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Hazards Identification and Risk Assessment in Thermal Power Plant

Ruchi Shrivastava,
M.tech (Indu. Safety Engg.)
Dept. of Fire technology and Safety Engg.,
IES-IPS Academy, Indore (M.P), India

Praveen Patel,
Assistant professor
Dept. of Fire technology and Safety Engg.,
IES-IPS Academy, Indore (M.P), India

***Abstract*— The thermal power plant is a large electricity generation industry. It consist a number of process by mean to generate electricity by use of fossil fuel. It also consist several major equipment and operations involve in its process. The purpose of hazard identification and risk assessment in thermal power plant is to identify physical, chemical, biological and environmental hazards in the plant, analyse the event sequences leading to those hazards and calculate the frequency and consequences of hazardous events. Then risk level is assigned to each hazard for identifying required corrective action to minimize the risk or eliminate the Hazard.**

***Keywords*— Thermal power plant; Risk assessment; Hazard identification;risk matrix.**

I. INTRODUCTION

In present scenario for any industry to be successful it should meet not only the production requirements but also maintain the safety standards for all concerned. The coal fired thermal power plant susceptible to a wide range of hazards in its various operational areas. Hazard identification and risk assessment is systematic approach to protect the health and minimize danger to life, property and environment.

This paper highlights report on HIRA applied in the C.S.E.B. thermal power plant, Korba EAST (C.G.). It includes the methodological steps to identify hazard related to materials, operations and conditions. Assess the risk level of the hazards and apply or suggest the possible remedies and corrective actions to reduce the risk.

II. METHODOLOGY

Hazard identification and risk assessment is a combinations deterministic, probabilistic and quantitative method. The deterministic methods take into consideration the products, the equipment and the quantification of the various targets such as people, environment and equipment. The probabilistic methods are based on the probability or frequency of hazardous situation apparitions or on the occurrence of potential accident. The quantitative methods analyses various data numerically.

The five steps of hazard identification and risk assessment are:

Step1: System Description: Define the system and there subsystem and operations.

Step2: Hazard Identification - Defining and describing a hazard, including its physical characteristics, magnitude and severity, causative factors, and locations or areas affected.

Step3: Risk Analysis- Analyze the Probability, frequency or likelihood the potential losses associated with a hazard.

Step4: Risk Rating - Risk Classification Screening Table is formed and value of hazard or calculated risk class gives the require action to be taken.

Step5: Resolve the Risk – corrective action recommended preventing, reducing or transferring the risks, by short and long term planning.

III. PLANT DISCRIPTION

Thermal power plant is electricity generation plant which converts the fossil fuel stored energy to electrical energy by means of generating electricity. In other words, it is merely a chain of Energy conversion as follow:

- Chemical energy in the fuel is converted to Heat energy of steam.
- Heat energy of steam is converted to Mechanical or rotating energy of a rotating wheel called Turbine.
- The mechanical energy of Turbine is converted as Electrical Energy in a Generator**.**

As shown in the fig.1 the thermal power plant has the following area operations:

A. Coal Handling Plant

Coal transported to the plant by the rail line and carrier trucks. This coal is transfer from the underground bunker to crusher by series of conveyer belt. In coal crusher coal size reduced up to ¾" after that coal transfer to the boiler's coal bunker or coal yard. In the case of emergency the coal is fetch from coal yard. Coal feeder control the quantity of coal from coal bunker and send it to the ball mill or roll mill for pulverization process. Where coal crushed to the fine powder and mixed with preheated air come through the air from pre-heater. This process use for drying the coal and sends coal powder up to the burner of furnace. The rest of impure coal and rocks pass out to the bottom of mill and transfer to the clinker grinder then to the storage.

B. D.M. Plant

Raw water is de-mineralizing to free water from salts and ions then treated with sulphuric acid and caustic soda to retain the ph level up to 9. This process is done in the demineralization plant. De-mineralized water transfers through pipeline to D. M. water tank.

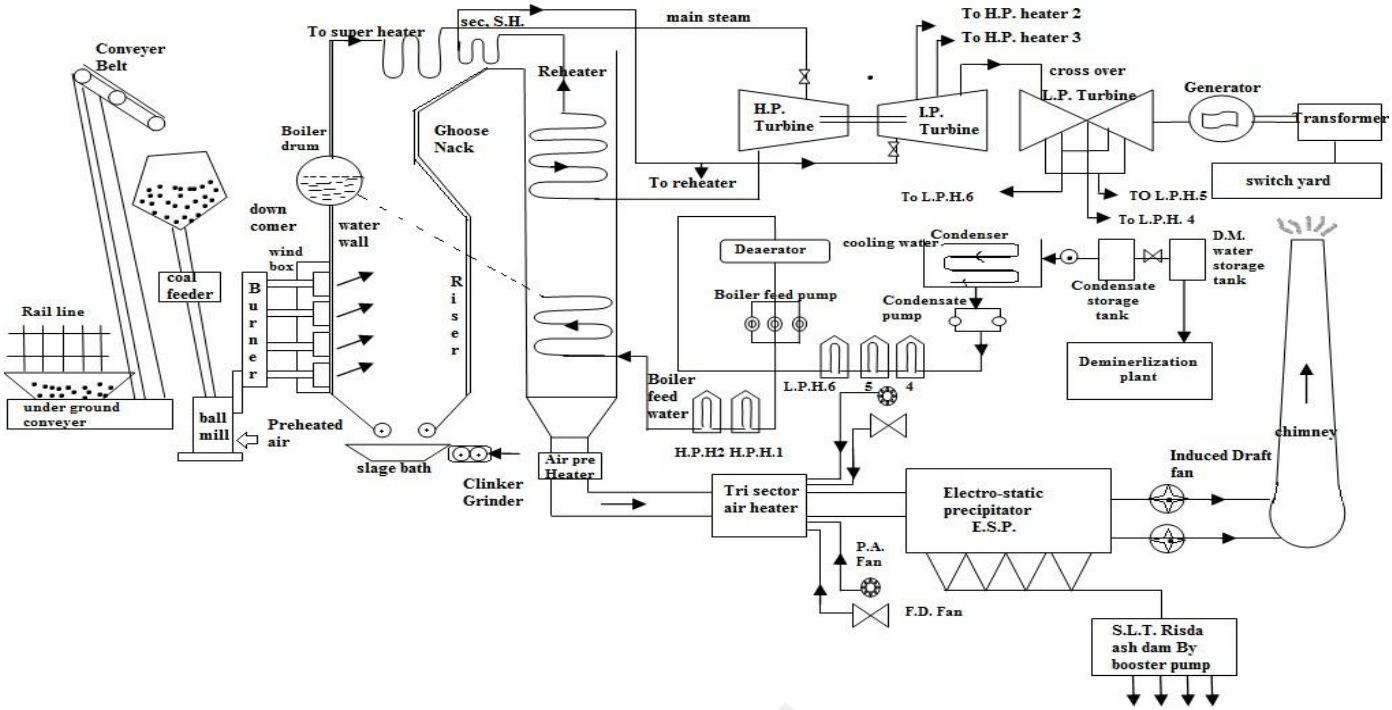

Figure 1: Thermal power plant layout

C. *Boiler*

The Feed water pump pass the water through low pressure heater, high pressure heater and economizer to raise its temperature and send to boiler drum. The furnace of the boiler had four coal burner and one diesel burner. Diesel burner used to rises the temperature of furnace up to up to auto ignition temperature of pulverized coal. Coal burn and generate flue gases which boil the water of boiler drum. Then flue gases passes through super heater , secondary super heater, re-heater, economizer, air pre-heater and tri-sector air heater after that its temperature is reduced. The flue gas mainly content fly ash particles and air pollutants like SOx , NOx, COx, toxic gases, metal fumes so before passing it to the chimney its treated in the Electro-static precipitator. In E.S.P. the fly ash particles and pollutants are extracted from the flue gases by using ammonia.

D. *Turbine and Generator*

The generated steam is passing through the super heater to the high pressure turbine. After driving the turbine a part of this steam sends to the H.P. heater 2 and left pass through the re-heater then secondary super heater and regain its pressure to drive Intermediate turbine. Then the steam transfer to the H.P.H 2 and low pressure turbine. Then steam from low pressure turbine transfer to L.P.H 4-5-6 and condenser. In condenser steam is cooled by cooling water and then deaerator circulates it for steam generation. The three turbines used to drive one shaft which drives the rotor of the generator by mean to generate electricity. The various auxiliaries of turbine and generator is cooled by hydrogen gas and cooling oil.

E. *Switch Yard*

The generate electricity transfer to the unit step-up transformer and passed it to switch yard. Switch yard boost up and divide generated electricity and pass it to the transmission line for distribution.

IV. RISK ASSESSMENT

Risk acceptance criteria are adopted by the authors from Ref. No. [2]. Risk initiating event likelihood and consequences are assumed by taken reference of visited plant real activities. Risk Classification screening table is given below

TABLE I: RISK CLASSIFICATION SCREENING TABLE

S. NO.	HAZARD DISCIPTION	INITIATING EVENT LIKELIHOOD	UNMITIGATED CONSEQUENCES		RISK CLASS	COREECTIVE ACTION
			LIFE SAFETY	*PROPERTY DAMAGE*		
1	COAL HANDLING PLANT HAZARD					
i	Fire in coal storage	2	1	2	B	Regular inspection, water spray, isolation from ignition sources
ii	Coal dust explosion in coal conveyer bunker	1	3	4	B	Proper ventilation, spark proof electrical equipment
iii	Injury during coal handling like slip and trip	4	1	-	A	Proper PPE's
iv	Respiratory problem due to coal dust	3	3	-	B	Dust mask should be provided
v	Catches on conveyer belt	2	2	2	B	Safety guard on the moving part
vi	Rail line and other transport line accidents	4	2	1	A	Speed limit on plant area
vii	Injury during maintenance on ball mill	3	3	1	B	Training, proper supervision, PPE's
viii	Fall from the height during work on conveyer belt, conveyer control room etc	3	4	-	C	Safety belt, safety net should provided, training
ix	Struck by falling object	4	2	1	A	Safety helmet, safety net
2	D.M. PLANT HAZARD					
i	Fire hazard	2	3	3	B	Fire extinguisher, eliminate the possible ignition source
ii	Chemical burn by Spillage of sulphuric acid and caustic soda lye during unloading, overflow, Damage on storage tank or pipe line	4	3	2	A	Wash rinse exposed area, training, maintenance, proper supervision
iii	High noise level	1	3	-	A	Ear plug, ear muff should provided
3.	BOILER HAZARD					
i	Explosion in boiler due to over pressure and temperature	1	4	4	C	Continuous monitoring, maintenance
ii	Explosion in boiler due to improper combustion of fuel.	1	4	4	C	Regular inspection, maintenance
iii	Burn injury due to hot water and hot steam pipeline leakage	3	3	3	B	Inspection, maintenance
iv	Exposure to the hot surface of pipeline or machineries.	3	1	-	A	Regular inspection, maintenance
v	Water tube burst due to Failure in boiler water level control	2	-	4	C	Continuous monitoring, maintenance
vi	Fire in diesel supply line	3	3	3	B	Regular inspection, maintenance
vii	Burn injury by hot fly ash	4	1	-	A	Maintenance, proper exhaust
viii	Catches on the moving part of the machinery like F.D. fans or motors	3	2	1	A	Proper fencing on the moving part of turbine
ix	Burst of the equipment body due to over pressure and over temperature	3	1	4	A	Regular inspection, maintenance
x	Sleep , trip and from the height during routine work, maintenance or inspection	4	4	2	B	Training, proper supervision, PPE's
4.	GENERATOR AND TURBINE HAZARD					
i	Explosion in turbine due to cooling system failure	1	4	5	C	Regular inspection, maintenance
ii	Damage on generator due to lack of lubrication in coupling shaft	2	1	4	A	Regular inspection, maintenance

iii	Fire on cooling oil	3	3	3	B	Proper storage, isolation from the ignition sources
iv	Fire and explosion on hydrogen tank	2	5	4	D	Proper storage, isolation from the ignition sources
v	High noise level	1	3	-	B	Ear plug, ear muff should provided
5.	SWITCH YARD HAZARD					
i	Fire on transformer	3	-	4	C	Regular inspection, maintenance
ii	Electric shock and electric burn routine work, maintenance or inspection of electrical panels in switch yard	5	4	1	B	Training, PPE's should provided
iii	Slip , trip and from the height during routine work, maintenance on switch yard	4	4	1	B	Safety belt, safety harness should provided, training
6.	OTHER HAZARD					
i	Control room fire hazard	2	1	3	A	Fire extinguisher, eliminate the over heating
ii	Eye irritation and respiratory problem from the exposure of ammonia leakage from storage tank or pipeline	4	1	-	A	Wash rinse exposed area, maintenance
iii	Fire on ammonia storage tank	2	4	4	C	Fire extinguisher, eliminate the possible ignition source
iv	Fire hazard on fuel storage tank	2	4	4	C	Fire extinguisher, eliminate the possible ignition source

TABLE II: RISK CLASSIFICATION ASSOCIATED WITH TABLE I

CLASS	GENERAL DISCRIPTION	ACTION
A	Low risk events	Low risk level ;no further risk reduction action required
B	Moderate risk events	Required minor risk reduction improvements; generally addressed by codes, standards, company or industry practices
C	Moderate-High risk events	Generally required further analysis to determine an optimal risk reduction strategy or reliability analysis of propose risk controls
D	High risk events	High risk required immediate risk reduction analysis

V. CONCLUSION

In this paper we observe present scenario of existing safety measures and its efficiency. The risk rating of the present and possible hazard is evaluated which divide them into acceptable, tolerable and unacceptable risk level. Which risks are in unacceptable level there possible corrective action also recommended to improve safety measure and analysis. The results of this analysis will be of valuable to find out the consequence on emergency situation that may occur. With this knowledge, the level of preparedness can be assessed and measures taken to enhance capabilities through training and preparation of a more effective response to such occurrences.

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