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Use of Analytic Hierarchy Process Methodology for Criticality Analysis of Thermal Power Plant Equipments

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Abstract

The Analytic Hierarchy Process (AHP) method is used to prioritize plant assets according to their criticality. The Analytic Hierarchy Process (AHP) method allows the decision makers to model the problem into hierarchical structure with relationship between goal, objectives and alternatives. This paper describes an application of Analytic Hierarchy Process (AHP) applied for identification of critical equipments of thermal power plant. For this AHP based analysis, four criterion are considered for criticality analysis viz. Effect on failure of equipment on power generation, environment and safety, frequency of failure and Maintenance Cost. The major equipments of thermal power plant have considered for this study viz. Turbine, Generator, Induced Draft fan, Forced Draft Fan, Primary Air fan, Boiler feed pump, Cooling water pump, Condensate Extraction Pump, HT motors of mills.

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*Keywords:*Criticality anlysis, Analytic Hierarchy Process,Effect on power Generation,Environment and safety,Frequency of failure,Maintenance Cost

1. Introduction

Thermal power is the largest source of power in India. About 65% of electricity consumed in India is generated by thermal power plants. In order to make Thermal Power Plants (TPPs) economical, the maintenance functions should be optimized by carefully selecting and planning the maintenance strategies that will address the maintenance needs of the plant at the least cost. Identification of critical equipments from thermal power plant is major and important step for defining maintenance strategy and making decisions. The earlier researchers have used Multi-Criteria Decision Making methods for making decisions with multiple criterions. The Multi-Criteria Decision Making methods helps to improve quality of decisions by making them more explicit, rational and efficient[1].The Multiple criteria decision-making (MCDM) methods provides the best alternative under various criteria. The Multiple criteria decision-making (MCDM) methods are Analytic Hierarchy Process (AHP), Technique of Order Preference by

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Similarity to Ideal Solution (TOPSIS), Complex Proportional Assessment (COPRAS), and Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE). The earlier researchers have used Analytic Hierarchy Process (AHP) as tool of the multi-criteria decision making methods. The Analytic Hierarchy Process (AHP) is a methodology for supporting complex decisions. It is very intuitive, easy to use and understandable[2].In this study,AHP method has been applied for ranking of selected equipments of thermal power plant.

This paper explains use of AHPmethodology for ranking of major equipments of thermal power plant viz. Turbine, Generator, Induced Draft fan, Forced Draft Fan, Primary Air fan, Boiler feed pump, Cooling water pump, Condensate Extraction Pump, HT motors of mills.

The various research databases have been referred;related relevant published literature is reviewed and its review is discussed next.

2. Review of literature

The relevant published literature till date is reviewed with the objective a) To study Multiple Criteria Decision Making Methods for thermal power plant b) To analyse criticality of thermal power plant equipmentsc) To identify critical equipments of thermal power plant d) To classify equipments of Thermal Power Plant using AHP method.The selected references have been categorized which are tabulated in Table No.1

Table 1 Literature Survey of MCDM's of thermal power plant

Sr. No	Author (Year)	Tool Used	Findings
1	M. Bevilacquaa, M. Braglia 2000	AHP	Analyzes an application of the Analytic Hierarchy Process (AHP) for selecting the best maintenance strategy for Italian oil refinery plant) where five possible alternatives are considered: preventive, predictive, condition-based, corrective and opportunistic maintenance.
2	Amalia Sergaki, Kostas kalaitzakis 2002	Fuzzy	Proposed fuzzy relational database model for manipulating database for criticality analysis of thermal power plant with criterion concerning aspects of safety and reliability, economy, operational conditions and environmental impacts.
3	M. Bertolini 2006	VIKOR	Presents an approach based on fuzzy logic extension of VIKOR methodology for Criticality Analysis in Failure Modes Effects and Criticality Analysis (FMECA) technique.
4	Ling Wanga,, Jian ChuaJun Wub 2007	Fuzzy and AHP	Proposed optimal maintenance strategy (predictive maintenance strategy) using fuzzy analytic hierarchy process method for power plant equipments.
5	Rakesh Kumar Singh &Makarand S. Kulkarni 2013	AHP	Analyzes AHP method for thermal power plant equipments to identify and rank the equipments own the basis of selected multiple criterions viz. environmental impact, customer inconvenience and maintenance cost.
6	Debasis Das Adhikary and Goutam Kumar Bose 2014	COPRAS-G	Present a multi criterion failure mode effect and criticality analysis for coal-fired thermal power plants using uncertain data as well as substituting the traditional risk priority number estimation method.
7	Suebsomran A. 2010	FMEA & AHP	Applies the combination of Failure Mode Effect Analysis (FMEA) and AHP approaches to find the critical ranking priority of failure mode relating to three criteria such as maintenance cost, man per hour working, line priority of thermal power plant.

The relevant published literature revealed the following observations.

1. The earlier researchers have used MCDM's methods for decision making in thermal power plant.
2. The used MCDM's methods are AHP, Fuzzy, VIKROR, COPRAS-G, fuzzy with AHP, FMEA with AHP.
3. The earlier researchers have analyzed complex problems by using AHP method for decision making.
4. The published literature is silent about use of AHP based methodology for thermal power plant.

The methodology adopted for criticality analysis and identification critical equipments for this study is discussed next.