

# Reliability, Availability, Maintainability & Supportability Analysis of a Boiler

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**Abstract** - Sudden failures of any power plant boiler component lead to, loss of production and high maintenance cost due to unplanned and irregular maintenance. This unnecessarily increases the production cost of electricity. This study is focused at examining & analysing the failure times of boiler at thermal power plant identify its critical failure expectancy & system reliability. Method to choose best analysis mode has been discussed here. Reliability and maintainability analysis was carried out using Weibull probability plot & statistical analysis and the results being presented in charts. Achieved results & conclusions drawn shows the need & way to improvement.

**Keywords** :- Reliability, Maintainability, Availability, Hazard plot, Probability Distribution Function, Industrial processes, Production instability, industrial organization, defect, failure, maintenance costs, Weibull Distribution, failure data sorting.

## I. INTRODUCTION

India as one of the largest electricity consumption country produces 65% of its power from thermal power plant with 85% being coal based. The boiler used in power plant extracts energy from fuel (such as coal etc.) to produce highly pressurized steam. This highly pressurized steam produced every hour is used to generate power with turbine, compressor and other mechanical devices.

The constant working of boiler for long hours can cause failure in the boiler unit like super-heater tube leakage, economizer tube leakage, water wall tube leakage etc. The main/sub-reason of these failures are thermal fatigue, creep, thermal stress, corrosion, cavitation, over-heating, high pressure, low pressure etc. That's why periodically maintenance of boiler is necessary as it may result in loss of hundreds of megawatt and also decline its revenue. Sometimes it may cause big explosion or disaster which can cost many lives.

The RAM analysis helps in analysing the reliability (which tells about the probability of working efficiently under stated condition), availability (which gives a measure of boiler to be available at any given time to work in the stated condition) and maintainability (which tells about the

probability of maintenance time of a boiler to work again in its stated condition). This analysis helps in deeply analysing how much work should be taken or can take from the boiler before shutting down for maintenance. This helps in reducing the number of failures and hence estimating the maintenance time / outage time required for the unit.

The RAM analysis can be done with different methods and different probability distribution but the most used and accurate method is 3-parameter Weibull distribution. The curves helps in understanding the nature of reliability and maintainability and find its value at any given time  $t$  in period  $T$ . The 3-parameter in Weibull distribution indicates scale parameter, shape meter and location parameter of the given failure data.

## II. LITERATURE REVIEW :

There are various method to analyze the performance of system using RAMS.

RAMS is a logistic tool that estimate the performance of equipment at different levels. It directs safety and operation problems and find the area in the system where refinement work should be done. Certain key performance parameters such as Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), Mean Down Time (MDT), Mean Time To Repair (MTTR) and Availability (A) values can be determined to perform the analysis. The result gained from the statistics analysis of these values help in the assessment of the RAMS need of systems.

### A. Discrete Analysis

$MTBF = \text{Total System Operating Hours} / \text{Number of Failures}$

$MTTR = \text{Forced outage hour} / \text{Total number of failure}$

$\text{Availability} = \text{System Uptime} / \text{System Uptime} + \text{System Downtime}$

### B. Continuous Analysis

#### A.1 Goodness of fit

An applied mathematics model's goodness of work (GOF) refers to how well it fits a group of information. The distinction between actual values and foretold values beneath applied mathematics model is summarized by the

# The Journal Of Reliability Maintainability Supportability

**Lev M. Klyatis, Edward L. Anderson**



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*Reliability Prediction and Testing Textbook* Lev M. Klyatis,Edward L. Anderson,2018-11-20 This textbook reviews the methodologies of reliability prediction as currently used in industries such as electronics automotive aircraft aerospace off highway farm machinery and others It then discusses why these are not successful and presents methods developed by the authors for obtaining accurate information for successful prediction The approach is founded on approaches that accurately duplicate the real world use of the product Their approach is based on two fundamental components needed for successful reliability prediction first the methodology necessary and second use of accelerated reliability and durability testing as a source of the necessary data Applicable to all areas of engineering this textbook details the newest techniques and tools to achieve successful reliabilityprediction and testing It demonstrates practical examples of the implementation of the approaches described This book is a tool for engineers managers researchers in industry teachers and students The reader will learn the importance of the interactions of the influencing factors and the interconnections of safety and human factors in product prediction and testing      *Supply Chain Strategies, Issues and Models* Usha Ramanathan,Ramakrishnan

Ramanathan,2013-09-12 In the 21st century supply chain operations and relationships among supply chain partners have become highly challenging necessitating new approaches e g the development of new models Supply Chain Strategies Issues and Models discusses supply chain issues and models with examples from actual industrial cases Expert authors with a wide spectrum of knowledge working in various areas of supply chain management from various geographical locations offer refreshing novel and insightful ideas and address possible solutions using established theories and models Supply Chain Strategies Issues and Models features studies that have used mathematical modeling statistical analyses and also descriptive qualitative studies The chapters cover many relevant themes related to supply chains and logistics including supply chain complexity information sharing quality six sigma electronic Kanbans inventory models scheduling purchasing and contracts To facilitate easy reading the chapters that deal with supply chain related issues are first followed by studies on inventory scheduling purchasing and logistics This book can be used as a useful resource of supply chain management by academics students and practitioners This book can serve as a helping tool in managerial decision making for investments in collaboration and information exchange to improve forecasts scheduling and inventory management and for supply chain managers to leverage product and process complexities into competitive advantage Some interesting mathematical models can appeal to students and researchers interested in modeling the impact of information sharing in supply chains

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support systems DSSs The series offers a broad range of subjects addressed in specific areas such as health care business management banking agriculture environmental improvement natural resource and spatial management aviation administration and hybrid applications of information technology aimed to interdisciplinary issues This book series is composed of three volumes Volume 1 consists of general concepts and methodology of DSSs Volume 2 consists of applications of DSSs in the biomedical domain Volume 3 consists of hybrid applications of DSSs in multidisciplinary domains The book is shaped upon decision support strategies in the new infrastructure that assists the readers in full use of the creative technology to manipulate input data and to transform information into useful decisions for decision makers

Enterprise Sustainability Dennis F.X. Mathaisel, Joel M. Manary, Clare L. Comm, 2009-10-21 Military supply chains are unique because what is supplied to the end user is routinely returned to the supply chain for maintenance repair and overhaul MRO Offering a blueprint for transforming military depot workload and processes into those of high performance commercial facilities Enterprise Sustainability Enhancing the Military's Ability **Design and the Reliability Factor** John Day, 2015-11-23 Sophisticated infotainment systems lane departure warning adaptive cruise control and blind spot monitoring are increasingly common in cars today The proliferation of automotive electronics and other smart features has increased the market for automotive semiconductor devices and the number of sensors per vehicle Yet more chips and greater functionality translate to further networking communications activity within the car and that raises the prospect of potentially serious errors How to minimize them by design is the focus of this book which contains seven of SAE International's handpicked technical papers covering A way to calculate the reliability of priority driven real time components with respect to timing failures resulting in a realistic estimate of each component's reliability A delayed decision cycle detection method that can detect and prevent spoofing attacks with high accuracy An AUTOSAR compliant automotive platform for meeting reliability and timing constraints An eight point process for determining the cause of failures with real world cases in which the process was used The use of accelerated reliability and durability testing technology for better performance estimation How to achieve reliable sensor fusion despite system complexity and inconsistency How to improve domain controller availability while maintaining functional safety in mixed criticality automotive safety systems **Defense Management Journal**, 1983 *Trends in Development of Accelerated Testing for Automotive and Aerospace Engineering* Lev M. Klyatis, 2020-04-21 Accelerated testing most types of laboratory testing proving ground testing intensive field flight testing any experimental research is increasingly a key component for predicting of product's process performance Trends in Development Accelerated Testing for Automotive and Aerospace Engineering provides a completely updated analysis of the current status of accelerated testing including the basic general directions of testing methods and equipment development how one needs to study real world conditions for their accurate simulation and successful accelerated testing describes in details the role of accurate simulation in the development of automotive and aerospace engineering shows that failures are

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*Proceedings of the 7th International Conference on Axiomatic Design* Mary Kathryn Thompson,2013-06-26

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**Systems Maintainability J.** Knezevic, 1997-07-31 Maintainability is of crucial importance throughout industry and is established as one of the most important issues in the aerospace and defence arena No new system can be introduced without full maintainability analysis

and demonstration a type of analysis which reduces life cycle costs by decreasing operational and maintenance costs and increasing systems operational effectiveness leading in turn to the creation of more competitive products This book establishes the full methodology for maintainability mathematics and modelling as well as the relationship between the maintainability and maintenance processes Defense Standardization Program Journal ,2000 The Modern Theory of the Toyota Production System Phillip Marksberry,2012-11-27 Numerous books have been written about Toyota s approach to workplace improvement however most describe Toyota s practices as case studies or stories Designed to aid in the implementation of Lean manufacturing The Modern Theory of the Toyota Production System A Systems Inquiry of the Worlds Most Emulated and Profitable Management System expla **AI Techniques for Reliability Prediction for Electronic Components** Bhargava, Cherry,2019-12-06 In the industry of manufacturing and design one major constraint has been enhancing operating performance using less time As technology continues to advance manufacturers are looking for better methods in predicting the condition and residual lifetime of electronic devices in order to save repair costs and their reputation Intelligent systems are a solution for predicting the reliability of these components however there is a lack of research on the advancements of this smart technology within the manufacturing industry AI Techniques for Reliability Prediction for Electronic Components provides emerging research exploring the theoretical and practical aspects of prediction methods using artificial intelligence and machine learning in the manufacturing field Featuring coverage on a broad range of topics such as data collection fault tolerance and health prognostics this book is ideally designed for reliability engineers electronic engineers researchers scientists students and faculty members seeking current research on the advancement of reliability analysis using AI

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### **Table of Contents The Journal Of Reliability Maintainability Supportability**

1. Understanding the eBook The Journal Of Reliability Maintainability Supportability
  - The Rise of Digital Reading The Journal Of Reliability Maintainability Supportability
  - Advantages of eBooks Over Traditional Books
2. Identifying The Journal Of Reliability Maintainability Supportability
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an The Journal Of Reliability Maintainability Supportability
  - User-Friendly Interface
4. Exploring eBook Recommendations from The Journal Of Reliability Maintainability Supportability
  - Personalized Recommendations



- The Journal Of Reliability Maintainability Supportability User Reviews and Ratings
- The Journal Of Reliability Maintainability Supportability and Bestseller Lists
- 5. Accessing The Journal Of Reliability Maintainability Supportability Free and Paid eBooks
  - The Journal Of Reliability Maintainability Supportability Public Domain eBooks
  - The Journal Of Reliability Maintainability Supportability eBook Subscription Services
  - The Journal Of Reliability Maintainability Supportability Budget-Friendly Options
- 6. Navigating The Journal Of Reliability Maintainability Supportability eBook Formats
  - ePub, PDF, MOBI, and More
  - The Journal Of Reliability Maintainability Supportability Compatibility with Devices
  - The Journal Of Reliability Maintainability Supportability Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of The Journal Of Reliability Maintainability Supportability
  - Highlighting and Note-Taking The Journal Of Reliability Maintainability Supportability
  - Interactive Elements The Journal Of Reliability Maintainability Supportability
- 8. Staying Engaged with The Journal Of Reliability Maintainability Supportability
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers The Journal Of Reliability Maintainability Supportability
- 9. Balancing eBooks and Physical Books The Journal Of Reliability Maintainability Supportability
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection The Journal Of Reliability Maintainability Supportability
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine The Journal Of Reliability Maintainability Supportability
  - Setting Reading Goals The Journal Of Reliability Maintainability Supportability
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of The Journal Of Reliability Maintainability Supportability
  - Fact-Checking eBook Content of The Journal Of Reliability Maintainability Supportability

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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