

Reliability Analysis of a Rotary Vane Type Steering Gear System

Prof. Dr. M R Martins

Department of Naval Architecture & Ocean Engineering
University of São Paulo, São Paulo, Brazil

MSc. F B Natacci

Naval Architecture and Marine Engineering Department
Brazilian Navy Technological Center
São Paulo, São Paulo, Brazil

ABSTRACT

Classification societies have increasingly been considering new requirements based on risk as an acceptable means for the design of ships, formerly based only on the application of old rules. This paper is an attempt to use some concepts comprised in goal-based standards in the safety field applied to develop the qualitative reliability analysis model of the steering gear system. The main purpose for developing this type of analysis is to identify weak points in order to improve the design and operation of the analyzed system, based on the concepts of RCM, Reliability Centered Maintenance.

KEY WORDS: Reliability; steering gear; risk; FMEA; fault tree; RCM.

INTRODUCTION

The development of several reliability analyses is required as part of a risk assessment for a ship as a whole. The steering gear system was chosen as an example for this study because it is one of the essential systems required for the successful and safe operation of the ship.

A systematic approach to analyze and determine weak points that can contribute to system malfunction is fundamental. Among many techniques mentioned on goal based standards as references for the implementation of risk and safety concepts, reliability analysis was chosen as the most suitable one for the present work. The main reason for this choice is because reliability analysis uses a combination of two other techniques, failure modes and effects analysis (FMEA) and fault tree analysis, which as a whole lead to the identification of the components that most contribute to steering gear system unreliability and unavailability.

There are basically two different types of steering gear systems used for the maneuvering of ships. The first type uses conventional hydraulic cylinders to move the rudderstock. The other one uses a hydraulic actuator directly assembled to the rudderstock which is commonly called rotary vane. This paper deals with the development of the reliability analysis of a steering gear system using a rotary vane type actuator.

The technical information used for the study were based on reference documents such as the flow diagram of the steering gear system and the

operating procedures of an oil transport ship which operates loading crude oil from production platforms and discharging this oil to terminals on the Brazilian coast. Fig. 1 shows a typical steering gear system using a rotary vane actuator. In the foreground it is shown the oil return line, the pump tank and the strainer of one train of the power supply subsystem. In the background it is shown the rotary vane actuator and the expansion tank assembled on the top.

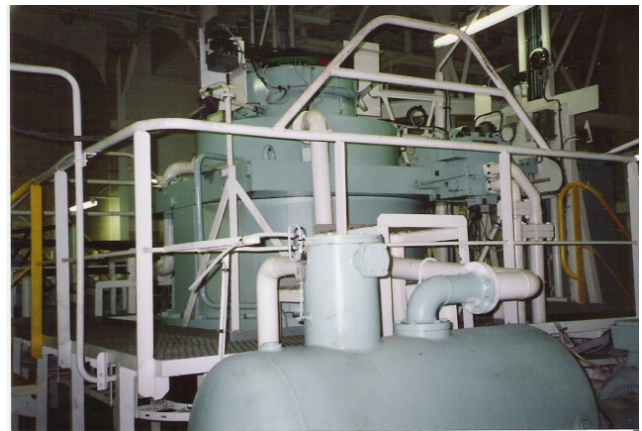


Fig. 1: Rotary Vane Steering Gear System

RELIABILITY ANALYSIS DEVELOPMENT

The reliability analysis of the steering gear system will be detailed in the next subsections.

Methodology

Reliability analyses comprise some basic steps that shall be carefully followed, to be consistent and understandable to people other than the reliability analysts themselves.

The first step is the knowledge of the system. This may seem obvious but it is probably the fundamental one. A superficial knowledge of the system may lead to an improper analysis. So, it is necessary to spend a great amount of time gathering understanding of system operation and,