BACHELOR THESIS – ME 1502

TIME OPTIMIZATION OF SHIP MAINTENANCE WORKING PLAN FOR THE NEXT DOWNTIME PERIOD OF MV. TANTO TENANG

Benedictus Kenny Pradipta

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Supervisors:

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DEPARTMENT OF MARINE ENGINEERING

Faculty of Marine Technology

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SKRIPSI – ME 1502

OPTIMISASI WAKTU RENCANA KERJA PERBAIKAN KAPAL UNTUK PERIODE DOWNTIME SELANJUTNYA DARI MV. TANTO TENANG

Benedictus Kenny Pradipta
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JURUSAN TEKNIK SISTEM PERKAPALAN
Fakultas Teknologi Kelautan
Institut Teknologi Sepuluh Nopember
Surabaya 2016

Approval Form

Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang

BACHELOR THESIS

Submitted To Comply One Of The Requirements To Obtain A
Bachelor Engineeting Degree
On
Laboratory Of Reliability, Availability, Maintainability, And Safety (RAMS)
S-1 Program Department Of Marine Engineering
Faculty Of Marine Technology
Institut Teknologi Sepuluh Nopember

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SURABAYA,
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July 2016

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DECLARATION OF HONOUR

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Bachelor Thesis Title	: Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang
Department	: Marine Engineering

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Surabaya, July 25th, 2016

Benedictus Kenny Pradipta

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Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang

Name	:	Benedictus Kenny Pradipta
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Title	:	Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang
Reference	:	9 books, 1 research paper

ABSTRACT

Optimum maintenance planning is very important for every company, also for the shipping company. Improper planning can decrease the ship's availability to sail or delivering cargoes. This unavailability of the sip will impact the shipping company revenue. But, also need to be noticed about cost of ship maintenance that will be spent by the shipping company.

This research is meant to optimizing time of main engine maintenance for a ship. In this thesis the ship is MV. Tanto Tenang. The main problem in this research is unoptimum time for maintenance process. So, this research try to solve that problem through some steps of problem solving.

The theory that being used to solve the problem is a combination between project planning from PMBOK Guide Book and maintenance management process from NORSOK STANDARD Z-008. To optimize the maintenance time, this research use Primavera as a software for project planning. This

software is very good to manage the maintenance time, risks, and what activities that need to be semi-overlapped.

The first step is review the literatures to identify the need for maintenance. The review shows that maintenance scheduling, optimization software, capabilities of the crew, and list of maintenance activities are the most imporant things.

The second step is analyzing the PMS, working hour of each component, ship's voyage plan, and capability of the crew to do the maintenance. These are very connected to arrange the right maintenance optimization for MV. Tanto Tenang. The result show that there are a lot of components need to be maintained at the end of 2016 or at the begining of 2017. According to the PMS, working hour of each component, and ship's voyage plan, every cylinder need to be maintained. This is a major maintenance for main engine of MV. Tanto Tenang.

The third step is making the maintenance schedule plan by Primavera. This method is done through some steps, those are: input the work breakdown structure, input the activities (including plan of starting time and finish time for each activity), and the possible risk of each component. The result is a connected chart from one activity to another activity of each component that show how is semi-overlap happen.

The forth step is comparing the result of this thesis to maintenance time duration of MV. Tanto Tenang's sister ship. The result shows that MV. Tanto Tenang as a subject of this research could has 10 days for main engine maintenance. This is 2 days shorter than MV. Tanto Semangat as the sister ship.

Keyword: Time optimization, ship maintenance management, Primavera

Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang

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Referensi	:	9 buku, 1 paper penelitian

ABSTRAK

Perencanaa *maintenance* yang optimum sangat penting bagi setiap perusahaan, juga untuk *shipping company*. Perencanaan yang tidak tepat dapat menurunkan keandalan kapal untuk berlayar atau mengirimkan barang. Ketidakandalan kapal ini akan berdampak pada pendapatan perusahaan. Tetapi, perlu diperhatikan juga biaya untuk *maintenance* kapal yang akan dikeluarkan oleh *shipping company*.

Penelitian ini dimaksudkan untuk mengoptimasi waktu dari *maintenance* mesin induk untuk sebuah kapal. Dalam skripsi ini kapal tersebut adalah MV. Tanto Tenang. Masalah utama dalam penelitian ini adalah waktu yang tidak optimum untuk proses *maintenance*. Sehingga, penelitian ini mencoba untuk menyelesaikan masalah tersebut melalui beberapa langkah penyelesaian masalah.

Teori yang digunakan untuk menyelesaikan masalah tersebut adalah kombinasi antara perencanaan proyek dari PMBOK Guide Book dan manajemen proses maintenance dari NORSOK STANDARD Z-008. Untuk mengoptimasi waktu maintenance, penelitian ini menggunakan Primavera sebagai software untuk perencanaan proyek. Software ini sangat baik untuk mengatur waktu, resiko, dan aktivitas apa saja yang perlu dilakukan semi-overlap dari maintenance.

Langkah pertama adalah mengulas teori-teori untuk mengidentifikasi kebutuhan dari maintenance. Ulasan tersebut menunjukkan bahwa agenda maintenance, software optimisasi, kemampuan dari kru kapal, dan daftar kegiatan maintenance adalah hal-hal yang paling penting.

Langkah kedua adalah menganalisa PMS, jam kerja dari tiap komponen, rencana pelayaran kapal, dan kemampuan kru kapal untuk melakukan maintenance. Hal-hal tersebut sangat berkaitan untuk mengatur optimisasi maintenance yang tepat untuk kapal MV. Tanto Tenang. Hasil menunjukan bahwa terdapat banyak komponen yang harus diperbaiki pada akhir tahun 2016 atau awal tahun 2017. Berdasarkan pada PMS, jam kerja komponen, dan rencana pelayaran kapal, setiap silinder harus diperbaiki. Ini adalah maintenance besar untuk mesin induk dari kapal MV. Tanto Tenang.

Langkah ketiga adalah membuat jadwal rencana maintenance menggunakan Primavera. Metode ini dilakukan melalui beberapa langkah, yaitu: memasukan work breakdown structure (WBS), memasukan kegiatan maintenance (termasuk rencan waktu dimulainya dan diakhirinya setiap kegiatan), dan kemungkinan resiko untuk tiap komponen. Hasilnya adalah grafik kegiatan yang berhubungan satu dengan yang lainnya dari tiap komponen yang menunjukan bagaimana semi-overlap terjadi.

Langkah keempat adalah membandingkan hasil dari penelitian terhadap durasi waktu maintenance dari sister ship

MV. Tanto Tenang. Hasil menunjukan bahwa MV. Tanto Tenang sebagai subjek dari penelitian ini bisa memiliki 10 hari untuk maintenance mesin induk. Hasil ini adalah 2 hari lebih singkat dari MV. Tanto Tenang sebagai sister ship.

Kata kunci: Optimisasi waktu, manajemen perbaikan kapal, Primavera

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PREFACE

Thank to God Almighty who has given His grace so the authors can finished Bachelor Thesis. In this Title Bachelor Thesis authors is Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang.
Bachelor thesis Submitted to comply one of the requirements to obtain a Bachelor Engineering Degree in Department of Marine Engineering, Institut Teknologi Sepuluh Nopember.
The writter also wish to express his deep and sincere gratitude for those who helped in completing this Bachelor Thesis:

1. Parents writter Mr. Ir. R. Blasius Pascal Prijana, Mrs. Kartini Seno for the support, love and prayers that never ends.
2. Mr. Muh. Badrus Zaman, ST. MT. as Head Department of Marine Engineering, FTK, ITS Surabaya.
3. Ir. Dwi Priyanta M,Se as Supervisor I.
4. Dr. –Ing. Wolfgang busse as Supervisor II .
5. Dimas my younger brother and Jeanice my younger sister, thank you for your support and prayers during the thesis process.

Hopefully, this Bachelor Thesis can help the readers to expand their knowledge.

Surabaya, July 2016
Author

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Table of Content

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List of Figure

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Title: Time Optimization of a Ship Maintenance Working Plan for the Next Downtime Period of MV. Tanto Tenang

Summary:

The history said, anything that broken or not possible to work properly have to be disposed. This term made people in the past didn't have knowledge about maintenance. Their mind are so primitive. But that was not a problem because many tools and things are simple to be made. People didn't need to worry about disposing so many things. This was a mindset in the very past. The mindset of our great grandmothers in primitive life.

Nowdays the growing of industry has reached its success. Construction, automotive, and transportation could be the example as main role in industry growth. It could happen in maritime field such as shipping industries have taken a place to send their business through other country or could be city which could not be sent by land routes. People aren't thought about disposing things so easily anymore. Tools and things are getting much better. The prices are also more expensive. Now people repair everything. Anything broken or damaged can be fixed. People also learn how to prevent the tools and things broken. Learn how to expand the life time of tools and things. People learn how to maintain everything. This knowledge is called maintenance.

Maintenance has been a very important part of every industry including maritime industry. In maritime world, maintenance plays a very important role. Every ship has to be maintained to gain her life time. Many Bureau Classification Societies were born to give surveys and maintenance advices for the ships. Bureau Classification Society such as Lloyd Register (LR), Class NK (Nippon Kaiji Kyokai), GL (Germansicher Loyd), BKI (Biro Klasifikasi Indonesia), etc.

are some examples which usually give surveys and maintenance advice. Those advices are based on some standards. Every single item, engine, and equipment on ship has different standards, different life time, and different survey.

Therefore, maintenance is a crucial factor in a ship‘s performance and, in turn, can affect the shipping company‘s revenue. There should be a balance between maintenance cost and over-maintenance. Thus, a good framework with which to measure maintenance performance and to plan maintenance policy for the shipping marine organisation is of vital importance.[1]

The bachelor thesis will be more in the direction of literature analysis about optimizing time for maintenance process especially Main Engine maintenance of a ship.

Implementation Place

1. Reliability, Availability, and Maintainability System Laboratory, Marine Engineering, FTK – ITS
2. Shipping Company
3. ITS Library

[1] Alhouli, Yoseh Mohammed, 2011, *Development of Ship Maintenance Performance Measurement Framework to Assess the Decision Making Process to Optimise in Ship Maintenance Planning*, The University of Manchester for the degree of PhD in the Faculty of Engineering and Physical Sciences, England, page 18

CHAPTER 1
INTRODUCTION

1.1. Background

As we know, PT. Tanto Intim Line is a big shipping company in Indonesia. This company has so many ships those are used to deliver the cargoes. If the shipping company could deliver these cargoes, their business is running. But, what happen if the ships can't be operated? Yes, their business will stop. To avoid this "bad thing" happens, every ship need to be surveyed and to be checked if there are any troubles and then maintain them.

For example, on a survey the surveyor checks a few items such as hull, watertight bulkheads, decks, tunnels, plate thickness gauging, stability information, etc. By doing inspections, classification society will decide what are the parts the need to be maintained. They will also decide which parts that must be maintained right on maintenance schedule and which parts that able to be idled until the next maintenance schedule. Classification decisions are also based on the regulations. Every single part has different regulations. So, the same maintenance methode can't be done to every ship.

One of a few ways to prevent a ship unable to be operated is maintenance. Decision maker of the company has to make a good decision about when the ship has to be maintained, what items are need to be maintained, and what is the best schedule for maintenance. The maintenance schedule isn't decided only from one side (for example is ship owner or company), but also by class, dock, and customer. This process of making decision for maintenance schedule is a maintenance

management process. It's about how to mix every consideration into one fine decision.

Mostly, the reason why a ship owner or a company wants a shorter ship's downtime because of they want to reduce cost. If the maintenance process could be done faster, the ship would come out earlier from the dock. It will reduce a lot of money. Then the ship could sail again and earn more money.

But, also need to be remembered, the decision of maintenance schedule on ship's downtime, can't take too long time. Why? Because it will decrease the income of the company or ship owner. So, to arrange ship maintenance schedule at ship's downtime, has to be as optimum as possible.

1.2. Statement of Problem

1.2.1. Problem

Every process must be takes time. The longer process is, the longer time that being taken. Also the maintenance process is. If there are a lot of troubles at some components, the downtime of the ships will be longer.

On one side, the ship owner wants to do some maintenance later to save more money. For example the ship has so many cargoes to be delivered. But, the ship already needs maintenance. The ship owner still wants to earn money. But the classification society said the ship has to be maintained right on that time. On another side the dock also said the ship has to wait because there still some ships on docks. But, on the other side the customer wants the cargoes arrive right on time.

This is a problem to rearrange maintenance schedule. How to utilizing the very small space that

"being pressed" from every side. Based on the description above, could be concluded some problems are:

1. How to optimize the duration of the next period of maintenance on ship's downtime of MV. Tanto Tenang?
2. How can the scope of work organize in more time saving optimization?
3. How can several works be done in parallel or overlap?

1.2.2. Problem Limitation:

1. This research is done by scope of work from an existing draft of a specific ship.
2. This research is done by data base from shipping company.
3. This research will take data from a real ship.

1.3. Objectives

From the problems above, this thesis has some objectives to be done to solve those problems:

1. Differentiates which items that possible to be maintained in parallel, overlap, or keep on normal schedule.
2. Recommendation for a better maintenance schedule.

1.4. Research Benefits

By doing this thesis, some benefits that being expected which are hopefully usefull. Those benefits are:

1. Give the shipping company another choice for maintenance schedule which is can improve the benefits of the shipping company and also keeps the ships reliable to keep sailing.
2. Knowing the most possible schedule for maintenance in a very small time to make decision when the company has to do maintenance and what items need to be maintained.

CHAPTER 2
LITERATURE STUDY

2.1. Theory of Maintenance

2.1.1. Definition of Maintenance

Maintenance processes vary from one industrial field to another. For example, the maintenance of bridges requires different processes from the maintenance of buildings, and the maintenance of machine equipment differs from one unit to another. Maintenance has attained an important position as a result of modern technology, which requires frequent maintenance; such maintenance is required to ensure the performance of machines, irrespective of whether the maintenance is classified as planned or unplanned.[2]

In the production industry, as an example, maintenance represents a very significant function within the overall production environment, which is necessary in order to increase production levels or maintain maximum production levels. However, in other organisations, such as the marine industry, the need for maintenance is based on the availability of ships in a safe condition.[3]

The maintenance system plays a very important role, as does many other systems within an organisation. The maintenance system must be considered carefully because this system can have great influence on the overall performance of the organisation. The importance

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[2] Alhouli, Yoseh Mohammed, 2011, *Development of Ship Maintenance Performance Measurement Framework to Assess the Decision Making Process to Optimise in Ship Maintenance Planning*, The University of Manchester for the degree of PhD in the Faculty of Engineering and Physical Sciences, England, page 30

[3] Ibid. Page 31

of maintenance has generated an increasing interest in the development and implementation of optimal maintenance strategies for improving system reliability, preventing the occurrence of system failures, and reducing maintenance costs of deteriorating systems.[4]

The importance of maintenance has generated an increasing interest in the development and implementation of optimal maintenance strategies for improving system reliability, preventing the occurrence of system failures, and reducing maintenance costs of deteriorating systems. In addition to attempting to achieve those objectives, applying an optimum maintenance system in an organisation can produce many other benefits, which can be summarised as follows:[5]

- The asset remains in its operational state and breakdown risks can be avoided.
- The instant availability of the asset when it is required to operate.
- The increase in safety levels for the employees who operate the machinery.
- Increased reliability, leading to less lost time while facilities are being repaired, less disruption to the normal activities of the operation, less variation in output rates, and more reliable service levels.
- Quality errors can be avoided, because well maintained equipment is more likely to perform to meet standards, thereby avoiding quality problems.
- The potential reduction of operating costs if maintenance is conducted at regular intervals.

[4] Ibid
[5] Ibid. Page 32

- Longer life spans for the machinery; regular care can prolong the effective life of facilities by reducing the small problems in operation whose cumulative effect causes wear or deterioration.
- Higher end value of the machinery; well maintained facilities are generally easier to dispose in the second-hand market.

Maintenance is a process to gain life time of a ship. The function of this maintenance is to repair the parts or equipment of the ship that maybe broke or not in appropriate condition. This repair is purposed to gain the life time and performance of the ship. The reason why a ship owner must do the maintenance is because the ship performance is always getting low and lower. If the ship already reach the failure point, the ship will not be able to operate at all. So to avoid it, the ship owner has to do the maintenance.

Having extra crew on board to undertake maintenance work may increase directly maintenance expenditure. However, if the maintenance is postponed, it may result in higher future maintenance outlays (higher dry-docking bills) and foregone earnings. Hence the relationship of crew on board and maintenance expenditure is not straightforward. In addition, the composition of the in terms of different nationalities does not impose any a priori expectation, since all crew carry internationally equivalent certificates. To be sure there are wage differences among different crew nationalities and possibly different productivity levels. But a more productive crew may pay more attention to maintenance, thus raising current maintenance outlays but potentially

reducing the risk of unexpected higher maintenance bills in the future.[6]

Another important subject for consideration by the ship owner is the quality of repairs. The ship owner does not have much leverage over the shipyard, when it concerns the quality. However, the increased presence of the qualified owner representatives at the yard is very effective in controlling it. The fact that more monitoring is done allows to uncover the shipyard defects on time and to prevent substantial financial losses. The ship owner might affect the quality of repairs also by supplying certain materials and equipment.[7]

Availability is ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided.

Prioritization of corrective maintenance should be done based on the risk the failure represents, described as consequence and failure impact/probability of failure. Some companies call this process "Risk Based Work Selection", and have implemented it in their maintenance management system.[8]

Factors such as the ship's original construction may affect subsequent maintenance requirements. If epoxy coating was applied on cargo and ballast tanks when the vessel was built it may bring long lasting

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[6] George C. Bitros, *A Cross Sectional Analysis of Ship Maintenance Expenses, Athens University of Economics and Business*, Greece, Page 10

[7] Butman, Boris, *Fundamentals of Ship Maintenance and Repair for Future Marine Engineers,*US. Merchant Marine Academy, USA, Page 141

[8] NORSOK Standar Z-008,2011,*Risk Based Maintenance And Consequence Classification,* Standard Norway, Norway, page 24

benefits because it protects the vessel from the early corrosion on its surface. In addition, a series of vessels built with high tensile steel technology resulted in higher maintenance demands. High tensile steel is thinner and resulted in higher future steel replacements as a result of extensive corrosion on vessels' hull superstructure. It is expected that vessels built with high tensile steel require higher maintenance expenditures. In particular, one should test if the specific repairs and survey expenses are positively related to this factor.

This maintenance process is a circular process. Which means, after a long process of making decision for maintenance schedule, there will be a correction to improve the next maintenance schedule.

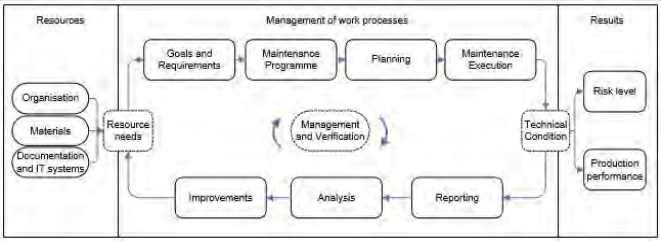
Maintenance management definition is all activities of the management that determine the maintenance objectives, strategies, and the responsibilities and implement them by means such as maintenance planning, maintenance control and supervision, improvements of methods in the organisation including economical aspects. And the maintenance successesfulness could be measure by maintenance effectiveness, which is ratio between the maintenance performance target and the actual result.[9] The maintenance performance result is the objective of maintenance. To achieve it we have to do maintenance strategy.

The first thing of maintenance management is defining the resource data. The data resource could be ship's documents, general data of the ship, log book, daily reports, etc. Annual survey result is also a resource data. Then we set a target or objective of the maintenance process. The target or objective is a result that being

[9] NORSOK Standar Z-008,2011,*Risk Based Maintenance And Consequence Classification,* Standard Norway, Norway, page 9

expected from the maintenance process. Then we plan how the maintenance will be done to reach the target, run the maintenance, make a report of the maintenance process, analyze the result is it already reach the target that already being setted before, if the target hasn't reach, then identify the causes, make some conclusions, and make an improvement for the next maintenance plan. It is a circular process. This circular process is related with NORSOK STANDARD Z-008 maintenance management process. Here is the diagram of management process from NORSOK STANDARD Z-008:

Figure 2. 1 Maintenance Management Process



Reference: NORSOK Standard, Risk based maintenance and consequence classification

A GMC is a set of maintenance actions, strategies and maintenance details, which demonstrates a cost efficient maintenance method for a defined generic group of equipment functioning under similar frame and operating conditions. Generic Maintenance Concepts may be developed in order to:

- Establish a company's minimum requirements to maintenance
- Reduce the effort in establishing the maintenance programme as similar equipments/technologies are pre-analyzed

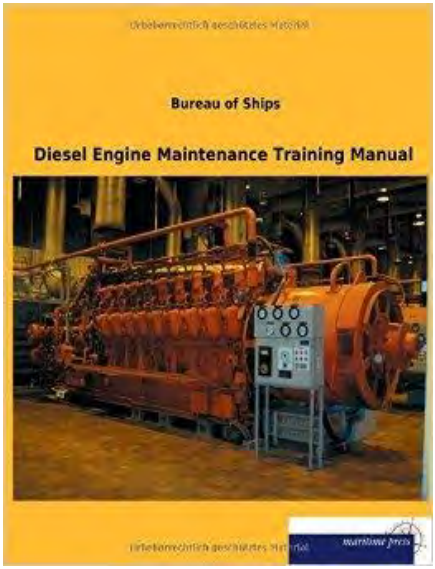
- Ensure uniform and consistent maintenance activities
- Facilitate analysis of equipment groups
- Provide proper documentation of selected maintenance strategies
- Ensure experience transfer between plants with similar technology and operation

2.1.2. Maintenance Manual

Maintenance manual is a book that explains about the data of an item or a component. It is explain about the maintenance maximum working hour of each component, which means if the maximum working hour is already approach, the components need maintenance. It talks about the detail of a component.

Management of shipboard PMS and corrective maintenance is the responsibility of the Commanding Officer. It is imperative that Commanding Officers maintain a comprehensive program within their command to monitor the health of their maintenance system.

Figure 2. 2 Maintenance Manual Book



Reference: Bureau of Ships

2.1.3. Downtime Period

Downtime period is the time during the ship is not working because it is incapable of sailing, as when under maintenance. Usually every ship has its own downtime duration for the next maintenance schedule. But, that duration musn't be too long because it will inflict a financial lost for the company or ship owner.

However, the downtime duration for ship maintenance depends on number of items those need to be maintained. It could be repair the items, or replace them with the new one.

Figure 2. 3 Downtime of A Container Ship

Reference: Fortune Technologies

From the picture above, we can see a container ship already in the dry dock. This is the time when the ship is in on downtime periode for maintenance. During this downtime periode, the ship won't earn money. It will only cost money for maintenance. This is why the ship downtime for maintenance shouldn't be too long.

2.1.4. Maintenance Working Plan

A maintenance plan is a key component of your MOSS (Maritime Operator Safety System) Operator Plan. Under MOSS, every ship needs a maintenance plan. If the vessel has an SSM (Safe Ship Management) certificate, it will already have a maintenance plan. You can use this plan as the starting point for the maintenance plan under MOSS.

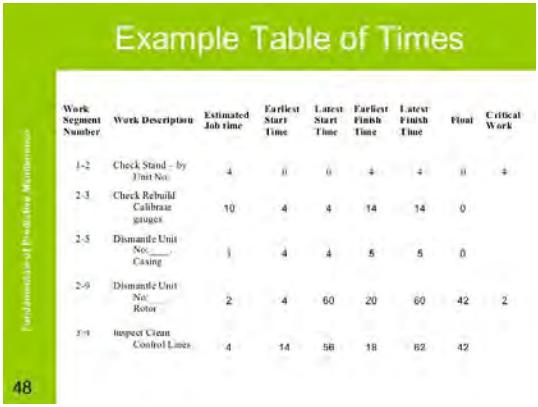
A maintenance plan helps by listing all of the items to be checked and how often these checks need to be done. It also:[10]

- Includes the maintenance requirements for the hull, decks, superstructure, machinery, equipment and critical shipboard systems
- Includes the routine maintenance requirements and the timing for these
- Includes a log (record) of the maintenance that has been done, who did it, and any further action that is required
- describes the maintenance requirements for at least the next five years
- Includes a list of your preferred maintenance providers and shore based contractors

From this maintenance working plan, we also could analyze which items that possible to be done on parallel, over lap, or only possible on normal schedule.

[10] Maritime Newzealand, *2014, Developing a maintenance plan,* page 3

Figure 2. 4 Maintenance Working Plan Draft



Reference: Fundamental of Predictive Maintenance

2.1.5. Maintenance Duration

Maintenance duration is the time length of maintenance process. This is also the time when the ship doesn't earn money. Usually, the duration of ship maintenance is estimated based on operator experiences.There is no standard method that is used to estimate the duration of ship maintenance.[11]

So, this is why the ship maintenance duration shouldn't be too long. Because it only makes a lot of cost. It should be shorten to reduce the cost. For example, the maintenance for piston and cylinder liner. These items could be done in one work. Which means, when the main engine is already opened and the piston for its

[11] International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:7, No:7, 2013, *Estimation Model of Dry Docking Duration Using Data Mining*, page 1

maintenance is already taken out, check and maintain the cylinder liner. Avoid to do double works. This is a parallel maintenance that could shorten the maintenance downtime duration.

2.1.6. Maintenance Time Table or Schedule

Maintenance time table or schedule is an agenda or schedule what items are on maintenance, what items are not maintained yet, and what items are already maintained. This time table shows very detail about the maintenance process. The ship owner or company could monitorize the maintenance process trough this time table. It also shows how long an item needs time for maintenance.

This could be a time target about when the maintenance process of each item should be done. Because by sets a time target about when maintenance process should be done, the ship owner or company could estimate when the ship is ready to be operated again. And they can also arranging their business or do asomething else that could give some benefits.

2.2. Voyage Plan

Voyage plan is a plan that show the ship's destination in a certain range of time. It also show about how long the ship has to sail and how long the ship berthing at some ports. Usually the destinations of this voyage plan is determined by the shipping company. But, the experienced ship officers (ship captain) will rearrange the plan include how long the voyages will be and how long the berthing at some ports will be.

While making a passage plan, the officer must keep in mind that the ship must reach the destination safe by abiding to both local and international rules and

regulations. A ship's passage planning involves 4 major steps/stages. They are as follows:[12]

a. Appraisal

In this stage, the master of the ship discusses with the chief navigating officer (usually the First Officer), as to how he intends to sail to the destination port. (In some cases it may be required for the master to plan the passage).

b. Planning

In this stage the intended courses of the ships are actually laid out on the charts of suitable scale and all additional information is marked. The plan is laid out from pier to pier, including the pilotage waters.

c. Executing

In this stage, the navigating officers execute the plan that has been prepared. After departure, the speed is adjusted based on the ETA and the expected weather and oceanographic conditions. The speed should be adjusted such that the ship is not either too early or late at its port of destination.

d. Monitoring

A safe and successful voyage can only be achieved by close and continuous monitoring of the ship's progress along the pre-planned tracks. Situations may arise wherein the navigating officer might feel it prudent to deviate from the plan. In such case he shall inform the master and take any action

[12] KARANC, 2012, *Understanding The Principles of Passage Planning,* accessed through: http://www.marineinsight.com/marine-navigation/understanding-the-principles-of-passage-planning/, accessed at 08.00 AM

that he may deem necessary for the safety of the ship and its crew. This stage is a very important stage wherein all the deck officers contribute their part to execute the plan.

2.3. Maintenance as a project

Every project has its own characteristics. No matter what is the project, it must be has its own characteristics. Also with the maintenance. Manintenance is a project too. The reason is because a project must be different with the other. But, in a big scope there are some similar characters that every project has. The characteristics of a project are:[13]

a. Performed by people
b. Constrained by limited resource
c. Planned, executed, and controlled

Those are some characterisc that we always find in every project. First, every project must be performed by people. It is impossible if a project only performed by machine or robot. Even there is only one person that could operates all of themachines or robots, it still performed by people. Second, constrained by limited resource. In a project, not every resource can be fulfilled by 100%. This is because the resource is limited. So, we need to find another thing that can replace the resource but has the exactly same function. Third, a project must be planned, executed, and controlloed. These are the main steps of a project, the major sequence of a project that not even a single step could miss.

There some another characteristcs too. For example, every project is temporary. It has time duration.

[13] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 4.

Begins with starting date and time, and ends with closing date and time. But, usually the ship owner or company that perform a maintenance, wants to finish it as soon as possible. The reason is to stop the cost and earn more money. If the ship could be come out faster from the dock, then it could earn money again. But, they can't decide by themself because there is a Classification Society that decide which items need to be maintained.

Another characteristic is unique. Why unique? Because it has some special differences with another maintenance. Even from the demand of the ship owner or company, the material that being used, or the tecchnology that help the mintenance project. Every differences make a maintenence project become unique.

Also it involves a single person or many. As I said before, it is impossible if a maintenance project doesn't involve even a single person. Even only one person as an operator or the machines that doing the maintenance, it still involves a person to do the maintenance.

Project management of maintenance is a structure of o few main important steps. These steps may not be missed even one. The steps are:[14]

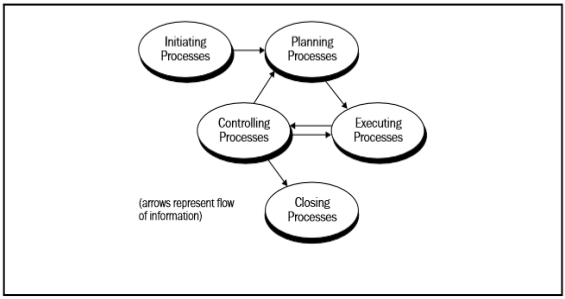
a. Initiating
b. Planning
c. Executing
d. Controlling
e. Closing

Start from initiating. Initiating is a process where the ship owner or company decided to de the maintenance project. In intiating process they do some meetings, identificating some items, and preparing for the

[14] Ibid. Page 6.

maintenance. Then they do planning. They planned about what items are need to be maintained, what is the dock yard to do the maintenance, how much the estimated cost, how to do it, when to do it, and who will do it. Everything about detail of maintenance process. And then they execute the plan. During this eecution, they also monitorize how is the maintenance doing. Is it already right on the plan and doing good? Or there are a few things that need to be fixed from the plan. If they find out a few things need to fixed from the plan, they they will do the planning again. What should be done to fix the wrong things. And then they are giving order to execute the new plan. If it's alradey good, then the mainenance process keep go on. Then after the whole maintenance activity is already done, they could do closing. Closing is only about administrative activity. If they already the closing sto, that means the maintenance process is already done. Here is the connection of the structure in diagram:

Figure 2. 5 Structure Connection of Maintenance Management



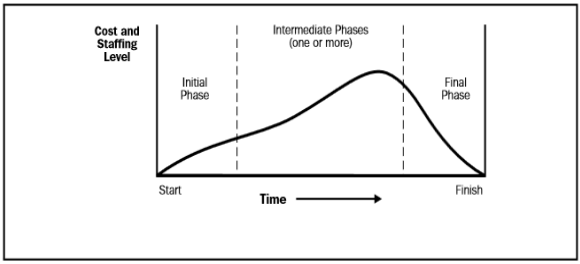
Reference: PMBOK Guide

Project management also has disciplines area. This disciplines are connected to build the whole project management. Those disciplines are:[15]

a. Project integration management
b. Project scope management
c. Project time management
d. Project cost management
e. Project quality management
f. Project human resource management
g. Project communication management
h. Project risk management
i. Project procurement management

Maintenance project also has a life cycle. This life cycle consist of three main part, those are initial phase, intermediate phase, and final phase. If we draw this life cycle into a diagram, it will be:

Figure 2. 6 Life Cycle Diagram of Maintenance Project



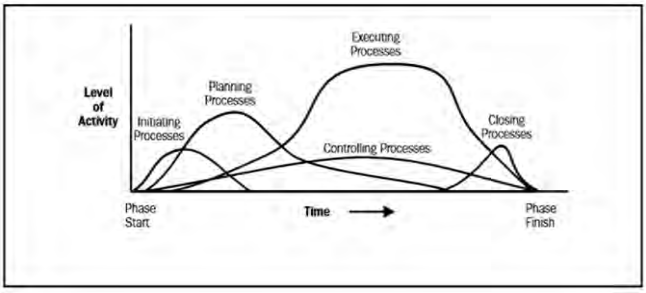
Reference: PMBOK Guide

[15] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 7.

From the diagram above, we can see that the life cycle of maintenance project is based on time for X axis and cost and staffing level for Y axis. The most critical cost and staffing level is the intermediate phase right a moment before final phase. Why? Because on this phase, the activity is rising. A lot of tasks need to be done. When the maintenance project just started, maybe the level of cost and staffing is low. This is because of the initial phase is only about meeting, planning, checking, etc. which is dosen't need a lot of people to do it. Then in intermediate phase, the activity of maintenance is begun. Repairing items, replace them with the new one, checking the quality of repair result, etc. These phase needs al lot of people and cost. And then after the intermediate phase is done, only the final phase left. This is only the clsing process. It would't need a lot of people and cost. The longest time that needed is intermediate phase.

In order to optimize the time of maintenance project process, the company or ship owner do an overlap when do the every step of structure. Even not all acttivities on each step can be overlap with another activity on another step, but it's good enough to minimze the time. It is much better then do the whole things in sequence.

Figure 2. 7 Overlapping of Maintenance Process



Reference: PMBOK Guide

From the diagram above, we can see the overlapping thing. If we look at initiating process, we also can look some another processes. But, based on the time on X axis, the main activity is at initiating process. The another processes are only the begining, such as preparation. One thing that need to be remembered, these overlapping is still on the sequence structure. The longer time of X axis is followed with farther structure of the process. if there is no everlapping of processes, surely there will be longer time. This isn't effective because a lot of time will be wasted.

2.3.1. Initiating Process

Initiating process is the very begining of every process. this process consist of authorizing the maintenance management project and checking every step of works. As the very first part of process this part determine how the maintenance project will be, what are the plans that needed, where is the maintenance will be held, etc. If there is a mistake in initiating process, it will make another trouble in the next process.

2.3.2. Planning Process

Planning process is a process where the whole maintenance activities are desgined. The planning is consist of time planning, cost planning, staffing planning, risk planning, procurement planning, and human resource planning. This is a very long process. Why? Because the plan could changed during the execution. If the plan isn't good enough to solve a problem in maintenance activity, then it need to be replanned. So this process could finish almost be in conformity with executing process.

Planning is of major importance to a project because the project involves doing something that has not

been done before. As a result, there are relatively more processes in this section. However, the number of processes does not mean that project management is primarily planning, the amount of planning performed should be commensurate with the scope of the project and the usefulness of the information developed. Planning is an ongoing effort throughout the life of the project.[16]

2.3.3. Executing Process

This is a process where the plans are being executed. Repair some items, replace items eith the new one, checking condition of items, ect. This process must be done carefully. No any deffect can be tolerated. If there is a problem, then we need to try to do it again. If the result still has a problem, then there is something wrong with plan. Then we need to make a new plan to solve the problem.

2.3.4. Monitoring Process

Monitoring process is a controlling process of the whole maintenance process since the initiating process until closing process. The cycle is the level activity of monitoring process is getting higher in the executing process and lower in the initiating, planning, and closing process. Why? It is because of executing process is the most critical process of maintenance project. So it needs more attention then another process.

Project performance must be monitored and measured regularly to identify variances from the plan. Variances are fed into the control processes in the various knowledge areas. To the extent that significant variances are observed (i.e., those that jeopardize the project

[16] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 32.

objectives), adjustments to the plan are made by repeating the appropriate project planning processes. For example, a missed activity finish date may require adjustments to the current staffing plan, reliance on overtime, or tradeoffs between budget and schedule objectives. Controlling also includes taking preventive action in anticipation of possible problems.[17]

2.3.5. Closing Process

Closing process is only about administrative closure. It is about making a statement letter or proposal that the maintenance project is already done and making the report of the project. And then if the administrative closure is already done, the ship could come out from the dock and go for sail again.

2.4. Maintenance Time Management

Maintenance time management is identifying and documenting the specific activities that must be performed to produce the deliverables and sub-deliverables identified in the WBS (work breakdown structure). It also has a time schedule:[18]

- Activity definition
- Activity sequencing
- Activity resource estimating
- Activity duration estimating
- Schedule development
- Schedule control

[17] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 36.
[18] Ibid. Page 65.

Each time schedule has more specific activity in it. Of course every activity in a time schedule will be different with another. But, they are connected to reach a single target of result.

2.4.1. Activity Definition

Activity definition involves identifying and documenting the specific activities that must be performed to produce the deliverables and sub-deliverables identified in the work breakdown structure (WBS). It is divided into three main parts:[19]

a. Input:
   - WBS
   - Scope statement
   - Historical information
   - Constraints
   - Assumption
   - Expert judgement

b. Tools and techniques:
   - Decomposition
   - Templates

c. Output:
   - Activity list
   - Supporting detail
   - WBS update

2.4.2. Activity Sequencing

Activity sequencing involves identifying and documenting interactivity logical relationship. Activities must be sequenced accurately to support later

[19] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 67.

development of a realistic and achieveable schedule. The parts are:[20]

a. Input:
   - Activity list
   - Product description
   - Mandatory dependencies
   - Dicretionary dependencies
   - External dependencies
   - Milestones

b. Tools and techniques:
   - Precedence diagramming method (PDM)
   - Arrow diagramming method (ADM)
   - Conditional diagramming method
   - Network templates

c. Output:
   - Project network diagram
   - Activity list update

2.4.3. Activity Resource Estimating

Estimating schedule activity resource involves determining what resource (human, equipment, or material) and what quantities of each resources will be used, and when each resources will be available for maintenance project activities. The parts are:[21]

a. Input:
   - Enterprise environmental factors
   - Organizational process assets
   - Activity list
   - Activity attributes
   - Resource availability

[20] Ibid. Page 68.
[21] Ibid. Page 135.

- Maintenance management plan

b. Tools and techniques:
   - Expert judgement
   - Alternatives analysis
   - Published estimating data
   - Project management software
   - Bottom-up estimating

c. Output:
   - Activity resource requirements
   - Activity attributes update
   - Resource breakdown structure
   - Resource calendar
   - Requested changes

2.4.4. Activity Duration Estimating

Activity duration estimating is the process of taking information on project scope and resources, and then developing duration for input to schedule. The estimate is often progressively elaborated, and the process consider the quality and avalibility of the input data. The prats are:[22]

a. Input:
   - Activity list
   - Constraints
   - Assumption
   - Resource requirement
   - Resource capability
   - Historical information
   - Identified risks

b. Tools and techniques:
   - Expert judgement

[22] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 71.

- Analgous estimating
- Quantitively based durations
- Reserve time

c. Output:
- Activity duration estimates
- Basis of estimates
- Activity list updates

2.4.5. Schedule Development

Schedule development means determining start and finish dates for maintenance project activities. If the start and finish dates are not realistic, then the maintenance project is unlikely to finish as schedule. The parts are:[23]

a. Input:
- Project network diagram
- Activity duration estimate
- Resource requirement
- Resource pool description
- Calendars
- Constraints
- Assumption
- Leads and lags
- Risk management plan
- Activity attributes

b. Tools and techniques:
- Mathematical analysis
- Duration compression
- Simulation
- Resource leveling heuristic
- Project management software

[23] PMBOK Guide, 2000, PMBOK, Project Management Institute, Inc., USA, page 73

- Coding structure

c. Output:
   - Project schedule
   - Supporting detail
   - Schedule management plan
   - Resource requirement updates

2.4.6. Schedule Control

Schedule control is concerned with influencing the factors that create schedule changes to ensure that changes agreed upon, determining that the schedule has changed, and managing the actual changes when and as they occur. The parts are:[24]

a. Input:
   - Project schedule
   - Performance report
   - Changes requests
   - Schedule management plan

b. Tools and techniques:
   - Schedule change control system
   - Performance measurement
   - Additional planning
   - Project management software
   - Variance analysis

c. Output:
   - Schedule updates
   - Corrective actions
   - Lessons learned

[24] Ibid. Page 79.

2.5. Primavera

Primavera is a software that used to solve management activity problem. Primavera was made by Primavera Inc. System. The data entry could be input in table or PERT diagram form.[25]

Primavera is a good program that used in construction project. This program will make easier to do the project, designing project, bulid network, and processisng data more efficient. Primavera has a few advantages, such as could store the project information (resource and cost) in a single data base, and separating data in different form, with complete information and showed in a single diagram.[26]

By those superiority, the project management using Primavera could help the project managers when arranging WBS (Work Breakdown Structure), project data collecting for the resource input data (labour, material, equipment, subcont, volume, and each price), monitoring work activity, show actual information about project activity through S-curve diagram, controlling working result as an agreed decision, and also create report about the controlling result.[27]

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[25]DEVELOP, 2016, *Project Management Training With Primavera 6*, DEVELOP, Indonesia, page 2

[26] Ibid. Page 1

[27] Ibid.

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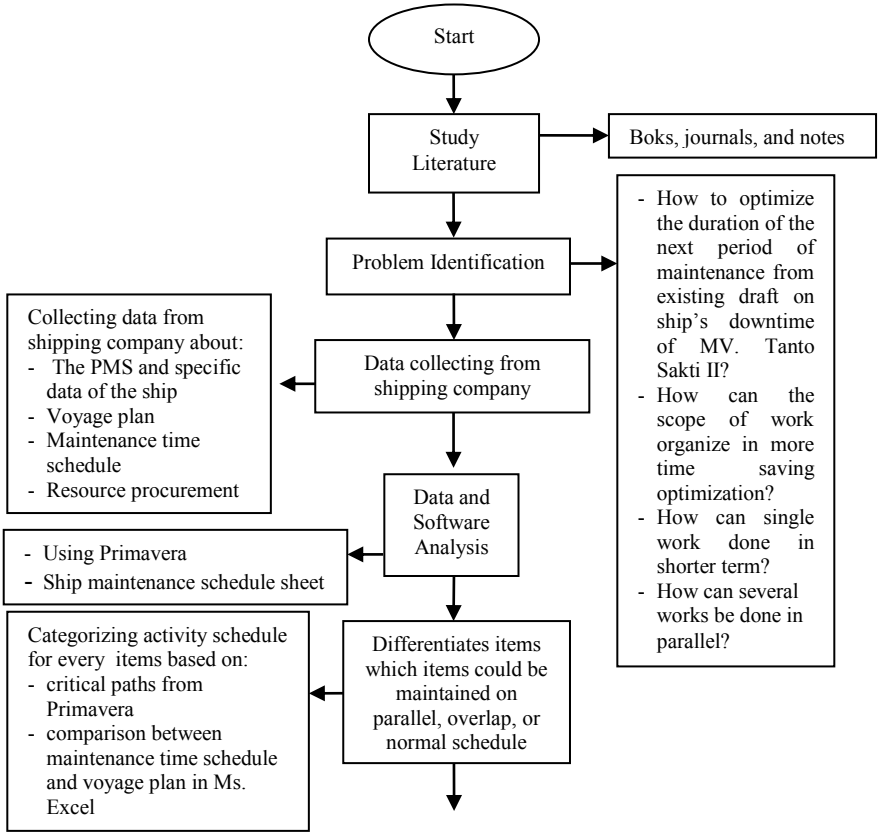
CHAPTER 3
METHODOLOGY

3.1. Methodology flow chart

Here is the methodology flow chart of this thesis as the steps to solve the problem that mentioned above in chapter 1.



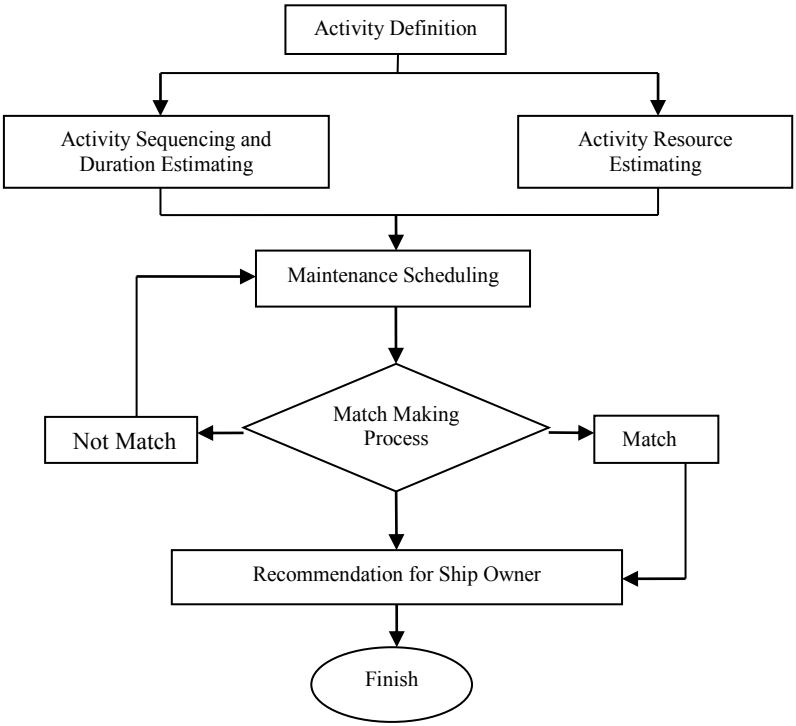


Figure 3. 1 Methodology Chart

3.2. Definition

In order to solve the problem above, this thesis will use data analysis from some literatures.

1. Literature study

Study literature is the first step to learn about basic theories that will be used to write the thesis. Basic theory about ship maintenance. In this bachelor thesis mostly adapts project management theory into ship maintenance management. References for this step is from books, notes, and journals from PT. Tanto Intim Line. Also takes regulation from Main Engine Maintenance Manual. To collect these literature studies, also needed to go to one specific ship. In this case the ship is MV. Tanto Tenang at Tanjung Perak Port. The reason of MV. Tanto Tenang being selected is that ship is the nearest ship from campus. So if some additional data are needed, the data could be could be optained easier.

Also needed to get some books about maintenance process and project management guide. As long as being expected the books are NORSOK Sandard Z-008 as the basic that show the maintenance process is a circular process and PMBOK Guide as the basic of project management. And then corellates them as the basic theory of this thesis.

2. Problem identification

Problem identification is a step where the problems in the maintenance process is defined. In this case, the problem is too much time for a docking ship maintenance. This problem comes directly from a ship yard in Jakarta (PT. DKB) when a ship owner

ask the maintenance worker about "is the maintenance process can de done faster or not?". From this question can defined the ship owner wants the maintenance process being done in a shorter time for his reason.

Of courese not every shipping company or ship owner has a same problem. But, in this thesis the shipping company is PT. Tanto Intim Line, MV. Tanto Tenang as the research subject. Then the problem that can be concluded are:

a) How to optimize the duration of the next period of maintenance from existing draft on ship's downtime of MV. Tanto Tenang?
b) How can the scope of work organize in more time saving optimization?
c) How can several works be done in parallel or overlap?

3. Data collection

This step is to get information about data from shipping company about the PMS and specific data of the ship (general data, documentation, and another data which match with this thesis needs). Match making the ship's items and the regulation from Main Engine Maintenance Manual Book. The data that needed are:

a. PMS data (time table of maintenance plan, maintenance duration)
b. Dock list of Main Engine maintenance
c. Work hours of the components
d. Voyage plan
e. Maintenance time schedule
f. Spare parts and man power procurement

In purpose to collect those data, I need to directly go to MV. Tanto Tenang at Tanjung Perak Port and ask the Engine Room Chief. Also needed to make a disscussion with him if there are some data that can't be understood how to get them.

4. Data analysis

Data and software analysis is a step where the scientific analysis from maintenance data sheet is done. The reason is to know about what items those are possible maintained on board and those are have to be on dock. The data that will being analized are voyage plan, items those need to be maintained, regulation of Main Engine standard condition from Main Engine Maintenance Manual Book, work hour of the components, and PMS of the specific ship. Software that will be used is Primavera.

The analytical process is done by this Primavera and manually by comparing the maintenance time schedule and voyage plan in Ms. Excel. There are some ways to get this software. Buy it or find another way. In this case also needed take a course for management project by using Primavera. And then get this software from the course. Then using the knowledge about project management to solve the problem in this thesis. Also from this software could be accomplished a direct report about the ship maintenance project from the data that included to it.

5. Differentiating items

This step is about making decision which item can be maintained in parallel or overlap with the others, or need to be keep on normal schedule. The differentiating activities could be based on spare

parts procurement and man power. There will be some connections between some activities to another.

This differentiation will comes automatically from comparison of maintenance time schedule and voyage plan in Ms. Excel. By analyzing the voyage plan, could be planned what maintenances are able to be done on port when loading and unloading. And the unable on port when loading and unloading, will be done on dock when downtime periode. But of course this differentiating activity is based on Main Engine Maintenance Manual Book.

The differentiation result which are can't be maintained on port, will be included to Primavera to be planned on docking maintenance. From this Primavera, will be shown the critical paths which are the most important activites of docking maintenance process. So to decide the differentiation also needed to comparing th result of maintenance time schedule and voyage plan comparison and critical path from Primavera.

6. Activity definition

Defines what activties need to be done for each items. These activities are based on PMS from Main Engine Maintenance Manual Book and maintenance time schedule that already exist. Mostly the activities are about checking, dissambling, and assembling some parts of the main engine. Activity definition will show the critical path of Main Engine maintenance process.

But also needed to define more detail about every activity for each part of Main Engine based on Main Engine Maintenance Manual Book. These activities have to make sense activities. So also

needed to think about spare parts procurement, number of main power, and remaining time (for loading unloading time at port and downtime docking period). Some activities will make connection to each other. So the longest activites time will make critical paths (will be show in Primavera). These critical paths are the mos important activities of maintenance process.

7. Activity sequencing and duration estimating

By sequencing activities that already defined in activity definition by Primavera, we could see which are the critical paths of the maintenance project. This means, the activities on critical path that don't have a float to be late for being done. Then, if the critical path that already sequenced is known, then could estimte the time duration of the docking maintenance project.

The process is making activities list. From the result of Primavera's critical paths and comparison between maintenance time schedule and voyage plan in Ms. Excel, could be made the activities list for mainenance on port when loading unloading and activities on downtime docking period.

That list will gives time estimation about how long the maintenance when downtime docking period will be finished. But of course this time duration will be depends on spare parts procurement and man power.

8. Activity resource estimating

It is an activity that estimates about resource such as spare parts procurement and man power. The information about spare parts procurement that being

needed are about is the ship already has the spare part or the crew or company need to order it first. If the procurement of the ordering spare part need a long time, then the maintenance project will takes more time to be done. Also with the man power. If the number of man power is not enough, then it will expand the maintenance time.

This data will come from the shipping company PT. Tanto Intim Line. If the company already has stock resource for spare parts then this data will be only as additional information. But, if PT. Tanto Intim Line has to order some spare parts from vendor, it will be a consideration in the time duration estimating process.

9. Maintenance Schedulling

This step is an important step. This step will give the ship owner a recommendation how to arranging a good schedule for ship maintenance. The most optimum time. Which items can be maintained on port when loading unloadingprocess, which items need to be maintained on dock when downtime docking period, and which item can be maintained on the next maintenance schedule. By arranging those schedule correctly, PT. Tanto Intim Line will not pay too much for the downtime docking time.

Also by considering the research result from Primavera, could be given a better maintenance schedule to PT. Tanto Intim Line, especially for MV. Tanto Tenang. Because as being explained before, Primavera could give the critical paths of the whole maintenance process. which are the most important activities in maintenance process that if these activities on critical paths don’t being done right on time, the ship will not be able to sail.

10. Match making process

The match making process is a process where the schedule that already made will be correlated with Main Engine Maintenance Manual Book. If schedule is match with the manual book, then the schedule could be executed.

This process considering about each parts working hours of the Main Engine. Because of every parts has different present working hour and maximum working hour, so the maintenance activity will not exactly same with the maintenance manual book. If a part has reach its maximumworking hour, that spare part need to be replace or repair. But, there are some spare parts which haven't reach their maximum working hour but already broken. These spare parts also need repair or being replaced. But, the basic regulation is the Main Engine Maintenance Manual Book.

If the schedule doesn't match with the regulation, in this case is the Main Engine Maintenance Manual Book, then need to reschedule. The schedule can be match if the working hour of the parts that in the schedule for maintenance activity are approaching or same with the standard in maintenance manual book.

11. Recommendation for ship owner

This step is about giving recommendation for the ship owner (PT. Tanto Intim Line). Advice the ship owner and differentiates about maintaining items on port when loading unloading, on downtime docking maintenance period, and items that still possible to be maintained on the next maintenance schedule. The result must be a shorter maintenance

time when the ship is up on dock. This result comes from some steps that mentioned above. If the the ship owner approve the recommendation, then the ship maintenance can be executed. But, during the maintenance process using this recommendation, there always need a monitoring or controlling activity. This recommendation only the planning activity. So if during the maintenance process soe troubles happen, they need to replanning the schedule.

Also need to be remebered, this recommendation is only for one specific ship (MV. Tanto Tenang). So if the shipping company (PT. Tanto Intim Line) wants make another with MV. Tanto Tenang schedule for dofferent ship, the shipping company need to do the same way.

CHAPTER 4

ANALYSIS AND DISCUSSION OF CASE STUDY

4.1. General

This chapter describes a case study that was based on a real ship of PT. Tanto Intim Line. The ship name is MV. Tanto Tenang. The maintenance objectives and importance of maintenance to the MV. Tanto Tenang is also being discussed. The key of maintenance performance indicators are identified and explored. The factors that affect the maintenance planning are considered. The study data are based on real data of the ship from working hour of each month, PMS data, Main Engine Maintenance Manual, and interview with crew of the engine room.

4.2. PT. Tanto Intim Line

PT. Tanto Intim Line is a shipping company that has already operating for 40 years. This company has served various industries in the cargo solutions. The head office of this company is located in Surabaya. PT. Tanto Intim Line's staff are experienced worker. They able to do some different jobs in their work field. For example, a crew of engine room could do every job the engine room (except chief engine room's job), not only a job for a single component in the engine room.

This company serves a local cargoes shipping. Every shipping voyages are only in Indonesia. The assets of PT. Tanto Intim Line are 40 container vessels, more than 41.000 container units in 3 types of container, container yards in Jakarta and Surabaya, also container handlers. From those assets, could be defined that PT. Tanto Intim Line is a huge shipping company in Indonesia.

This company has a history as a shipping company. The timeline history of PT. Tanto Intim Line is as follow.

- 1971
  Established in the early 1971 by Mr Herman Hartanto, set the early roots as a conventional dry bulk shipping line.
- 1974
  Tanto Sakti, at a 734 dwt, was the company's first owned vessel to transport general cargo from Surabaya to Ambon.
- 1976
  The line subsequently expanded through the purchase of second-hand cargo vessels. By 1976, Tanto operated services to most East Indonesia.
- 1980
  The expansion continued through the 1980s and outgrew the home office and move to current, Jln Perak Barat 43, office with just 8 employees.
- 1992
  Just as the concept of containerization was making its own entrance, Tanto introduced its first container liner operation. Tanto Multi made its first voyage with a full capacity of 125 TEUs from Surabaya to Bitung on June 18th, 1992.
- 1993
  Plan for expansion on land was also foreseen. Tanto Depo 1, sitting on a 1.2 hectare land started operation 1st February 1993, has a capacity of about 800 TEUs.
- 1999
  A variety of new routes were added in the late 1990s to continue its rise as a mojor player in shipping. Our Jakarta office was opened in June 1999.

- 2002
  Tanto adopted the International Safety Management (ISM Code) in 2002 and incorporated it into the core values. The first, Gorontalo, agent was also appointed on 9th September 2002.
- 2008
  Tanto introduced a new Surabaya-Luwuk service.
- 2010
  Implemented Indonesia's first via SMS Release Order (RO) and Online Container Information System.
- Today
  Tanto serves 18 ports within the islands of Indonesia, employing a total of approximately 3,500 people. The company remains independent and wholly owned by its founder, Mr Herman Hartanto.

4.3. MV. Tanto Tenang

MV. Tanto Tenang is the object study in this thesis. This ship serves shipping route from Jakarta, to Surabaya, to Bitung (North Sulawesi), and then back to Jakarta. This trip takes 25 days until the ship back to Jakarta. MV. Tanto Tenang has its very own spesification. The spesification of this ship is:

IMO	:	9192040
Flag	:	Indonesia [ID]
AIS Type	:	Cargo
Gross Tonnage	:	9030
Deadweight	:	11400 t
LoA x B	:	136.5m × 22.5m
Year Built	:	1999
Status	:	Active

This ship was bought from China on 2013 (near the end of the year). Before joined with PT. Tanto Intim Line the ship name was MV. Vega Topas. In average, ships of PT. Tanto Intim Line go for docking maintenance every 3 years. This ship has never been docking for maintenance in Indonesia because its operation hasn't reach 3 years yet.

Today this ship has 21 men as total of the crew. Which are 9 men for engine room (include 1 chief engine room) and 12 men on deck. The men in engine work in shift in every 4 hours. In that every 4 hours the person who in charge has to write the condition of every system in engine room (for example, pressure, temperature, oil level, etc). These are not only the main engine but also fuel oil, pumps, boiler, turbocharger, auxiliary engine, etc. The daily reports of the shifts are written in the engine room daily log book. Also from this daily log book, could be seen the working hours of each component.

4.4. Data Collecting and Interview

4.4.1. Working Hour

Working hour is the total working time of each component in a month. This data is written in the daily log book. Each component could have diffferent working hour. The reason is could be so many. For example piston ring cylinder no. 1 has 1200 working hours. But, piston ring cylinder no. 2 has 400 working hours. There are could be some reasons for this differences. One of them is piston ring cylinder no. 1 was replaced las month because it was broken. But the piston ring cylinder no. 2 still fine. So cylinder no. 1 has a new piston ring which is with zero working hour.

MV. Tanto Tenang has its own working hour for each component of its main engine. The working hours are shown in Figure 4.1 and Figure 4.2.

No.	Component M/E	Working Hour of Each Component on 2015											
		January	February	March	April	May	June	July	August	September	October	November	December
A	1500 Hours												
1	Fuel injector no. 1	1589.21	1908.59	402.38	762.28	1131.2	1448.49	o	x	x	o	x	x
2	Fuel injector no. 2	757.17	319.58	722.16	1082	225.48	543.18	x	x	o	x	x	o
3	Fuel injector no. 3	757.17	721.5	1122.28	0	368.55	685.04	x	x	o	x	x	o
4	Fuel injector no. 4	1000.42	1320.2	1722.58	270.34	639.29	956.58	x	x	o	x	x	o
5	Fuel injector no. 5	1589.21	1908.59	154.25	514.15	882.1	1219.39	x	o	x	x	o	x
B	3500 Hours												
1	Exhasut valve no. 1	1715.56	2035.34	2438.12	762.28	1131.2	1448.49	x	x	x	o	x	x
2	Exhasut valve no. 2	1715.56	2035.34	2438.12	149.59	518.14	835.43	x	x	x	x	x	o
3	Exhasut valve no. 3	1715.56	2035.34	2438.12	2789.02	3166.6	3484.14	x	x	x	x	x	x
4	Exhasut valve no. 4	1715.56	2035.34	2438.12	270.34	639.29	956.58	x	x	x	x	x	x
5	Exhasut valve no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
6	Lubricating Oil Sump Tank	1151.3	1471.08	1873.46	2236.36	2599.3	2916.49	x	o	x	x	x	x
C	6000 Hours												
1	Piston no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
2	Piston no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
3	Piston no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
4	Piston no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
5	Piston no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
6	Ring piston cylinder no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
7	Ring piston cylinder no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	30.13	x	x	x	x	x	x
8	Ring piston cylinder no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
9	Ring piston cylinder no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
10	Ring piston cylinder no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
D	8000 Hours												
1	Cylinder liner no.1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
2	Cylinder liner no.2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
3	Cylinder liner no.3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
4	Cylinder liner no.4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
5	Cylinder liner no.5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
E	8000 Hours												
1	Main Bearing no.6	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
2	Upper and lower conrod bearing no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
3	Upper and lower conrod bearing no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
4	Upper and lower conrod bearing no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
5	Upper and lower conrod bearing no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
6	Upper and lower conrod bearing no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
7	Starting air valve no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
8	Starting air valve no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
9	Starting air valve no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
10	Starting air valve no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
11	Starting air valve no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
12	Safety valve of cylinder head no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
13	Safety valve of cylinder head no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
14	Safety valve of cylinder head no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
15	Safety valve of cylinder head no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
16	Safety valve of cylinder head no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
17	Fuel injection pump no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
18	Fuel injection pump no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
19	Fuel injection pump no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
20	Fuel injection pump no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
21	Fuel injection pump no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
F	12000 Hours												
1	Turbocharger	997.52	1317.3	1720.08	2079.58	2448.1	2764.19	x	x	x	x	x	x
G	60 Months (approximate 30000 Hours)												
1	Woodward governor	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x

Figure 4. 1 Working Plan in 2015

No.	Component M/E	Working Hour of Each Component on 2016 (Prediction based on monthly working hours on 2015 and without any accident)											
		January	February	March	April	May	June	July	August	September	October	November	December
A	1500 Hours												
1	Fuel injector no. 1	o	x	x	o	x	x	o	x	x	x	o	x
2	Fuel injector no. 2	x	x	o	x	x	o	x	x	o	x	x	o
3	Fuel injector no. 3	x	x	o	x	x	o	x	x	o	x	x	o
4	Fuel injector no. 4	x	x	o	x	x	o	x	x	o	x	x	o
5	Fuel injector no. 5	x	o	x	x	o	x	x	o	x	x	o	x
B	3500 Hours												
1	Exhasut valve no. 1	x	x	x	x	x	o	x	x	x	x	x	x
2	Exhasut valve no. 2	x	x	x	x	x	x	x	o	x	x	x	x
3	Exhasut valve no. 3	x	x	x	x	x	o	x	x	x	x	x	x
4	Exhasut valve no. 4	x	x	o	x	x	x	x	x	x	x	x	x
5	Exhasut valve no. 5	x	x	x	x	x	o	x	x	x	x	x	x
6	Lubricating Oil Sump Tank	x	x	x	x	o	x	x	x	x	x	x	x
C	6000 Hours												
1	Piston no. 1	x	x	x	x	x	x	x	x	x	x	x	o
2	Piston no. 2	x	x	x	x	x	x	x	x	x	x	x	o
3	Piston no. 3	x	x	x	x	x	x	x	x	x	x	x	o
4	Piston no. 4	x	x	x	x	x	x	x	x	x	x	x	o
5	Piston no. 5	x	x	x	x	x	x	x	x	x	x	x	o
6	Ring piston cylinder no. 1	x	x	x	x	x	x	x	x	x	x	x	o
7	Ring piston cylinder no. 2	x	x	x	x	x	o	x	x	x	x	x	x
8	Ring piston cylinder no. 3	x	x	x	x	x	x	x	x	x	x	x	o
9	Ring piston cylinder no. 4	x	x	x	x	x	x	x	x	x	x	x	o
10	Ring piston cylinder no. 5	x	x	x	x	x	x	x	x	x	x	x	o
D	8000 Hours												
1	Cylinder liner no.1	x	x	x	x	x	x	x	o	x	x	x	x
2	Cylinder liner no.2	x	x	x	x	x	x	x	o	x	x	x	x
3	Cylinder liner no.3	x	x	x	x	x	x	x	o	x	x	x	x
4	Cylinder liner no.4	x	x	x	x	x	x	x	o	x	x	x	x
5	Cylinder liner no.5	x	x	x	x	x	x	x	o	x	x	x	x
E	8000 Hours												
1	Main Bearing	x	x	x	x	x	x	x	o	x	x	x	x
2	Upper and lower conrod bearing no. 1	x	x	x	x	x	x	x	o	x	x	x	x
3	Upper and lower conrod bearing no. 2	x	x	x	x	x	x	x	o	x	x	x	x
4	Upper and lower conrod bearing no. 3	x	x	x	x	x	x	x	o	x	x	x	x
5	Upper and lower conrod bearing no. 4	x	x	x	x	x	x	x	o	x	x	x	x
6	Upper and lower conrod bearing no. 5	x	x	x	x	x	x	x	o	x	x	x	x
7	Starting air valve no. 1	x	x	x	x	x	x	x	o	x	x	x	x
8	Starting air valve no. 2	x	x	x	x	x	x	x	o	x	x	x	x
9	Starting air valve no. 3	x	x	x	x	x	x	x	o	x	x	x	x
10	Starting air valve no. 4	x	x	x	x	x	x	x	o	x	x	x	x
11	Starting air valve no. 5	x	x	x	x	x	x	x	o	x	x	x	x
12	Safety valve of cylinder head no. 1	x	x	x	x	x	x	x	o	x	x	x	x
13	Safety valve of cylinder head no. 2	x	x	x	x	x	x	x	o	x	x	x	x
14	Safety valve of cylinder head no. 3	x	x	x	x	x	x	x	o	x	x	x	x
15	Safety valve of cylinder head no. 4	x	x	x	x	x	x	x	o	x	x	x	x
16	Safety valve of cylinder head no. 5	x	x	x	x	x	x	x	o	x	x	x	x
17	Fuel injection pump no. 1	x	x	x	x	x	x	x	o	x	x	x	x
18	Fuel injection pump no. 2	x	x	x	x	x	x	x	o	x	x	x	x
19	Fuel injection pump no. 3	x	x	x	x	x	x	x	o	x	x	x	x
20	Fuel injection pump no. 4	x	x	x	x	x	x	x	o	x	x	x	x
21	Fuel injection pump no. 5	x	x	x	x	x	x	x	o	x	x	x	x
F	12000 Hours												
1	Turbocharger	x	x	x	x	x	x	x	x	x	x	x	x
G	60 Months (approximate 30000 Hours)												
1	Woodward governor	x	x	x	x	x	x	x	x	x	x	x	x

*o = maintenance; x = not maintenance yet

Figure 4. 2 Working Plan in 2016

The data above are combined with prediction which is there are no accidents and working hour estimation of all components are about 300 until 400 hours a month. The estimation comes from working time average from month to month started from Januari 2015 until June 2015. For a component with different working hours of its kind, that means that component had a trouble in the middle of operation. So it was need an overhaul earlier than the others. That makes the working hour of that component back to zero.

The estimation of working hours also can be estimated from MV. TantoTenang's trip in month which is takes 24 until 25 days until the ship back to Jakarta. The calculations are:

1 day = 24 hours
Trip Jakarta to Surabaya = 1 day
Trip Surabaya to Bitung = 5 days
Trip Bitung to Jakarta = 7 days
Total trip in hour (ship on the sea) =
(1 x 24) + (5 x 24) + (7 x 24) = 312 hours
*this calculation is only for one trip in a month

The calculation above isn't added yet with unpredictable situations such as waiting time for berthing or another situations. So without taking any risks, the estimation for components working hours are taken close to 400 hours or at 400 hours. This is the safest estimation.

4.4.2. PMS (Planned Maintenance System)

PMS (Planned Maintenance Sytem) is a schedule of maintenance activity. The maintenance activities list of each component are clearly explained in PMS. Also completed with maximum working hour of the components, running hour of the components, date of

work for maintenance, and who will do the maintenance. PMS is setted for a month. But, in this shipping company (PT. Tanto Intim Line) the PMS for every month are the same for every ship. This comes from comparison from PMS of MV. Tanto Tenang with PMS of MV. Tanto Sakti II. The PMS of both ships are exactly same even for different month and different year. Not only for main engine, but there are also another PMS for electrical system, pumps, auxiliary engine, etc. But, in this thesis the PMS that needed is only PMS for main engine.

As explanation above, the working hour and maximum working hour of every component also could be seen here. That working hour will define the treatment for the component. When the component already reach the maximum working hour (or over than that), that component will need an overhaul. In this overhaul could be seen the condition of the component (by measurement, some tests, or etc). If that compenent still in good condition, then the treatment will only check, cleaning, or another light activities. But, if the condition is not good enough anymore (for xample could be the poor resistance and performance, has some cracks, or etc) then that component need to be replaced. So, the activity such as fixing, replacing, cleaning, and another else will be depends on overhaul result. Except, if there is an accident and the damage directly hits the component of main engine, then absolutely the components that being direct hitted need to be fixed (not cleaning, check, or test anymore) liked by emergency fixing or replacement with new components if the crew have spare parts stock.

The PMS was made based on Main Engine Maintenance Manual Book. This manual book explains every single step of every maintenance activity, maximum working hour, and the category of the maintenance (overhaul, check, or adjustment). The

provision activities for maintenance in Main Engine Maintenance Manual Book comes from the main engine industry (in this thesis the industry that made the main engine for MV. Tanto Tenang is MAN B&W with engine type S50MC-C). So, will be very possible if every single industry has different provision activities for the main engine products. PMS is combination of actual working hours of each month with the manual book of main engine. Thus, after combining information of working hour with standard or maintenance from manual book, PMS is done being made. The main engine's PMS of MV. Tanto Tenang is as follow.

PT. TANTO INTIM LINE			PLAN MAINTENANCE SYSTEM	Vessel	KM. Tanto Tenang		
Group : 1-Main Engine				Month			
		Components	Working List	FREQ UNIT [HOUR]	RUNNING HOUR	Working Date	Exectioner
1.1.1	CYLINDER NO. 1	Injector	Take out, check, fitting	1500			
1.1.2		Cylinder Head	Check and fitting Valve Head Clearance	1500			
			Check Valve Spring	5000			
			Open and check Valve Rotator	5000			
			Open Cylinder Head and clean up	10000			
			Grinding Suction and Exhaust Valve Seat	10000			
			Clean up Water Chamber from crust and Hydraulic Test	10000			
			Replace Stem Seal Suction and Exhaust Valve	10000			
			Check the tightness value of Cylinder Head Bolt	10000			
1.1.3		Piston	Take out, clean up, check and measure piston	10000			
			Check and measure Piston Rings	10000			
			Check and measure Piston Pin	10000			
1.1.4		Connecting Rod	Check and measure Piston Pin Metal	10000			
			Check and measure Crank Pin Metal	10000			
			Check the tightness value of Connecting Rod Bolt	10000			
			Replace the Connecting Rod Bolt	10000			
1.1.5		Cylinder Liner	Clean up, check and measure inner diameter	10000			
			Take out, clean up and check water jacket section	20000			
1.1.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000			
			Measure Web Deflection	2500			
1.1.7		Main Bearing	Open, check and measure Metal	10000			
			Check the tightness value of clamp Bolt	10000			
			Check the tightness value of Side Bolt	10000			
1.2.1	CYLINDER NO. 2	Injector	Take out, check, fitting	1500			
1.2.2		Cylinder Head	Check and fitting Valve Head Clearance	1500			
			Check Valve Spring	5000			
			Open and check Valve Rotator	5000			
			Open Cylinder Head and clean up	10000			
			Grinding Suction and Exhaust Valve Seat	10000			
			Clean up Water Chamber from crust and Hydraulic Test	10000			
			Replace Stem Seal Suction and Exhaust Valve	10000			
			Check the tightness value of Cylinder Head Bolt	10000			
1.2.3		Piston	Take out, clean up, check and measure piston	10000			
			Check and measure Piston Rings	10000			
			Check and measure Piston Pin	10000			
1.2.4		Connecting Rod	Check and measure Piston Pin Metal	10000			
			Check and measure Crank Pin Metal	10000			
			Check the tightness value of Connecting Rod Bolt	10000			
			Replace the Connecting Rod Bolt	10000			
1.2.5		Cylinder Liner	Clean up, check and measure inner diameter	10000			
			Take out, clean up and check water jacket section	20000			
1.2.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000			
			Measure Web Deflection	2500			
1.2.7		Main Bearing	Open, check and measure Metal	10000			
			Check the tightness value of clamp Bolt	10000			
			Check the tightness value of Side Bolt	10000			
1.3.1	CYLINDER NO. 3	Injector	Take out, check, fitting	1500			
1.3.2		Cylinder Head	Check and fitting Valve Head Clearance	1500			
			Check Valve Spring	5000			
			Open and check Valve Rotator	5000			
			Open Cylinder Head and clean up	10000			
			Grinding Suction and Exhaust Valve Seat	10000			
			Clean up Water Chamber from crust and Hydraulic Test	10000			
			Replace Stem Seal Suction and Exhaust Valve	10000			
			Check the tightness value of Cylinder Head Bolt	10000			
1.3.3		Piston	Take out, clean up, check and measure piston	10000			
			Check and measure Piston Rings	10000			
			Check and measure Piston Pin	10000			
1.3.4		Connecting Rod	Check and measure Piston Pin Metal	10000			
			Check and measure Crank Pin Metal	10000			
			Check the tightness value of Connecting Rod Bolt	10000			
			Replace the Connecting Rod Bolt	10000			
1.3.5		Cylinder Liner	Clean up, check and measure inner diameter	10000			
			Take out, clean up and check water jacket section	20000			
1.3.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000			
			Measure Web Deflection	2500			
1.3.7		Main Bearing	Open, check and measure Metal	10000			
			Check the tightness value of clamp Bolt	10000			
			Check the tightness value of Side Bolt	10000			
1.4.1	CYLINDER NO. 4	Injector	Take out, check, fitting	1500			
1.4.2		Cylinder Head	Check and fitting Valve Head Clearance	1500			
			Check Valve Spring	5000			
			Open and check Valve Rotator	5000			
			Open Cylinder Head and clean up	10000			
			Grinding Suction and Exhaust Valve Seat	10000			
			Clean up Water Chamber from crust and Hydraulic Test	10000			
			Replace Stem Seal Suction and Exhaust Valve	10000			
			Check the tightness value of Cylinder Head Bolt	10000			
1.4.3		Piston	Take out, clean up, check and measure piston	10000			
			Check and measure Piston Rings	10000			
			Check and measure Piston Pin	10000			
1.4.4		Connecting Rod	Check and measure Piston Pin Metal	10000			
			Check and measure Crank Pin Metal	10000			
			Check the tightness value of Connecting Rod Bolt	10000			
			Replace the Connecting Rod Bolt	10000			
1.4.5		Cylinder Liner	Clean up, check and measure inner diameter	10000			
			Take out, clean up and check water jacket section	20000			
1.4.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000			
			Measure Web Deflection	2500			
1.4.7		Main Bearing	Open, check and measure Metal	10000			
			Check the tightness value of clamp Bolt	10000			
			Check the tightness value of Side Bolt	10000			

Figure 4. 3 PMS of Cylinder 1 Until 4

1.5.1	CYLINDER NO. 5	Injector	Take out, check, fitting	1500			
1.5.2		Cylinder Head	Check and fitting Valve Head Clearance	1500			
			Check Valve Spring	5000			
			Open and check Valve Rotator	5000			
			Open Cylinder Head and clean up	10000			
			Grinding Suction and Exhaust Valve Seat	10000			
			Clean up Water Chamber from crust and Hydraulic Test	10000			
			Replace Stem Seal Suction and Exhaust Valve	10000			
			Check the tightness value of Cylinder Head Bolt	10000			
1.5.3		Piston	Take out, clean up, check and measure piston	10000			
			Check and measure Piston Rings	10000			
			Check and measure Piston Pin	10000			
1.5.4		Connecting Rod	Check and measure Piston Pin Metal	10000			
			Check and measure Crank Pin Metal	10000			
			Check the tightness value of Connecting Rod Bolt	10000			
			Replace the Connecting Rod Bolt	10000			
1.5.5		Cylinder Liner	Clean up, check and measure inner diameter	10000			
			Take out, clean up and check water jacket section	20000			
1.5.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000			
			Measure Web Deflection	2500			
1.5.7		Main Bearing	Open, check and measure Metal	10000			
			Check the tightness value of clamp Bolt	10000			
			Check the tightness value of Side Bolt	10000			
1.6		Camshaft	Check the condition of Cam and Roller Bearing	5000			
			Open and check the Fuel Pump Tappet	10000			
			Open, check and measure Swing Arm	10000			
			Take out the Camshaft, Check the Bearing dan Measure	20000			
1.7		Timing Gear	Check Bearing Gear dan Backlash	10000			
			Open Idle Gear, check and measure Bearing	20000			
			Check the tightness value of Idle Gear Mounted Bolt	20000			
1.8		Governor	Replace Hydraulic Oil	2500			
			Open and check the Governor	10000			
			Open and check the Bearing Gear on Driving Gear	10000			
1.9		Turbo Charger	Open and clean up	5000			
			Check and measure Clearance (axial and radial)	5000			
1.10		Boost Air Cooler	Open, check, clean up and Hydraulic test	5000			
1.11		Starting Air Motor	Open and clean up Muffler Element (wash by neutral detergent)	2500			
			Off from Main Engine, rotate the pinion gear, check is the rotation is light and no unnormal noise	2500			
			Open, check, clean up and replace grease, replace O-ring, replace Bearing and gear on First Reduction Gear	10000			
			Open, check, clean up and replace grease, replace O-ring, replace Bearing and grease on First dan Second Reduction Gear	20000			
1.12		Fuel Oil System					
1.12.1		Fuel Injection Pump	Check Injection timing	2500			
			Check and replace Deflector	2500			
			Open, clean up and check	5000			
1.12.2		Fuel Feed Pump	Open and check	5000			
			Replace seal oil	5000			
1.12.3		FO Control & Stop Air Piston	Replace O-ring	10000			
1.13		Lub Oil System					
1.13.1		Lub Oil	Replace (depends on analysis result)	1500			
1.13.2		Lub Oil Cooler	Open, clean up, check, hydraulic test	10000			
1.13.3		Thermostatic Valve	Open, clean up and check	5000			
1.13.4		Lub Oil Pump	Open, clean up, check and measure	10000			
			Open and check Press Regulating Valve and Safety valve	10000			
1.13.5		Turbo Charger LO Strainer	Replace strainer element	1500			
1.14		Cooling Water System					
1.14.1		Thermostatic Valve	Open, clean up and check	2500			
1.14.2		Cooling Water Pump	Open, clean up and measure	5000			
			Replace Mechanical Seal	5000			
1.14.3		Fresh Water Cooler	Open, clean up, check, and Hydraulic Test	5000			
1.14.4		Cooling Water (Fresh Water)	Replace (depends on analysis result)	5000			
1.14.5		Sea Water Cooling Parts	Check Zinc Anode and replace (on Air Cooler and Lub Oil Cooler)	1500			

Figure 4. 4 PMS of Cylinder 5

4.4.3. Voyage Plan

In this company (PT. Tanto Intim Line) every ship has a different voyage or trip. Some ships only has 1 destination in their trip. But some other ships have 2, 3, even 4 destinations in their trip. These different trips make every ship has different maintenance needs, activities, and treatment. Of course their engine could be different too (except for ships that have sister ships).

In this thesis, MV. Tanto Tenang has a trip starts from Jakarta, and then to Surabaya, and then Bitung, and back to Jakarta. At some ports this ship has different time duration for loading unloading activity. At port of Surabaya the ship takes 3 days, at the port of Bitung the ship takes 4 days, and at the port of Jakarta (back to starting port) the ship takes 4 days. These time durations should be used for maintenance activities. But of course the maintenance activities are not possible of being too much. For example, the crew only possible to maintain one cylinder at every port. Then in a single trip in a month, there are only 3 cylinders could be maintained (by condition there are no accidents). Very possible to maintain one cylinder at every port because MV. Tanto Tenang has 9 persons as the crew of engine room include the chief engine room. The ship's voyage plan is as follow.

VESEL	VOY	JAKARTA					SURABAYA		BITUNG	
		ETA	Closing SURABAYA		Closing		ETD	ETA	ETD	ETA	ETD
			Heavy	Light	Heavy	Light					
TANTO STAR	181	09-03-2016	05-03-2016	09-03-2016			11-03-2016	12-03-2016	14-03-2016	17-03-2016	19-03-2016
TANTO PERMAI	133	15-03-2016	13-03-2016	17-03-2016			18-03-2016	19-03-2016	21-03-2016	25-03-2016	21-03-2016
TANTO SEMANGAT	108	18-03-2016	17-03-2016	21-03-2016			22-03-2016	23-03-2016	25-03-2016	29-03-2016	25-03-2016
TANTO TENANG	074	23-02-2016	21-02-2016	25-03-2016			26-03-2016	27-03-2016	29-03-2016	02-04-2016	02-04-2016

Source: https://www.tantonet.com/our-schedule/#

Figure 4. 5 Voyage Plan of MV. Tanto Tenang

4.4.4. Interview

Engine room crew are the persons that very familiar with the main engine and of course the maintenance of it. One of them said that this ship (MV. Tanto Tenang) was bought from China near the end of 2013 with its name was MV. Vega Topas. It was bulit on 1999. So until now this ship had been operated for 17 years.

MV. Tanto Tenang has 21 persons as total of the whole crew. They are devided into 9 persons for engine room crew and 12 persons for deck crew. During the voyage the engine room crew are work in shift every 4 hours. The man who in charge in his shift should write everything that happens in the daily log book. But, this shift change when the ship is berthing at port. Every person has 24 hours as his working shift. When 1 person is in charge, the other 8 are take a rest. They are all work if only they do some maintenances. When there are no maintenances, they imposing that rules. That rules is not from company, but the engine room crew made it by they own. The reason is to make them could go back home and meet their family.

"*For maintenance activity at a port the crew take maximum 2 days for a cylinder. Those 2 days are pretty enough to complete whole maintenance for on cylinder. Maintenance activities for every component usually take 1 until 2 hours (for port maintenance). This ship has never been go for docking in Indonesia. But, if the docking schedule for ships of PT. Tanto Intim Line are every 3 years, then this ship will go for docking on near the end of 2016 or early 2017*" said the engine room crew.

4.5. Analysis

The analytical process was done by Primavera as project management software, which is in this thesis the project is making the docking maintenance schedule plan for MV. Tanto Tenang. Through this software also could be defined the risk of each components for the whole system. The work breakdown structure also described very clearly.

4.5.1. Work Breakdown Structure (WBS)

Work breakdown structure or WBS is a sequence that defined the list of component that should be done. In this thesis the WBS comes from PMS of MV. Tanto Tenang. But, also being added with documentation, procurement, report, and closure. The reason is to write this maintenance schedule into a complete project.

A complete project was started from initiating. Initiating consists of project preparation. Project preparation is a step where every documents that suport the maintenance are being prepared. These documents have to complete, because if the documents are not complete, there could be some missing data when defining the next steps. But, this preparation activities are

not done when the ship is already on dock. It should be done before the ship is on dock. This is a part of the maintenance project plan of MV. Tanto Tenang. So it should be planned in a long time before docking. But, for some data (such as last voyage log) could only be added a few days or week before docking.

In this thesis the base line of time is planned on September 29th, 2016 and the maintenance project is planned to start on October 3rd, 2016. The reason why the date is planned like that because the crew (especially chief engine room) have to prepare and making list about components that need to be maintained when the ship is already on dock. For collecting information from daily log book is not a hard part. But, making plan about what are the components that need to be maintained on dock it will takes time. So in this thesis it is being assumed about 2 days for preparation activities.

After the initiating step, the next activities in WBS is procurement. Every project always need procurement. Procurement is an ordering activity for the spare parts, waiting time until the spare parts are coming, and receiving activity. Usually every company (also PT. Tanto Intim Line) already has vendor(s) for procurement. Vendor(s) is the party that already agree with the company to provie the spare parts, materials, or tools that the company need. It is very possible for one project got the procurement from some vendors. Usually the vendor(s) that being chosen to cooperates with the company is the vendor(s) that could provide a good quality (usually equal with the others) of company needs with lower price than the others. The reason is of course for company's advantages. If the company could get the same quality with lower price, then the vendor(s) that gives a higher price will not be chosen for cooperation.

The next step of WBS are cylinders. Every cylinder has its own parts that need to be maintained. This ship (MV. Tanto Tenang) is a ship with main engine that has 5 cylinders. These 5 cylinders have exactly same components. Actually every cylinder has different components to be maintained every month. This could caused by many reason. But usually it is because different date of overhaul or components replacement. Accidentally, major maintenance for each cylinder happens near the end of 2016. This prediction comes from working hour calculation and prediction as explained above. Actually there are more components if refer to PMS. But the engine room crew can't provide that data because the machinist and chief engine room were not at the engine room when collecting data is being done. So the only data that possible to be collected are only data of the cylinders becasue those data has the working hour of the components.

After the whole maintenance activities of each cylinder are done, then the next step of WBS is making final report of the whole maintenance activities result. This final report consist of reports from every cylinder. These cylinder's report will give a conclusion to the chief engine room. Then the chief engine room make the final report. For the closure step of WBS, the chief engine room have to give the final report to PT. Tanto Intim Line as the shipping company of MV. Tanto Tenang. Then the main engine docking maintenance project of MV. Tanto Tenang is done.

4.5.2. Activities

4.5.2.1. Activity Definition

The maintenance activity is scheduled to start on October 3rd, 2016. But, in this sub-chapter will be discussed start from initiating activities on

September 29th, 2016. On September 29th, 2016 the first activity is initiating. Actually this is not included in docking maintenance. But, initiating need to be added to make a complete maintenance project. The initiating activity devided into 4 main activities, those are defining activities, daily log book check, tools procurement, and item listing. These activities are an unity. Defining activities is an activity which the chief engine room and machinists discussing what activities should be done on dock later. But, to defining activities they need to know the main engine condition. The information could be reached from main engine daily log book. From this daily log book they could know the running hours, pressure level, and everything about condition of the main engine. Then these informations could be the basic of which components need to be maintained. Then, after defining the activities the chief engine room and the machinists could make the item list. Item list is a list that consist of components that need to be maintained when the ship is on dock. Also with the activities list of maintenance for every components about fixing, cleaning, checking, and replacing. Then, this item list will tell about the tools that needed for the maintenance activities. For example, to lift a piston the tools that needed is crane. But, before lift the piston the cylinder head have to be opened by some keys. That is what being called tools procurement.

Those 4 activities are connected as explanatioan above. So, if 1 activity is missed then the initiating process will be hampered. This thing will affect the rest of maintenance project activities. For example, if the item listing is not complete, then the component that maybe need to be fixed or

replace become not being fixed or replaced. The crew will think nothing wrong because of this missing activitiy. Then when the ship sails, that component down, and the ship stranded at the sea. Calling people from the land to deliver the spare parts will takes time. As a result is the cargoes delivery will be late. Another example, if the tools procurement is not complete. The crew will have to find the missing tool. Either from the ship yard or where ever. This will hampered the maintenance activity. As a result is the schedule of the finish date will be late. Those examples above are some proves that nothing may be miss since the initiating activity a few days or weeks before docking. Simple mistake could give a big trouble.

Also by Primavera could be estimated from what time until what time every initiating activities shall be done. The persons that responsible for this initiating step is the chief engine room. The chief engine room could give commands to engine room crew about what need to be done, such as collecting information, preparing tools completeness, etc. These initiating activities are activities where the docking maintenance activities are defined.

4.5.2.2. Activity Sequencing and Duration Estimating

The activities sequencing are sequenced by Primavera. But of course the activities are being cohered with the PMS and working hour of components in main engine. Also the activities are based on Main Engine Maintenance Manual Book. Usually, to make the chief engine room and machinist become easier in sequencing activities, the crew has a note that represent the components that devided based on working hour. For example, the

component with maximum working hour 1500 hours are written in one block, 3000 hours in one block, etc.

Regardless of working hour and PMS, the very first activity to maintain every cylinder is dismantling the cylinder head. Cylinder head is a head cover of the cylinder. It connects many pipes such as drain pipe, fuel oil pipe, cooling water pipe, etc. into the the cylinder. Then after the cylinder head is already opened, the maintenance activity for the inner components could be started. Of course the maintenance for each cylinder shall be started from the upper components until the lower component.

MV. Tanto Tenang is a ship with 5 cylinders main engine. Every cylinder has almost exactly same maintenance treatment when the first docking period. This accidentally happen because it comes from the working hour calculation of each component. The first maintenance activity is started with cylinder 1 (could be started from another cylinder). The first component of cylinder no. 1 is fuel injection pump. Fuel injector is located at the upper side of cylinder. The activities for fuel injector are take the injector out, check, and fitting. The checking activity here is an measurement about the fuel injection still able to spray properly, then the condition still good. But if it can'y spray properly, then it is need to be checked what is the problem. Usually there are some dirts that stuck in the spray nozzle. And then the fitting activity is an activity that sets the spray nozzle that already check back to its normal condition if there was a problem during check.

After the cylinder, the next component is the piston. The treatment activities for the piston are take the piston out, check, and measure piston. Taking out

the piston is not an easy work. With its weight, power of men only woll not be enough to take it out. So it will need a crane. Then after the piston is already take out, the crew have to clean up the piston. The cleaning activity means to clean the piston from combustion residual. The purpose is to ease the checking and measuring activity. Things that being done on checking activities are check the piston crown is there any damage that cause by combustion or not (if there is a bad damage, then the piston crown need to be replaced), check the piston rod condition, and the piston pin. For the measuring activity , the crew have to measure the friction damage between piston crown and cylinder liner. If the friction damage give a lot of reduction on the piston crown, then the piston crown need to be replaced too. Not only friction could reduce the piston crown surface but also the combustion temperature during combustion. So friction, temperature, and stress are a combination that could reduce the piston crown surface.

Together with the piston, there also maintenance treatments for the ring piston. The ring piston is a seal that prevent fuel oil leakge after being sprayed from fuel injector into the cylinder liner for combustion. If there is a leakage, then the combustion will not be optimum. This will reduce the power that generated. The maintenance activity for ring psiton is checking. If the ring piston is broken or has a bad damage, then it need to be replaced. Usually the ring piston will broke after 5000 until 6000 working hours. Those are the maximum working hour limit of ring piston. Also if the ring piston already reach this maximum working hour it will be replaced too.

After the piston is take out and already done with its maintenance activities, the next one is cylinder liner. The treatment activities to maintain cylinder liner consist of take out, clean up, check, and measure inner diameter. The first one is take out the cylinder liner. The purpose is to clean up the cylinder liner from residual of combustion just like the piston crown. Both of them got the same combustion residual. So cylinder liner also got the same damage such as surface reduction that caused by friction, temperature, and stress. Also for the maintenance activities the cyliner liner need to be measured to check the clearance with piston crown. If the surface is already too much eroded, it will make too much clearance with piston crown. That means the cylinder liner need tobe replaced. But, if the problem only dirts as combustion residual, it only need to be cleaned up. Also with the water jacket section need to be checked. If the water jacket can't work properly as cooling system for cylinder liner, then there must be a problem. For example, sometimes the trouble may comes from the coolant, or maybe there is somet dirts or another else in the water jacket that could disturb the cooling system process for cylinder liner. The cylinder liner also has maximum working hour. It is 8000 working hours (for MV. Tanto Tenang). Then the cylinder liner needs an overhaul for maintenance when already reach that maximum limit of working hour.

The next components are upper and lower conrod bearing. The treatment activities for these components are check them for clearance and wear measuring, and check the tightness value of connecting rod bolt. The clearance check is meant to measure the reduction surface of the ball bearing and

its holder. The friction because of ratational movement could cause a surface reduction. This reduction will give clearance that will getting bigger during engine operational. If the clearance is already too much, it could cause the ball bearing going slip from the holder. So if the clearance (could be measure during check) is already too big, then it need to be replaced, either the ball bearing or the holder. Also some grease will be added to the bearing to reduce the friction damage for the next operations. For the tightness check of connecting rod bolt is meant to measure is the bolt still able the connecting rod properly or not. If the tightness value is already low, then it need to be tightened again. Impact of untight bolt is fatal. When the bolt is not tight anymore it will getting slack and keep bing slack until being off. This is because the vibration. When the bolt is already off then everything will be ruin.

After the maintenance for conrod bearing is don, then the naxt component is starting air valve. Starting air valve is a valve that flows air for engine's first ignition.This starting valve is fitted in the cylinder head. The maintenance activities for starting air valve are only check and cleap up. Checking activity is meant to know is the valve still work properly or not. Usually if a starting air valve is not good anymore, it will jam when pumps the air (with 30 bar pressure) into the combustion room. The causes could be so many. But usually for an error like this case the cause is the spring is not elastic anymore. Then the spring need to be replaced when maintenance. But, another case could be only dirt that stuck in the valve and only need to be cleaned up because the dirt could decrease the air

pressure that being pumped into combustion chamber.

Fuel injection pump is not a component that include in the cylinder. But, this component absolutely connected with the component in cylinder or cylinder head. The component that directly connected to fuel injection pump is the fuel injector. These component are work unitedly, which means they are can't be separated. There are some treatment activities for fuel injection pump maintenance. The first one is open and clean up the fuel injection pump. The purpose of this activity is clean up the pump from the dirt that contain in the fuel itself. Spare part that need to be cleaned up from fuel injection pump is the fuel filter. If there are too many dirts stuck in the fuel filter, it will disturb the fuel flow. The second one is fuel injection timming check. As explained before that fuel injection pump and fuel injector are united components. So the maintenance treatment almost same. Fuel injection pump also need a checkfor its injection timming. The injection timming is memonet where the fuel injection pump send the fuel to fuel injector and then the fuel injector spray it into combustion chamber. There are two mistakes with the injection timming, those are overdue or too fast. Both of them will cause small combustion in the combustion chamber and wasted fuel. If the injection timming from the fuel injection pump is overdue or too fast, then the combustion will not generate maximum power.

Safety valve of cylinder head is puprosed to lift when over pressure occurs in the combustion chamber, the resultant combustion gas being expelled to a through a flanged pipe to deck. This is a very component. Preventing over pressure in the

combustion chamber will prevent explosion in it. The maintenance activity treatement for safety valve of cylinder head is leakage check. The crew have to make sure is there is no leakage on this valve. If there is a leakage, the combustion gas that will generate power will be lost. The the power that being generated will not be maximum. But, also need to make sure that this valve will automatcally open (not stuck) if there is an over pressure in the combustion chamber.

The last component that need to be maintained in every cylinder is main bearing. Main bearing is a connector between piston connecting rod and crank shaft. Rotational work of crank shaft cause friction on the ball bearing. As time goes by the ball bearing will be eroded even it already has grease. So it need to be checked. There are some maintenance activities treatment for main bearing. The first one is metal condition check. The metal that meant is the ball bearing and the holder. Both of them are the components that receive direct friction from the rotational work of crank shaft and connecting rod. So if the ball bearing and the holder are already too much eroded, they need to be replaced. Check the tightness of clamp bolt and side bolt. These bolt are the fastener of the main bearing. If the are not tight enough, the main bearing position could be slip. The worst consequence if the main bearing slip is it could ruin the main engine.

For cylinder no. 5 there is also exhaust valve that need to be maintained on the maintenance docking period. It is different with exhaust valve from another cylinder because of there was a different replacement time for exhaust valve of cylinder no. 5 during operation since 2013 until

2016. The first maintenance treatment activity for exhaust valve is grinding suction and exhaust valve holder. The puspose of this activity is to clean up the exhaust valve from combustion residual dirt. As its name, this component is meant as a valve that flows the combustion residual gas to the exhaust pipe. So, of course a lot of dirts as combustion residual material will stuck on it. The second activity is replacing stem seal suction and exhaust valve. The purpose is to prevent exhaust gas back leakage. If there is a leakage on the valve and the exhaust gas flows back into combustion chamber, it could disturb the combustion process. so if the stem seal isn't tight anymore, it need to be replaced.

From the activity list above, could be estimated the time duration for the whole maintenance process for main engine during docking period is around 10 days. This estimation also comes from the interview result with the engine room that said "Usually every cylinder needs 1 day until 2 days for complete maintenance like the guide from Main Engine Maintenance Manual Book. Also the capability of every engine room crew (all work as a team) could finish maintenance for one component is around 1 hour until 2 hours." So it is very possible to be estimated if the whole maintenance process could be done in 10 days. Detail of every activity schedule will be explained in Maintenance Scheduling.

4.5.2.3. Activity Resource Estimating

Maintenance resources for MV. Tanto Tenang are spare parts procurement and men power. For men power, there is no problems because MV. Tanto Tenang has 9 persons include 1 chief engine

room and 3 machinists as engine room crew. This number is pretty enough to do all maintenance activity for main engine in 10 days during docking period. In case if 1 person has to absent because of family reason, it is still possible to finish all maintenance activities in 10 days.

For spare part procurement, MV. Tanto Tenang always has ready stock spare parts for critical components such as rings piston, piston crowns, connecting rods, etc. This is meant to prevent the ship stranded in the middleof sea if there are some accidental problems that causes the ship unable to be operated during voyage.

In this thesis analysis, the spare parts that need more attentioon fro procurement are rings piston. The reason is because of rings piston are predicted need to be replaced when docking period. If the procurement for rings piston are already stock, there will not be any problem. But, if the procurement for rings piston are late, there will be some problems. In this part is estimated the rings piston are ready stock for maintenance during docking period. But, also will be explained some samples if the procurement of rings piston are coming late from the vendor. The explanation will be in Case Samples.

4.5.2.4. Maintenance Scheduling

Maintenance scheduling is a part where every maintenance treatment activities are placed in specified time duration (in hour). These estimated time duration are comes from interview result with the crew of engine room about main engine crew capabilities for maintenance activity and combined

with PMS, Main Engine Maintenance Manual Book, and working hour of every components.

As explained before, every maintenance activity takes 1 hour until 2 hours, and in this thesis is assumed that the people working hour are 8 hours a day which is started at 08.00 AM and finish at 17.00 PM. Also for lunch time and pray from 12.00 PM until 13.30 PM. Except for Friday the workers could stop the maintenance activity at 11.30 AM for *'Solat Jumat'* preparation. In a week the workers have 5 day for work (Monday until Friday). So, in this time duration, the whole maintenance activities are setted to be done. For some maintenance activities are given a little bit extra time duration. The purpose is to make spare time for another maintenances that probably late from schedule of being done.

As explained before in Activity Sequencing, the first activity is dismantling the cylinder as the cover of the cylinder. This activity is planned for an hour until it really taken off from the cylinder itself. It is eastimated for an hour because of it's neither easy nor hard to unplug every pipes and cables from the cylinder head. The ship has 9 persons as engine room crew. If dismantling cylinder head done by all 9 persons (in another case maybe 1 person has to absent on that day), an hour is pretty enough time. So, if the maintenance is started at 08.00 AM, that means this is a starting time of dismantling the cylinder head, and it is estimated to finish at 09.00 AM.

The next component is fuel injector. Maintenance treatment activities of fuel injector take around 45 minutes. It is estimated in that time range because of the activities are not hard to do. Also with

the capabilities of the engine room crew make this estimation become very possible to do. So, the maintenance activities for fuel injector is planned to be started at 09.15 AM and finish at 10.00 AM. This estimation maybe will not exact on 45 minutes on practical. But, there is an extra time around 15 minutes since cylinder head dismantling is done. This extra time could be used by the crew to finish fuel injector maintenance right on 10.00 AM.

Maintenance treatment activities for piston is estimated will be done in 2 hours (more or less). The reason is beacuse of taking out piston from the cylinder is neither hard nor easy thing. After the piston is already taken out, then the crew have to clean up the piston and then measure the piston crown surface. Check and measure the piston condition also neither hard nor easy thing. Because if the crew didn't measure it accuratelly there will some troubles. Thing that being measured from piston crown are about is there any damage as impact of combustion that caused by bad fuel quality, how much the surface reduction because of combustion activity, etc. Maintenance activities for piston is estimated to finish at 12.00 PM. After that, the crew could stop the maintenance activities for a break.

The closest component with piston is ring piston. Maintenance activity treatment for ring piston doesn't take a lot of time. Because, based on prediction that using working hour, the maintenance for ring piston is only replace it with the new one. It is estimated only takes 30 minutes if the crew's team work is good enough. This activity is estimated to start right after lunch break at 13.30 PM and finish at 14.00 PM.

After the ring piston, the next component is cylinder liner. Maintenance treatment acitivities for cylinder liner consist of 2 main activities. The first on is take out, clean up, and check water jacket section and the second one is clean up, check, measure inner diameter. These activities is estimated to be done in 1 hour and 15 minutes. The reason is because of cylinder liner has almost same treatment as piston that need to be taken out, and the rest activities are clening and measuring. Taking out cylinder liner is neither har nor easy. But of course it will takes time.

Upper and lower conrod bearing are component that stick with the connecting rod itself. The maintenance activities for these bearing are the last maintenance activities for the first day of one cylinder. The reason is beacuse of the time. It started at 15.00 PM and of course will finish around 16.00 PM or more. So it is not possible to continue the maintenance activities for the next components because of the working hour in a day almost done. This also will give extra time for some activities that being late from schedule to be done.

The next day is started at 08.00 AM again. The component that will be being maintained at this time is starting air valve. Maintenance activities for starting air valve are only cleaning and facing up. These will not take a lot of time. So, it is estimated to be done in one hour. Maybe there will be an extra time from this component maintenance activities. That will give advantage for another components maintenance.

Fuel injection pump is neither hard nor easy to be maintained. It is estimated to be done in 2 hours (mor or less). The reason is because of the

crew have to open it first, and then clean up the inner side, and then check for injection timming. Clean up the fuel injection pump from dirts or another materials that contain in the fuel oil will takes time. For the injection timming check, it has to be make sure that synchronized with fuel injector beacuse of these components are united. Both of them need to be made sure there is no dirt that stuck in them or any trouble happens. If there are any trouble happens, it will disturb the fuel injection process, and it will disturb the combustion. Then the power that being generated will not be maximum.

After the fuel injection pump, the next component is safety valve. Safety valve only has one maintenance activity, that is check the valve still work properly or not. Safety valve is very important because it will open when there is an over pressure in the combustion chamber and blow up to the pipe that connected to the deck. If this valve doesn't open when over pressure happens, it could endangered the combustion chamber and the main engine. Maintenance activity for this component is estimated only in 45 minutes which is started at 10.30 AM and finish at 11.15 AM. It is pretty enough time if considering the number of the crew and the capabality of the crew for maintenance.

Main bearing is the last component that being maintained in one cylinder. It has 3 main maintenance treatment activities, those are open, check, and measure metal, check the tightness value of clamp bolt, and check the tightness value of side bolt. These are very important because of this bearingis a connector between connecting rod and crank shaft. If the metal is already eroded too much, it need to be replaced. Maintenance activities for

main bearing is estimated 1 hour and 45 minutes. It needs a long time because of the position of main bearing is not very easy to be reached. Also there are 3 main maintenance treatment activities. But, maybe there will be some extra time from main beraing maintenance. This also will give advantage for some components maintenance above that maybe being late from schedule to be done. Maintenance for main bearing is planned to be start at 13.30 PM right after lunch break and finish at 15.15 PM.

The last activity for maintenance of one cylinder is making report. This is the chief engine room's job. The chief engine room has to write every detail that already done in one cylinder. Start from the time of maintenance started and finished, problems of some components, replacing some component, and every activity that already done. Also the chief engine room has to make sure that every maintenances is already complete of being done in one cylinder. This report will be a document fro the engine control room and also for the shipping company (PT. Tanto Intim Line). If everything is already really complete, fine, and no problems, the crew could assembling back all components into the cylinder and mounting back the cylinder head. Thus, the maintenance work for one cylinder is already done.

Every cylinder almost has same maintenance treatment activities. These are come from estimation of working hour of each component. So, for the time schedules are almost same too. But, there is a little diffence with cylinder no. 5 as teh reason of different time of component replacement or overhaul. There is an extra component for cylinder no. 5 that is exhaust valve. Exhaust valve is a valve that prevent the

residual gas of combustion flow back into te combustion chamber. It is estimated to be done in an hour because of the maintenance treatent activities are not too hard to do. Also it planned to be overlapped with safety valve of cylinder head. It is very possible to be overlapped because of both of this component have little activities of maintenance. Also considering the crew number, it is very possible to be overlapped. Maintenance activities for exhaust valve is planned to start at 10.30 AM and finish at 11.30 AM.

There one maintenance that also being paralelled. It lubrication oil sump tank test. The maintenance activity is only laboratory test. So it could started on September 3rd, 2016 and the result will come at September 4th, 2016. It is paralelled with cylinder no. 1. The reason these 2 component could be paralelled is beacuse of these component are done at the different place and different people.

After the whole maintenance activities of all 5 cylinders and laboratory test are done, its time for the cheif engine room make the final report. The final report consists of every cylinder reports and the lubrication oil sump tank laboratory result. These report will build some conclusions result of all maintenance treatment activities. Then this final report will be given to shipping company as the document. It also could be used to planned the next docking maintenance. But of course also with comparing to the voyage log for the next 3 years. This final report is the closure of the whole maintenance activity for main engine.

4.5.3. Risks

Risks are a few things that highly prioritize if some troubles happen to these few things are capable to make harmness. From Primavera could be define what are the risks of a project like maintenance project. In this maintenance project (maintenance of MV. Tanto Tenang) there are also some risks that need attention.

The risks of MV. Tanto Tenang maintenance project come from WBS that show the components that need to be maintained. Most of risks are affect the engine performance because all of them are parts of the engeine work. The purpose of main engine maintenance is to increase its performance that already go down during the voyage in more or less 3 years operation. So, any risk that may affect the engine performance need to be prevent from causing troubles during the maintenance.

Most of risks in this project are high risks. The reason is because of the every components affect the engine performance. The maintenance activities are about maintaining the main engine itself and every parts in it that sustain the engine work. So, every single component has a high risk that may affect the main engine. If one component is not being complete or well of maintenance, it still contain a risk that could harm the engine performance. Components that have high risk are:

a. Cylinder head
b. Fuel injector
c. Piston
d. Ring piston
e. Cylinder liner
f. Upper and lower connecting rod bearing

g. Starting air valve
h. Fuel injection pump
i. Safety valve of cylinder head
j. Main bearing
k. Lubrication oil sump tank

The only thing that has medium risk is are only reports. Report has no influence to the main engine performance. It is only notes that show the result of main engine maintenance result. But, the risk is on the shipping company. If the report is not clear enough, the shipping company could give sanctions to the engine room crew especially the chief engine room.

4.5.4. Case Samples

In this thesis the only thing that could easily as case samples is procurement of ring piston.The case samples that will be made is what about if the ring piston procurement is being late. This will devided into how long it is late and what are the impact to the main engine maintenance project.

Case sample 1. The procurement of rings piston are late about 1 day. Then the maintenance for replacing ring piston for cylinder no.1 could be idled until tomorrow, switch with starting air valve maintenance. These two maintenance take almost same duration. This is not a big problem if the tardiness only 1 day. It still able to be covered in the next day. Also there are some extra time on the next day to replace the ring piston So it still not possible if the procurement of rings piston late only for a day.

Case sample 2. If it is late for 2 days, the maintenance of piston ring cylinder no.1 could by couple with piston ring cylinder no. 2. In this case,

the man power need to be doubled. If replacing one piston ring need 3 persons, then on the date for maintenance of piston ring cylinder no.2 will need 6 persons to work. This starts to give a trouble by complicates the engine room crew to do a work that should be able to be done on the day before.

Case sample 3. If it is late for 3 days, the shipping company (PT. Tanto Intim Line) should contact the vendor of piston ring and ask why the procurement of piston ring lates for so long. If the tardiness is more than 2 days, the shipping company should find a new vendor for piston rings procurement. The very first thing to do is buy piston ring from the most possible spare part dealler. This is an emergency expense. The reason of this act is to prevent an extra time that could make more than 10 days for main engine maintenance activities.

Piston ring is a vital part of the main engine maintenance. If the procurement of piston ring is late, the optimization project could be fail. If the tardiness is about 1 day until 2 days, it is still tolerable. Those days are the maximum tolerance for piston ring procurement tardiness. The tardiness and its effect could be seen in the Table 4.1.

Table 4. 1 Tardiness of Piston Ring

No.	Tardi-ness	Effect	Loss	Solution	Tolerance
1	1 day	Iddle execution for piston ring of cylinder no. 1. Extra job for the crew on the next day after the tardiness day.	Time loss	Wait for the next day if the piston ring will come from the vendor.	Tolerable
2	2 days	Iddle execution for piston ring	Time loss.	Contact the vendor.	Tolerable

		of cylinder no. 1. Extra job for the crew on the next day after the tardiness day.	Extra job.	Asking about the time arrival of piston ring. Prepare for emergency expense.	
3	3 days	Iddle execution for piston ring of cylinder no. 2. Extra job for the crew on the next day after the tardiness day. Big mess during maintenance execution for cylinder no. 2. Unfinished work or extra work from cylinder no. 1. Extra job for the crew. Continuos effect that could expand the maintenance duration.	Time loss. Extra job. More cost if it cause extra time for docking.	Contact the vendor. Cancel the order. Do an emergency expense. Find new vendor.	Untolerable

Another thing that could be made as a sample case is the voyage plan. If the voyage route of the ship is being changed, then the main engine maintenance will also change. Things that could change the main engine maintenance that related to the voyage route are working hour, voyage duration, and the distance.

Different voyage route means different voyage duration. If the voyage duration is longer than the existing plan, it will cause different working hour for each component of main engine. These things will cause different schedule from this thesis analysis result because the different data will be a new data input to Primavera. So, if the voyage plan is changed, the whole data log of the ship is also change. Thus, the maintenance schedule will also change into a new different schedule.

From all examples above could be concluded that the longer idle time for spare parts procurement, then the longer time will be needed to finish the whole maintenance project. Ring piston is only an example because in this thesis ring piston is the only detected that need more attention. But, actually there could be another components such as spare parts for stem seal, valves, nozzles, grease, etc. All of them should be prepared a few days before docking. If some components are late, the result will be like the examples above. The purpose of on time spare parts procurement is to keep the maintenance project is done as on schedule. It is being scheduled for 10 days and extra 1 day for the final report. If some components are late that could cause the maintenance project extand more days (it could be 2 or 4 days). This is really bad especially for PT. Tanto Intim Line because the shipping company has to spend extra money because of these faults. Also the ship's voyage plan has to be changed. Spending more cost but doesn't earn money. This is a loss for PT. Tanto Intim Line. So it will be very wise if all spare parts procurement all already prepared a few days before docking.

Another thing that could be concluded is different voyage plan will give different maintenance schedule. This is the reason why one ship of PT. Tanto Intim Line only has one voyage route. If one ship has some voyage routes, it will complicates the maintenance plan scheduling. Also it could make a ship need a docking maintenance less then every 3 years (genereally every ship of PT. Tanto Intim Line goes for docking maintenance every 3 years). The worst impact is more cost because of more often docking maintenance for a ship.

4.5.5. Time Optimization

Time optimization is a method to shorten the main engine maintenance duration, in this thesis for MV. Tanto Tenang. Actually, Mv. Tanto Tenang has never been docking for maintenance because of its operation in Indonesia hasn't reach 3 years yet. So, the time optimization in this thesis is a new docking maintenance schedule for MV. Tanto Tenang. But, MV. Tanto Tenang has a sister ship, that is MV. Tanto Semangat. From the interview result at PT. Tanto Intim Line head office, the expert in that office said, "Normally, every ship in PT. Tanto Intim Line takes 12 until 14 days for main engine maintenance during docking period. But, in that 12 until 14 days the other workers from shp yard also maintain another part of the ship such as hull, plate, etc. So, the total maximum days of docking maintenance for one ship of PT. Tanto Intim Line is 14 days. Also with MV. Tanto Semangat as a sister ship of MV. Tanto Tenang. Usually, MV. Tanto Semangat takes 12 days when docking for maintenance". From this information, could be assumed that MV. Tanto Tenang also takes around 12 days for maintenance

during docking period. If the main engine maintenance also takes 12, then from the schedule as this thesis research result, the new schedule for main engine maintenance for docking period is planned for 10 days for main engine maintenance process included the risk of every component and the impact if spare parts procurement are being late from the schedule plus 1 day for final report.

From the Primavera as software that being used in this thesis research, could be seen the maintenance schedule for main engine maintenance of MV. Tanto Tenang. That schedule shows some activities that possible being paralleled or overlap. In this thesis some components that possible for being semi-overlap are piston, cylinder liner, upper and lower conrod bearing, and fuel injection pump. Semi-overlap is a condition where a maintenance activity is started a while before another maintenance activity is done. The reason of these these components maintenance are possible for being semi-overlap is because of the number of engine room crew, capabilities of the crew, and working time in a day for the crew.

These semi-overlap activities are the form of time optimization. But, not every part could be semi-overlap because of the maintenance execution is done in 2 days maximum. So, the total of main engine maintenance for 5 cylinders take 10 days of workday. This is the shortest time that the engine room crew are capable to do. Here is the form of semi-overlap activities.

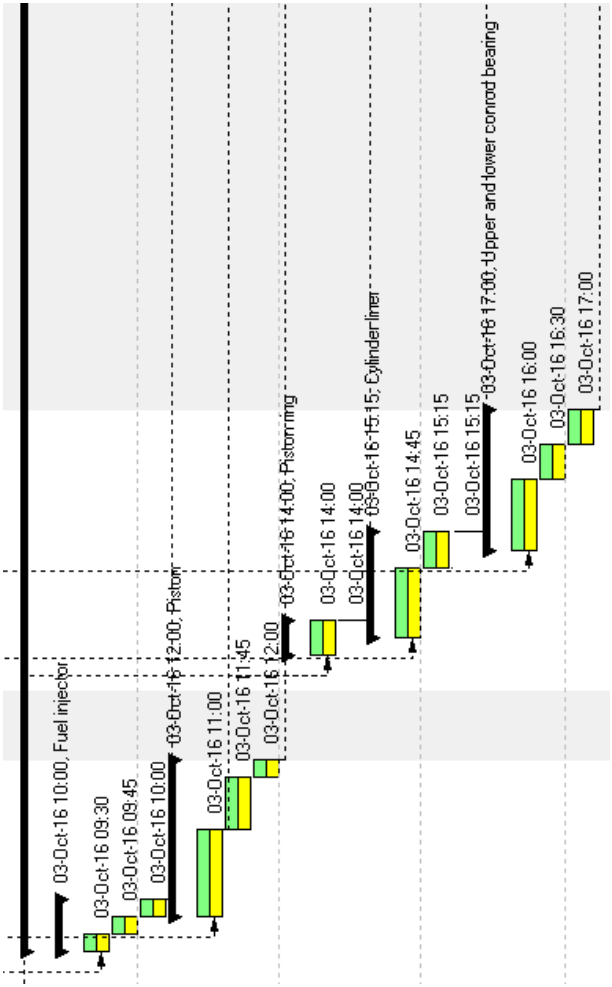


Figure 4. 6 Time Optimization Chart

4.5.6. Match Making Process

The match making process is a process where the schedule that already made (in this thesis research the schedule is made by Primavera as a new schedule for docking period) will be correlated with Main Engine Maintenance Manual Book. If the activities in th schedule are match with the manual book, then the schedule could be executed.

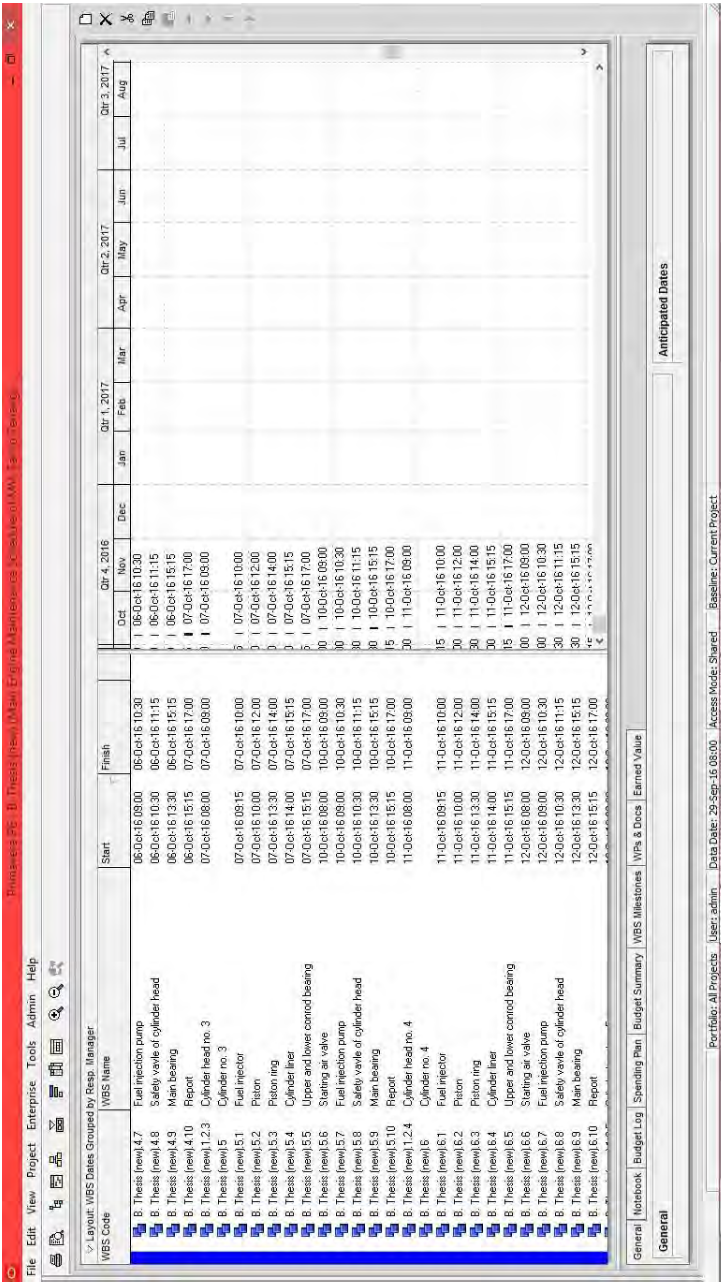
Also has to considering about each parts working hours of the Main Engine. Because of every parts has different present working hour and maximum working hour, so the maintenance activity schedule will not exactly same with the maintenance manual book. If a part has reach its maximum working hour, that spare part need to be replace or repair. But, there are some spare parts which haven't reach their maximum working hour but already broken. These spare parts also need overhaul (repair or being replaced). But, the basic regulation is the Main Engine Maintenance Manual Book.

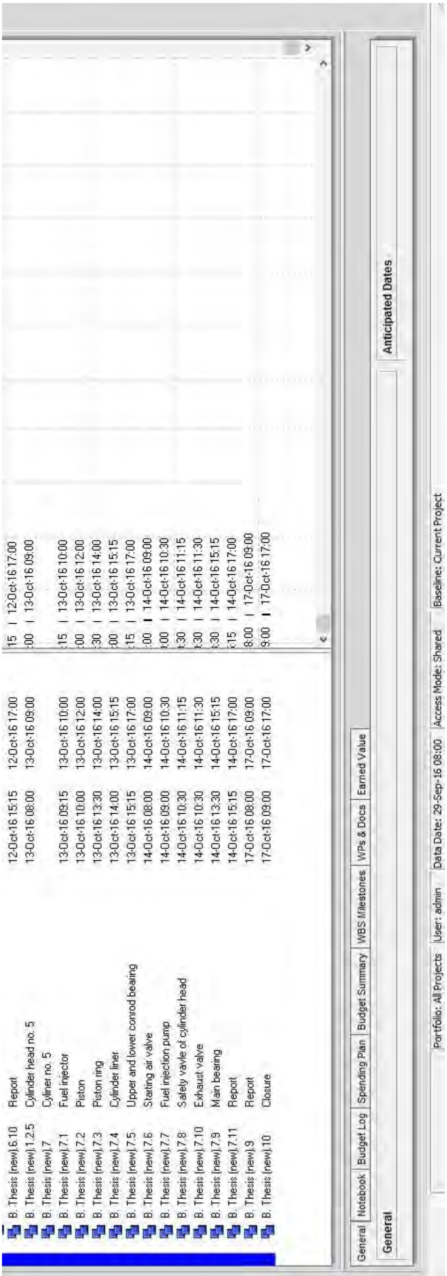
From the research result of this thesis the maintenance schedule for docking period is already match with the Main Engine Maintenance Manual Book. The reason why the schedule in this thesis is match because of every activity is arranged based on Main Engine Maintenance Manual Book. Also with the PMS is already match with the Main Engine Maintenance Manual Book. Thus, schedule also match with the PMS and working hour (comes from daily log book of main engine running hour) of each component of MV. Tanto Tenang. This schedule is match and applicable for MV. Tanto Tenang in condition there is no unpredictable accident happens to the ship. If there is an unpredictable accident happen to the ship, then the shipping company (PT.

Tanto Intim Line) or chief engine room and the crew have to rescedule the maintenance schedule for the docking period.

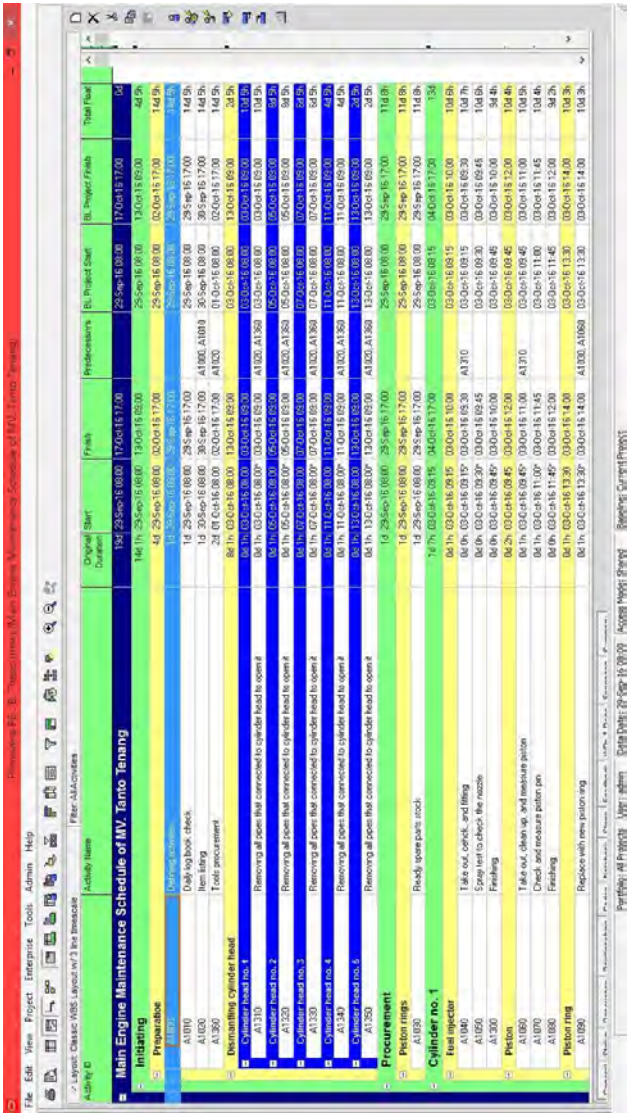
ATTACHMENT

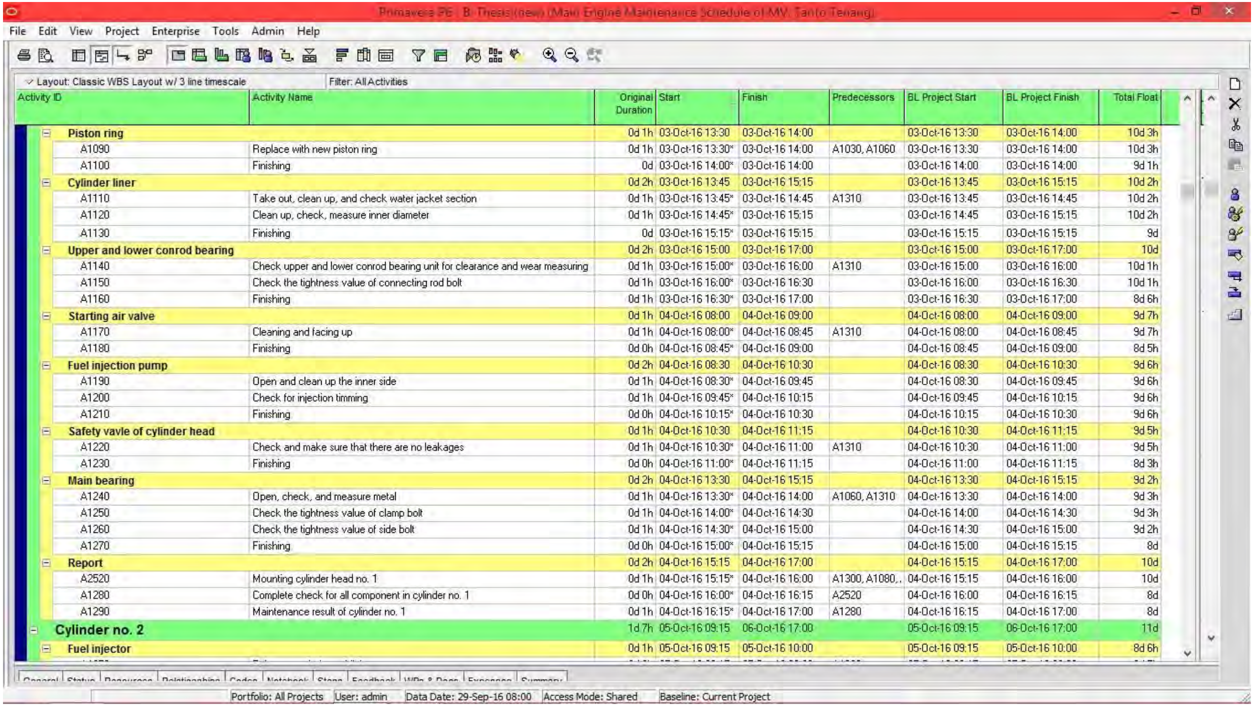
1. WBS of Maintenance Project


File Edit View Project Enterprise Tools Admin Help
Layout: WBS Dates Grouped by Resp. Manager
WBS Code | WBS Name | Start | Finish
Qtr 4, 2016 | Qtr 1, 2017 | Qtr 2, 2017 | Qtr 3, 2017
Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug
B. Thesis (new).4.7 Fuel injection pump 06-Oct-16 09:00 06-Oct-16 10:30
B. Thesis (new).4.8 Safety vavle of cylinder head 06-Oct-16 10:30 06-Oct-16 11:15
B. Thesis (new).4.9 Main bearing 06-Oct-16 13:30 06-Oct-16 15:15
B. Thesis (new).4.10 Report 06-Oct-16 15:15 07-Oct-16 17:00
B. Thesis (new).1.2.3 Cylinder head no. 3 07-Oct-16 08:00 07-Oct-16 09:00
B. Thesis (new).5 Cylinder no. 3
B. Thesis (new).5.1 Fuel injector 07-Oct-16 09:15 07-Oct-16 10:00
B. Thesis (new).5.2 Piston 07-Oct-16 10:00 07-Oct-16 12:00
B. Thesis (new).5.3 Piston ring 07-Oct-16 13:30 07-Oct-16 14:00
B. Thesis (new).5.4 Cylinder liner 07-Oct-16 14:00 07-Oct-16 15:15
B. Thesis (new).5.5 Upper and lower conrod bearing 07-Oct-16 15:15 07-Oct-16 17:00
B. Thesis (new).5.6 Starting air valve 10-Oct-16 08:00 10-Oct-16 09:00
B. Thesis (new).5.7 Fuel injection pump 10-Oct-16 09:00 10-Oct-16 10:30
B. Thesis (new).5.8 Safety vavle of cylinder head 10-Oct-16 10:30 10-Oct-16 11:15
B. Thesis (new).5.9 Main bearing 10-Oct-16 13:30 10-Oct-16 15:15
B. Thesis (new).5.10 Report 10-Oct-16 15:15 10-Oct-16 17:00
B. Thesis (new).1.2.4 Cylinder head no. 4 11-Oct-16 08:00 11-Oct-16 09:00
B. Thesis (new).6 Cylinder no. 4
B. Thesis (new).6.1 Fuel injector 11-Oct-16 09:15 11-Oct-16 10:00
B. Thesis (new).6.2 Piston 11-Oct-16 10:00 11-Oct-16 12:00
B. Thesis (new).6.3 Piston ring 11-Oct-16 13:30 11-Oct-16 14:00
B. Thesis (new).6.4 Cylinder liner 11-Oct-16 14:00 11-Oct-16 15:15
B. Thesis (new).6.5 Upper and lower conrod bearing 11-Oct-16 15:15 11-Oct-16 17:00
B. Thesis (new).6.6 Starting air valve 12-Oct-16 08:00 12-Oct-16 09:00
B. Thesis (new).6.7 Fuel injection pump 12-Oct-16 09:00 12-Oct-16 10:30
B. Thesis (new).6.8 Safety vavle of cylinder head 12-Oct-16 10:30 12-Oct-16 11:15
B. Thesis (new).6.9 Main bearing 12-Oct-16 13:30 12-Oct-16 15:15
B. Thesis (new).6.10 Report 12-Oct-16 15:15 12-Oct-16 17:00
General Notebook Budget Log Spending Plan Budget Summary WBS Milestones WPs & Docs Earned Value
General
Anticipated Dates
Portfolio: All Projects | User: admin | Data Date: 29-Sep-16 08:00 | Access Mode: Shared | Baseline: Current Project


B. Thesis (new).6.10 Report 12-Oct-16 15:15 12-Oct-16 17:00
B. Thesis (new).1.2.5 Cylinder head no. 5 13-Oct-16 08:00 13-Oct-16 09:00
B. Thesis (new).7 Cyliner no. 5
B. Thesis (new).7.1 Fuel injector 13-Oct-16 09:15 13-Oct-16 10:00
B. Thesis (new).7.2 Piston 13-Oct-16 10:00 13-Oct-16 12:00
B. Thesis (new).7.3 Piston ring 13-Oct-16 13:30 13-Oct-16 14:00
B. Thesis (new).7.4 Cylinder liner 13-Oct-16 14:00 13-Oct-16 15:15
B. Thesis (new).7.5 Upper and lower conrod bearing 13-Oct-16 15:15 13-Oct-16 17:00
B. Thesis (new).7.6 Starting air valve 14-Oct-16 08:00 14-Oct-16 09:00
B. Thesis (new).7.7 Fuel injection pump 14-Oct-16 09:00 14-Oct-16 10:30
B. Thesis (new).7.8 Safety vavle of cylinder head 14-Oct-16 10:30 14-Oct-16 11:15
B. Thesis (new).7.10 Exhaust valve 14-Oct-16 10:30 14-Oct-16 11:30
B. Thesis (new).7.9 Main bearing 14-Oct-16 13:30 14-Oct-16 15:15
B. Thesis (new).7.11 Report 14-Oct-16 15:15 14-Oct-16 17:00
B. Thesis (new).9 Report 17-Oct-16 08:00 17-Oct-16 09:00
B. Thesis (new).10 Closure 17-Oct-16 09:00 17-Oct-16 17:00
General
Notebook
Budget Log
Spending Plan
Budget Summary
WBS Milestones
WPs & Docs
Earned Value
General
Anticipated Dates
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

2. Project Activities



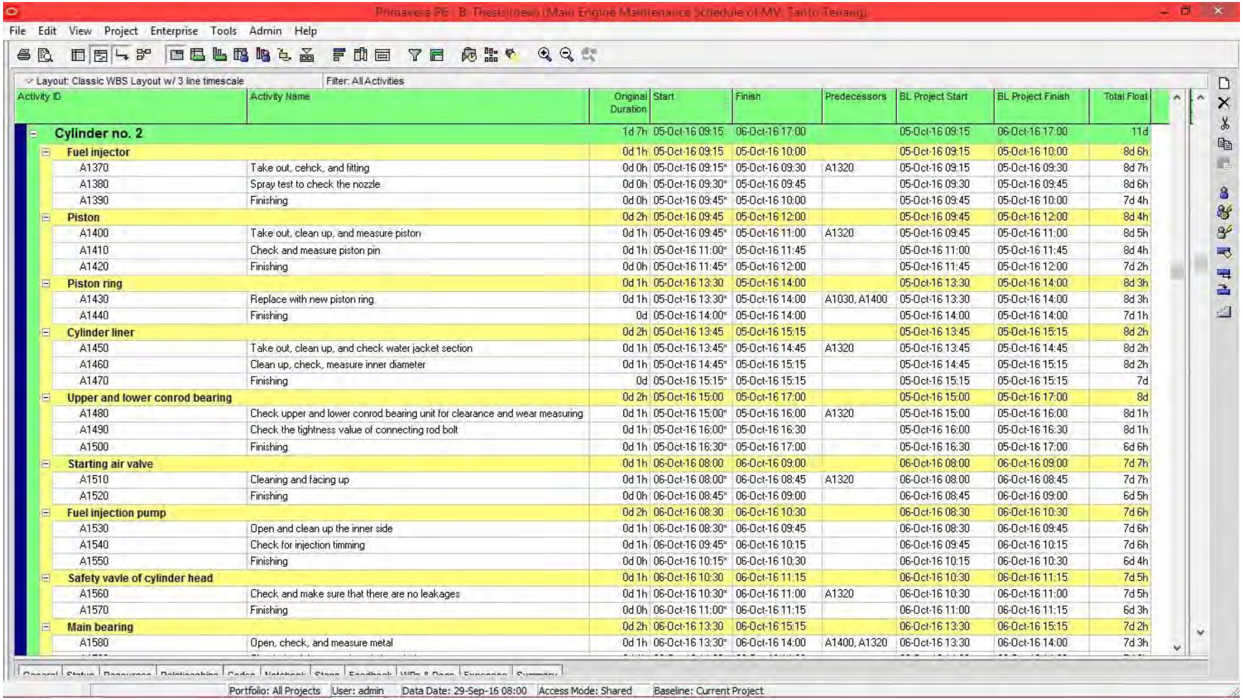


Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)

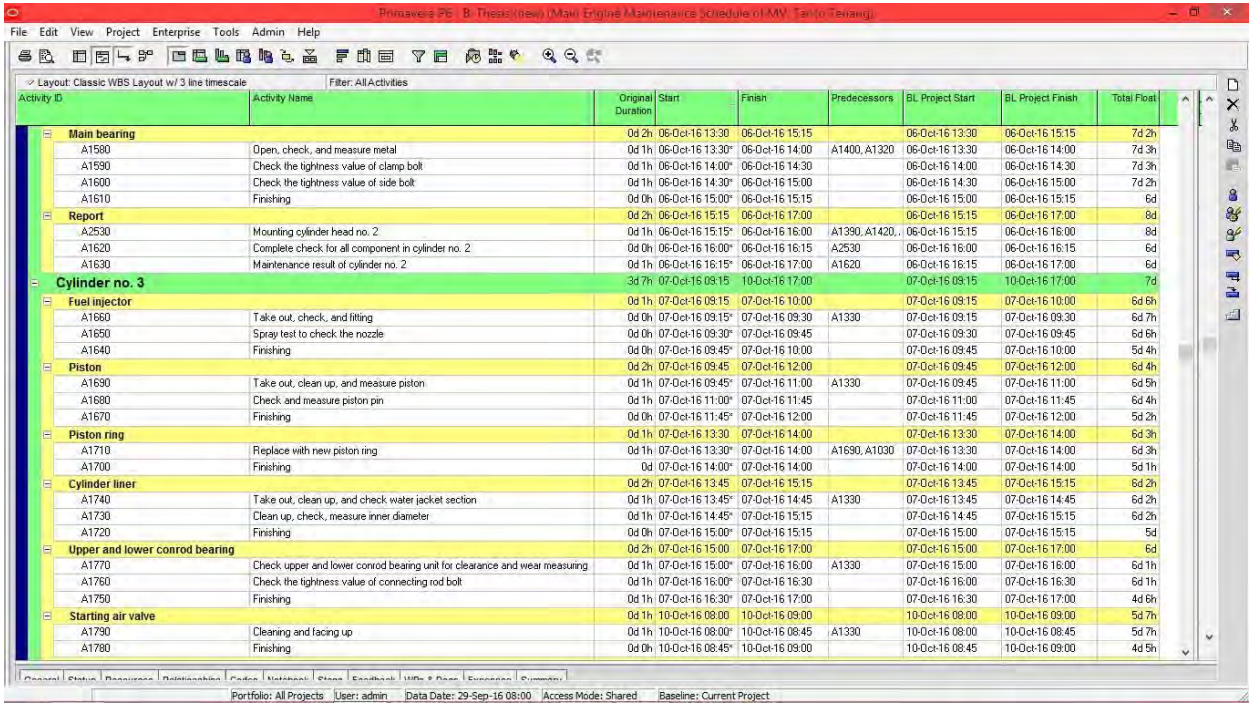
Layout: Classic WBS Layout w/ 3 line timescale | Filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	BL Project Start	BL Project Finish	Total Float
Piston ring		0d 1h	03-Oct-16 13:30	03-Oct-16 14:00		03-Oct-16 13:30	03-Oct-16 14:00	10d 3h
A1090	Replace with new piston ring	0d 1h	03-Oct-16 13:30*	03-Oct-16 14:00	A1030, A1060	03-Oct-16 13:30	03-Oct-16 14:00	10d 3h
A1100	Finishing	0d	03-Oct-16 14:00*	03-Oct-16 14:00		03-Oct-16 14:00	03-Oct-16 14:00	9d 1h
Cylinder liner		0d 2h	03-Oct-16 13:45	03-Oct-16 15:15		03-Oct-16 13:45	03-Oct-16 15:15	10d 2h
A1110	Take out, clean up, and check water jacket section	0d 1h	03-Oct-16 13:45*	03-Oct-16 14:45	A1310	03-Oct-16 13:45	03-Oct-16 14:45	10d 2h
A1120	Clean up, check, measure inner diameter	0d 1h	03-Oct-16 14:45*	03-Oct-16 15:15		03-Oct-16 14:45	03-Oct-16 15:15	10d 2h
A1130	Finishing	0d	03-Oct-16 15:15*	03-Oct-16 15:15		03-Oct-16 15:15	03-Oct-16 15:15	9d
Upper and lower conrod bearing		0d 2h	03-Oct-16 15:00	03-Oct-16 17:00		03-Oct-16 15:00	03-Oct-16 17:00	10d
A1140	Check upper and lower conrod bearing unit for clearance and wear measuring	0d 1h	03-Oct-16 15:00*	03-Oct-16 16:00	A1310	03-Oct-16 15:00	03-Oct-16 16:00	10d 1h
A1150	Check the tightness value of connecting rod bolt	0d 1h	03-Oct-16 16:00*	03-Oct-16 16:30		03-Oct-16 16:00	03-Oct-16 16:30	10d 1h
A1160	Finishing	0d 1h	03-Oct-16 16:30*	03-Oct-16 17:00		03-Oct-16 16:30	03-Oct-16 17:00	8d 6h
Starting air valve		0d 1h	04-Oct-16 08:00	04-Oct-16 09:00		04-Oct-16 08:00	04-Oct-16 09:00	9d 7h
A1170	Cleaning and facing up	0d 1h	04-Oct-16 08:00*	04-Oct-16 08:45	A1310	04-Oct-16 08:00	04-Oct-16 08:45	9d 7h
A1180	Finishing	0d 0h	04-Oct-16 08:45*	04-Oct-16 09:00		04-Oct-16 08:45	04-Oct-16 09:00	8d 5h
Fuel injection pump		0d 2h	04-Oct-16 08:30	04-Oct-16 10:30		04-Oct-16 08:30	04-Oct-16 10:30	9d 6h
A1190	Open and clean up the inner side	0d 1h	04-Oct-16 08:30*	04-Oct-16 09:45		04-Oct-16 08:30	04-Oct-16 09:45	9d 6h
A1200	Check for injection timming	0d 1h	04-Oct-16 09:45*	04-Oct-16 10:15		04-Oct-16 09:45	04-Oct-16 10:15	9d 6h
A1210	Finishing	0d 0h	04-Oct-16 10:15*	04-Oct-16 10:30		04-Oct-16 10:15	04-Oct-16 10:30	9d 6h
Safety vavle of cylinder head		0d 1h	04-Oct-16 10:30	04-Oct-16 11:15		04-Oct-16 10:30	04-Oct-16 11:15	9d 5h
A1220	Check and make sure that there are no leakages	0d 1h	04-Oct-16 10:30*	04-Oct-16 11:00	A1310	04-Oct-16 10:30	04-Oct-16 11:00	9d 5h
A1230	Finishing	0d 0h	04-Oct-16 11:00*	04-Oct-16 11:15		04-Oct-16 11:00	04-Oct-16 11:15	8d 3h
Main bearing		0d 2h	04-Oct-16 13:30	04-Oct-16 15:15		04-Oct-16 13:30	04-Oct-16 15:15	9d 2h
A1240	Open, check, and measure metal	0d 1h	04-Oct-16 13:30*	04-Oct-16 14:00	A1060, A1310	04-Oct-16 13:30	04-Oct-16 14:00	9d 3h
A1250	Check the tightness value of clamp bolt	0d 1h	04-Oct-16 14:00*	04-Oct-16 14:30		04-Oct-16 14:00	04-Oct-16 14:30	9d 3h
A1260	Check the tightness value of side bolt	0d 1h	04-Oct-16 14:30*	04-Oct-16 15:00		04-Oct-16 14:30	04-Oct-16 15:00	9d 2h
A1270	Finishing	0d 0h	04-Oct-16 15:00*	04-Oct-16 15:15		04-Oct-16 15:00	04-Oct-16 15:15	8d
Report		0d 2h	04-Oct-16 15:15	04-Oct-16 17:00		04-Oct-16 15:15	04-Oct-16 17:00	10d
A2520	Mounting cylinder head no. 1	0d 1h	04-Oct-16 15:15*	04-Oct-16 16:00	A1300, A1080,.	04-Oct-16 15:15	04-Oct-16 16:00	10d
A1280	Complete check for all component in cylinder no. 1	0d 0h	04-Oct-16 16:00*	04-Oct-16 16:15	A2520	04-Oct-16 16:00	04-Oct-16 16:15	8d
A1290	Maintenance result of cylinder no. 1	0d 1h	04-Oct-16 16:15*	04-Oct-16 17:00	A1280	04-Oct-16 16:15	04-Oct-16 17:00	8d
Cylinder no. 2		1d 7h	05-Oct-16 09:15	06-Oct-16 17:00		05-Oct-16 09:15	06-Oct-16 17:00	11d
Fuel injector		0d 1h	05-Oct-16 09:15	05-Oct-16 10:00		05-Oct-16 09:15	05-Oct-16 10:00	8d 6h

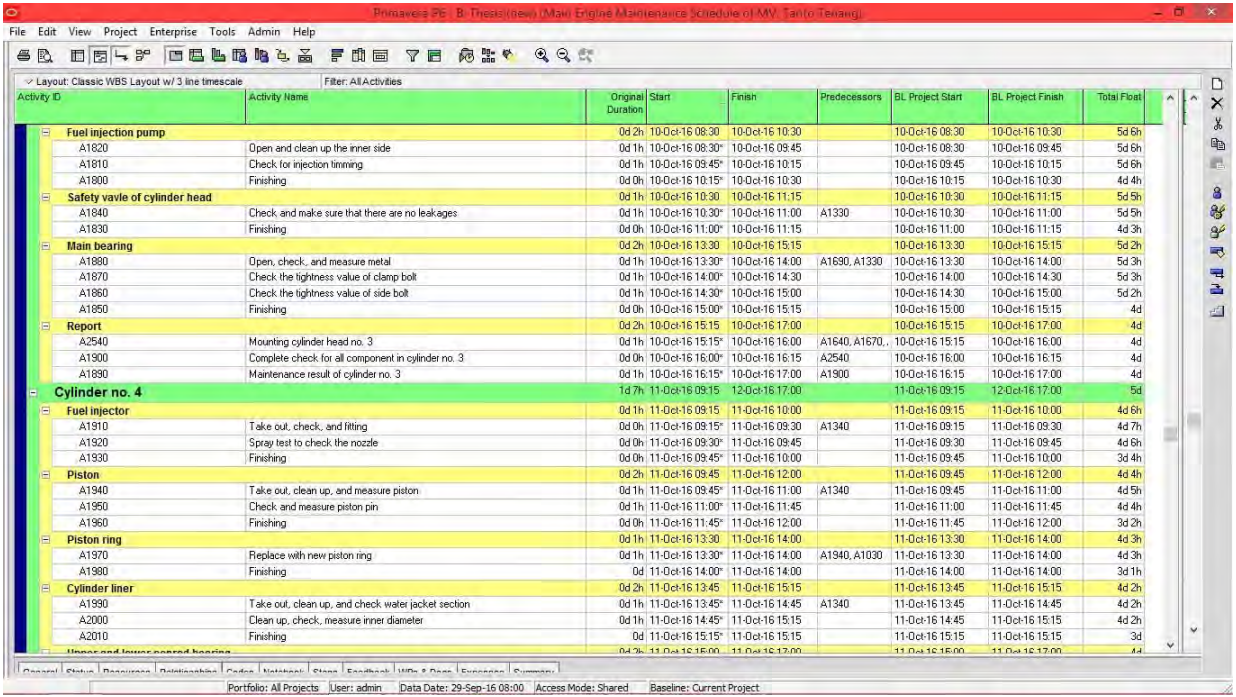
Portfolio: All Projects | User: admin | Data Date: 29-Sep-16 08:00 | Access Mode: Shared | Baseline: Current Project



Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	BL Project Start	BL Project Finish	Total Float
Cylinder no. 2		1d 7h	05-Oct-16 09:15	06-Oct-16 17:00		05-Oct-16 09:15	06-Oct-16 17:00	11d
Fuel injector		0d 1h	05-Oct-16 09:15	05-Oct-16 10:00		05-Oct-16 09:15	05-Oct-16 10:00	8d 6h
A1370	Take out, cehck, and fitting	0d 0h	05-Oct-16 09:15*	05-Oct-16 09:30	A1320	05-Oct-16 09:15	05-Oct-16 09:30	8d 7h
A1380	Spray test to check the nozzle	0d 0h	05-Oct-16 09:30*	05-Oct-16 09:45		05-Oct-16 09:30	05-Oct-16 09:45	8d 6h
A1390	Finishing	0d 0h	05-Oct-16 09:45*	05-Oct-16 10:00		05-Oct-16 09:45	05-Oct-16 10:00	7d 4h
Piston		0d 2h	05-Oct-16 09:45	05-Oct-16 12:00		05-Oct-16 09:45	05-Oct-16 12:00	8d 4h
A1400	Take out, clean up, and measure piston	0d 1h	05-Oct-16 09:45*	05-Oct-16 11:00	A1320	05-Oct-16 09:45	05-Oct-16 11:00	8d 5h
A1410	Check and measure piston pin	0d 1h	05-Oct-16 11:00*	05-Oct-16 11:45		05-Oct-16 11:00	05-Oct-16 11:45	8d 4h
A1420	Finishing	0d 0h	05-Oct-16 11:45*	05-Oct-16 12:00		05-Oct-16 11:45	05-Oct-16 12:00	7d 2h
Piston ring		0d 1h	05-Oct-16 13:30	05-Oct-16 14:00		05-Oct-16 13:30	05-Oct-16 14:00	8d 3h
A1430	Replace with new piston ring	0d 1h	05-Oct-16 13:30*	05-Oct-16 14:00	A1030, A1400	05-Oct-16 13:30	05-Oct-16 14:00	8d 3h
A1440	Finishing	0d	05-Oct-16 14:00*	05-Oct-16 14:00		05-Oct-16 14:00	05-Oct-16 14:00	7d 1h
Cylinder liner		0d 2h	05-Oct-16 13:45	05-Oct-16 15:15		05-Oct-16 13:45	05-Oct-16 15:15	8d 2h
A1450	Take out, clean up, and check water jacket section	0d 1h	05-Oct-16 13:45*	05-Oct-16 14:45	A1320	05-Oct-16 13:45	05-Oct-16 14:45	8d 2h
A1460	Clean up, check, measure inner diameter	0d 1h	05-Oct-16 14:45*	05-Oct-16 15:15		05-Oct-16 14:45	05-Oct-16 15:15	8d 2h
A1470	Finishing	0d	05-Oct-16 15:15*	05-Oct-16 15:15		05-Oct-16 15:15	05-Oct-16 15:15	7d
Upper and lower conrod bearing		0d 2h	05-Oct-16 15:00	05-Oct-16 17:00		05-Oct-16 15:00	05-Oct-16 17:00	8d
A1480	Check upper and lower conrod bearing unit for clearance and wear measuring	0d 1h	05-Oct-16 15:00*	05-Oct-16 16:00	A1320	05-Oct-16 15:00	05-Oct-16 16:00	8d 1h
A1490	Check the tightness value of connecting rod bolt	0d 1h	05-Oct-16 16:00*	05-Oct-16 16:30		05-Oct-16 16:00	05-Oct-16 16:30	8d 1h
A1500	Finishing	0d 1h	05-Oct-16 16:30*	05-Oct-16 17:00		05-Oct-16 16:30	05-Oct-16 17:00	6d 6h
Starting air valve		0d 1h	06-Oct-16 08:00	06-Oct-16 09:00		06-Oct-16 08:00	06-Oct-16 09:00	7d 7h
A1510	Cleaning and facing up	0d 1h	06-Oct-16 08:00*	06-Oct-16 08:45	A1320	06-Oct-16 08:00	06-Oct-16 08:45	7d 7h
A1520	Finishing	0d 0h	06-Oct-16 08:45*	06-Oct-16 09:00		06-Oct-16 08:45	06-Oct-16 09:00	6d 5h
Fuel injection pump		0d 2h	06-Oct-16 08:30	06-Oct-16 10:30		06-Oct-16 08:30	06-Oct-16 10:30	7d 6h
A1530	Open and clean up the inner side	0d 1h	06-Oct-16 08:30*	06-Oct-16 09:45		06-Oct-16 08:30	06-Oct-16 09:45	7d 6h
A1540	Check for injection timming	0d 1h	06-Oct-16 09:45*	06-Oct-16 10:15		06-Oct-16 09:45	06-Oct-16 10:15	7d 6h
A1550	Finishing	0d 0h	06-Oct-16 10:15*	06-Oct-16 10:30		06-Oct-16 10:15	06-Oct-16 10:30	6d 4h
Safety vavle of cylinder head		0d 1h	06-Oct-16 10:30	06-Oct-16 11:15		06-Oct-16 10:30	06-Oct-16 11:15	7d 5h
A1560	Check and make sure that there are no leakages	0d 1h	06-Oct-16 10:30*	06-Oct-16 11:00	A1320	06-Oct-16 10:30	06-Oct-16 11:00	7d 5h
A1570	Finishing	0d 0h	06-Oct-16 11:00*	06-Oct-16 11:15		06-Oct-16 11:00	06-Oct-16 11:15	6d 3h
Main bearing		0d 2h	06-Oct-16 13:30	06-Oct-16 15:15		06-Oct-16 13:30	06-Oct-16 15:15	7d 2h
A1580	Open, check, and measure metal	0d 1h	06-Oct-16 13:30*	06-Oct-16 14:00	A1400, A1320	06-Oct-16 13:30	06-Oct-16 14:00	7d 3h



Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	BL Project Start	BL Project Finish	Total Float
Main bearing		0d 2h	06-Oct-16 13:30	06-Oct-16 15:15		06-Oct-16 13:30	06-Oct-16 15:15	7d 2h
A1580	Open, check, and measure metal	0d 1h	06-Oct-16 13:30*	06-Oct-16 14:00	A1400, A1320	06-Oct-16 13:30	06-Oct-16 14:00	7d 3h
A1590	Check the tightness value of clamp bolt	0d 1h	06-Oct-16 14:00*	06-Oct-16 14:30		06-Oct-16 14:00	06-Oct-16 14:30	7d 3h
A1600	Check the tightness value of side bolt	0d 1h	06-Oct-16 14:30*	06-Oct-16 15:00		06-Oct-16 14:30	06-Oct-16 15:00	7d 2h
A1610	Finishing	0d 0h	06-Oct-16 15:00*	06-Oct-16 15:15		06-Oct-16 15:00	06-Oct-16 15:15	6d
Report		0d 2h	06-Oct-16 15:15	06-Oct-16 17:00		06-Oct-16 15:15	06-Oct-16 17:00	8d
A2530	Mounting cylinder head no. 2	0d 1h	06-Oct-16 15:15*	06-Oct-16 16:00	A1390, A1420, ..	06-Oct-16 15:15	06-Oct-16 16:00	8d
A1620	Complete check for all component in cylinder no. 2	0d 0h	06-Oct-16 16:00*	06-Oct-16 16:15	A2530	06-Oct-16 16:00	06-Oct-16 16:15	6d
A1630	Maintenance result of cylinder no. 2	0d 1h	06-Oct-16 16:15*	06-Oct-16 17:00	A1620	06-Oct-16 16:15	06-Oct-16 17:00	6d
Cylinder no. 3		3d 7h	07-Oct-16 09:15	10-Oct-16 17:00		07-Oct-16 09:15	10-Oct-16 17:00	7d
Fuel injector		0d 1h	07-Oct-16 09:15	07-Oct-16 10:00		07-Oct-16 09:15	07-Oct-16 10:00	6d 6h
A1660	Take out, check, and fitting	0d 0h	07-Oct-16 09:15*	07-Oct-16 09:30	A1330	07-Oct-16 09:15	07-Oct-16 09:30	6d 7h
A1650	Spray test to check the nozzle	0d 0h	07-Oct-16 09:30*	07-Oct-16 09:45		07-Oct-16 09:30	07-Oct-16 09:45	6d 6h
A1640	Finishing	0d 0h	07-Oct-16 09:45*	07-Oct-16 10:00		07-Oct-16 09:45	07-Oct-16 10:00	5d 4h
Piston		0d 2h	07-Oct-16 09:45	07-Oct-16 12:00		07-Oct-16 09:45	07-Oct-16 12:00	6d 4h
A1690	Take out, clean up, and measure piston	0d 1h	07-Oct-16 09:45*	07-Oct-16 11:00	A1330	07-Oct-16 09:45	07-Oct-16 11:00	6d 5h
A1680	Check and measure piston pin	0d 1h	07-Oct-16 11:00*	07-Oct-16 11:45		07-Oct-16 11:00	07-Oct-16 11:45	6d 4h
A1670	Finishing	0d 0h	07-Oct-16 11:45*	07-Oct-16 12:00		07-Oct-16 11:45	07-Oct-16 12:00	5d 2h
Piston ring		0d 1h	07-Oct-16 13:30	07-Oct-16 14:00		07-Oct-16 13:30	07-Oct-16 14:00	6d 3h
A1710	Replace with new piston ring	0d 1h	07-Oct-16 13:30*	07-Oct-16 14:00	A1690, A1030	07-Oct-16 13:30	07-Oct-16 14:00	6d 3h
A1700	Finishing	0d	07-Oct-16 14:00*	07-Oct-16 14:00		07-Oct-16 14:00	07-Oct-16 14:00	5d 1h
Cylinder liner		0d 2h	07-Oct-16 13:45	07-Oct-16 15:15		07-Oct-16 13:45	07-Oct-16 15:15	6d 2h
A1740	Take out, clean up, and check water jacket section	0d 1h	07-Oct-16 13:45*	07-Oct-16 14:45	A1330	07-Oct-16 13:45	07-Oct-16 14:45	6d 2h
A1730	Clean up, check, measure inner diameter	0d 1h	07-Oct-16 14:45*	07-Oct-16 15:15		07-Oct-16 14:45	07-Oct-16 15:15	6d 2h
A1720	Finishing	0d 0h	07-Oct-16 15:00*	07-Oct-16 15:15		07-Oct-16 15:00	07-Oct-16 15:15	5d
Upper and lower conrod bearing		0d 2h	07-Oct-16 15:00	07-Oct-16 17:00		07-Oct-16 15:00	07-Oct-16 17:00	6d
A1770	Check upper and lower conrod bearing unit for clearance and wear measuring	0d 1h	07-Oct-16 15:00*	07-Oct-16 16:00	A1330	07-Oct-16 15:00	07-Oct-16 16:00	6d 1h
A1760	Check the tightness value of connecting rod bolt	0d 1h	07-Oct-16 16:00*	07-Oct-16 16:30		07-Oct-16 16:00	07-Oct-16 16:30	6d 1h
A1750	Finishing	0d 1h	07-Oct-16 16:30*	07-Oct-16 17:00		07-Oct-16 16:30	07-Oct-16 17:00	4d 6h
Starting air valve		0d 1h	10-Oct-16 08:00	10-Oct-16 09:00		10-Oct-16 08:00	10-Oct-16 09:00	5d 7h
A1790	Cleaning and facing up	0d 1h	10-Oct-16 08:00*	10-Oct-16 08:45	A1330	10-Oct-16 08:00	10-Oct-16 08:45	5d 7h
A1780	Finishing	0d 0h	10-Oct-16 08:45*	10-Oct-16 09:00		10-Oct-16 08:45	10-Oct-16 09:00	4d 5h

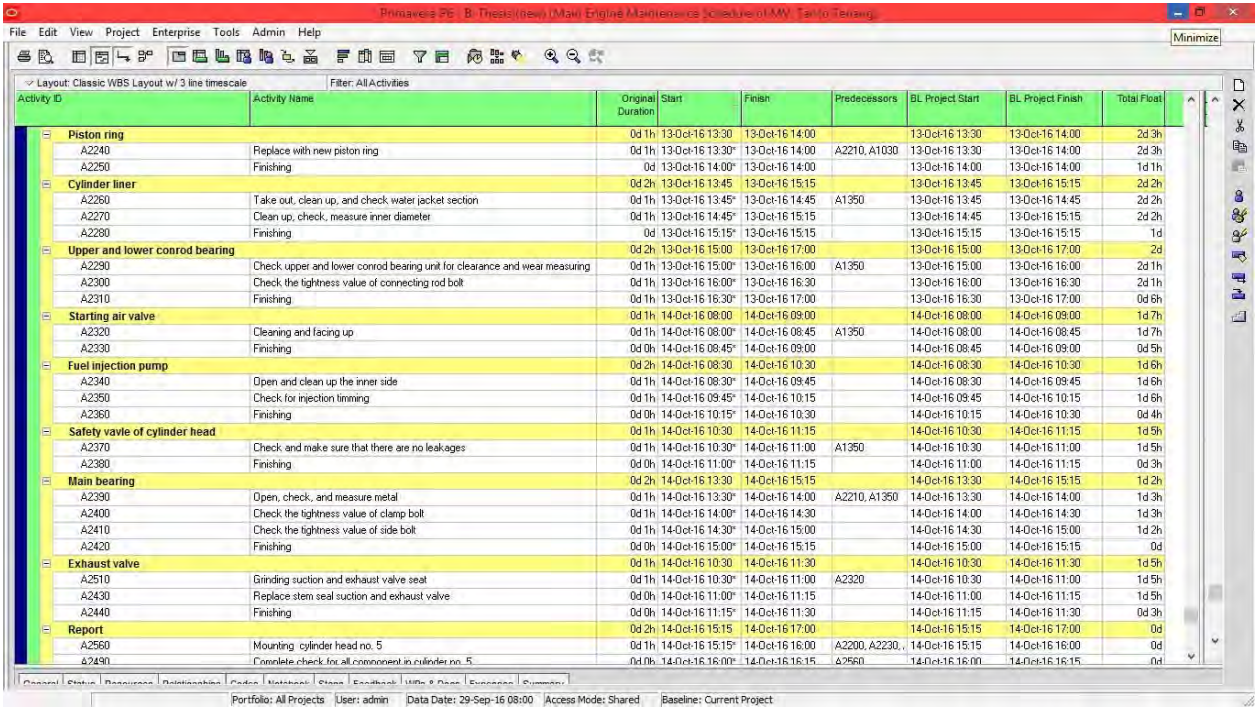

Primavera P6 - B. Thesis (new) (Main) Engine Maintenance Schedule of MV. Tan(o Terang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
Activity ID | Activity Name | Original Duration | Start | Finish | Predecessors | BL Project Start | BL Project Finish | Total Float
Fuel injection pump | 0d 2h | 10-Oct-16 08:30 | 10-Oct-16 10:30 | | 10-Oct-16 08:30 | 10-Oct-16 10:30 | 5d 6h
A1820 | Open and clean up the inner side | 0d 1h | 10-Oct-16 08:30* | 10-Oct-16 09:45 | | 10-Oct-16 08:30 | 10-Oct-16 09:45 | 5d 6h
A1810 | Check for injection timming | 0d 1h | 10-Oct-16 09:45* | 10-Oct-16 10:15 | | 10-Oct-16 09:45 | 10-Oct-16 10:15 | 5d 6h
A1800 | Finishing | 0d 0h | 10-Oct-16 10:15* | 10-Oct-16 10:30 | | 10-Oct-16 10:15 | 10-Oct-16 10:30 | 4d 4h
Safety vavle of cylinder head | 0d 1h | 10-Oct-16 10:30 | 10-Oct-16 11:15 | | 10-Oct-16 10:30 | 10-Oct-16 11:15 | 5d 5h
A1840 | Check and make sure that there are no leakages | 0d 1h | 10-Oct-16 10:30* | 10-Oct-16 11:00 | A1330 | 10-Oct-16 10:30 | 10-Oct-16 11:00 | 5d 5h
A1830 | Finishing | 0d 0h | 10-Oct-16 11:00* | 10-Oct-16 11:15 | | 10-Oct-16 11:00 | 10-Oct-16 11:15 | 4d 3h
Main bearing | 0d 2h | 10-Oct-16 13:30 | 10-Oct-16 15:15 | | 10-Oct-16 13:30 | 10-Oct-16 15:15 | 5d 2h
A1880 | Open, check, and measure metal | 0d 1h | 10-Oct-16 13:30* | 10-Oct-16 14:00 | A1690, A1330 | 10-Oct-16 13:30 | 10-Oct-16 14:00 | 5d 3h
A1870 | Check the tightness value of clamp bolt | 0d 1h | 10-Oct-16 14:00* | 10-Oct-16 14:30 | | 10-Oct-16 14:00 | 10-Oct-16 14:30 | 5d 3h
A1860 | Check the tightness value of side bolt | 0d 1h | 10-Oct-16 14:30* | 10-Oct-16 15:00 | | 10-Oct-16 14:30 | 10-Oct-16 15:00 | 5d 2h
A1850 | Finishing | 0d 0h | 10-Oct-16 15:00* | 10-Oct-16 15:15 | | 10-Oct-16 15:00 | 10-Oct-16 15:15 | 4d
Report | 0d 2h | 10-Oct-16 15:15 | 10-Oct-16 17:00 | | 10-Oct-16 15:15 | 10-Oct-16 17:00 | 4d
A2540 | Mounting cylinder head no. 3 | 0d 1h | 10-Oct-16 15:15* | 10-Oct-16 16:00 | A1640, A1670, . | 10-Oct-16 15:15 | 10-Oct-16 16:00 | 4d
A1900 | Complete check for all component in cylinder no. 3 | 0d 0h | 10-Oct-16 16:00* | 10-Oct-16 16:15 | A2540 | 10-Oct-16 16:00 | 10-Oct-16 16:15 | 4d
A1890 | Maintenance result of cylinder no. 3 | 0d 1h | 10-Oct-16 16:15* | 10-Oct-16 17:00 | A1900 | 10-Oct-16 16:15 | 10-Oct-16 17:00 | 4d
Cylinder no. 4 | 1d 7h | 11-Oct-16 09:15 | 12-Oct-16 17:00 | | 11-Oct-16 09:15 | 12-Oct-16 17:00 | 5d
Fuel injector | 0d 1h | 11-Oct-16 09:15 | 11-Oct-16 10:00 | | 11-Oct-16 09:15 | 11-Oct-16 10:00 | 4d 6h
A1910 | Take out, check, and fitting | 0d 0h | 11-Oct-16 09:15* | 11-Oct-16 09:30 | A1340 | 11-Oct-16 09:15 | 11-Oct-16 09:30 | 4d 7h
A1920 | Spray test to check the nozzle | 0d 0h | 11-Oct-16 09:30* | 11-Oct-16 09:45 | | 11-Oct-16 09:30 | 11-Oct-16 09:45 | 4d 6h
A1930 | Finishing | 0d 0h | 11-Oct-16 09:45* | 11-Oct-16 10:00 | | 11-Oct-16 09:45 | 11-Oct-16 10:00 | 3d 4h
Piston | 0d 2h | 11-Oct-16 09:45 | 11-Oct-16 12:00 | | 11-Oct-16 09:45 | 11-Oct-16 12:00 | 4d 4h
A1940 | Take out, clean up, and measure piston | 0d 1h | 11-Oct-16 09:45* | 11-Oct-16 11:00 | A1340 | 11-Oct-16 09:45 | 11-Oct-16 11:00 | 4d 5h
A1950 | Check and measure piston pin | 0d 1h | 11-Oct-16 11:00* | 11-Oct-16 11:45 | | 11-Oct-16 11:00 | 11-Oct-16 11:45 | 4d 4h
A1960 | Finishing | 0d 0h | 11-Oct-16 11:45* | 11-Oct-16 12:00 | | 11-Oct-16 11:45 | 11-Oct-16 12:00 | 3d 2h
Piston ring | 0d 1h | 11-Oct-16 13:30 | 11-Oct-16 14:00 | | 11-Oct-16 13:30 | 11-Oct-16 14:00 | 4d 3h
A1970 | Replace with new piston ring | 0d 1h | 11-Oct-16 13:30* | 11-Oct-16 14:00 | A1940, A1030 | 11-Oct-16 13:30 | 11-Oct-16 14:00 | 4d 3h
A1980 | Finishing | 0d | 11-Oct-16 14:00* | 11-Oct-16 14:00 | | 11-Oct-16 14:00 | 11-Oct-16 14:00 | 3d 1h
Cylinder liner | 0d 2h | 11-Oct-16 13:45 | 11-Oct-16 15:15 | | 11-Oct-16 13:45 | 11-Oct-16 15:15 | 4d 2h
A1990 | Take out, clean up, and check water jacket section | 0d 1h | 11-Oct-16 13:45* | 11-Oct-16 14:45 | A1340 | 11-Oct-16 13:45 | 11-Oct-16 14:45 | 4d 2h
A2000 | Clean up, check, measure inner diameter | 0d 1h | 11-Oct-16 14:45* | 11-Oct-16 15:15 | | 11-Oct-16 14:45 | 11-Oct-16 15:15 | 4d 2h
A2010 | Finishing | 0d | 11-Oct-16 15:15* | 11-Oct-16 15:15 | | 11-Oct-16 15:15 | 11-Oct-16 15:15 | 3d
Upper and lower paired bearing
General Status Resources Relationships Codes Notebook Steps Feedback WPs & Docs Expenses Summary
Portfolio: All Projects User: admin Data Date: 29-Sep-16 08:00 Access Mode: Shared Baseline: Current Project

Primavera P6 : B.Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)

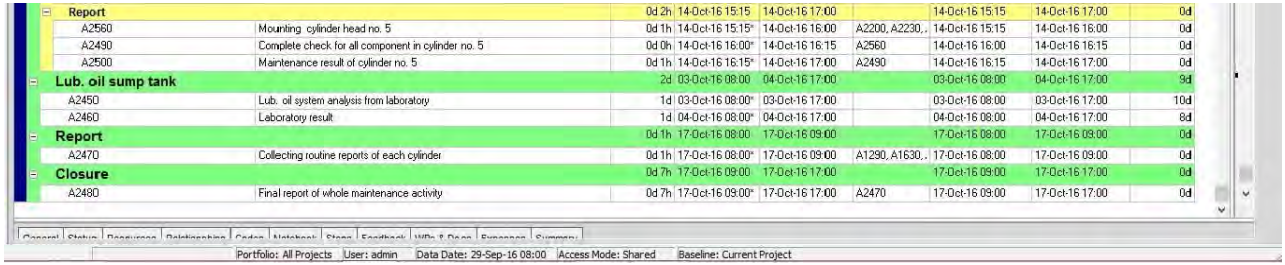
Layout: Classic WBS Layout w/ 3 line timescale — Filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	BL Project Start	BL Project Finish	Total Float
Upper and lower conrod bearing		0d 2h	11-Oct-16 15:00	11-Oct-16 17:00		11-Oct-16 15:00	11-Oct-16 17:00	4d
A2020	Check upper and lower conrod bearing unit for clearance and wear measuring	0d 1h	11-Oct-16 15:00*	11-Oct-16 16:00	A1340	11-Oct-16 15:00	11-Oct-16 16:00	4d 1h
A2030	Check the tightness value of connecting rod bolt	0d 1h	11-Oct-16 16:00*	11-Oct-16 16:30		11-Oct-16 16:00	11-Oct-16 16:30	4d 1h
A2040	Finishing	0d 1h	11-Oct-16 16:30*	11-Oct-16 17:00		11-Oct-16 16:30	11-Oct-16 17:00	2d 6h
Starting air valve		0d 1h	12-Oct-16 08:00	12-Oct-16 09:00		12-Oct-16 08:00	12-Oct-16 09:00	3d 7h
A2050	Cleaning and facing up	0d 1h	12-Oct-16 08:00*	12-Oct-16 08:45	A1340	12-Oct-16 08:00	12-Oct-16 08:45	3d 7h
A2060	Finishing	0d 0h	12-Oct-16 08:45*	12-Oct-16 09:00		12-Oct-16 08:45	12-Oct-16 09:00	2d 5h
Fuel injection pump		0d 2h	12-Oct-16 08:30	12-Oct-16 10:30		12-Oct-16 08:30	12-Oct-16 10:30	3d 6h
A2070	Open and clean up the inner side	0d 1h	12-Oct-16 08:30*	12-Oct-16 09:45		12-Oct-16 08:30	12-Oct-16 09:45	3d 6h
A2080	Check for injection timming	0d 1h	12-Oct-16 09:45*	12-Oct-16 10:15		12-Oct-16 09:45	12-Oct-16 10:15	3d 6h
A2090	Finishing	0d 0h	12-Oct-16 10:15*	12-Oct-16 10:30		12-Oct-16 10:15	12-Oct-16 10:30	2d 4h
Safety vavle of cylinder head		0d 1h	12-Oct-16 10:30	12-Oct-16 11:15		12-Oct-16 10:30	12-Oct-16 11:15	3d 5h
A2100	Check and make sure that there are no leakages	0d 1h	12-Oct-16 10:30*	12-Oct-16 11:00	A1340	12-Oct-16 10:30	12-Oct-16 11:00	3d 5h
A2110	Finishing	0d 0h	12-Oct-16 11:00*	12-Oct-16 11:15		12-Oct-16 11:00	12-Oct-16 11:15	2d 3h
Main bearing		0d 2h	12-Oct-16 13:30	12-Oct-16 15:15		12-Oct-16 13:30	12-Oct-16 15:15	3d 2h
A2120	Open, check, and measure metal	0d 1h	12-Oct-16 13:30*	12-Oct-16 14:00	A1940, A1340	12-Oct-16 13:30	12-Oct-16 14:00	3d 3h
A2130	Check the tightness value of clamp bolt	0d 1h	12-Oct-16 14:00*	12-Oct-16 14:30		12-Oct-16 14:00	12-Oct-16 14:30	3d 3h
A2140	Check the tightness value of side bolt	0d 1h	12-Oct-16 14:30*	12-Oct-16 15:00		12-Oct-16 14:30	12-Oct-16 15:00	3d 2h
A2150	Finishing	0d 0h	12-Oct-16 15:00*	12-Oct-16 15:15		12-Oct-16 15:00	12-Oct-16 15:15	2d
Report		0d 2h	12-Oct-16 15:15	12-Oct-16 17:00		12-Oct-16 15:15	12-Oct-16 17:00	2d
A2550	Mounting cylinder head no. 4	0d 1h	12-Oct-16 15:15*	12-Oct-16 16:00	A1930, A1960, .	12-Oct-16 15:15	12-Oct-16 16:00	2d
A2160	Complete check for all component in cylinder no. 4	0d 0h	12-Oct-16 16:00*	12-Oct-16 16:15	A2550	12-Oct-16 16:00	12-Oct-16 16:15	2d
A2170	Maintenance result of cylinder no. 4	0d 1h	12-Oct-16 16:15*	12-Oct-16 17:00	A2160	12-Oct-16 16:15	12-Oct-16 17:00	2d
Cyliner no. 5		1d 7h	13-Oct-16 09:15	14-Oct-16 17:00		13-Oct-16 09:15	14-Oct-16 17:00	3d
Fuel injector		0d 1h	13-Oct-16 09:15	13-Oct-16 10:00		13-Oct-16 09:15	13-Oct-16 10:00	2d 6h
A2180	Take out, check, and fitting	0d 0h	13-Oct-16 09:15*	13-Oct-16 09:30	A1350	13-Oct-16 09:15	13-Oct-16 09:30	2d 7h
A2190	Spray test to check the nozzle	0d 0h	13-Oct-16 09:30*	13-Oct-16 09:45		13-Oct-16 09:30	13-Oct-16 09:45	2d 6h
A2200	Finishing	0d 0h	13-Oct-16 09:45*	13-Oct-16 10:00		13-Oct-16 09:45	13-Oct-16 10:00	1d 4h
Piston		0d 2h	13-Oct-16 09:45	13-Oct-16 12:00		13-Oct-16 09:45	13-Oct-16 12:00	2d 4h
A2210	Take out, clean up, and measure piston	0d 1h	13-Oct-16 09:45*	13-Oct-16 11:00	A1350	13-Oct-16 09:45	13-Oct-16 11:00	2d 5h
A2220	Check and measure piston pin	0d 1h	13-Oct-16 11:00*	13-Oct-16 11:45		13-Oct-16 11:00	13-Oct-16 11:45	2d 4h
A2230	Finishing	0d 0h	13-Oct-16 11:45*	13-Oct-16 12:00		13-Oct-16 11:45	13-Oct-16 12:00	1d 2h

Portfolio: All Projects | User: admin | Data Date: 29-Sep-16 08:00 | Access Mode: Shared | Baseline: Current Project



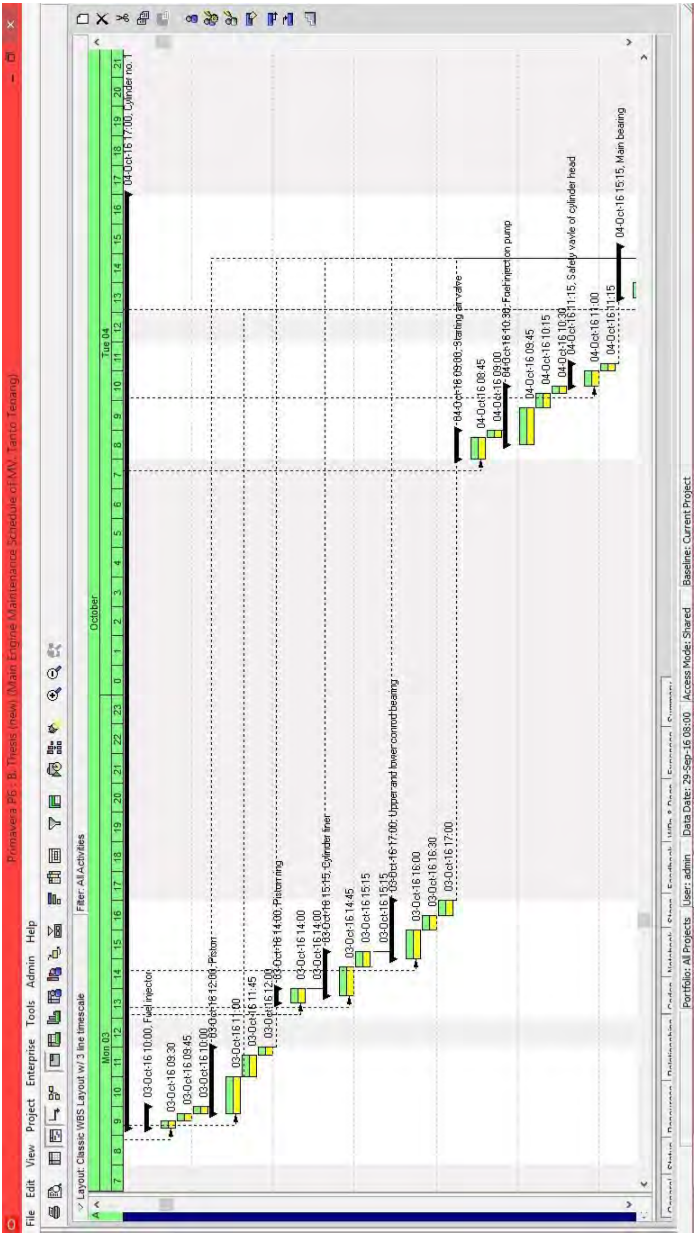
Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	BL Project Start	BL Project Finish	Total Float
Piston ring		0d 1h	13-Oct-16 13:30	13-Oct-16 14:00		13-Oct-16 13:30	13-Oct-16 14:00	2d 3h
A2240	Replace with new piston ring	0d 1h	13-Oct-16 13:30*	13-Oct-16 14:00	A2210, A1030	13-Oct-16 13:30	13-Oct-16 14:00	2d 3h
A2250	Finishing	0d	13-Oct-16 14:00*	13-Oct-16 14:00		13-Oct-16 14:00	13-Oct-16 14:00	1d 1h
Cylinder liner		0d 2h	13-Oct-16 13:45	13-Oct-16 15:15		13-Oct-16 13:45	13-Oct-16 15:15	2d 2h
A2260	Take out, clean up, and check water jacket section	0d 1h	13-Oct-16 13:45*	13-Oct-16 14:45	A1350	13-Oct-16 13:45	13-Oct-16 14:45	2d 2h
A2270	Clean up, check, measure inner diameter	0d 1h	13-Oct-16 14:45*	13-Oct-16 15:15		13-Oct-16 14:45	13-Oct-16 15:15	2d 2h
A2280	Finishing	0d	13-Oct-16 15:15*	13-Oct-16 15:15		13-Oct-16 15:15	13-Oct-16 15:15	1d
Upper and lower conrod bearing		0d 2h	13-Oct-16 15:00	13-Oct-16 17:00		13-Oct-16 15:00	13-Oct-16 17:00	2d
A2290	Check upper and lower conrod bearing unit for clearance and wear measuring	0d 1h	13-Oct-16 15:00*	13-Oct-16 16:00	A1350	13-Oct-16 15:00	13-Oct-16 16:00	2d 1h
A2300	Check the tightness value of connecting rod bolt	0d 1h	13-Oct-16 16:00*	13-Oct-16 16:30		13-Oct-16 16:00	13-Oct-16 16:30	2d 1h
A2310	Finishing	0d 1h	13-Oct-16 16:30*	13-Oct-16 17:00		13-Oct-16 16:30	13-Oct-16 17:00	0d 6h
Starting air valve		0d 1h	14-Oct-16 08:00	14-Oct-16 09:00		14-Oct-16 08:00	14-Oct-16 09:00	1d 7h
A2320	Cleaning and facing up	0d 1h	14-Oct-16 08:00*	14-Oct-16 08:45	A1350	14-Oct-16 08:00	14-Oct-16 08:45	1d 7h
A2330	Finishing	0d 0h	14-Oct-16 08:45*	14-Oct-16 09:00		14-Oct-16 08:45	14-Oct-16 09:00	0d 5h
Fuel injection pump		0d 2h	14-Oct-16 08:30	14-Oct-16 10:30		14-Oct-16 08:30	14-Oct-16 10:30	1d 6h
A2340	Open and clean up the inner side	0d 1h	14-Oct-16 08:30*	14-Oct-16 09:45		14-Oct-16 08:30	14-Oct-16 09:45	1d 6h
A2350	Check for injection timming	0d 1h	14-Oct-16 09:45*	14-Oct-16 10:15		14-Oct-16 09:45	14-Oct-16 10:15	1d 6h
A2360	Finishing	0d 0h	14-Oct-16 10:15*	14-Oct-16 10:30		14-Oct-16 10:15	14-Oct-16 10:30	0d 4h
Safety vavle of cylinder head		0d 1h	14-Oct-16 10:30	14-Oct-16 11:15		14-Oct-16 10:30	14-Oct-16 11:15	1d 5h
A2370	Check and make sure that there are no leakages	0d 1h	14-Oct-16 10:30*	14-Oct-16 11:00	A1350	14-Oct-16 10:30	14-Oct-16 11:00	1d 5h
A2380	Finishing	0d 0h	14-Oct-16 11:00*	14-Oct-16 11:15		14-Oct-16 11:00	14-Oct-16 11:15	0d 3h
Main bearing		0d 2h	14-Oct-16 13:30	14-Oct-16 15:15		14-Oct-16 13:30	14-Oct-16 15:15	1d 2h
A2390	Open, check, and measure metal	0d 1h	14-Oct-16 13:30*	14-Oct-16 14:00	A2210, A1350	14-Oct-16 13:30	14-Oct-16 14:00	1d 3h
A2400	Check the tightness value of clamp bolt	0d 1h	14-Oct-16 14:00*	14-Oct-16 14:30		14-Oct-16 14:00	14-Oct-16 14:30	1d 3h
A2410	Check the tightness value of side bolt	0d 1h	14-Oct-16 14:30*	14-Oct-16 15:00		14-Oct-16 14:30	14-Oct-16 15:00	1d 2h
A2420	Finishing	0d 0h	14-Oct-16 15:00*	14-Oct-16 15:15		14-Oct-16 15:00	14-Oct-16 15:15	0d
Exhaust valve		0d 1h	14-Oct-16 10:30	14-Oct-16 11:30		14-Oct-16 10:30	14-Oct-16 11:30	1d 5h
A2510	Grinding suction and exhaust valve seat	0d 1h	14-Oct-16 10:30*	14-Oct-16 11:00	A2320	14-Oct-16 10:30	14-Oct-16 11:00	1d 5h
A2430	Replace stem seal suction and exhaust valve	0d 0h	14-Oct-16 11:00*	14-Oct-16 11:15		14-Oct-16 11:00	14-Oct-16 11:15	1d 5h
A2440	Finishing	0d 0h	14-Oct-16 11:15*	14-Oct-16 11:30		14-Oct-16 11:15	14-Oct-16 11:30	0d 3h
Report		0d 2h	14-Oct-16 15:15	14-Oct-16 17:00		14-Oct-16 15:15	14-Oct-16 17:00	0d
A2560	Mounting cylinder head no. 5	0d 1h	14-Oct-16 15:15*	14-Oct-16 16:00	A2200, A2230...	14-Oct-16 15:15	14-Oct-16 16:00	0d
A2490	Complete check for all component in cylinder no. 5	0d 0h	14-Oct-16 16:00*	14-Oct-16 16:15	A2560	14-Oct-16 16:00	14-Oct-16 16:15	0d

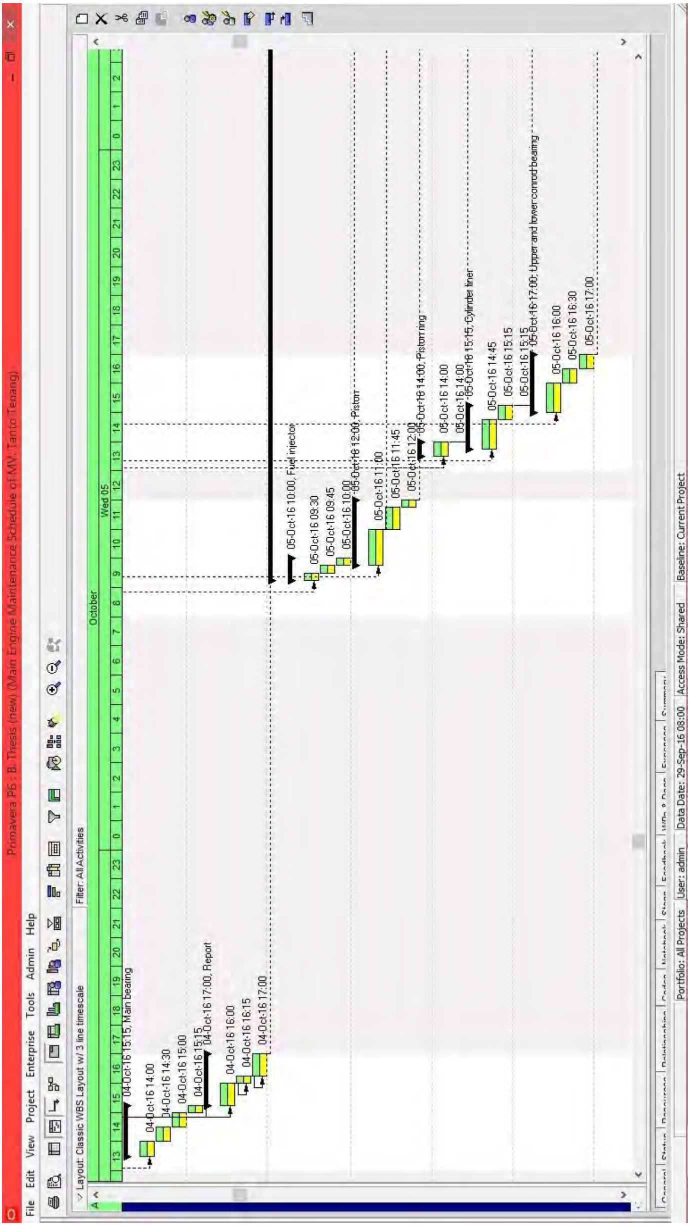


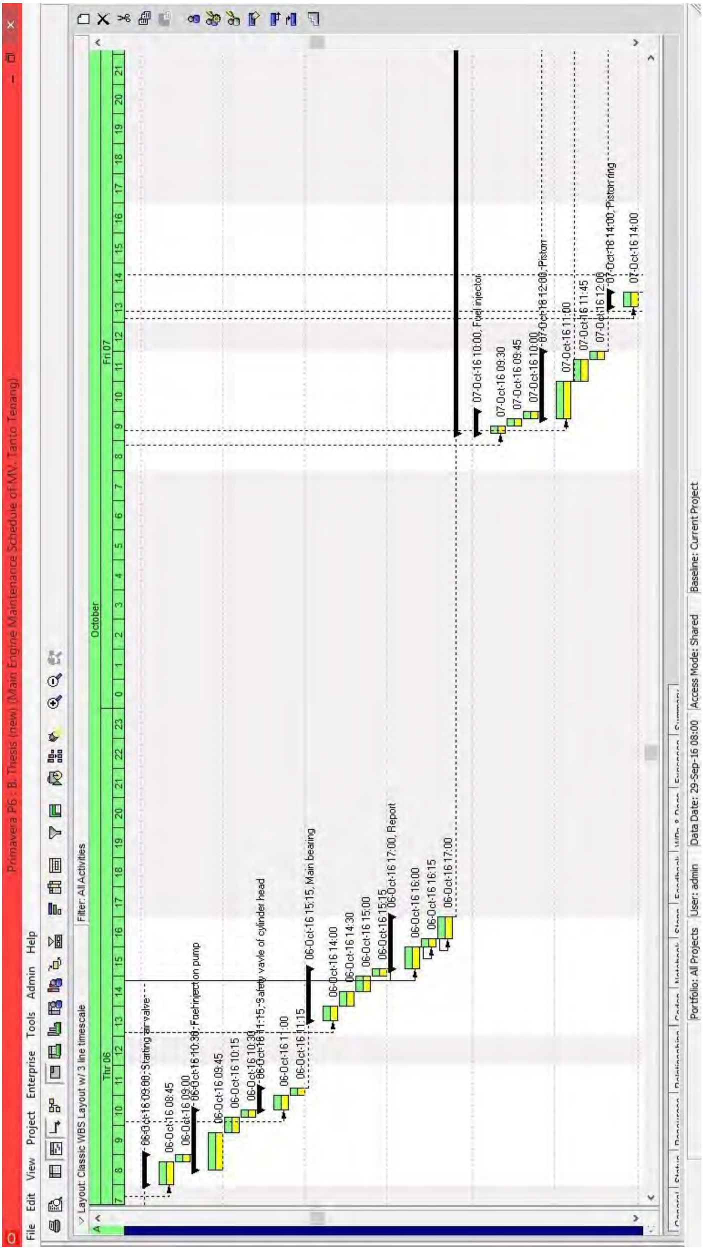
Report		0d 2h	14-Oct-16 15:15	14-Oct-16 17:00		14-Oct-16 15:15	14-Oct-16 17:00	0d
A2560	Mounting cylinder head no. 5	0d 1h	14-Oct-16 15:15*	14-Oct-16 16:00	A2200, A2230, .	14-Oct-16 15:15	14-Oct-16 16:00	0d
A2490	Complete check for all component in cylinder no. 5	0d 0h	14-Oct-16 16:00*	14-Oct-16 16:15	A2560	14-Oct-16 16:00	14-Oct-16 16:15	0d
A2500	Maintenance result of cylinder no. 5	0d 1h	14-Oct-16 16:15*	14-Oct-16 17:00	A2490	14-Oct-16 16:15	14-Oct-16 17:00	0d
Lub. oil sump tank		2d	03-Oct-16 08:00	04-Oct-16 17:00		03-Oct-16 08:00	04-Oct-16 17:00	9d
A2450	Lub. oil system analysis from laboratory	1d	03-Oct-16 08:00*	03-Oct-16 17:00		03-Oct-16 08:00	03-Oct-16 17:00	10d
A2460	Laboratory result	1d	04-Oct-16 08:00*	04-Oct-16 17:00		04-Oct-16 08:00	04-Oct-16 17:00	8d
Report		0d 1h	17-Oct-16 08:00	17-Oct-16 09:00		17-Oct-16 08:00	17-Oct-16 09:00	0d
A2470	Collecting routine reports of each cylinder	0d 1h	17-Oct-16 08:00*	17-Oct-16 09:00	A1290, A1630, .	17-Oct-16 08:00	17-Oct-16 09:00	0d
Closure		0d 7h	17-Oct-16 09:00	17-Oct-16 17:00		17-Oct-16 09:00	17-Oct-16 17:00	0d
A2480	Final report of whole maintenance activity	0d 7h	17-Oct-16 09:00*	17-Oct-16 17:00	A2470	17-Oct-16 09:00	17-Oct-16 17:00	0d

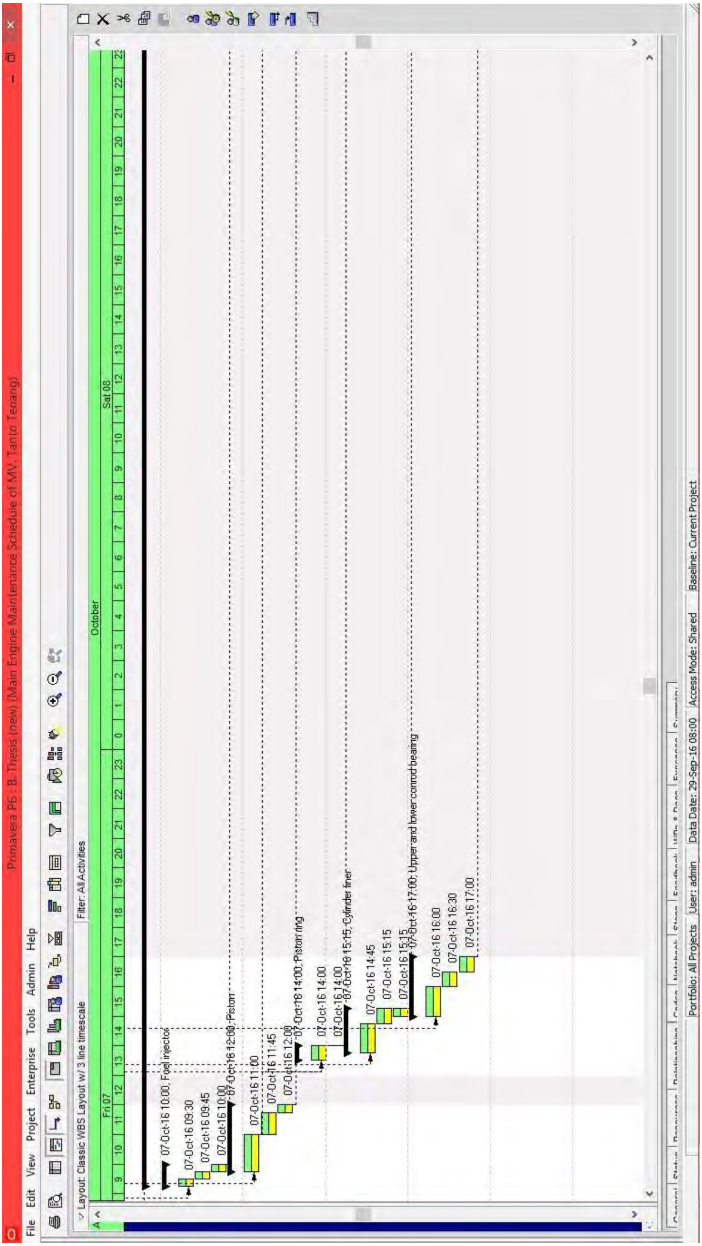
3. Gan Chart


29-Sep-16 17:00
29-Sep-16 17:00
30-Sep-16 17:00
29-Sep-16 17:00, Procurement
29-Sep-16 17:00, Purchasings
29-Sep-16 17:00

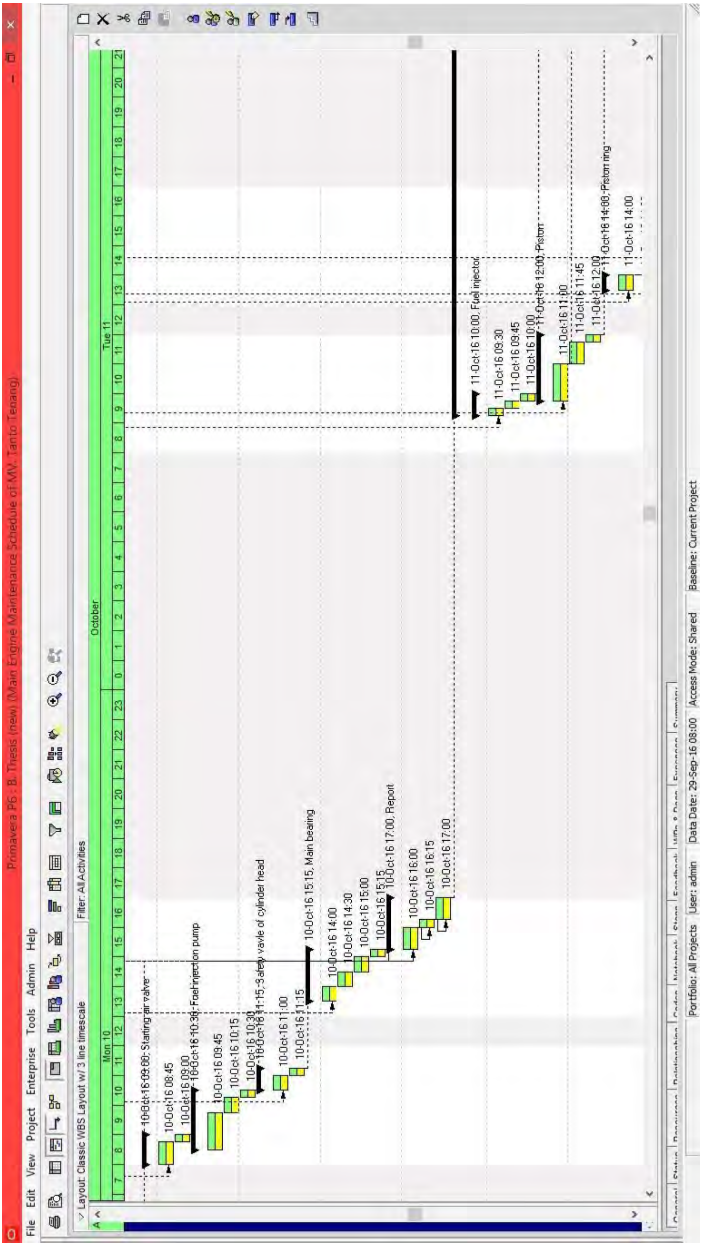

Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Mon 03
Tue 04
04-Oct-16 17:00, Cylinder no. 1
03-Oct-16 10:00, Fuel injector
03-Oct-16 09:30
03-Oct-16 09:45
03-Oct-16 10:00
03-Oct-16 12:00, Piston
03-Oct-16 11:00
03-Oct-16 11:45
03-Oct-16 12:00
03-Oct-16 14:00, Piston ring
03-Oct-16 14:00
03-Oct-16 14:00
03-Oct-16 15:15, Cylinder liner
03-Oct-16 14:45
03-Oct-16 15:15
03-Oct-16 15:15
03-Oct-16 17:00, Upper and lower conrod bearing
03-Oct-16 16:00
03-Oct-16 16:30
03-Oct-16 17:00
04-Oct-16 09:00, Starting air valve
04-Oct-16 08:45
04-Oct-16 09:00
04-Oct-16 10:30, Fuel injection pump
04-Oct-16 09:45
04-Oct-16 10:15
04-Oct-16 10:30
04-Oct-16 11:15, Safety vavle of cylinder head
04-Oct-16 11:00
04-Oct-16 11:15
04-Oct-16 15:15, Main bearing
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

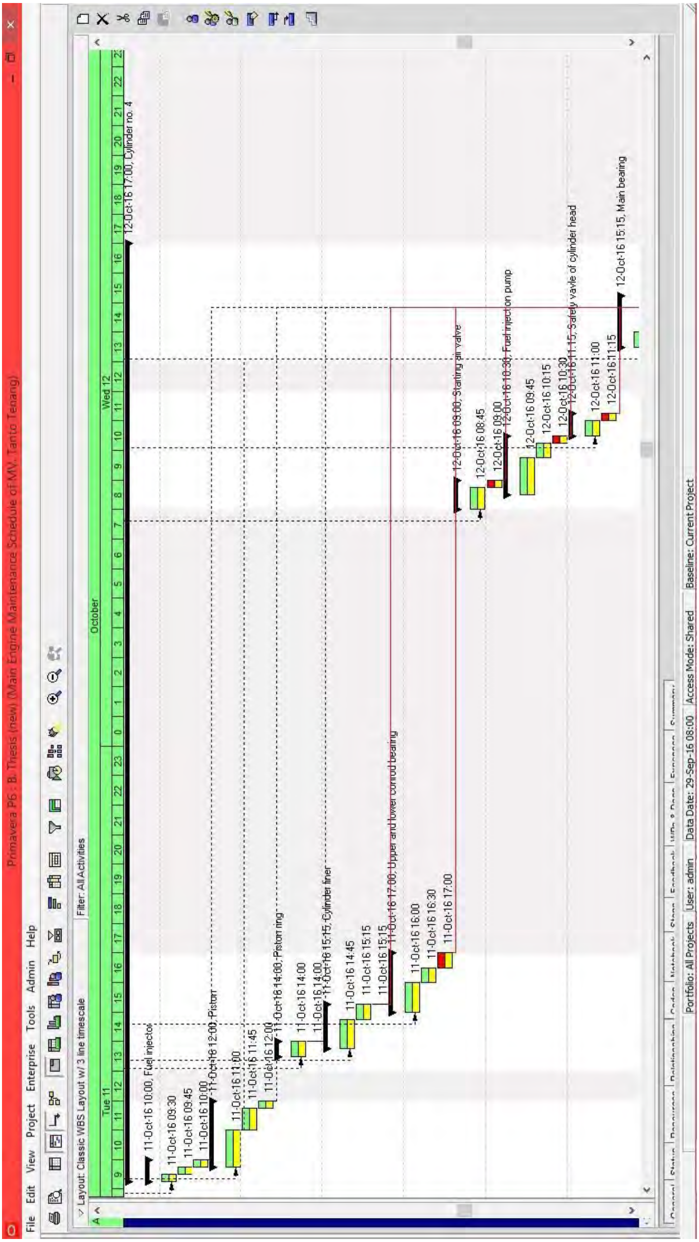

Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Wed 05
13 14 15 16 17 18 19 20 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0 1 2
04-Oct-16 15:15, Main bearing
04-Oct-16 14:00
04-Oct-16 14:30
04-Oct-16 15:00
04-Oct-16 15:15
04-Oct-16 17:00, Report
04-Oct-16 16:00
04-Oct-16 16:15
04-Oct-16 17:00
05-Oct-16 10:00, Fuel injector
05-Oct-16 09:30
05-Oct-16 09:45
05-Oct-16 10:00
05-Oct-16 12:00, Piston
05-Oct-16 11:00
05-Oct-16 11:45
05-Oct-16 12:00
05-Oct-16 14:00, Piston ring
05-Oct-16 14:00
05-Oct-16 14:00
05-Oct-16 15:15, Cylinder liner
05-Oct-16 14:45
05-Oct-16 15:15
05-Oct-16 15:15
05-Oct-16 17:00, Upper and lower conrod bearing
05-Oct-16 16:00
05-Oct-16 16:30
05-Oct-16 17:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

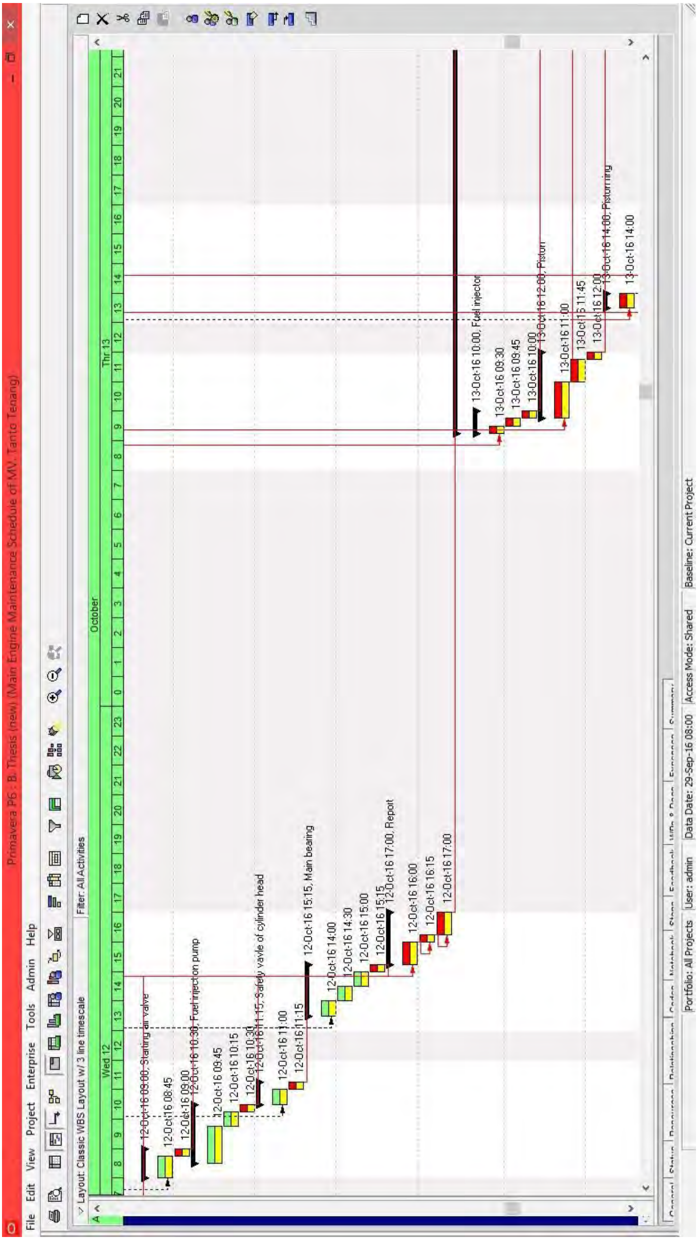

Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Thr 06
Fri 07
06-Oct-16 09:00, Starting air valve
06-Oct-16 08:45
06-Oct-16 09:00
06-Oct-16 10:30, Fuel injection pump
06-Oct-16 09:45
06-Oct-16 10:15
06-Oct-16 10:30
06-Oct-16 11:15, Safety vavle of cylinder head
06-Oct-16 11:00
06-Oct-16 11:15
06-Oct-16 15:15, Main bearing
06-Oct-16 14:00
06-Oct-16 14:30
06-Oct-16 15:00
06-Oct-16 15:15
06-Oct-16 17:00, Report
06-Oct-16 16:00
06-Oct-16 16:15
06-Oct-16 17:00
07-Oct-16 10:00, Fuel injector
07-Oct-16 09:30
07-Oct-16 09:45
07-Oct-16 10:00
07-Oct-16 12:00, Piston
07-Oct-16 11:00
07-Oct-16 11:45
07-Oct-16 12:00
07-Oct-16 14:00, Piston ring
07-Oct-16 14:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project



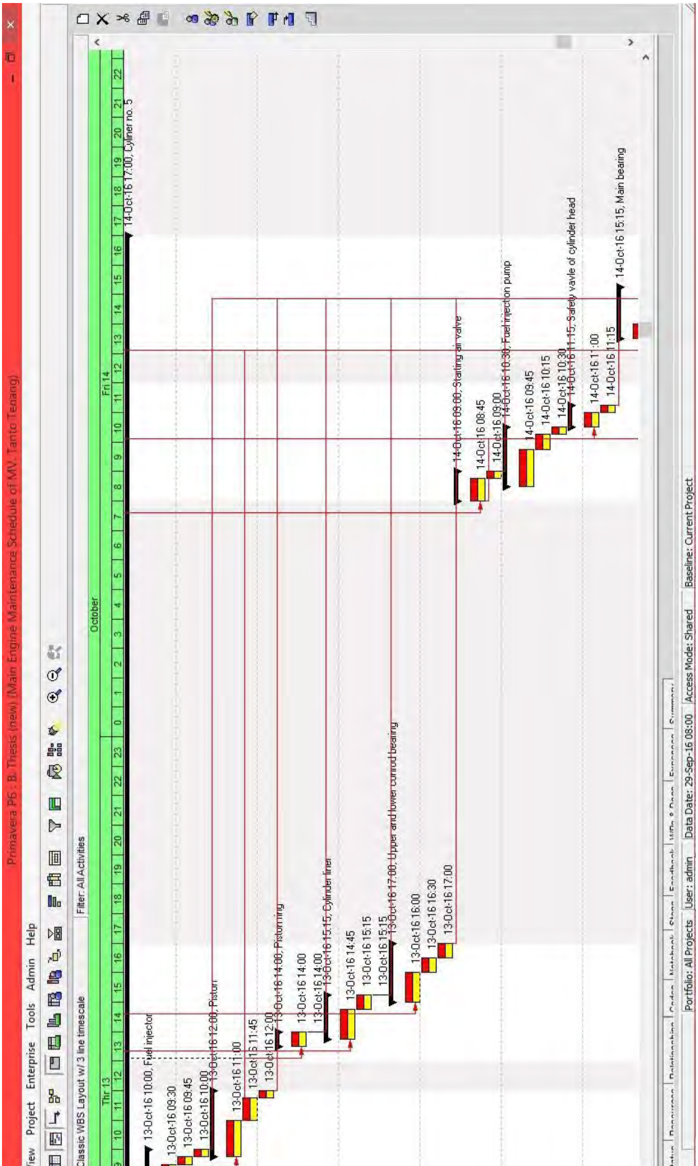
Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Fri 07
Sat 08
07-Oct-16 10:00, Fuel injector
07-Oct-16 09:30
07-Oct-16 09:45
07-Oct-16 10:00
07-Oct-16 12:00, Piston
07-Oct-16 11:00
07-Oct-16 11:45
07-Oct-16 12:00
07-Oct-16 14:00, Piston ring
07-Oct-16 14:00
07-Oct-16 14:00
07-Oct-16 15:15, Cylinder liner
07-Oct-16 14:45
07-Oct-16 15:15
07-Oct-16 15:15
07-Oct-16 17:00, Upper and lower conrod bearing
07-Oct-16 16:00
07-Oct-16 16:30
07-Oct-16 17:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

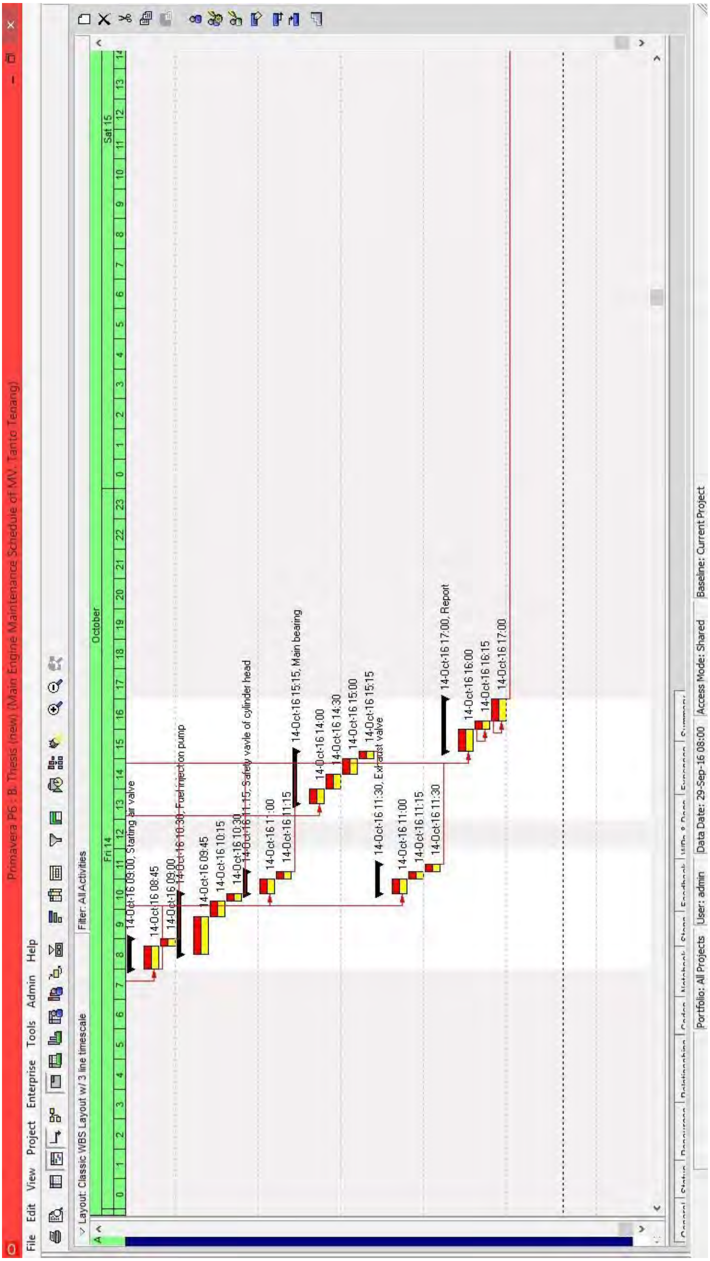

Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Mon 10
Tue 11
10-Oct-16 09:00, Starting air valve
10-Oct-16 08:45
10-Oct-16 09:00
10-Oct-16 10:30, Fuel injection pump
10-Oct-16 09:45
10-Oct-16 10:15
10-Oct-16 10:30
10-Oct-16 11:15, Safety vavle of cylinder head
10-Oct-16 11:00
10-Oct-16 11:15
10-Oct-16 15:15, Main bearing
10-Oct-16 14:00
10-Oct-16 14:30
10-Oct-16 15:00
10-Oct-16 15:15
10-Oct-16 17:00, Report
10-Oct-16 16:00
10-Oct-16 16:15
10-Oct-16 17:00
11-Oct-16 10:00, Fuel injector
11-Oct-16 09:30
11-Oct-16 09:45
11-Oct-16 10:00
11-Oct-16 12:00, Piston
11-Oct-16 11:00
11-Oct-16 11:45
11-Oct-16 12:00
11-Oct-16 14:00, Piston ring
11-Oct-16 14:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project


Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Tue 11
Wed 12
11-Oct-16 10:00, Fuel injector
11-Oct-16 09:30
11-Oct-16 09:45
11-Oct-16 10:00
11-Oct-16 12:00, Piston
11-Oct-16 11:00
11-Oct-16 11:45
11-Oct-16 12:00
11-Oct-16 14:00, Piston ring
11-Oct-16 14:00
11-Oct-16 14:00
11-Oct-16 15:15, Cylinder liner
11-Oct-16 14:45
11-Oct-16 15:15
11-Oct-16 15:15
11-Oct-16 17:00, Upper and lower conrod bearing
11-Oct-16 16:00
11-Oct-16 16:30
11-Oct-16 17:00
12-Oct-16 09:00, Starting air valve
12-Oct-16 08:45
12-Oct-16 09:00
12-Oct-16 10:30, Fuel injection pump
12-Oct-16 09:45
12-Oct-16 10:15
12-Oct-16 10:30
12-Oct-16 11:15, Safety vavle of cylinder head
12-Oct-16 11:00
12-Oct-16 11:15
12-Oct-16 15:15, Main bearing
12-Oct-16 17:00, Cylinder no. 4
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

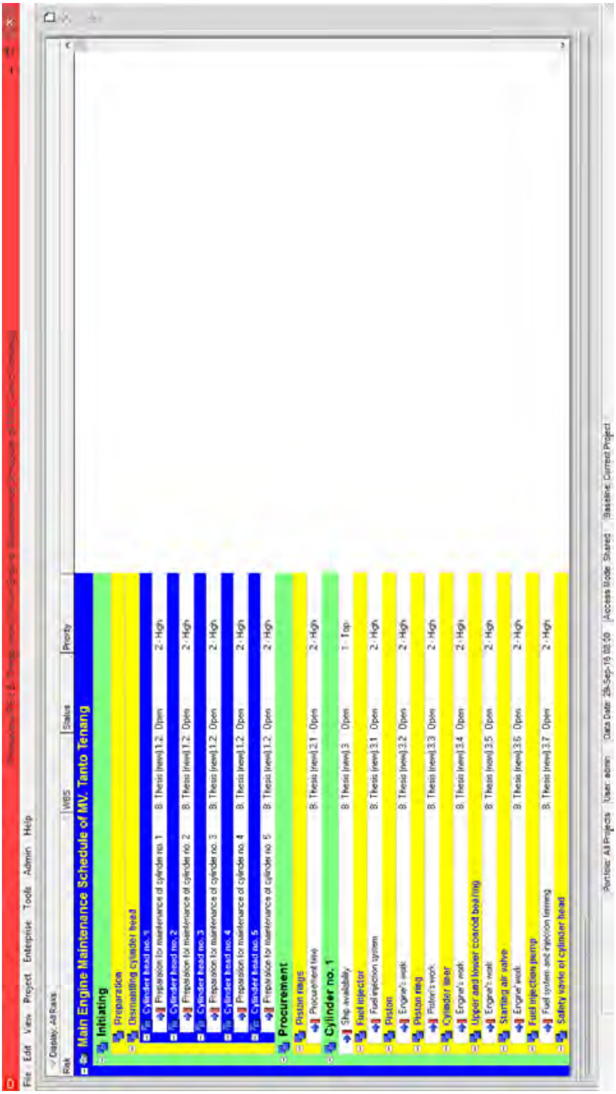


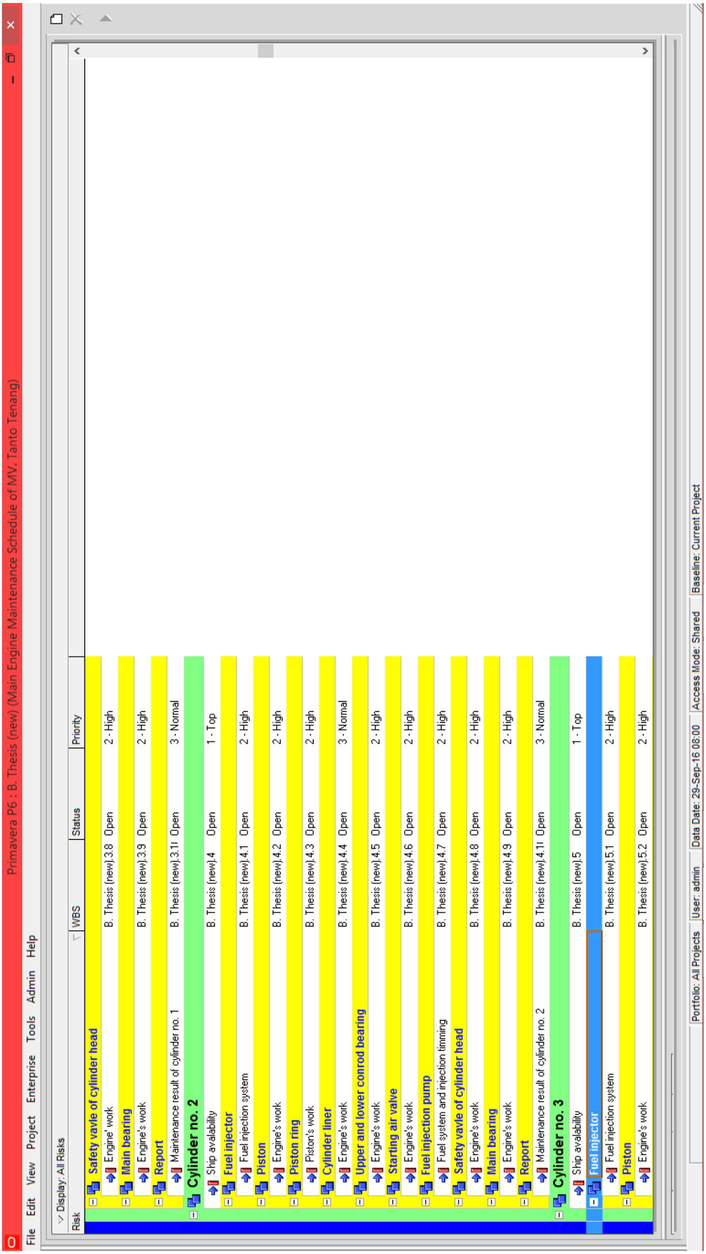
Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Wed 12
Thr 13
12-Oct-16 09:00, Starting air valve
12-Oct-16 08:45
12-Oct-16 09:00
12-Oct-16 10:30, Fuel injection pump
12-Oct-16 09:45
12-Oct-16 10:15
12-Oct-16 10:30
12-Oct-16 11:15, Safety vavle of cylinder head
12-Oct-16 11:00
12-Oct-16 11:15
12-Oct-16 15:15, Main bearing
12-Oct-16 14:00
12-Oct-16 14:30
12-Oct-16 15:00
12-Oct-16 15:15
12-Oct-16 17:00, Report
12-Oct-16 16:00
12-Oct-16 16:15
12-Oct-16 17:00
13-Oct-16 10:00, Fuel injector
13-Oct-16 09:30
13-Oct-16 09:45
13-Oct-16 10:00
13-Oct-16 12:00, Piston
13-Oct-16 11:00
13-Oct-16 11:45
13-Oct-16 12:00
13-Oct-16 14:00, Piston ring
13-Oct-16 14:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project


Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Thr 13
Fri 14
13-Oct-16 10:00, Fuel injector
13-Oct-16 09:30
13-Oct-16 09:45
13-Oct-16 10:00
13-Oct-16 12:00, Piston
13-Oct-16 11:00
13-Oct-16 11:45
13-Oct-16 12:00
13-Oct-16 14:00, Piston ring
13-Oct-16 14:00
13-Oct-16 14:00
13-Oct-16 15:15, Cylinder liner
13-Oct-16 14:45
13-Oct-16 15:15
13-Oct-16 15:15
13-Oct-16 17:00, Upper and lower conrod bearing
13-Oct-16 16:00
13-Oct-16 16:30
13-Oct-16 17:00
14-Oct-16 09:00, Starting air valve
14-Oct-16 08:45
14-Oct-16 09:00
14-Oct-16 10:30, Fuel injection pump
14-Oct-16 09:45
14-Oct-16 10:15
14-Oct-16 10:30
14-Oct-16 11:15, Safety vavle of cylinder head
14-Oct-16 11:00
14-Oct-16 11:15
14-Oct-16 15:15, Main bearing
14-Oct-16 17:00, Cyliner no. 5
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

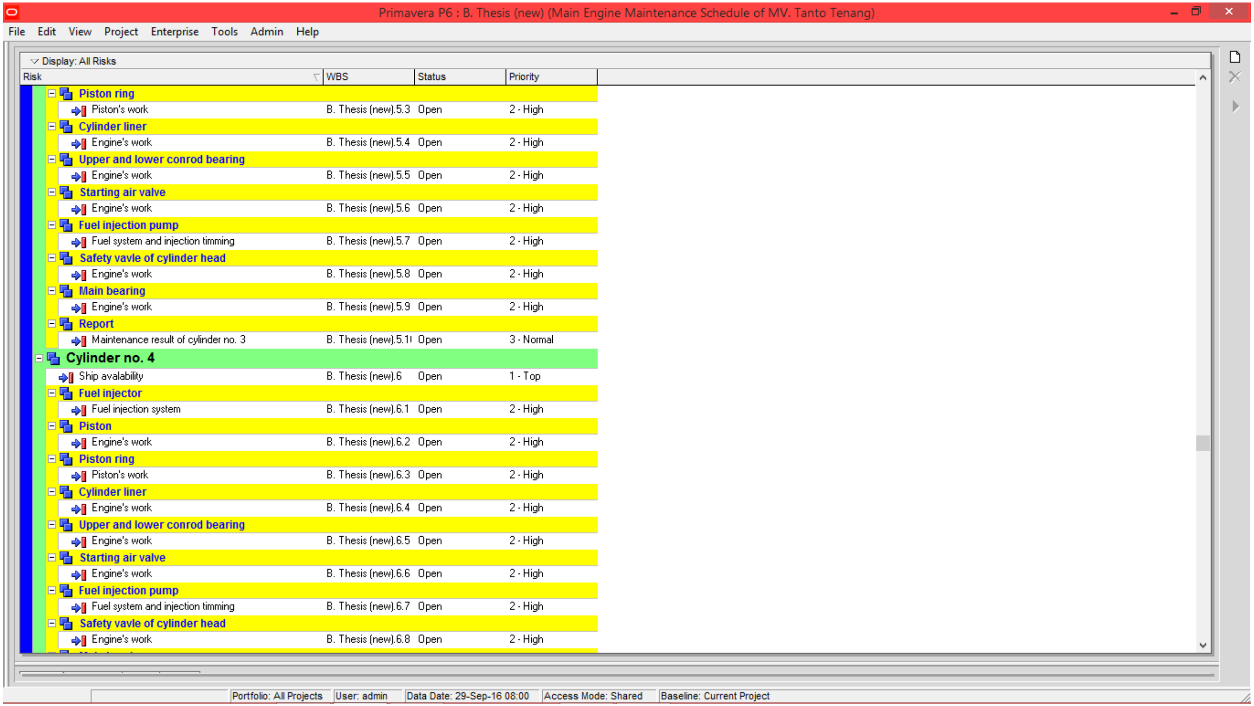

Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Layout: Classic WBS Layout w/ 3 line timescale
Filter: All Activities
October
Fri 14
Sat 15
14-Oct-16 09:00, Starting air valve
14-Oct-16 08:45
14-Oct-16 09:00
14-Oct-16 10:30, Fuel injection pump
14-Oct-16 09:45
14-Oct-16 10:15
14-Oct-16 10:30
14-Oct-16 11:15, Safety vavle of cylinder head
14-Oct-16 11:15
14-Oct-16 15:15, Main bearing
14-Oct-16 14:00
14-Oct-16 14:30
14-Oct-16 15:00
14-Oct-16 15:15
14-Oct-16 11:30, Exhaust valve
14-Oct-16 11:00
14-Oct-16 11:15
14-Oct-16 11:30
14-Oct-16 17:00, Report
14-Oct-16 16:00
14-Oct-16 16:15
14-Oct-16 17:00
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

4. Risks

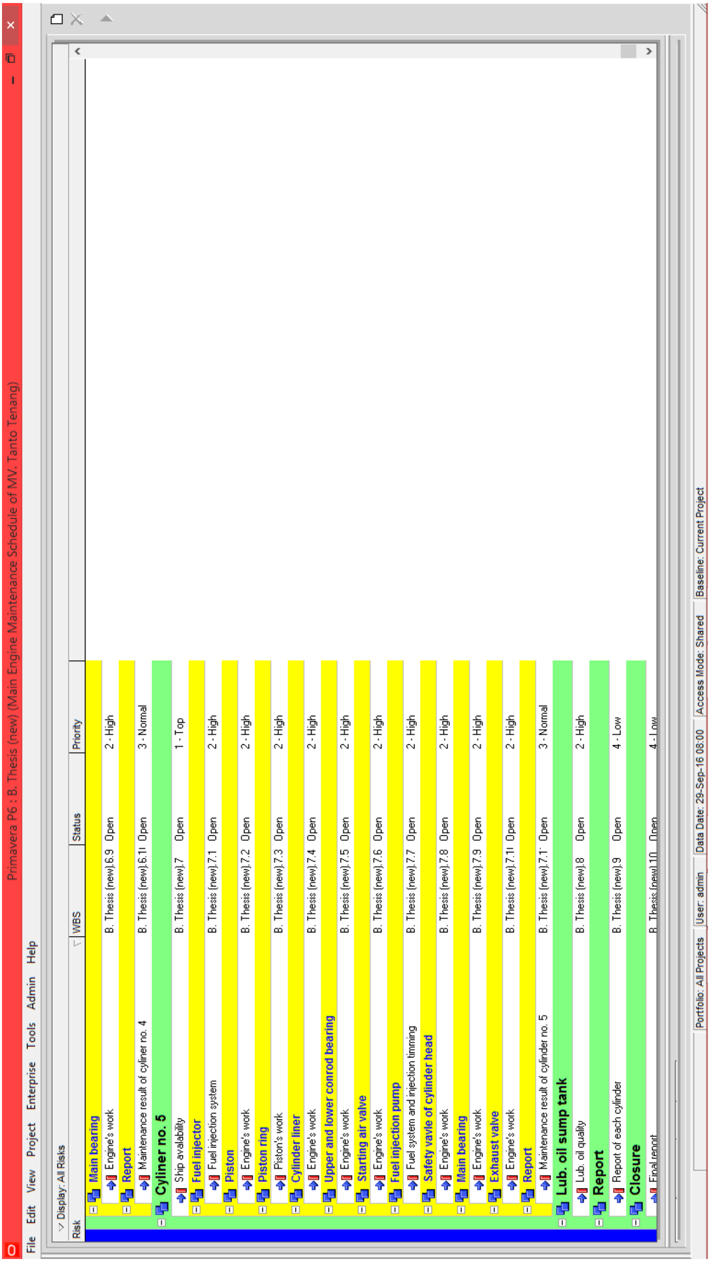

File Edit View Project Enterprise Tools Admin Help
Display: All Risks
Risk
WBS
Status
Priority
Main Engine Maintenance Schedule of MV. Tanto Tenang
Initiating
Preparation
Dismantling cylinder head
Cylinder head no. 1
Preparation for maintenance of cylinder no. 1 B. Thesis (new) 1.2 Open 2 - High
Cylinder head no. 2
Preparation for maintenance of cylinder no. 2 B. Thesis (new) 1.2 Open 2 - High
Cylinder head no. 3
Preparation for maintenance of cylinder no. 3 B. Thesis (new) 1.2 Open 2 - High
Cylinder head no. 4
Preparation for maintenance of cylinder no. 4 B. Thesis (new) 1.2 Open 2 - High
Cylinder head no. 5
Preparation for maintenance of cylinder no. 5 B. Thesis (new) 1.2 Open 2 - High
Procurement
Piston rings
Procurement time B. Thesis (new) 2.1 Open 2 - High
Cylinder no. 1
Ship availability B. Thesis (new) 3 Open 1 - Top
Fuel injector
Fuel injection system B. Thesis (new) 3.1 Open 2 - High
Piston
Engine's work B. Thesis (new) 3.2 Open 2 - High
Piston ring
Piston's work B. Thesis (new) 3.3 Open 2 - High
Cylinder liner
Engine's work B. Thesis (new) 3.4 Open 2 - High
Upper and lower conrod bearing
Engine's work B. Thesis (new) 3.5 Open 2 - High
Starting air valve
Engine' work B. Thesis (new) 3.6 Open 2 - High
Fuel injection pump
Fuel system and injection timing B. Thesis (new) 3.7 Open 2 - High
Safety valve of cylinder head
Portfolio: All Projects User: admin Data Date: 28-Sep-16 08:00 Access Mode: Shared Baseline: Current Project



Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Display: All Risks
Risk | WBS | Status | Priority
Safety vavle of cylinder head
Engine' work | B. Thesis (new).3.8 | Open | 2 - High
Main bearing
Engine's work | B. Thesis (new).3.9 | Open | 2 - High
Report
Maintenance result of cylinder no. 1 | B. Thesis (new).3.1 | Open | 3 - Normal
Cylinder no. 2
Ship avalability | B. Thesis (new).4 | Open | 1 - Top
Fuel injector
Fuel injection system | B. Thesis (new).4.1 | Open | 2 - High
Piston
Engine's work | B. Thesis (new).4.2 | Open | 2 - High
Piston ring
Piston's work | B. Thesis (new).4.3 | Open | 2 - High
Cylinder liner
Engine's work | B. Thesis (new).4.4 | Open | 3 - Normal
Upper and lower conrod bearing
Engine's work | B. Thesis (new).4.5 | Open | 2 - High
Starting air valve
Engine's work | B. Thesis (new).4.6 | Open | 2 - High
Fuel injection pump
Fuel system and injection timming | B. Thesis (new).4.7 | Open | 2 - High
Safety vavle of cylinder head
Engine's work | B. Thesis (new).4.8 | Open | 2 - High
Main bearing
Engine's work | B. Thesis (new).4.9 | Open | 2 - High
Report
Maintenance result of cylinder no. 2 | B. Thesis (new).4.1 | Open | 3 - Normal
Cylinder no. 3
Ship avalability | B. Thesis (new).5 | Open | 1 - Top
Fuel injector
Fuel injection system | B. Thesis (new).5.1 | Open | 2 - High
Piston
Engine's work | B. Thesis (new).5.2 | Open | 2 - High
Portfolio: All Projects | User: admin | Data Date: 29-Sep-16 08:00 | Access Mode: Shared | Baseline: Current Project


Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Display: All Risks
Risk | WBS | Status | Priority
Piston ring
Piston's work | B. Thesis (new).5.3 | Open | 2 - High
Cylinder liner
Engine's work | B. Thesis (new).5.4 | Open | 2 - High
Upper and lower conrod bearing
Engine's work | B. Thesis (new).5.5 | Open | 2 - High
Starting air valve
Engine's work | B. Thesis (new).5.6 | Open | 2 - High
Fuel injection pump
Fuel system and injection timming | B. Thesis (new).5.7 | Open | 2 - High
Safety vavle of cylinder head
Engine's work | B. Thesis (new).5.8 | Open | 2 - High
Main bearing
Engine's work | B. Thesis (new).5.9 | Open | 2 - High
Report
Maintenance result of cylinder no. 3 | B. Thesis (new).5.1! | Open | 3 - Normal
Cylinder no. 4
Ship avalability | B. Thesis (new).6 | Open | 1 - Top
Fuel injector
Fuel injection system | B. Thesis (new).6.1 | Open | 2 - High
Piston
Engine's work | B. Thesis (new).6.2 | Open | 2 - High
Piston ring
Piston's work | B. Thesis (new).6.3 | Open | 2 - High
Cylinder liner
Engine's work | B. Thesis (new).6.4 | Open | 2 - High
Upper and lower conrod bearing
Engine's work | B. Thesis (new).6.5 | Open | 2 - High
Starting air valve
Engine's work | B. Thesis (new).6.6 | Open | 2 - High
Fuel injection pump
Fuel system and injection timming | B. Thesis (new).6.7 | Open | 2 - High
Safety vavle of cylinder head
Engine's work | B. Thesis (new).6.8 | Open | 2 - High
Portfolio: All Projects | User: admin | Data Date: 29-Sep-16 08:00 | Access Mode: Shared | Baseline: Current Project

4.


Primavera P6 : B. Thesis (new) (Main Engine Maintenance Schedule of MV. Tanto Tenang)
File Edit View Project Enterprise Tools Admin Help
Display: All Risks
Risk
WBS
Status
Priority
Main bearing
Engine's work B. Thesis (new).6.9 Open 2 - High
Report
Maintenance result of cyliner no. 4 B. Thesis (new).6.1I Open 3 - Normal
Cyliner no. 5
Ship avalability B. Thesis (new).7 Open 1 - Top
Fuel injector
Fuel injection system B. Thesis (new).7.1 Open 2 - High
Piston
Engine's work B. Thesis (new).7.2 Open 2 - High
Piston ring
Piston's work B. Thesis (new).7.3 Open 2 - High
Cylinder liner
Engine's work B. Thesis (new).7.4 Open 2 - High
Upper and lower conrod bearing
Engine's work B. Thesis (new).7.5 Open 2 - High
Starting air valve
Engine's work B. Thesis (new).7.6 Open 2 - High
Fuel injection pump
Fuel system and injection timming B. Thesis (new).7.7 Open 2 - High
Safety vavle of cylinder head
Engine's work B. Thesis (new).7.8 Open 2 - High
Main bearing
Engine's work B. Thesis (new).7.9 Open 2 - High
Exhaust valve
Engine's work B. Thesis (new).7.1I Open 2 - High
Report
Maintenance result of cylinder no. 5 B. Thesis (new).7.1 Open 3 - Normal
Lub. oil sump tank
Lub. oil quality B. Thesis (new).8 Open 2 - High
Report
Report of each cylinder B. Thesis (new).9 Open 4 - Low
Closure
Final report
Portfolio: All Projects
User: admin
Data Date: 29-Sep-16 08:00
Access Mode: Shared
Baseline: Current Project

5. Working Hour

No.	Component M/E	Working Hour of Each Component on 2015											
		January	February	March	April	May	June	July	August	September	October	November	December
A	1500 Hours												
1	Fuel injector no. 1	1589.21	1908.59	402.38	762.28	1131.2	1448.49	o	x	x	o	x	x
2	Fuel injector no. 2	757.17	319.38	722.16	1082	225.48	543.18	x	x	o	x	x	o
3	Fuel injector no. 3	757.17	721.5	1122.28	0	368.55	685.04	x	x	o	x	x	o
4	Fuel injector no. 4	1000.42	1320.2	1722.58	270.34	639.29	956.58	x	x	o	x	x	o
5	Fuel injector no. 5	1589.21	1908.59	154.25	514.15	882.1	1219.39	x	o	x	x	o	x
B	3500 Hours												
1	Exhasut valve no. 1	1715.56	2035.34	2438.12	762.28	1131.2	1448.49	x	x	x	o	x	x
2	Exhasut valve no. 2	1715.56	2035.34	2438.12	149.59	518.14	835.43	x	x	x	x	x	o
3	Exhasut valve no. 3	1715.56	2035.34	2438.12	2789.02	3166.6	3484.14	x	x	x	x	x	x
4	Exhasut valve no. 4	1715.56	2035.34	2438.12	270.34	639.29	956.58	x	x	x	x	x	x
5	Exhasut valve no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
6	Lubricating Oil Sump Tank	1151.3	1471.08	1873.46	2236.36	2599.3	2916.49	x	o	x	x	x	x
C	6000 Hours												
1	Piston no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
2	Piston no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
3	Piston no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
4	Piston no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
5	Piston no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
6	Ring piston cylinder no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
7	Ring piston cylinder no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	30.13	x	x	x	x	x	x
8	Ring piston cylinder no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
9	Ring piston cylinder no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o
10	Ring piston cylinder no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	o

D	8000 Hours												
1	Cylinder liner no.1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
2	Cylinder liner no.2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
3	Cylinder liner no.3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
4	Cylinder liner no.4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
5	Cylinder liner no.5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
E	8000 Hours												
1	Main Bearing no.6	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
2	Upper and lower conrod bearing no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
3	Upper and lower conrod bearing no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
4	Upper and lower conrod bearing no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
5	Upper and lower conrod bearing no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
6	Upper and lower conrod bearing no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
7	Starting air valve no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
8	Starting air valve no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
9	Starting air valve no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
10	Starting air valve no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
11	Starting air valve no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
12	Safety valve of cylinder head no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
13	Safety valve of cylinder head no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
14	Safety valve of cylinder head no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
15	Safety valve of cylinder head no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
16	Safety valve of cylinder head no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
17	Fuel injection pump no. 1	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
18	Fuel injection pump no. 2	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
19	Fuel injection pump no. 3	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
20	Fuel injection pump no. 4	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x

21	Fuel injection pump no. 5	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
F	**12000 Hours**												
1	Turbocharger	997.52	1317.3	1720.08	2079.58	2448.1	2764.19	x	x	x	x	x	x
G	**60 Months (approximate 30000 Hours)**												
1	Woodward governor	1715.56	2035.34	2438.12	2798.02	3166.6	3484.14	x	x	x	x	x	x
Total of running hour		355.05	319.38	402.38	359.5	368.55	314.29						

No.	Component M/E	Working Hour of Each Component on 2016 (Prediction based on monthly working hours on 2015 and without any accident)											
		January	February	March	April	May	June	July	August	September	October	November	December
A	**1500 Hours**												
1	Fuel injector no. 1	o	x	x	o	x	x	o	x	x	x	o	x
2	Fuel injector no. 2	x	x	o	x	x	o	x	x	o	x	x	o
3	Fuel injector no. 3	x	x	o	x	x	o	x	x	o	x	x	o
4	Fuel injector no. 4	x	x	o	x	x	o	x	x	o	x	x	o
5	Fuel injector no. 5	x	o	x	x	o	x	x	o	x	x	o	x
B	**3500 Hours**												
1	Exhasut valve no. 1	x	x	x	x	x	o	x	x	x	x	x	x
2	Exhasut valve no. 2	x	x	x	x	x	x	x	o	x	x	x	x
3	Exhasut valve no. 3	x	x	x	x	x	o	x	x	x	x	x	x
4	Exhasut valve no. 4	x	x	o	x	x	x	x	x	x	x	x	x
5	Exhasut valve no. 5	x	x	x	x	x	o	x	x	x	x	x	x
6	Lubricating Oil Sump Tank	x	x	x	x	o	x	x	x	x	x	x	x
C	**6000 Hours**												
1	Piston no. 1	x	x	x	x	x	x	x	x	x	x	x	o
2	Piston no. 2	x	x	x	x	x	x	x	x	x	x	x	o
3	Piston no. 3	x	x	x	x	x	x	x	x	x	x	x	o
4	Piston no. 4	x	x	x	x	x	x	x	x	x	x	x	o
5	Piston no. 5	x	x	x	x	x	x	x	x	x	x	x	o
6	Ring piston cylinder no. 1	x	x	x	x	x	x	x	x	x	x	x	o
7	Ring piston cylinder no. 2	x	x	x	x	x	o	x	x	x	x	x	x
8	Ring piston cylinder no. 3	x	x	x	x	x	x	x	x	x	x	x	o
9	Ring piston cylinder no. 4	x	x	x	x	x	x	x	x	x	x	x	o
10	Ring piston cylinder no. 5	x	x	x	x	x	x	x	x	x	x	x	o

D	8000 Hours												
1	Cylinder liner no.1	x	x	x	x	x	x	x	o	x	x	x	x
2	Cylinder liner no.2	x	x	x	x	x	x	x	o	x	x	x	x
3	Cylinder liner no.3	x	x	x	x	x	x	x	o	x	x	x	x
4	Cylinder liner no.4	x	x	x	x	x	x	x	o	x	x	x	x
5	Cylinder liner no.5	x	x	x	x	x	x	x	o	x	x	x	x
E	8000 Hours												
1	Main Bearing	x	x	x	x	x	x	x	o	x	x	x	x
2	Upper and lower conrod bearing no. 1	x	x	x	x	x	x	x	o	x	x	x	x
3	Upper and lower conrod bearing no. 2	x	x	x	x	x	x	x	o	x	x	x	x
4	Upper and lower conrod bearing no. 3	x	x	x	x	x	x	x	o	x	x	x	x
5	Upper and lower conrod bearing no. 4	x	x	x	x	x	x	x	o	x	x	x	x
6	Upper and lower conrod bearing no. 5	x	x	x	x	x	x	x	o	x	x	x	x
7	Starting air valve no. 1	x	x	x	x	x	x	x	o	x	x	x	x
8	Starting air valve no. 2	x	x	x	x	x	x	x	o	x	x	x	x
9	Starting air valve no. 3	x	x	x	x	x	x	x	o	x	x	x	x
10	Starting air valve no. 4	x	x	x	x	x	x	x	o	x	x	x	x
11	Starting air valve no. 5	x	x	x	x	x	x	x	o	x	x	x	x
12	Safety valve of cylinder head no. 1	x	x	x	x	x	x	x	o	x	x	x	x
13	Safety valve of cylinder head no. 2	x	x	x	x	x	x	x	o	x	x	x	x
14	Safety valve of cylinder head no. 3	x	x	x	x	x	x	x	o	x	x	x	x
15	Safety valve of cylinder head no. 4	x	x	x	x	x	x	x	o	x	x	x	x
16	Safety valve of cylinder head no. 5	x	x	x	x	x	x	x	o	x	x	x	x
17	Fuel injection pump no. 1	x	x	x	x	x	x	x	o	x	x	x	x
18	Fuel injection pump no. 2	x	x	x	x	x	x	x	o	x	x	x	x
19	Fuel injection pump no. 3	x	x	x	x	x	x	x	o	x	x	x	x
20	Fuel injection pump no. 4	x	x	x	x	x	x	x	o	x	x	x	x

21	Fuel injection pump no. 5	x	x	x	x	x	x	x	o	x	x	x	x
F	**12000 Hours**												
1	Turbocharger	x	x	x	x	x	x	x	x	x	x	x	x
G	**60 Months (approximate 30000 Hours)**												
1	Woodward governor	x	x	x	x	x	x	x	x	x	x	x	x
Total of running hour													

PT. TANTO INTIM LINE			PLAN MAINTENANCE SYSTEM	Vessel	KM. Tanto Tenang		
Group : 1-Main Engine				Month	January 31, 2015		
		Components	Working List	FREQ UNIT [HOUR]	RUNNING HOUR	Working Date	Exectioner
1.1.1	CYLINDER NO. 1	Injector	Take out, check, fitting	1500	1589.21		
1.1.2		Cylinder Head	Check and fitting Valve Head Clearance	1500	1715.56		
			Check Valve Spring	5000	1715.56		
			Open and check Valve Rotator	5000	1715.56		
			Open Cylinder Head and clean up	10000	1715.56		
			Grinding Suction and Exhaust Valve Seat	10000	1715.56		
			Clean up Water Chamber from crust and Hydraulic Test	10000	1715.56		
			Replace Stem Seal Suction and Exhaust Valve	10000	1715.56		
			Check the tightness value of Cylinder Head Bolt	10000	1715.56		
1.1.3		Piston	Take out, clean up, check and measure piston	10000	1715.56		
			Check and measure Piston Rings	10000	1715.56		
			Check and measure Piston Pin	10000	1715.56		
1.1.4		Connecting Rod	Check and measure Piston Pin Metal	10000	1715.56		
			Check and measure Crank Pin Metal	10000	1715.56		
			Check the tightness value of Connecting Rod Bolt	10000	1715.56		
			Replace the Connecting Rod Bolt	10000	1715.56		
1.1.5		Cylinder Liner	Clean up, check and measure inner diameter	10000	1715.56		
			Take out, clean up and check water jacket section	20000	1715.56		
1.1.6		Crankshaft	Measure Journal and outter diameter of Crank Pin	10000	1715.56		
			Measure Web Deflection	2500	1715.56		

1.1.7		**Main Bearing**	Open, check and measure Metal	10000	1715.56		
			Check the tightness value of clamp Bolt	10000	1715.56		
			Check the tightness value of Side Bolt	10000	1715.56		
1.2.1		**Injector**	Take out, check, fitting	1500	402.12	January 26, 2016	Chief of engine room
1.2.2		**Cylinder Head**	Check and fitting Valve Head Clearance	1500	1715.56		
			Check Valve Spring	5000	1715.56		
			Open and check Valve Rotator	5000	1715.56		
			Open Cylinder Head and clean up	10000	1715.56		
			Grinding Suction and Exhaust Valve Seat	10000	1715.56		
	C		Clean up Water Chamber from crust and Hydraulic Test	10000	1715.56		
	Y		Replace Stem Seal Suction and Exhaust Valve	10000	1715.56		
	L		Check the tightness value of Cylinder Head Bolt	10000	1715.56		
	I						
1.2.3	**N**	**Piston**	Take out, clean up, check and measure piston	10000	1715.56		
	D		Check and measure Piston Rings	10000	1715.56		
	E		Check and measure Piston Pin	10000	1715.56		
1.2.4	**R**	**Connecting Rod**	Check and measure Piston Pin Metal	10000	1715.56		
	N		Check and measure Crank Pin Metal	10000	1715.56		
	O		Check the tightness value of Connecting Rod Bolt	10000	1715.56		
	.		Replace the Connecting Rod Bolt	10000	1715.56		
1.2.5	**2**	**Cylinder Liner**	Clean up, check and measure inner diameter	10000	1715.56		
			Take out, clean up and check water jacket section	20000	1715.56		
1.2.6		**Crankshaft**	Measure Journal and outter diameter of Crank Pin	10000	1715.56		
			Measure Web Deflection	2500	1715.56		
1.2.7		**Main Bearing**	Open, check and measure Metal	10000	1715.56		
			Check the tightness value of clamp Bolt	10000	1715.56		
			Check the tightness value of Side Bolt	10000	1715.56		

1.3.1	**C Y L I N D E R N O . 3**	**Injector**	Take out, check, fitting	1500	402.12		
1.3.2		**Cylinder Head**	Check and fitting Valve Head Clearance	1500	1715.56		
			Check Valve Spring	5000	1715.56		
			Open and check Valve Rotator	5000	1715.56		
			Open Cylinder Head and clean up	10000	1715.56		
			Grinding Suction and Exhaust Valve Seat	10000	1715.56		
			Clean up Water Chamber from crust and Hydraulic Test	10000	1715.56		
			Replace Stem Seal Suction and Exhaust Valve	10000	1715.56		
			Check the tightness value of Cylinder Head Bolt	10000	1715.56		
1.3.3		**Piston**	Take out, clean up, check and measure piston	10000	1715.56		
			Check and measure Piston Rings	10000	1715.56		
			Check and measure Piston Pin	10000	1715.56		
1.3.4		**Connecting Rod**	Check and measure Piston Pin Metal	10000	1715.56		
			Check and measure Crank Pin Metal	10000	1715.56		
			Check the tightness value of Connecting Rod Bolt	10000	1715.56		
			Replace the Connecting Rod Bolt	10000	1715.56		
1.3.5		**Cylinder Liner**	Clean up, check and measure inner diameter	10000	1715.56		
			Take out, clean up and check water jacket section	20000	1715.56		
1.3.6		**Crankshaft**	Measure Journal and outter diameter of Crank Pin	10000	1715.56		
			Measure Web Deflection	2500	1715.56		
1.3.7		**Main Bearing**	Open, check and measure Metal	10000	1715.56		
			Check the tightness value of clamp Bolt	10000	1715.56		
			Check the tightness value of Side Bolt	10000	1715.56		

1.4.1		**Injector**	Take out, check, fitting	1500	645.37		
1.4.2		**Cylinder Head**	Check and fitting Valve Head Clearance	1500	1715.56		
			Check Valve Spring	5000	1715.56		
			Open and check Valve Rotator	5000	1715.56		
			Open Cylinder Head and clean up	10000	1715.56		
			Grinding Suction and Exhaust Valve Seat	10000	1715.56		
	CYLINDER NO. 4		Clean up Water Chamber from crust and Hydraulic Test	10000	1715.56		
			Replace Stem Seal Suction and Exhaust Valve	10000	1715.56		
			Check the tightness value of Cylinder Head Bolt	10000	1715.56		
1.4.3		**Piston**	Take out, clean up, check and measure piston	10000	1715.56		
			Check and measure Piston Rings	10000	1715.56		
			Check and measure Piston Pin	10000	1715.56		
1.4.4		**Connecting Rod**	Check and measure Piston Pin Metal	10000	1715.56		
			Check and measure Crank Pin Metal	10000	1715.56		
			Check the tightness value of Connecting Rod Bolt	10000	1715.56		
			Replace the Connecting Rod Bolt	10000	1715.56		
1.4.5		**Cylinder Liner**	Clean up, check and measure inner diameter	10000	1715.56		
			Take out, clean up and check water jacket section	20000	1715.56		
1.4.6		**Crankshaft**	Measure Journal and outter diameter of Crank Pin	10000	1715.56		
			Measure Web Deflection	2500	1715.56		
1.4.7		**Main Bearing**	Open, check and measure Metal	10000	1715.56		
			Check the tightness value of clamp Bolt	10000	1715.56		
			Check the tightness value of Side Bolt	10000	1715.56		

1.5.1		**Injector**	Take out, check, fitting	1500	1234.16		
1.5.2		**Cylinder Head**	Check and fitting Valve Head Clearance	1500	1715.56		
			Check Valve Spring	5000	1715.56		
			Open and check Valve Rotator	5000	1715.56		
			Open Cylinder Head and clean up	10000	1715.56		
			Grinding Suction and Exhaust Valve Seat	10000	1715.56		
	C		Clean up Water Chamber from crust and Hydraulic Test	10000	1715.56		
	Y		Replace Stem Seal Suction and Exhaust Valve	10000	1715.56		
	L		Check the tightness value of Cylinder Head Bolt	10000	1715.56		
	I						
1.5.3	**N**	**Piston**	Take out, clean up, check and measure piston	10000	1715.56		
	D		Check and measure Piston Rings	10000	1715.56		
	E		Check and measure Piston Pin	10000	1715.56		
	R						
1.5.4		**Connecting Rod**	Check and measure Piston Pin Metal	10000	1715.56		
	N		Check and measure Crank Pin Metal	10000	1715.56		
	O		Check the tightness value of Connecting Rod Bolt	10000	1715.56		
	.		Replace the Connecting Rod Bolt	10000	1715.56		
1.5.5		**Cylinder Liner**	Clean up, check and measure inner diameter	10000	1715.56		
	5		Take out, clean up and check water jacket section	20000	1715.56		
1.5.6		**Crankshaft**	Measure Journal and outter diameter of Crank Pin	10000	1715.56		
			Measure Web Deflection	2500	1715.56		
1.5.7		**Main Bearing**	Open, check and measure Metal	10000	1715.56		
			Check the tightness value of clamp Bolt	10000	1715.56		
			Check the tightness value of Side Bolt	10000	1715.56		

1.6		**Camshaft**	Check the condition of Cam and Roller Bearing	5000	1715.56		
			Open and check the Fuel Pump Tappet	10000	1715.56		
			Open, check and measure Swing Arm	10000	1715.56		
			Take out the Camshaft, Check the Bearing dan Measure	20000	1715.56		
1.7		**Timing Gear**	Check Bearing Gear dan Backlash	10000	1715.56		
			Open Idle Gear, check and measure Bearing	20000	1715.56		
			Check the tightness value of Idle Gear Mounted Bolt	20000	1715.56		
1.8		**Governor**	Replace Hydraulic Oil	2500	1715.56		
			Open and check the Governor	10000	1715.56		
			Open and check the Bearing Gear on Driving Gear	10000	1715.56		
1.9		**Turbo Charger**	Open and clean up	5000	997.52		
			Check and measure Clearance (axial and radial)	5000	997.52		
1.10		**Boost Air Cooler**	Open, check, clean up and Hydraulic test	5000	1715.56		
1.11		**Starting Air Motor**	Open and clean up Muffler Element (wash by neutral detergent)	2500	1715.56		
			Off from Main Engine, rotate the pinion gear, check is the rotation is light and no unnormal noise	2500	1715.56		
			Open, check, clean up and replace grease, replace O-ring, replace Bearing and gear on First Reduction Gear	10000	1715.56		
			Open, check, clean up and replace grease, replace O-ring, replace Bearing and grease on First dan Second Reduction Gear	20000	1715.56		

1.12		**Fuel Oil System**			1715.56		
1.12.1		Fuel Injection Pump	Check Injection timing	2500	1715.56		
			Check and replace Deflector	2500	1715.56		
			Open, clean up and check	5000	1715.56		
1.12.2		Fuel Feed Pump	Open and check	5000	1715.56		
			Replace seal oil	5000	1715.56		
1.12.3		FO Control & Stop Air Piston	Replace O-ring	10000	1715.56		
1.13		**Lub Oil System**					
1.13.1		Lub Oil	Replace (depends on analysis result)	1500	1148.3		
1.13.2		Lub Oil Cooler	Open, clean up, check, hydraulic test	10000	1148.3		
1.13.3		Thermostatic Valve	Open, clean up and check	5000	1148.3		
1.13.4		Lub Oil Pump	Open, clean up, check and measure	10000	1148.3		
			Open and check Press Regulating Valve and Safety valve	10000	1148.3		
1.13.5		Turbo Charger LO Strainer	Rplace strainer element	1500	1148.3		
1.14		**Cooling Water System**					
1.14.1		Thermostatic Valve	Open, clean up and check	2500	1715.56		
1.14.2		Cooling Water Pump	Open, clean up and measure	5000	1715.56		
			Replace Mechanical Seal	5000	1715.56		
1.14.3		Fresh Water Cooler	Open, clean up, check, and Hydraulic Test	5000	1715.56		
1.14.4		Cooling Water (Fresh Water)	Replace (depends on analysis result)	5000	1715.56		
1.14.5		Sea Water Cooling Parts	Check Zinc Anode and replace (on Air Cooler and Lub Oil Cooler)	1500	757.17		

7. Maintenance Activity

No.	Component	Maintenance Activity
	500 Hours	**Maintenance of 500 hours**
1	Lube oil system	Lub oil system spot test
2	Cleaned turbo with marine grit	Tie rod check to prevent vibration
3	Under side piston	Cleaning of turbine side, solid cleaning giving / 2 lt of marine grit without fresh water, only helped by wind
		Checking of piston and piston ring (from underside piston) is there any broke or not. Clean up underside piston if
	1000 Hours	**Maintenance of 1000 hours**
4	Fuel injector no. 1	Governor oil replace
5	Fuel injector no. 2	Take out fuel injector and do the spray test without overhaul. If it's still good, then it doesn't need overhaul for check nozzle spray
6	Fuel injector no. 3	Charge air receiver/ room check, clean up also repair non return valve. Clean up the scavenge space, underside piston, and liner ports.
7	Fuel injector no. 4	Make sure every pipe of drain scavenge space and underside piston are clear.
8	Fuel injector no. 5	Clean up fuel oil filter and lub oil
9	Cylinder lubricator pumps	
10	Charge air receiver	
11	Fuel and lube oil filter	

	3500 Hours	Maintenance of 3500 hours
12	Exhaust valve no. 1	Overhaul, clean up valves, check / new replace he spindle and seating. Make sure the laping is good
13	Exhaust valve no. 2	Check the cooling water system doesn't leak
14	Exhaust valve no. 3	Check O-ring for steam guide valve
15	Exhaust valve no. 4	Overhaul, clean up indicator valves, do lapping and test
16	Exhaust valve no. 5	Crankshaft deflection measurement
17	Crankcase inspection	Turning gear, v-belt check, oil check (add / replace)
18	Crankcase deflection	Turb C., clean up filter suction, clean up blower side
19	Camshaft driving gearwheels	Fuel cam check (the bokts and nuts) and exhaust cam
20	Fuel cams	Gear check for camshaft driving gear
21	Indicator valves no. 1	Clean up filter of exhaust valve rocker arm lubricator
22	Indicator valves no. 2	Check the discharge drain of lubricator
23	Indicator valves no. 3	Check the driving gear for exhaust valve rocker arm libricator
24	Indicator valves no. 4	Safety devices and engine local control check. Make sure they work normally
25	Indicator valves no. 5	Alarm test and make sure every input pressure, tempearture trips and the alarm work normally
26	Turning gear	
27	Scavenge space	
28	Suction filter T/C	
29	Lube oil analysis	
30	Safety devices and engine	
31	Local control	

	6000 Hours	Maintenance of 6000 hours
32	Check clearance of main bearing	Main bearing check for clearance and wear measuring
33	Check and tie bed plate bolt	Check and tightening for bed plate bolt
34	Check trust bearing	Trust bearing check for clearance measuring
35	Check tie rod	Tie rod check. Check the stuffing box, clearance measuring of ring and groove of exhaust valve
36	Starting air valve cleaning	Starting air valve cleaning and facing up. Check the cylinder safety valve.
37	Clean up air cooler	Clean up air cooler by chemical element from air side
38	Clean up the tube from sea water	Clean up the tube from sea water side
39	Measuring deflection	Measuring deflection data taking
40	Overhaul piston and cylinder	Measure clearance of upper and lower bearing of connecting rod. Measure clearance of crosshead pin guide shoe. Piston cylinder overhaul. Clean up piston crown / skirt, recording for groove and gap size. Clean up and measure the stuffing box (scrapper), check every parts.
41	Ring piston no. 1	Replace with new piston rings
42	Ring piston no. 2	Replace with new piston rings
43	Ring piston no. 3	Replace with new piston rings
44	Ring piston no. 4	Replace with new piston rings
45	Ring piston no. 5	Replace with new piston rings
46	Fuel injection pump	Open and clean up the fuel injection pump. Check for the injection timing.
47	Governor oil	Replace the oil of governor
48	Turbocharger overhaul	Overhaul the turbocharger, clean up the turbine side and blower side.

	8000 Hours	Maintenance of 8000 hours
49	Foundation Bolts and chocks	Check and tightenning for bed plate bolts. Check the main bearing for clearance and wear measuring. Check trust bearing for clearance measuring. Check upper and lower conrod bearing unit for clearance and wear measuring. Check no leakage on safety valve. Check the cylinder lubrication system. Check the camshaft bearing.
50	Main bearing no. 1	
51	Main bearing no. 2	
52	Main bearing no. 3	
53	Main bearing no. 4	
54	Main bearing no. 5	
55	Upper and lower conrod bearings unit no. 1 (crosshead bearings)	Maintenance at the port: 1. Clean up fuel oil filter. 2. Clean up LO pump filter. 3. Clean up the filter from daily TK cylinder oil to lubricator separator, Clean up the filter ofsea chest high / low and filters from each pump.
		Maintenance for every 3 weeks: 1. Clean up the LO cooler from sea water side (and LO side if necessary). 2. Clean up intercooler from sea water side (and air side if necessary). 3. Clean up the jacket cooler from sea water side.
56	Safety valve of cylinder no. 1	
57	Safety valve of cylinder no. 2	
58	Safety valve of cylinder no. 3	
59	Safety valve of cylinder no. 4	
60	Safety valve of cylinder no. 5	
61	Cylinder lubricator no.1	
62	Cylinder lubricator no.2	
63	Cylinder lubricator no.3	
64	Cylinder lubricator no.4	
65	Cylinder lubricator no.5	
	Every 3 Months	**Maintenance for every 3 months**
66	LO cooler	
67	Intercooler	
68	Jacket cooler	

8. Voyage Plan

Voyage on January 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Cylinder head no. 1	1500	1715.56	Check and fitting valve head clearance

Voyage on February 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	1908.59	Take out, check, and fitting
		Fuel injector no. 5	1500	1908.59	Take out, check, and fitting

Voyage on March 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 4	1500	1722.58	Take out, check, and fitting

Voyage on April 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	-	-	-	-

Voyage on May 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	-	-	-	-

Voyage on June 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Exhaust valve no. 2	3500	3484.14	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve
		Exhaust valve no. 5	3500	3484.14	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve

Voyage on July 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	over	Take out, check, and fitting

Voyage on August 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Lubricating oil sump tank	3500	over	Lub. oil system analysis from laboratory
		Fuel injector no. 5	1500	over	Take out, check, and fitting

Voyage on September 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 2	1500	over	Take out, check, and fitting
		Fuel injector no. 3	1500	over	Take out, check, and fitting
		Fuel injector no. 4	1500	over	Take out, check, and fitting

Voyage on October 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	over	Take out, check, and fitting
		Exhaust valve no. 1	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve

Voyage on November 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 5	1500	over	Take out, check, and fitting

Voyage on December 2015

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
3 days	Surabaya	Fuel injector no. 2	1500	over	Take out, check, and fitting
		Fuel injector no. 3	1500	over	Take out, check, and fitting
		Fuel injector no. 4	1500	over	Take out, check, and fitting
4 days	Bitung	Exhaust valve no. 2	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust
		Exhaust valve no. 5	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust
		Piston no. 2	6000	over	Take out, clean up, check and measure piston
		Piston no. 5	6000	over	Take out, clean up, check and measure piston
		Ring piston cylinder no. 5	6000	over	Replace with new piston rings
4 days	Jakarta	Piston no. 1	6000	over	Take out, clean up, check and measure piston
		Piston no. 3	6000	over	Take out, clean up, check and measure piston
		Piston no. 4	6000	over	Take out, clean up, check and measure piston
		Ring piston cylinder no. 1	6000	over	Replace with new piston rings
		Ring piston cylinder no. 3	6000	over	Replace with new piston rings
		Ring piston cylinder no. 4	6000	over	Replace with new piston rings

Voyage on January 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	over	Take out, check, and fitting

Voyage on February 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 5	1500	over	Take out, check, and fitting

Voyage on March 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 2	1500	over	Take out, check, and fitting
		Fuel injector no. 3	1500	over	Take out, check, and fitting
		Fuel injector no. 4	1500	over	Take out, check, and fitting
		Exhaust valve no. 5	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve

Voyage on April 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	over	Take out, check, and fitting

Voyage on May 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 5	1500	over	Take out, check, and fitting
		Lubricating oil sump tank	3500	over	Lub. oil system analysis from laboratory

Voyage on June 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
3 days	Surabaya	Fuel injector no. 2	1500	over	Take out, check, and fitting
		Fuel injector no. 3	1500	over	Take out, check, and fitting
		Fuel injector no. 4	1500	over	Take out, check, and fitting
4 days	Bitung	Exhaust valve no. 1	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve
		Exhaust valve no. 3	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve
		Exhaust valve no. 5	3500	over	Grinding Suction and Exhaust Valve Seat, Replace Stem Seal Suction and Exhaust Valve
4 days	Jakarta	Ring piston cylinder no. 2	6000	over	Replace with new piston rings

Voyage on July 2016

Duration	Port	Item	Maximum Working Hour	Working hour	Maintenance Activity
4 days	Jakarta	Fuel injector no. 1	1500	over	Take out, check, and fitting

Voyage on August 2016

As the prediction in working hour sheet, there will be a major maintenance (especially for components with 8000 maximum work hours for Main Engine on August 2016. these maintenances aren't possible if being done only when berthing time at the ports. So if the shipping company agree, the docking for main engine maintenance should be done on August 2016. Or maybe still possible to be idled one or two months depends on the components condition.

CHAPTER 5
CONCLUSION

Based on explanation from the previous chapters, this thesis conlusions are the time optimization for maintenance of main engine during docking period could give some advantages, those are:

1. To optimize the duration of the next period of maintenance on ship's downtime of MV. Tanto Tenang is done by make some semi-overlap maintenance activities. When single maintenance activity is approaching final, then some crew could start the next maintenance activity from the maintenance activity list. This semi-overlap method could decrease the duration of maintenance until 2 days (compared to MV. Tanto Semangat as a sister ship of MV. Tanto Tenang) as the result of this thesis research.
2. The scope of work organize in more time saving optimization by semi-overlap method in Primavera. Through this software, the scope of work could be arranged to be done in shorter duration. The result of time saving could be seen in the graph from Primavera (attachment 4. Gan Chart).
3. Several works can be done in semi-overlap as shown in Primavera. There are no parallel and full overlap activity because of all crew are focused to finish single maintenance activity in sequence. This way is easier to be controlled by chief engine room. But, the semi-ovelap is only possible if one maintenance activity in the sequence is approaching final. Then some crew could prepare for the next maintenance activity in the sequence of maintenance activity list.

A ship maintenance schedule that being optimzed by this optimization method in this research is MV. Tanto Tenang from PT. Tanto Intim Line which is as the subject. In this thesis, the method that used for time optimization is a method that based on PMBOK (Project Management Body of Knowledge) Guide Book. PMBOK Guide Book is a guide book about how to manage a complete project. It contains a lot of management things of a project. But, in this thesis, the management method that being used is only time management for optimization. In the PMBOK Guide Book, time optimization of a project (in this thesis the ship maintenance is the project) is done by some steps, those are:

1. Activity definition
   Activity definition is defining what activities need to be done for each items. Mostly, the activities are about checking, dissambling, and assembling some parts of the main engine.
2. Activity sequencing and duration estimating
   Activity sequencing is an activity about making list of the maintenance activities for the maintenance of main engine. This list comes from combining data of PMS, working hour, and voyage plan. The duration estimating is a semi-result from data analysis by Primavera.
3. Activity resource estimating
   Activity resource estimating is an activity about making estimation of several resources that could support mainenance activity. The resources for maintenance activity are man power and spare parts procurement.
4. Maintenance scheduling
   Maintenance scheduling is a final step of the method. This step will gives the final schedule plan for main engine maintenance activities.

In the execution of this time optimization for main engine maintenance method, there will be some problems could be happen, such as:

1. Tardiness of spare part procurement (in this thesis the spare part that need to be procured is piston ring).
2. Cancelled spare part because of too long tardiness for the procurement. The maximum tolerance for procurement tardiness is 2 days.
3. Different voyage route for a single ship could gives impact from the side of working hour of the components, routine maintenance activity at every port, and list of maintenance activity for the docking period.

But, those tardiness and cancelling problems still able to be prevented by finding new vendor not only for present maintenance but also for the future maintenance. If the tardiness is more then 2 days, then the shipping company has to find a new vendor and do an emergency expense. Also avoids changing voyage route for a ship because it could change the whole maintenance schedule activity list.

This research result also give some benefits for the ship owner (PT. Tanto Intim Line). These benefits of course have one big point about decreasing cost. The benefits are:

1. Cost saving
   Shorter maintenance duration: less cost that need to be spent by PT. Tanto Intim Line to the ship yard for docking maintenance of MV. Tanto Tenang. Longer duration of ship to stay on the dock, then more money to be spent to pay the docking charge. Docking charge is an expensive cost. So, if the time duration of maintenance is shorter, then the docking

time of ship is also shorter. Shorter docking time cause less cost for docking which means cost saving.

2. Shorter duration
   Usually, the shipping company or ship owner wants as short as possible docking maintenance duration, also with PT. Tanto Intim Line. The reason is, the shipping company or ship owner wants a cost saving for the company profit. The shorten duration is a big chance for the shipping company or ship owner to increase company's income. So, if MV. Tanto Tenang has a shorter duration as result of research in this thesis, MV. Tanto Tenang could cut the cost for docking bill of itself. Research in this thesis show there are possibilities for shorter maintenance duration for MV. Tanto Tenang (those possibilities come from semi-overlap of some maintenance activities).
3. Back to earn more money earlier
   The most optimum time duration for ship maintenance, will give earlier time for the ship to go for sail again. If MV. Tanto Tenang could go for sail earlier, that means the ship will also earn more money earlier for PT. Tanto Intim Line. But, if the ship stay on dock for longer duration, then the ship will spent more money without earn anything. This is a loss for the shipping company. The fact is MV. Tanto Tenang as a research subject of this thesis, has a shorter duration (10 days) than its sister ship,MV. Tanto Semangat (12 days). That means MV. Tanto Tenang could earn more money earlier than MV. Tanto Semangat if these two ships do same maintenance activities. So, to prevent this loss, the time duration for ship maintenance should be optimize.

So, the advantages of time optimization research in this thesis has one final purpose, that is bigger profit for the shipping company (PT. Tanto Intim Line).

As the research in this thesis, there are some recommendations could be given to the ship owner (PT. Tanto Intim Line) for MV. Tanto Tenang, those are:

1. The schedule for maintenance activity should be arranged in clear sequence. This will ease the crew to finish all maintenance activity because the crew will work in a clear sequence too.
2. The ship owner (PT. Tanto Intim Line) has to prepare for some unpredictable incidents such as tardiness of piston ring or another procurement parts. The ship owner must be has a backup plan if the components procurement do not arrive in the right time. One way that could be given from this research is the ship owner must has 2 vendors in case if 1 vendor can not procure the components in the right time.
3. Semi-overlap method as applied in this thesis research is effective to reduce the time duration of main engine maintenance.
4. Further opportunities for maintenance optimization from another options should be analized. This research only optimize one optimization option. There are some more options that still possible to be optimized, such as:
    a. Sequencing similar maintenance activities of each cylinder in a single time line
    b. Do more maintenance activities at port or during voyage (only minor maintenance that possible to be executed during voyage)

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REFERENCES

[1] Alhouli, Yosef Mohammed. 2011. *Development of Ship Maintenance Performance Measurement Framework to Assess the Decision Making Process to Optimise in Ship Maintenance Planning*. The University of Manchester for the degree of PhD in the Faculty of Engineering and Physical Sciences: England.

[2] Bitros, George C. *A Cross Sectional Analysis of Ship Maintenance Expenses. Athens University of Economics and Business*: Greece.

[3] Butman, Boris. *Fundamentals of Ship Maintenance and Repair for Future Marine Engineers.* US. Merchant Marine Academy: USA.

[4] DEVELOP. 2016. *Project Management Training With Primavera 6*. DEVELOP: Indonesia.

[5] KARANC, 2012, *Understanding The Principles of Passage Planning,* accessed through: http://www.marineinsight.com/marine-navigation/understanding-the-principles-of-passage-planning/

[6] Maritime Newzealand. 2014. *Developing a Maintenance Plan*: Newzealand.

[7] NORSOK Standar Z-008. 2011. *Risk Based Maintenance And Consequence Classification.* Standard Norway: Norway.

[8] PMBOK Guide. 2000. PMBOK. Project Management Institute Inc.: USA.

[9] PT. Tanto Intim Line Schedule. 2016. *Our Schedule*, accessed through: https://www.tantonet.com/our-schedule/

[10] Surjandari, Isti and Riara Novita. 2013. *Estimation Model of Dry Docking Duration Using Data Mining*. Waset: Indonesia

BIOGRAPHY

The author name is Benedictus Kenny Pradipta. He was born on December 7th, 1993 in Jakarta. He is the first child of Mr. Blasius Pascal and Mrs. Kartini Seno. He has 1 younger brother, Dimas, and i younger sister, Jeanice. His first education was kindergarden in Pamulang, and then he continued his education until junior high school in Pamulang. The school name was Mater Dei. He was graduate from senior high school in Bandung on 2012. His high school name was SMAT Krida Nusantara. He continued his study to ITS in Marine Engineering Departement right after graduated from high school on 2012.

The author's study in ITS is about 4 years for 8 semester. On the 8th semester, the author wrote his bachelor thesis which the title is "*Time Optimization of Ship Maintenance Working Plan for The Next Downtime Period of MV. Tanto Tenang*" in the Reliability, Availability, Maintainability and Safety (RAMS) Laboratory.