. Safety is an organized activity for minimizing human loss/ economic loss & sociological loss.
- **Hazard-** It is considered as inherent intrinsic property of material or condition or situation environmental with the potential to cause injury or harm
- **Domino concern:** - Any operation & process which have significant potential to trigger or multiply the risk associated with the activity which can create potential emergency condition.
- **Man days Lost-** These are charges in days of worker earning capacity which is lost due to lost time injury which include permanent disability or partial disability. In Appendix A (part A & part B) of IS 3786:1983 listed scheduled charges which describes percentage of loss of earning capacity & its equivalent man days lost
- **Man hours-** man hours worked is the total number of employees (managerial, supervisory, technical, professional, clerical including contractor worker labor) hours worked by all employees in the Industrial premises.

- **Frequency rate (FR)** - frequency rate is the number of lost time injuries per million man hours worked. Its generally indicates how often injuries occur.
- **Severity Rate (SR)** - Severity rate is the total man days lost due to lost time injury per million man hours worked.
- **Near Miss Accident**- The near miss accident is the deviation from normal since nothing really happened but the incident has a potential to cause injury or accident.
- **Safety Budget**- The safety budget which emphasizes the cost of accident prevention activities against the cost of accident occurrences incidents. Safety budget programs including safety training, awareness programs, safety inspection, safety audits.
- **Accident** - The unplanned & unexpected event which lead to damage to people/ property or environment..
- **Lost Time Injury**- As per factory act 1984 due to any injury if person become disable to work for a period of 48 hours or more than the incident must be reportable lost time injury.
- **Accident preventive programme**-The process of correction of unsafe action & unsafe condition which is consider as immediate condition of an accident by apply corrective measure in human performance, machine performance, equipment performance & physical environment. In accident prevention involved organizing, fact finding, analysis, selection of remedy & application of remedy.
- **Job Hazard Analysis (JHA)**- It is a technique which helps in reducing the risk which is associated with the job to tolerable limit. In a JHA whole activity is broken down & each basic steps of job is identified for potential hazards.
- **Safety management system**- The safety management system is a systematic & continuous management process for managing the safety activities building safety in overall management system.
- **Safety organization**- It is the structure of group of employees which are further divided into different sections & department with specific safety duty & function. The authority, responsibility & accountability of employee are clearly defined for achieving objective of organization safety goal.

- **Safety activity rate**- The safety activity rate is the overall safety promotional & awareness activity which including safety training, safety inspection, safety related equipment inspection, safety audits, Safety activity rate are the leading indicators which are useful tools to educate the employees & making them alert in identification of hazards.

### 3. LITERATURE REVIEW

As per study of (kozlovska & strukova 2012 ) stated that most of the jobs in industries are relying closely on contractor's man power which is generally belonging to unorganized sectors which are the major contributor to lost time injuries & man days lost. This is one of the important aspects which affect the performance of safety management system & influences the efficiency of project due to high rate of accidents of contract labor at the work place there is provision of safety budgets in all contract tender price. The contractor should assessed & include safety budgets for safety related issues like purchasing of approved personal protective equipment deploying safety personal for monitoring, conducting induction safety training to labor. Before raising any tender the past record of safety performance of the contractor & sub contractors should be examined before allocation of any work contract.

Abdul -Rashid, I, Bassioni , H and BAWAZEER, F (2007) concluded in their research that safety awareness of top management & project manager towards the importance of safety are the most important factors affecting safety performance. For reducing the accidents administrative control involvement of management tools in safety for planning & performing the work with a proactive approach. Management should demonstrate commitment to safety by enforcement of safety legislation taking corrective action for unsafe act or unsafe condition which is generally responsible for 98 % of accidents as per Heinrich Accident Causation theory. Safety is everybody jobs there should be proper distribution of responsibility & adoption of proactive actions which include safety & health training education & promotional activities which are required to overcome the safety issues (ABDULLAH; GLORIA 2010)In another study done by Zubaidah Ismail, Doostdar & Harun,Z(2012)on Factors influencing the implementation of a safety management system concluded that personal factor was the most influential & safety awareness, use of better design equipment, protective equipment (PPE) are among the sub-factor was the most influencing safety factors for success of a safety management system.

For any accident there may be many contributory factors involvement which are classified as causes & sub causes. The combinations of all these factors give rise to accident. Root causes of accident is grouped as Immediate cause & contributing cause, unsafe act & unsafe condition which are only the proximate causes are considered as immediate causes of accident. The poor level of safety performance of in organization is primarily due to their reactive approach towards safety management. Accidents are mainly occur because of inadequacy of safety policy, unsafe practices, poor attitude, Lack of management control & commitment with regards to safety are the main contributing factor of accidents & without proper management support enhancing safety & health on work site is not possible (TEO, LING, CHONG 2005). All accidental causation model theories are failed in framing strategic guidelines for accident prevention practically for line managers for reducing risks at sites (HOSSEINIAN; TORGHABEH 2012).

In a research study conducted to identify factors that influencing the safety performance of contractor workers by (HINZE, GAMBATESE 2003) shown that injury rates increased with an increase in the high number of new workers, which are susceptible to injury & suggest that training should be conducted on workers for better safety performance. Safety training is imparted to contact workers before they are deputed to work. Contractor employees are taught about use of PPE. Continuous efforts for enhancing & maintaining workers safety consciousness & awareness regarding the hazards through workers participations in safety. The aim of promotion of safety awareness is to induce employees to improve their own safe behavior and that of their co-workers and to support an organizations stated safety goals.

As per Frank E. bird 600 near miss accidents are usually occurring before the occurrence of a major accident. The near miss accident is the deviation from normal since nothing really happened but the incident has a potential to cause injury or accident. They uncover all possible causes of future accidents They indication of site conditions and the safety culture and its shows the area need for improvement The time difference between a near miss accident and an accident may be a few seconds. Similarly a few centimeters of advancement may change a near miss accident into a major accident. They exposed inherent weakness of system should be rectified immediately. Near misses provide much large base for more effective control of accidental loss. Workers generally tend to ignore such incidences, but these incidents are indicators and if preventive actions are not taken, such incidents will get converted into major accidents. This will help to ensure

safe working environment in an organization. Reporting culture can be improved by motivating the workers. For the cultivation of safe attitude it is necessary to create interest in safety amongst the employees by developing the safety culture in the organization .

#### 4. METHODOLOGY

The methodology focuses directly on management aspect towards safety performance by evaluating safety activity rate, safety training statics, safety education statics, and investigation of near miss accidents & further analysis of near miss accidents as per IS 3786 so as to arrive at their root causes and to decide upon the corrective measures, they uncover all possible causes of future accidents. Near miss incidents are indication of site conditions and the safety culture and its shows the area need for improvement. If the root causes of these near miss incidents are found out and precautionary measures are taken then the probability of risk for all major accidents can be reduced to significant level.

##### 4.1. PURPOSE OF ANALYZING & MONITORING NEAR MISS ACCIDENTS-

Appraisal of safety culture from day to day safe working of people is indicated by near miss accident. The monitoring & analyzing of each & every Near miss accident which shows improvement in safety culture which indicate people & management of organization has become more safety conscious. Near Miss Accidents are considered as Wakeup call or called Warning bell. Therefore implementation of system for reporting near miss accidents, analyzing & recording for root cause analysis and lesson learnt from them is an essential step towards the protection. The occurrence of any near miss accidents is attributed to various contributing factors leaves a lot of scope to learn lessons from it to prevent its recurrence. It is realized beyond any doubt that most of the accidents are preventable provided the potential hazards are identified in advance and corrective measures are implemented. As per Frank E. bird 600 near miss accidents are usually occurring before the occurrence of a major accident. The investigation of near misses is very essential since they are the potential accidents in progress. They are considering the beginning of the sequence of events which lead to a series of errors that falls on one another creating a dominoes resulting in accident. There investigation of all degrading incidents occurring that provides a much longer basis for more effective control from total accident losses. The investigation of every major accident reveals that for every major accident there are several preceding minor incidents & near misses.

## 5. DATA ANALYSIS-

**Table 5.0 Year Wise Comparison Of Safety Indicators**

YEAR (1APRIL-31MARCH)	Regular Employees	Contract Employees	Total Employees	Near Miss Accident Reported	Safety Activity Number	Safety Activity Rate	Lost Time Injuries	Man Days Lost	FR	S.R
2012-2013	359	572	931	17	830	2.11	2	55	0.94	26.001
2013-2014	373	678	1051	34	983	1.94	3	6062	1.25	2520.90
2014-2015	412	872	1284	64	1132	1.51	5	6097	1.71	2089.98
2015-2016	326	438	764	88	1256	4.73	3	6053	1.72	3487.13
2016-2017	268	416	684	93	1463	6.85	1	6	0.64	3.85

The objective of the study is to evaluate the factors that influence safety performance in combined cycle power plant in the period of five year from year 2012 to year 2016. The Required data for the evaluation are collected from safety department & time office of DCCPP plant. This data pertaining to total employees worked including contractor man power, total man hours worked, number of near miss accidents reported, number of safety Activity performed, number of lost time injuries, number of total injuries & total man days lost.

Total 296 Near miss accidents were reported from year 2012 to year 2016 which include 14 reportable lost time injuries contributed to 18273 man days lost from year 2012 to year 2016, year 2014-15 from were major contributor of man days lost 6097(33 %) which including 05 lost time Injuries (36 %) which is because of maximum contract employees involvement (25 %) & maximum man hours worked (27 %) approximately 872 contract employees are engaged for completion of shut down activities. During the year 2016-17 the DCCPP achieved least number of Injuries rates & Number of lost time injuries reported were lowest with only 01 lost time injuries accounting to lose of 0.03 % man days lost. They safety performance for year 2016-2017 in comparison to previous years found best. This could be achieved with implementation of several innovative programs & mechanisms to provide impetus to industrial & industrial & fire safety. Maximum number of near miss accident 93 was investigated & conducting highest Safety Activity rate of 6.85 in year 2016. This is significant improvement with previous year.

### 5.1. ANALYSIS OF NEAR MISS ACCIDENTS

These Near misses have been analyzed as per IS-3786. The factors considered for the analysis are agency of accidents (B-1) and type of accidents (B-5). Analysis of near misses as per IS-3786 "Agency wise"- 49 % of the Near miss

accidents were due to deficiencies in working environment such as missing rungs or side railing in ladders or stairs, lack of barricading or inadequate barricading, floor openings, deficiencies in rolling shutters, flying of spatters during welding, improper use of chairs, spillage of oil or water in the floor, 9 % of the near miss accidents were due to deficiencies while using in Lifting Machines & appliances such as EOT crane, mobile crane, Forklifts, elevators slings & other lifting tools & tackles, which have either fall of persons or fall of objects with potential to cause injuries to the persons involved in handling these equipments, 8 % of the near miss accidents were due to deficiencies in working with electrical Installations with potential for electrocution of the person involved and could be prevented by suitable actions taken promptly, 7 % of the near miss accidents were due to deficiencies in the scaffolding erection practices such as loosely secured working platforms, hand railing etc. which had the potential for fall of persons and causing severe injuries to them.

Analysis of near miss accidents as per "Type of Accidents"- 33% of the near miss accidents were attributed to potential for Fall of Persons at the same level or from height such as stumbling with trench covers, slipping on the floor due to oil or water spill, slipping while working at heights, 23 % of the near miss accidents were attributed to stepping on or sticking against or struck by objects due to tripping hazards, struck by furniture materials, covers or grid plates, pressurized pipes, paint containers, rods, gas cylinders, valve hand wheel, transport vehicles etc, 13% of the near miss accidents were due to fall of objects such as hand tools, reinforcement rods, scaffolding material metallic plates etc during handling, ceiling materials, corrosion products from the equipments at height, 7 % of Near miss accidents were due to exposure to or contact with electrical current such as potential for electrical shock while working on electrical equipments or appliances due to weaknesses in equipment isolation

procedures, communication between the sections involved in the jobs or supervision etc.

## 5.2. SAFETY ACTIVITY RATE

Safety activity rate are the leading indicators which prevent the future events by conducting safety training & promotional activities, inspecting the safety related equipment, checking testing & calibration date, conducting safety inspection & emergency mock drill. Safety activity is the safety budget which emphasizes the cost of accident prevention activities against the cost of accident occurrences incidents. Also as per factory act 1948 it's the general duty of occupier (section 7A Factory act-1948) to ensuring the safety & health of all worker, providing training & information for safety health issue, ensuring all reasonable practicable measure for safety, health & welfare for all workers. Safety activity programs including safety training, awareness programs, safety inspection, safety audits & safety related equipment inspection are the useful tools to educate the employees & making them alert in identification of hazards, safe operating process, process safety parameters, any deviation from design intension easily discovered. They become more active in near miss accidents reporting & investigation which uncovering all possible causes of future accidents

## 6. RESULT-

The year wise trending of safety indices value shows that total contract employees worked, near miss accident reported, safety activity number, have a direct association with the safety performance. In the present study it was found that two variables \* Number of Near miss accident reported & \*Number of safety activity conducted have positive impact on safety performance. These two independent variables were influences & are correlated with the safety performance rating. Safety activity rate & number of near miss accident reported were indirectly influencing the safety performance variable & having positive impact on overall safety performance rating.

The safety performance is poor in the year 2014-2015 as compared with other year contributing maximum number of lost time injuries due to large contractor worker involvement in the plant because of plant stud down activities. Large contractor man power is engaged. The year 2016-2017 having the best safety performance that indicating considerable effect are put in improvement by increasing safety activity rate & implementation of low level event investigation policy which improving the near miss accident investigation by uncovering all possible causes of future accident.

After analyzing the data it is concluded that safety performance can be improved by improving the safety activities & investigating all reportable near missed accident cases which is used as tool for improving human performance as trained & alert worker is more safer in unsafe condition in comparison with an untrained & un alert worker with lack of knowledge & skill is unsafe in a safe condition .Hence focus should be given in imparting awareness on unsafe acts and unsafe conditions to the field worker. Hence a systematic training plan is needed because many of them are illiterates & are coming from unorganized sector.

## 7. STRATEGIES & CHALLENGES IN PROMOTING SAFETY CULTURE

“Safety increase productivity” this is the success mantra in power plant. Safety and production are considered as two faces of same coin. A poor accident record always indicating of mismanagement & inefficient production. Safety should be considered as necessary component for efficient industrial production. Both are interrelated without proper safety we cannot approach to 100 % production Thus it becomes vital to promote safety culture in the work place. Culture development is not an overnight process and it requires strategic planning and implementation. The foundation to an effective strategy starts with a well drafted health and safety policy which shows management commitment towards improving safety culture. The investigation of every major accident reveals that in majority of major accident there are several preceding minor incidents & near misses. To improve the working knowledge of the people suitable training programs are arranged for employees and contractor supervisors and workers. Since safety is everyone's responsibility, it must be open to suggestion from everyone too. There must be forum / platform provided to all employees where they can raise issues related to safety, suggest any changes in the current system or suggest about the best practices from any global sources. In short employee participation is mandatory for spreading safety culture.

## 8. MOTIVATING PEOPLE FOR SAFETY

Motivation is consider as a will or desire required for safe behaviors. By incorporation of training, safety policy & procedure, creating good ergonomically designed working station helps in creating awareness, alertness & changing their attitude, . All these factors relieving the job stress & ensure towards safe behavior that reinforce individual safety values & beliefs. Management should ensured all reasonable practicable safety measures to prevent, minimize or control of accidents by effectively

implementation of hazard Identification & accident prevention programme at work site. In this respect daily work related safety tips/ safety precautions are being taught to the worker prior to start of the daily work & efforts are being made to implement these safety tips/ safety precautions at work place to carry out work without any Injury. Conducting tool box talk is the effective safety tool in controlling the accidents. The effective tool box talk can change the attitude of workers in positive attitude.

## 9. SAFETY CULTURE

Safety culture of the organization reflects its employee's awareness towards safety & attributes or perception, values towards safe working. It consist of two aspects the behavioral aspect of employees their responsibility & the core values of organization. The decision actions in each level of management should reflect safety first. For reinforcing behavioral aspect of employee all safety activities should be focused on safe behaviors of employee. The attitude of any person is based on how he behaves with response to given subject. So behavior is act as the mirror in viewing the state of mind. Attitude is not measurable but behavior is measurable as safe behavior or unsafe behavior. In 1931 H.W.Heinrich consider as father of safety management identified that maximum percentage of accidents is associated with human error which is due to risk behavior or unsafe attitude.

### 9.1. INNOVATIVE MEASURES FOR IMPROVING SAFETY CULTURE

- I. Explaining the contractors worker regarding they need to know and understand what is expected in regards to managing safety and health in the workplace. Safety and health arrangements are explained to them. Explaining them the policies and procedures, work permit systems and make sure that they understand and will act in accordance with them.
- II. Providing information, instruction and training – providing information and instruction through meetings, class room lectures and on the job trainings. Hence arrangement of training for different category workers to give inputs not on safety and health but also on good morals. Making temporary workers feel part of teams. Frequent short training sessions at the beginning of work increase recognition of hazards and improve compliance.

- III. Constant monitoring of safety and health performance and continuous improvements-adequate supervision of contractor worker to monitor whether the work is being performed safely. The work performed by the contactor workers can sometimes require closer supervision than with permanent workers.
- IV. Investigation of all injuries- investigations of all injuries and cases of work related ill health and even more importantly the near misses to find out what went wrong and why they were not prevented. The lessons learnt from monitoring and investigations are shared with entire workforce.
- V. Personal protective equipment- the contractor should provide all specified safety PPEs to their labors. This equipment must meet with appropriate IS standard and be in good working conditions. The contractor shall ensure that it's labor have received appropriate training on the use and maintenance of these personal protective equipments prior to its use.

## 10. ENFORCING SAFETY-

For enforcement of safety statutory acts, rule & recommendation. Some are the various ways for enforcement of safety as below:-

- Engineering improvement- this is consider most effective way for controlling the hazard or preventing the danger due to the inherent hazard.
- Training- before deploying a person for a job, it is must that both orientation training, induction training & specific job training is provided in addition to pre job briefing & post job briefing.
- Checking out personnel & confiscations- Any observation of unsafe practice, unsafe action, use of wrong tools equipment & other work implements needs to be corrected on spot.
- Suspension of work- Yet another disciplinary aspect is stopping the entire activity or work.
- Penalty-if any violation of work practices & deviation from procedure is observed repeatedly occurring, enforcing penalty so that such activity not repeated in future.

- Self enforcing through appreciation & encouragement- It is also equally important to encourage good practices & safe work activity. For such various motivational measures & encouragement programmes need to be developed.

## 11. CONCLUSION-

To improve and maintain high standard of safety, cooperation of all employees is very essential. The attitude to adopt safe behavior is to be cultivated by suitable and appropriate techniques. Adoption of innovative ideas to enhance safety awareness amongst contractor worker. The Near Miss Accidents are considered as Wakeup call or called Warning bell. Therefore implementation of system for reporting near miss accidents, analyzing & recording for root cause analysis and lesson learnt from them is an essential step towards safety culture improved. Sound proactive measures and well practiced reactive measure are essential for safety. Strategic planning helps us to implement safety culture in work place by overcoming all the challenges. Due to implementation of effective safety management system & establishment of safe working culture, safety performance is improving continuously.

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