

Analysis of OREDA Data for Maintenance Optimisation

Langseth, H., Haugen, K., Sandtorv, H.

SINTEF Industrial Management

Safety and Reliability

ABSTRACT

This paper provides estimates for the average Rate of Occurrence of Failures, RO-COF ("failure rate"), for *critical* failures when also *degraded* failures are present. The estimation approach is exemplified with a data set from the offshore equipment reliability database "OREDA". The suggested modelling provides means to predict how maintenance tasks will affect the rate of critical failures.

1. INTRODUCTION

OREDA (Offshore Reliability Data) ¹ is a data collection programme that has been going on since the early eighties. Reliability data has been collected for some 24,000 offshore equipment units comprising approximately 33,000 failures. The project is supported by ten oil companies: AGIP, BP, Elf, Esso, Norsk Hydro, SAGA, Shell, Statoil, and Total. SINTEF has been the main contractor since 1990.

The project is now in its fourth phase ('96). In this phase data is collected by more automatic means, and the data collection specification, and the data collection and analysis software program have been revised in this phase.

The participating oil companies use the data in the development of new oil fields and improving existing facility operation. The reliability data are typically used as input to safety and reliability analysis. Some benefits are: safer operations, increased production availability, and optimised maintenance. Analysis of reliability data is one of several key factors in choosing cost-effective solutions. Two examples recently reported, have shown that savings of about \$60 millions can be achieved compared with the cost of the original design. Lately experiences and data from this project are also exchanged with the manufacturers in order for them to improve future designs.

Typical analyses where the data have been applied are: QRA, RAM, RCM, LCC and various maintenance planning assessments. A project on using the data in more advanced reliability analysis has also been undertaken by SINTEF.

The present paper describes a model where OREDA failure event data has been used to predict how maintenance tasks will affect the rate of critical failures, and it is argued that a *model* for the failure mechanisms should be provided. There are two obvious types of such mechanisms:

- the failure occurs immediately (as a "shock"), directly giving a *critical* failure
- the failure is caused by deterioration, so that the item first experiences a *degraded* failure, until finally an essential function is lost and the item is defined to have a *critical* failure.

This modelling of failure mechanisms to utilise the information on the *severity classes* (usually denoted *degraded/non-critical* and *critical*) is the topic of ² and ³. These papers, however, focus on *dormant* failures, i.e. failures detected by periodic (functional) testing, only. The present paper considers *all* failure modes and general principles of failure detection.

OREDA failure data on gas turbines are utilised giving estimates for critical failure rates as a function of the preventive maintenance interval t , and the critical failure rate given that no preventive maintenance is performed (as $t \rightarrow \infty$, this is denoted "the naked failure rate").

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Safety and Reliability. Theory and Applications Marko Cepin, Radim Bris, 2017-06-14 Safety and Reliability Theory and Applications contains the contributions presented at the 27th European Safety and Reliability Conference ESREL 2017 Portoro Slovenia June 18 22 2017 The book covers a wide range of topics including Accident and Incident modelling Economic Analysis in Risk Management Foundational Issues in Risk Assessment and Management Human Factors and Human Reliability Maintenance Modeling and Applications Mathematical Methods in Reliability and Safety Prognostics and System Health Management Resilience Engineering Risk Assessment Risk Management Simulation for Safety and Reliability Analysis Structural Reliability System Reliability and Uncertainty Analysis Selected special sessions include contributions on the Marie Skłodowska Curie innovative training network in structural safety risk approaches in insurance and finance sectors dynamic reliability and probabilistic safety assessment Bayesian and statistical methods reliability data and testing organizational factors and safety culture software reliability and safety probabilistic methods applied to power systems socio technical economic systems advanced safety assessment methodologies extended Probabilistic Safety Assessment reliability availability maintainability and safety in railways theory big data risk analysis and management and model based reliability and safety engineering Safety and Reliability Theory and Applications will be of interest to professionals and academics working in a wide range of industrial and governmental sectors including Aeronautics and Aerospace Automotive Engineering Civil Engineering Electrical and Electronic Engineering Energy Production and Distribution Environmental Engineering Information Technology and Telecommunications Critical Infrastructures Insurance and Finance Manufacturing Marine Industry Mechanical Engineering Natural Hazards Nuclear Engineering Offshore Oil and Gas Security and Protection Transportation and Policy Making

Quality, Reliability and Information Technology P. K. Kapur, A. K. Verma, 2005 Reliability Engineering and Quality Management provides a competitive advantage and market leadership in a global environment where market barriers are fast disappearing both in the domain of cutting edge and contemporary technologies manufacturing process and service sectors like information technology sector The growth of Q R has been fuelled by increasing sophistication and complexity of system and organisational awareness to produce and market high quality and reliability products and services by the consumer and global market pressures This subject being interdisciplinary in nature has also brought about a convergence of numerous solution strategies employing Fuzzy Sets Artificial Neural Nets Modeling and Simulation Knowledge Base Systems Operations Research and Mathematical Programming to achieve high Reliability This book is intended for both the beginner and practitioner from manufacturing and service sector research laboratories and academic institutions This book is unique also as it gives an insight into the current practices and future directions

Safety and Reliability 92 K.E. Peterson, B. Rasmussen, 1992-05-01 **Safety and Reliability of Complex Engineered Systems** Luca Podofillini, Bruno Sudret, Bozidar Stojadinovic, Enrico Zio, Wolfgang Kröger, 2015-09-03 Safety and

Reliability of Complex Engineered Systems contains the Proceedings of the 25th European Safety and Reliability Conference ESREL 2015 held 7-10 September 2015 in Zurich Switzerland Including 570 papers on theories and methods in the area of risk safety and reliability and their applications to a wide range of industrial civil and social sectors this book will be of interest to academics and professionals involved or interested in aspect of risk safety and reliability in various engineering areas

Reliability, Risk, and Safety, Three Volume Set Radim Bris, Carlos Guedes Soares, Sebastián Martorell, 2009-08-20 Containing papers presented at the 18th European Safety and Reliability Conference Esrel 2009 in Prague Czech Republic September 2009 Reliability Risk and Safety Theory and Applications will be of interest for academics and professionals working in a wide range of industrial and governmental sectors including civil and environmental engineering energy production and distribution information technology and telecommunications critical infrastructures and insurance and finance

CAD/CAM, Robotics and Factories of the Future Dipak Kumar Mandal, Chanan Singh Syan, 2016-01-05 This volume is based on the proceedings of the 28th International Conference on CAD CAM Robotics and Factories of the Future This book specially focuses on the positive changes made in the field of robotics CAD CAM and future outlook for emerging manufacturing units Some of the important topics discussed in the conference are product development and sustainability modeling and simulation automation robotics and handling systems supply chain management and logistics advanced manufacturing processes human aspects in engineering activities emerging scenarios in engineering education and training The contents of this set of proceedings will prove useful to both researchers and practitioners

Current Index to Statistics, Applications, Methods and Theory, 1998 The Current Index to Statistics CIS is a bibliographic index of publications in statistics probability and related fields

Risk, Reliability and Safety: Innovating Theory and Practice Lesley Walls, Matthew Revie, Tim Bedford, 2016-11-25 Risk Reliability and Safety contains papers describing innovations in theory and practice contributed to the scientific programme of the European Safety and Reliability conference ESREL 2016 held at the University of Strathclyde in Glasgow Scotland 25-29 September 2016 Authors include scientists academics practitioners regulators and other key individuals with expertise and experience relevant to specific areas Papers include domain specific applications as well as general modelling methods Papers cover evaluation of contemporary solutions exploration of future challenges and exposition of concepts methods and processes Topics include human factors occupational health and safety dynamic and systems reliability modelling maintenance optimisation uncertainty analysis resilience assessment risk and crisis management

Reliability of Sealing Systems for Rotating Machinery, 2000 The papers recorded in this text are drawn from practical and relevant industry experience and should be useful to all those who use design produce or operate rotating machinery as well as those who supply seals

Proceedings, 1992

The Practice of Bayesian Analysis Simon French, Jim Q. Smith, J. Q. Smith, 1997-08-06 The purpose of this book is twofold First it has been written to advertise the advantages a Bayesian analysis can bring New statistical and decision models can be tailored to the

unique beliefs values and needs of the user and the implications of the data she collects can be analysed with reference to this underlying structure The second purpose is to provide an analyst wanting to apply the Bayesian methodology with a resource of examples and techniques so that she may be better informed about the scope of opportunities and the pitfalls inherent in such an analysis

Proceedings of the ... International Conference on Offshore Mechanics and Arctic Engineering ,1990 OMC 99, Offshore Mediterranean Conference ,1999 **Proceedings - Offshore Technology Conference** ,2001 **Petroleum Abstracts** ,1991 **InTech** ,2001 *Offshore Safety* Institute of Marine Engineers,1992 **OREDA Data Analysis Guidelines** Jørn Vatn,Selskapet for industriell og Teknisk Forskning , Norges Tekniske Hogskole,1997 Applications of Maintenance Optimisation Models R. Dekker,1992 **Down Time Terms and Information Used for Assessment of Equipment Reliability and Maintenance Performance** Jon T. Selvik,2017

Reliability and maintenance data is important for predictive analysis related to equipment downtime in the oil and gas industry For example downtime data together with equipment reliability data is vital for improving system designs for optimizing maintenance and in estimating the potential for hazardous events that could harm both people and the environment The quality is largely influenced by the repair time taxonomy such as the measures used to define downtime linked to equipment failures However although it is important to achieve high quality from maintenance operations as part of this picture these often seem to receive less focus compared to reliability aspects Literature and experiences from e g the OREDA project suggest several challenging issues which we discuss in this chapter e g for the interpretation of MTTR Another challenge relates to the duration of maintenance activities For example while performing corrective maintenance on an item one could also be working on several other items while being on site This provides an opening for different ways of recording the mobilization time and repair time which may then influence the data used for predictive analysis Some relevant examples are included to illustrate some of the challenges posed and some remedial actions are proposed

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