

OUTSOURCING MAINTENANCE AS STRATEGIC TOOL OF MAINTENANCE MANAGEMENT FOR LIBYAN ORGANISATIONS

Ali Albuzidi and Nora Ammar Abusaida*

Mechanical and Industrial Engineering Department
Faculty of Engineering, University of Tripoli - Libya

*Engineering Management Department, Faculty of Engineering
University of Tripoli - Libya
E-mail: alialbuzidi@yahoo.com

المخلص

تهدف هذه الورقة لفهم إدارة الصيانة بما في ذلك معرفة التحديات لتحسينها وأسباب الاستعانة بمصادر خارجية. تم استخدام هذه المعلومات لتحديد مقاييس الأداء التي يمكن استخدامها لتحليل فعالية أنشطة الصيانة عن طريق الصيانة الخارجية ومقارنتها بالصيانة الداخلية للمضخات التي تمثل العمود الفقري لمنظومة الحساونة بجهاز تنفيذ النهر الصناعي خلال الفترة 2007-2012. تتحقق فعالية وكفاءة الصيانة في المؤسسات بقدرتها على تحقيق اعتمادية وموثوقية عالية للآلات وقدرة على التحكم في تكاليف الصيانة حيث كانت مقاييس الأداء الرئيسية التي تم تحديدها لتقييم ومقارنة فعالية الصيانة بالاستعانة بمصادر خارجية والصيانة الداخلية من حيث تكاليف الصيانة، ومقياس أداء الصيانة MTTR (الوقت اللازم للتصليح) أو ما يعرف بقابلية الصيانة. وقد أثبتت الدراسة الميدانية أن أداء المضخات كان أفضل خلال الفترة الزمنية التي نفذت فيها الصيانة الخارجية مقابل زيادة في التكاليف، مقارنة بالأداء خلال الفترة الزمنية التي نفذت فيها الصيانة الداخلية.

ABSTRACT

The aim of this paper was first to gain an understanding of maintenance managements and maintenance outsourcing including the identification, the challenges of maintenance improvement factors and the reasons of outsourcing. This information was used to identify the critical performance measures that could be used to analyze the effectiveness of maintenance activities for pumps, which are considered as the backbone of HASAWNA System in Man Made River Authority in the period from 2007 to 2012. The key performance measures that were identified to evaluate and compare the effectiveness of maintenance outsourcing and insourcing were the maintenance costs, and MTTR. The survey study showed that maintenance outsourcing did improve the pumps performance at the expense of high maintenance costs comparing with insourcing maintenance.

KEYWORDS: Maintenance; Outsourcing; Performance Measures; Costs.

INTRODUCTION

Maintenance Management is an orderly and systematic approach to planning, organizing, monitoring and evaluating maintenance activities and their costs. A good maintenance management system are coupled with capable people to maintain sophisticated pumps systems, the optimum level of inventory of maintenance parts, materials, and consumables, specialist maintenance engineering for support and an appropriate organization arrangements.[1]. Maintenance requirements continuously change due to wear and tear, technological developments, changing operational requirements, product quality and a host of other related topics. As organizations today

strive to achieve minimum operating costs and lean operations in terms of manpower, the maintenance activity has become a target for outsourcing [2].

MAINTENANCE

Maintenance is an important activity for all types of assets and pumps. Without proper and organized maintenance, a pump/machine will experience damages in a short period. This situation will reduce the lifetime of that particular pump/machine. Damages or disfigurements within pump/machine must be repaired as soon as possible to prevent further damages to happen.

Maintenance management involve a complex and dynamic process required to implement maintenance practice that improve the operations performance. The key objective of maintenance management is to maximize the availability and reliability of the assets and pumps to produce the desired quantity of products, within the required quality specifications, in a timely manner. Obviously, this objective must be attained in a cost-effective way and in accordance with environmental and safety regulations [4].

The Challenges of Maintenance Improvement

If the failure patterns and consequences are well understood, there will always be challenges in maintenance improvement. The effective maintenance is the one that can bring effective improvement in the way maintenance is performed. The challenges to the maintenance improvement are as follows [5]:

- **People:** The ability of the utility to perform maintenance at low costs lies on the available skilled maintenance people. Finding, training and retaining the skilled maintenance people is one of the top challenges facing maintenance organizations.
- **Maintenance Leadership:** Effective maintenance organizations needs leadership that is able to create an environment of change.
- **Tools and Technology:** Maintenance today is far more technology based than it is a repair activity with need for greater emphasis on predicting and forecasting maintenance needs. Now there is a great need to measure maintenance if improvement is required.
- **Processes:** In maintenance, 85% of problems are process related and 15% are people related.
- **Costs:** Maintenance must be able to demonstrate a measurable return on investment, and must be able to justify its existence through reduction of machine downtime and reduced overtime. Maintenance excellence is the balance of performance risk and cost to achieve optimal solution.

Maintenance Measured, Pumps performance measures

Maintenance performance measured is an essential step to effect improvement in the maintenance planning, organizing and control.

The evaluation of maintenance performance can be made on the following factors:

- | | |
|-------------------|-----------------------------------|
| ❖ Availability | ❖ MTTR/Mean Time to Repair |
| ❖ Reliability | ❖ MTBF/Mean Time between Failures |
| ❖ Maintainability | ❖ Cost of Maintenance |

Availability

Availability is a useful parameter, which describes the amount of the equipment available time. It is usually determined by both the reliability and the maintainability of

the equipment system. The availability (A) can be expressed as a ratio or as a percentage [7]

$$A = \frac{MTBF}{MTBF+MTTR} \quad (1)$$

Where: MTTR = Mean Time to Repair. MTBF =Mean Time between Failure.

Reliability

Reliability is the ability of an item to perform a required function under stated conditions for stated period of time. A primary component of reliability analysis is referred to as failure rate, or the number of failures expected during a certain period of time. Calculation of pumps failure rate and its inverse –The Mean Time between Failures (MTBF) for items which are repairable or Mean Time to Failures (MTTF) for non-repairable items is the basic of reliability predication [1,6].

$$\text{Failure rate} = \frac{\text{Number of Failures}}{\text{Operating Time}} \quad (2)$$

The Mean Time between Failures (MTBF) is the expected time between two successive failures of the system. The Mean Time to Failures (MTTF) is the expected time to failure of a non-repairable system

Maintainability

Maintainability is a design parameter intended to reduce repair time, as opposed to maintenance, which is the act of repairing or servicing an item or pumps. It can be defines also as the measure of ability to make pumps available after it has failed, or mean time to repair (MTTR). It is determine by:

$$MTTR = \frac{\text{Total downtime due to failures}}{\text{Number of Failure}} \quad (3)$$

The Mean Time to Repair (MTTR) is the expected time to recover a system from a failure. This may include the time it takes to diagnose the problem, the time it takes to get a repair technician onsite, and the time it takes to physically repair the system. Similar to MTBF, MTTR is represented in units of hours [6]. The useful life period as shown in Figure (1) is one in which there is a constant failure rate. Maintenance performed at regular intervals for the purpose of keeping the equipment in a condition that will extend the useful life period.

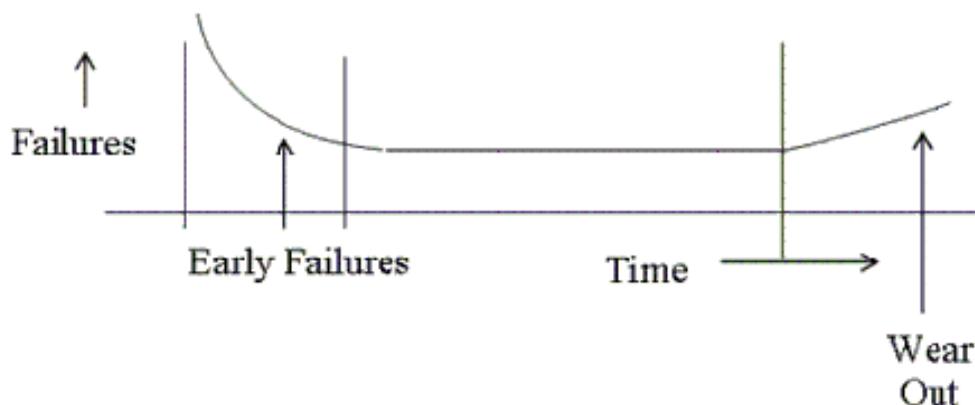


Figure 1: Typical Electronic Component Failure Rate as a Function of Age [7].

Maintenance Costs

In order for any organization to be successfully competitive today, the availability and reliability must be maintained at desired levels while operating and maintaining costs must be kept as low as is reasonably achievable. The operating costs consist of operating and maintenance costs. The simplified graph below Figure (2) shows the theory behind this concept [8].

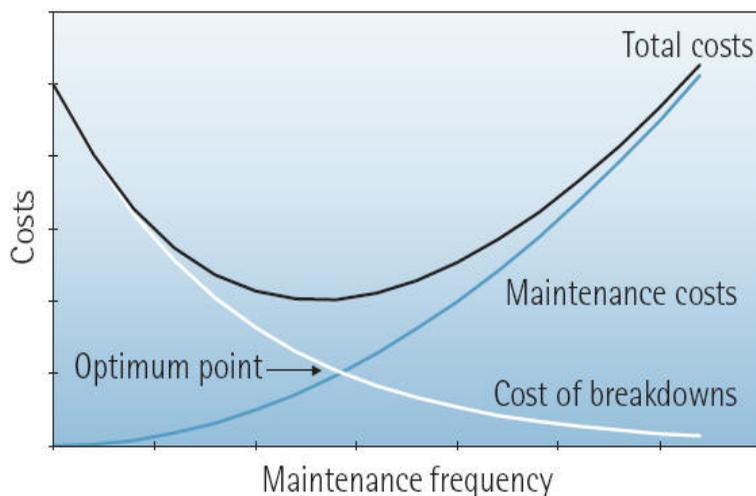


Figure 2: Maintenance Cost Analysis

Costs Performance Measures

Maintenance management is a business process, the maintenance costs are inputs into the process, and that means they can influence the outputs. Maintenance costs accrue in the following categories [8],

- Labor costs.
- Materials including all parts, components, and others used by maintenance.
- Services covers all workshops, stores warehousing, engineering and any other facilities supporting maintenance.
- Outside services covers all contracted services (maintenance, training and consultants).
- Technical support including supervision, planning, material coordination and data entry.
- Overhead covers all other support functions that are not directly involved with maintenance but provide that is vital in maintenance business.

Maintenance Options

To meet the maintenance requirements, the company can consider two specific options. The company can outsource the maintenance activities to the external provider (outsourcing) or choose to keep the capability insourcing (insourcing) [4].

Outsourcing

Outsourcing is an age old management practice of adding specialized expertise where needed to help management run or improve an organization. Outsourcing now has many dimensions to fit the globalized world we live in. Terms like 'offshoring,' 'insourcing' and 'shared services' are becoming part of a global business lexicon that defines the multitude of options a company has to improve its operations [3].

The Reasons of Outsourcing:

The organization will be more likely to outsource a function if there are multiple reasons [9]:

- **New skills:** In a fast evolving market where new technologies are emerging, knowledge and skills of individuals are very limited. Not every company is able to attract the knowledge and skill base. The company can solve this problem by handing over the function to the outsourcing supplier.
- **Better Management:** When the poor maintenance performance is attributed to poor management, outsourcing the maintenance function for experience managers.
- **Enhance Controls:** Where the company management is concerned about its ability to provide sufficient control over its operations, some functions can be outsource.
- **Focus on Strategy:** By outsourcing company managers can focus on strategy.
- **Focus on Core Functions:** The Company can choose to focus their energies on core functions and distributes all other functions through outsourcing.

The size of relevant outsourcing markets:

It is important to have a sense of the current size of various markets for outsourcing of technology-related services, their current rates of growth, and available estimates for their expected future levels. Although estimates are often apparently contradictory, because different assumptions have been made about which activities are outsourced, or about which outsourced activities should be considered in the category of information technology [3].

Outsourcing from Libya Market Perspectives

Outsourcing has become a growing business practice both internationally as well as in Libya. The research suggests that Libya is moving in the same direction as the rest of the world, toward greater use of flexible workers such as contract temporal and casual workers. This is collaborated by a number of small scale surveys that have identified an expansion of outsourcing, subcontracting and other form of typical work [9].

Outsourcing maintenance very much depends on the sector. There is huge demand and it will become a growing market, but till now preventative maintenance with own budgets only in energy, oil and important water sectors. In most cases companies consider only budget for necessary spare parts but not for service works, Local service still done by own service departments. Many companies got own service workshops with personal and try to keep the job at their own. That's even due to mostly governmental owned companies, only in very important cases company order service through outsourcing [10].

Pumps Maintenance Performance Measurement:

Pumping machinery and pumping station are very important components in different applications. Pumping machinery is subjected to wear, tear, erosion and corrosion due to their nature of functioning and therefore is vulnerable for failures. Generally the number of failures or interruptions are attributed to pumping machinery than any other component. Therefore, correct operation and timely maintenance and upkeep of pumping stations and pumping machinery are of vital importance. Sudden failures can be avoided by timely inspection, follow up actions on observations of inspection and planned periodical maintenance. Downtime can be reduced by maintaining inventory of fast moving spare parts. Efficiency of pumping machinery reduces due to

normal wear and tear. Timely action for restoration of efficiency can keep energy bill within reasonable optimum limit [11].

An Analysis of Pumps Performance and Maintenance cost:

This research used the 5 years maintenance performance data from questionnaire designed for this purpose for pumps. The main aim of the research was to analyze and compare the pumps performance in HASAWNA System during outsourcing from 2007 to 2010 and insourcing from 2011 to 2012, as shown in appendix A and B [12]. The key objective of maintenance activities is to maximize the maintainability and reliability of the pumps, within the required quality specifications, in a timely manner. Obviously, this objective must be attained in a cost-effective way and in accordance with environmental and safety regulations [1]. The overall success of pumps maintainability requires knowledge of pumps performance and conditions, training, focus on right goals, teamwork, communication and leadership [1]. The maintainability study or analysis normally uses quantitative data drawn from the questionnaire, therefore the choice of research variables for quantitative research was pump maintainability and maintenance costs [6]. The maintenance performance analysis only focused on the pumps, The reasons for this choice were that pumps are considered as the bottleneck of the system and the most expensive pumps, and they contributes the highest in maintenance costs.

Pumps performance analysis

The breakdown of the pumps failures from 2007 to 2012 is shown in Figure (3):

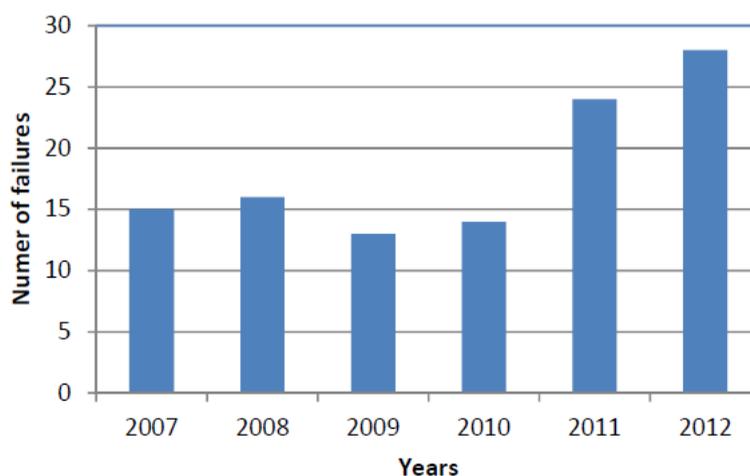


Figure 3: Number of Pumps Failures

Maintainability Analysis of Pumps

Maintainability provides a measure of the reparability of a system when it fails. The Mean Time to Repair (MTTR) is the expected time to recover a system from a failure. The total outage time for all the pumps incidents divided by the failures is the Mean Time to Repair of pumps [6]. The Mean Time to Repair (MTTR) trend of pumps from 2007 to 2012 in HASAWNA System is shown in Figure (4).

Maintenance Cost Analysis

The Maintenance Cost Analysis of pumps from 2007 to 2012 in HASAWNA System is shown in Figure (5). There was a significant drop of the maintenance budget in

2011 to 2012. The budget was above 3 million from 2007 to 2010, and it dropped below 2.5 million in 2011 to 2012.

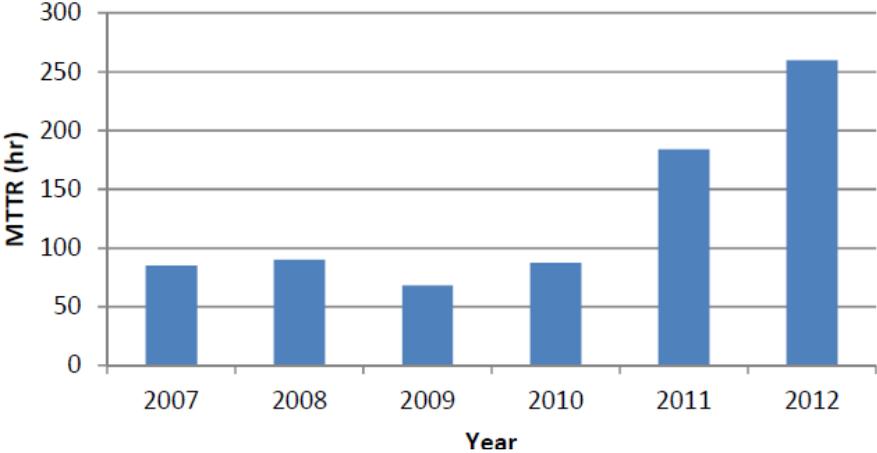


Figure 4: Mean Time to Repair (hours)

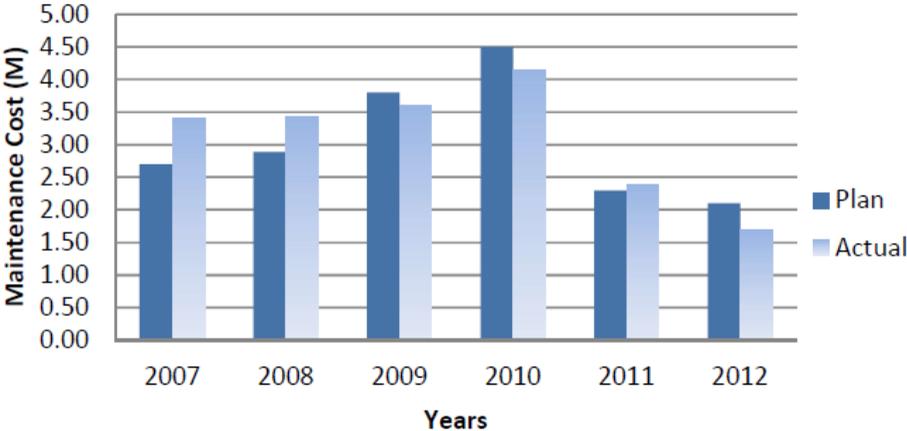


Figure 5: Maintenance Cost Analysis

The Actual Maintenance Cost Analysis

The Actual Maintenance Cost Analysis of pumps from 2007 to 2012 in HASAWNA System is shown in Figure (6).

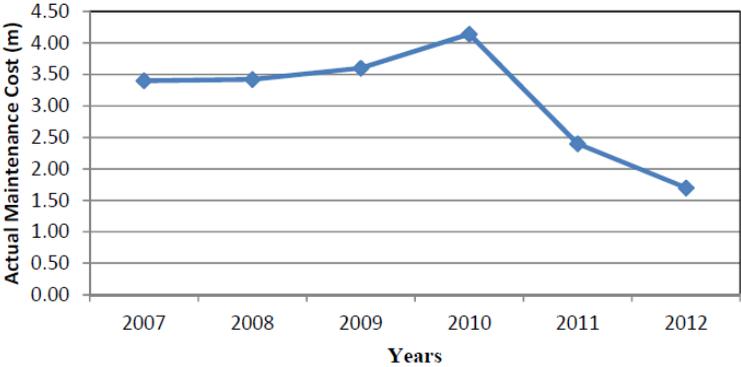


Figure 6: Actual Maintenance Cost Analysis

RESULTS DISCUSSION

Results Discussion of Pumps Performance Analysis

The breakdown maintenance from 2007 to 2010 was done by combination of outsourcing and insourcing staff; and the breakdown maintenance from 2011 to 2012 was done by insourcing staff only. The pumps analysis during 2007 -2012 period showed total number of 110 failures. The failure rate was constant in the first 4 years (2007-2010) with an average of 15 failures per year. Then there was a failure rate increase in the next 2 years (2011-2012).

The role of maintenance intervention is to reduce failures, but in addition the successful maintenance should reduce the pumps downtime. The recovery of operation after the failures is very essential in maintenance management. The minimum Mean Time to Repair (MTTR) of pumps in the first 4 years (2007-2010) was 82.5 hours (3.43 days), and the maximum MTTR was 260 hours (10.83 days). These figures indicate that the average pumps incident was taking a minimum of 68 hours to 260 hours to be repaired. The MTTR greater than 150 hours was recorded in 2011 and 2012. During these incidents the maintenance staff were taking an average of more than 4 days to repair the pump. The average MTTR during 2007-2010 period was 82.5 hours, and during 2011-2012 period the average MTTR increase to 222 hours.

The recovery time or Mean Time to Repair (MTTR) has two components, namely: response time and repair time. The response time component depends on the location of the maintenance staff relative to the work site. The repair time depends on the knowledge of the maintenance personnel, type of failure and availability of spares. The competent maintenance personnel will take shorter time to do the fault finding and conduct the repairs. There are failures that can take a very long time to be addressed, but these failures can be eliminated with pumps modification or replacement if they are critical to the operations.

The training of maintenance staff to the right competency level takes time. The success of maintenance insourcing depended on good training and development plans. In general the pumps suppliers understand their pumps better, therefore the combination maintenance of outsourcing & insourcing definitely improved the maintainability of pumps, and partnering with suppliers in providing relevant training will normally bring better results. The pumps performance clearly shows that the maintenance outsourcing did improve the maintenance performance.

Result Discussion of Maintenance Cost Analysis

There was a significant drop of the maintenance budget in 2011 to 2012. The budget was above 3 million from 2007 to 2010, and it dropped below 2.5 million in 2011 to 2012. The maintenance budget started shrinking after starting the only insourcing pumps maintenance in 2011. In 2011 & 2012, 100% of the pumps maintenance was done in-house. The reduce costs of outsourcing activities like supply spare parts & emergency services, all these affect the pump performance insourcing maintenance, and increase failure rate & the recovery time or Mean Time To Repair (MTTR).

CONCLUSION

The objective of this paper was to identify the maintenance performance measures and use these measures to evaluate the challenges and success of maintenance outsourcing and in-sourcing in HASAWNA System - Man Made River Authority between 2007 and 2012.

The aim of the paper was to gain an understanding of maintenance outsourcing and insourcing, including the identification of the drivers, the critical success factors and the benefits. This information was used to identify the critical performance measures that could be used to analyse the effectiveness of maintenance activities in pumps equipment.

The performance measures that were identified to evaluate and compare the effectiveness of maintenance outsourcing and insourcing were the maintenance costs, and maintainability (MTTR).

The outcomes of the paper revealed that the pumps performance during the outsourcing period (2007-2010) was almost constant, and averaging at 15 failures per year. The failures increase to an average of 26 failures per year during the insourcing period (2011-2012).

The pumps Mean Time to Repair (MTTR) or recovery time also increased by 68% during insourcing period (2011-2012), and there has been a reduction in maintenance costs during the insourcing.

RECOMMENDATIONS

- An effective management of maintenance system is needed for the planning of the maintenance works. According to the maintenance experts what is not measure it cannot be improved, the organizations and/or companies should implement a system to measure the maintenance performance.
- The implementation of outsourcing is very effective because it specialize in one activity only. Special services are needed periodically to provide unique or supplementary maintenance support.
- Companies do not generally know the full financial effects of outsourcing. This, however, becomes increasingly important as the outsourcing trend Companies. Life cycle costing is a tool that can be used when the outsourcing decision is being made.
- For the Libyan organisation, the recommendation is a well-planned and scheduled a combination system (in-sourcing + outsourcing) with a balanced percentage.

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Appendix A: Pumps Performance

Year	Number of failures (*)	Total time from pumps performance failure / week (*)	Total time from pumps performance failure / hours (*)
2007	15	7.6	1275
2008	16	8.6	1440
2009	13	5.3	884
2010	14	7.3	1218
2011	24	26.3	4416
2012	28	43.3	7280

(*) The data are collected from failures reports to the pumps supplier and interview with maintenance team.

Appendix B: Maintenance Cost

Year	Planned (million LYD)	Actual (million LYD)
2007	2.70	3.40
2008	2.89	3.42
2009	3.80	3.60
2010	4.50	4.14
2011	2.30	2.40
2012	2.10	1.70

Appendix C: Calculation Examples

Maintainability Calculation:

$$MTTR = \frac{\text{Total downtime from failures}}{\text{Number of Failure}}$$

Using 2007 pumps performance data:

The total downtime from pumps performance failures = 1275 hours

$$MTTR = \frac{1275 \text{ hours}}{15 \text{ failure}} = 85 \text{ hour/failure}$$