Preventive Maintenance Policy Based on Mission Reliability Analysis: A Case Study on Offshore Oil Platform in ShengLi Oilfield

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ABSTRACT

The traditional maintenance policy on offshore oil platform, which depends on experience, has many defects. This article deduces mission time according to the required system mission reliability to determine the optimal preventive maintenance (PM) cycle. Fault tree analysis and Monte Carlo simulation based on minimal cut sets were implemented to obtain mission time. Moreover, the result of component importance analysis was sorted by value to obtain a reasonable maintenance sequence. Finally, a case study on the power system of ChengDao NO.1 Center offshore oil platform in ShengLi oilfield was given to illustrate the proposed policy.

KEY WORDS: reliability; offshore oil platform; maintenance cycle; maintenance sequence.

INTRODUCTION

For offshore oil platforms with system complexity and harsh working conditions, serious economic loss and environmental disasters will occur with maintenance problems. From the economic point of view, according to Barabady and Kumar (2008), maintenance cost can be 15%–60% of all operating costs originating from unplanned system stoppage for unscheduled repairs. From the safety point of view, failure of oil-producing systems may lead to environmental disaster (Khan, Sadiq, and Husain, 2002).

Samrout, Yalaou, Chatellet, and Chebbo (2005) took preventive maintenance (PM) as an effective policy to reduce incidences of system failure and lower overall maintenance cost. One challenge of PM is determining maintenance cycle. Frequent disassembling and maintenance increase cost and even introduce new defects; nevertheless, long maintenance cycle leads to high system failure probability. The traditional method of determining maintenance cycle is based on experience (Da-wei and Jun-xin, 2002), which is too subjective for further applications. Another challenge is arranging maintenance sequence of components on the platform. Untargeted maintenance will result in longer downtime and increased cost.


This article focuses on mission reliability to obtain the optimized maintenance cycle. Mission reliability is defined as the capability of the system to complete the mission under specified conditions and within a specified time. The mission reliability of a system corresponds to mission time T. The probability of system failure will increase if working time is greater than mission time T. Hence, mission time T can be considered as the PM cycle to ensure safety of the system under the hypothesis that the system is as good as new after PM.

An offshore oil platform consists of many subsystems and devices, while the power system plays a core role. This article presents a case study that evaluates mission reliability of the power system of an offshore oil platform in ShengLi oilfield using FTA to obtain the optimum maintenance cycle. The rest of the paper is organized as follows. Section 2 briefly discusses FTA, the algorithm of PM cycle based on mission reliability and criticality importance (CI). Fault tree models of the power system on the platform in ShengLi oilfield, which are based on the failure models, effects, and criticality analysis (FMECA), are presented in Section 3. A numerical simulation, which obtains the optimum PM cycle and maintenance order of components, is given in Section 4. Finally, the main results are summarized.

PM POLICY BASED ON MISSION RELIABILITY ANALYSIS

A. Brief Introduction of Fault tree analysis (FTA)

Fault tree technology is a well-known engineering approach widely used by engineers in the field of reliability analysis (Liang, Yi, Zhang, and Li, 2010). FTA can obtain the causes leading to system failure. Furthermore, it can calculate the probability of system failure. Reliability parameters (e.g., mean time between failure (MTBF) and mission time T) are used in FTA to predict mission reliability of the