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Improving Maintenance Cost Allocation Process and Performance measurement in The Petroleum Industry Using Activity Based Cost Management Approach "A Field Case Study"

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Abstract

Since the 1980s, academics and Professionals (Kaplan & Atkinson,1998) criticized the traditional cost systems because they distorted product cost. This distortion is often caused by inconsistent allocations of such resources as maintenance services. In addition, some resources including maintenance cost are often lumped into cost centers more for expediency than for considering where the actual work is performed. Reducing maintenance costs has become a major initiative for petroleum companies worldwide, and one that every company must address in order to remain competitive. The case petroleum company* is a large and leading company in the Gulf area. For this petroleum company efficient maintenance of equipment directly affects costs and profitability. The company manages downstream distribution using an oil enterprise downstream. The maintenance is a critical mission because it provides the reliability the company needs to ensure its supply of crude oil and refined product is adequate, and to support the logistics of distributing product to service stations. Without the proper maintenance the company might produce and distribute too much product, incurring unnecessary costs, or too little product, losing sales opportunities to the international competitors. ABCM approach is one of the most effective tools of cost management that provides a new perspective to deal with this problem. ABCM has been found useful for several other purposes, such as costing non-value-added activities by focusing on other cost drivers than unit-level ones (Gary, 1996; 2002). This research will examine the basics of ABCM approach and conclude insights from applications within the petroleum industry. The field data collected by semi-structure interview and other different sources including general ledger, operational records, procedures manual, quality studies, job descriptions, labor reports and process charts. The findings indicate information provided by ABCM system expose better improvement opportunities in the maintenance cost allocation than the current cost accounting system In the case company.

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* The name of the case company is not disclosed because the field data are informally collected.

1. Theoretical Framework

1/1 Importance of the Research Topic

In recent years, there is a growing concern on the subject of higher maintenance cost and maintenance productivity (Williamson, 2000). Maintenance is the largest single manageable expenditure in the plant: in many companies, exceed their annual net profit. Every year, U.S. industry spends well over $300 billion on plant maintenance and operations. An estimated 80% of these dollars are expended to correct chronic failures of machines, systems, and people that occur daily, even hourly, in plants across the country. Eliminating these chronic failures can reduce maintenance costs between 40% and 60%. And that savings to industry of up to $115 billion annually can be realized without major restructuring, employee layoffs, or sacrifice of product quality (Charles & Hopewell, 2000). Although many agrees that maintenance strategies such as preventative and predictive maintenance programs have been shown to produce saving of up to 25%, the study has shown that still 1/3 of these maintenance cost can be saved (Hisham, 2003). Typically, maintenance cost can be divided into two main groups: the first group referred as direct costs are easy to justify and to report. These direct costs consist of items such as labor, materials, services, and maintenance overhead cost are the cost tabulated and shown as maintenance costs. The other group of maintenance costs is hidden costs or indirect costs which are harder to measure. These hidden cost of maintenance are classified as the six big losses:- (Huntsman, 2004)

1. Breakdowns and unplanned plant shutdown losses
2. Excessive set-up, changeovers and adjustments losses
3. Idling and minor stoppages
4. Running at reduced speed
5. Startup losses and
6. Quality defects

Therefore, it is very important for companies to maximize their maintenance effectiveness and equipment uptime. According to a study on maintenance productivity (Hisham,. 2003), most maintenance department is only 30 % productive.

This causes many companies to experience difficulties with quality control, production levels and schedule adherence, since the equipment they are using is not properly maintained. For the past 20 years, most manufacturers have only focusing on reducing costs in the manufacturing processes to stay competitive as the low cost producer. This effort although yielded some measurable productivity gain still retarded the opportunity for the additional maximum gain in the overall productivity since maintenance often was excluded from these improvement plans. Clearly, it is also important to integrate maintenance program into these improvement agenda. Another preference to increase the level of maintenance productivity is to outsourcing for maintenance partners. Associating with professional maintenance people give a company the advantage to address these issues with those experts who face and meet these challenges on a daily basis. In addition, outsourcing also enable a company to gain greater control over maintenance results.

1/2 Purpose of The Research Project

This research project aims at the following objectives:

- to enhance the process of maintenance cost allocation and performance by identifying the significant activity cost drivers
- to expose better improvement opportunities to reduce overall costs in the case company

1/3 Plan of The Research Project

The remainder of this research project is organized as follows: Section 2 reviewes the theoretical framework of ABCM model. Section 3 investigates the current operational system in the case company to explore the operational and strategic issues encountered by the company. It also assess the adequacy/relevance of ABCM model to apply in the case company. Section 4 describes the research methodology and presents the results analysis and conclusions.

1/4 Research Hypothesis

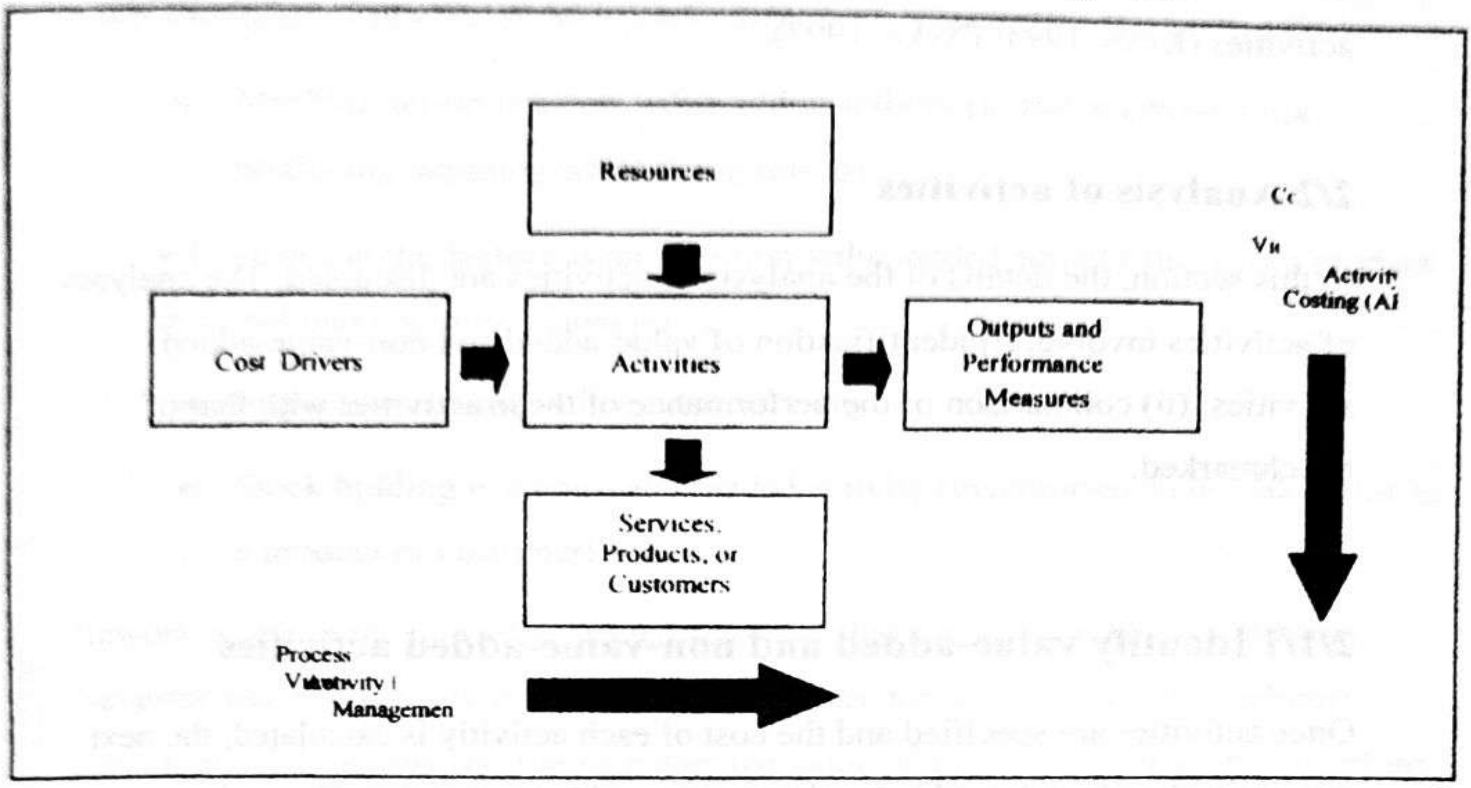
"It is expected that the activity cost drivers are more relevant allocation bases than the production volume ones to allocate maintenance costs in the petroleum industry."

2. Activity Based Cost Management (ABCM)

2/1 ABCM Model

The ABCM model was developed by the Cost Accounting and Management International (CAM-I) to assist managers in developing more accurate product costing than current financial accounting methodologies could deliver and to quantify methods of achieving tangible process improvements. CAM-1 defines ABCM as 'a discipline that focuses on the management of activities as the route to improving the value received by the customer and the profit achieved by providing this value'. This discipline includes cost deriver analysis, activity analysis and performance measurements (CAM-I, 1998). ABCM draws activity-based-costing (ABC) as its major source of information. ABC helps to analyse different activities in a company and to differentiate between value and non value added activities (Berliner and Brimson 1988). The aim of ABCM is to guide improvement efforts of management in the right direction by providing accurate information about activities (Kapan 1984). In this project, an ABC system is used to accurately calculate the cost of the company's products. ABCM techniques are widely applicable, ranging from production and maintenance departments to information technology and other support departments. By generating realistic costs of processes, products and improvement initiatives, ABCM provides managers with the data needed to make informed business decisions. The ABCM Model begins with resources, or the elements allowing work to occur, i.e., salaries & benefits, office space, travel, computer expenses, etc. Each resource is then traced to an activity (i.e., the work performed) based on how the activity uses that resource(Baker,1998). The ABCM can best be described by a review of the model shown in Figure 1.

Figure 1 – The CAM-I Cross of Activity Based Management



(source: CAM-I, 1998)

Once the activity is costed, it is then traced to cost out products, services or customers, depending on the nature of the department's work and the information the manager wishes to analyze. This vertical axis is referred to as the Cost View or ABC (Activity Based Costing) of ABCM. ABC is sufficient if the goal of the analysis is to provide accurate activity, product or service costing, i.e., costs of delivering barrels, customer/contract profitability analysis, etc. However, if the goal is improved cost performance or process improvement, then the horizontal axis, or process view, must be included. In the process view, each activity is analyzed to identify and quantify its cost drivers or the root causes that require an activity or task be performed. This analysis is performed through standard investigation techniques: Why tree, affinity diagrams, flow-charting, etc. Once cost drivers are quantified, determinations can be made on the value of that particular activity and task. To promote process improvement, one must change work processes and dedicate more resources to value-added work while eliminating resources assigned to non-value added work. Each activity also includes an output and therefore a performance measure. These outputs and performance measures

can often provide a valuable indicator of success in eliminating non-value-added activities (Keys, 1994; Eyske, 1997).

2/2 Analysis of activities

In this section, the details of the analysis of activities are discussed. The analyses of activities involve: (i) identification of value-added and non-value-added activities; (ii) comparison of the performance of those activities with that of benchmarked.

2/1/1 Identify value-added and non-value-added activities

Once activities are specified and the cost of each activitiy is calculated, the next step is to identify value added and non-value-added activtities. This judgement should be made within the context of company-wide and well-understood definitions for the terms. A non-value-added activity is often defined as 'an activity that can be eliminated with no detrioration of product atrributes' (e.g. performance, functionality, quality, perceived value) (Miller, 1992). Making non-value-added cost visible is one of the major benefits of ABCM, but also the most difficult to achieve (David and Robert 1995). Also, defining what is value added versus what is non-value added can be problematic. Definition of a value-added and non-value-added activity is often confused and misunderstood. Some think that non-value-added activity means waste, to others it might mean everything other than the labor. The reporting of non-value-added activities and costs can quickly become a people's issue because no one wants to be labelled as performing non-value added-activities e.g. labelling can easily be considered a threat to job security. Therfore, ABCM should focus on the activities, not on the people who perform the activities. Clarity and understanding between value-added and non-value-added activities are achieved when people understand and accept the reasons why an activity is classified as non-value-added or value added (Miller 1996). Most people perform their value-added analysis by simply designating an activity value-added or non-value-added. This level of analysis is insuffient because every value-added activity includes non-value-added tasks. A more thorough analysis should be undertaken to

identify the potential for improvement in value-added activities. The following are a few examples of non-value-added activities in an organization (Bennett, 1996):

- Machine set-up is a non-value-added activity (as the machine is not producing anything while being set-up).
- Logistics in the factory is another non-value-added activity (moving a product does not make it more valuable)
- Inspection is a non-value-added activity
- Stock hplding is a non-value-added activity (inventories do not add value to a product or customer)

Rework is one of the non-value-added activities that can be found in any industry. Nevertheless, this activity is a value-added activity for an operator who performs rework on a job because he/she increases the value of a product by rework. Therefore, all aspects of an organization should be considered while identifying value-added and non-value-added activities.

2/3 Performace measurements

In an ABCM system, performance measures include both financial and non-financial measures, and are designed to influence the behaviour of cost management. A fundamental issue is that a single performance measure will not reflect all the aspects of a company. Managers may require multiple performance measures even from individuals (Innes, et al. 1994). Generally, activities involve groups of employees, nd the performance measures therefore usually relate to the group rather than the individual and to the process as well as the output or result. The ABCM system uses cost derivers of a company's activtities as a basis for changing the performance measurements system. In particulare, some companies are concentrated on non-financial operational performance meaures to monitor the improvements in their business processes(Garrison and Noreen, 2003). It is important to appreciate those performance meausres which not only attempt to meausre the performance, but also control and evaluate the performance, and motivate the people. The behavioural impact of performance meaures is one of the most significant aspects of ABCM. Cost drivers, e.g. the number of purchase

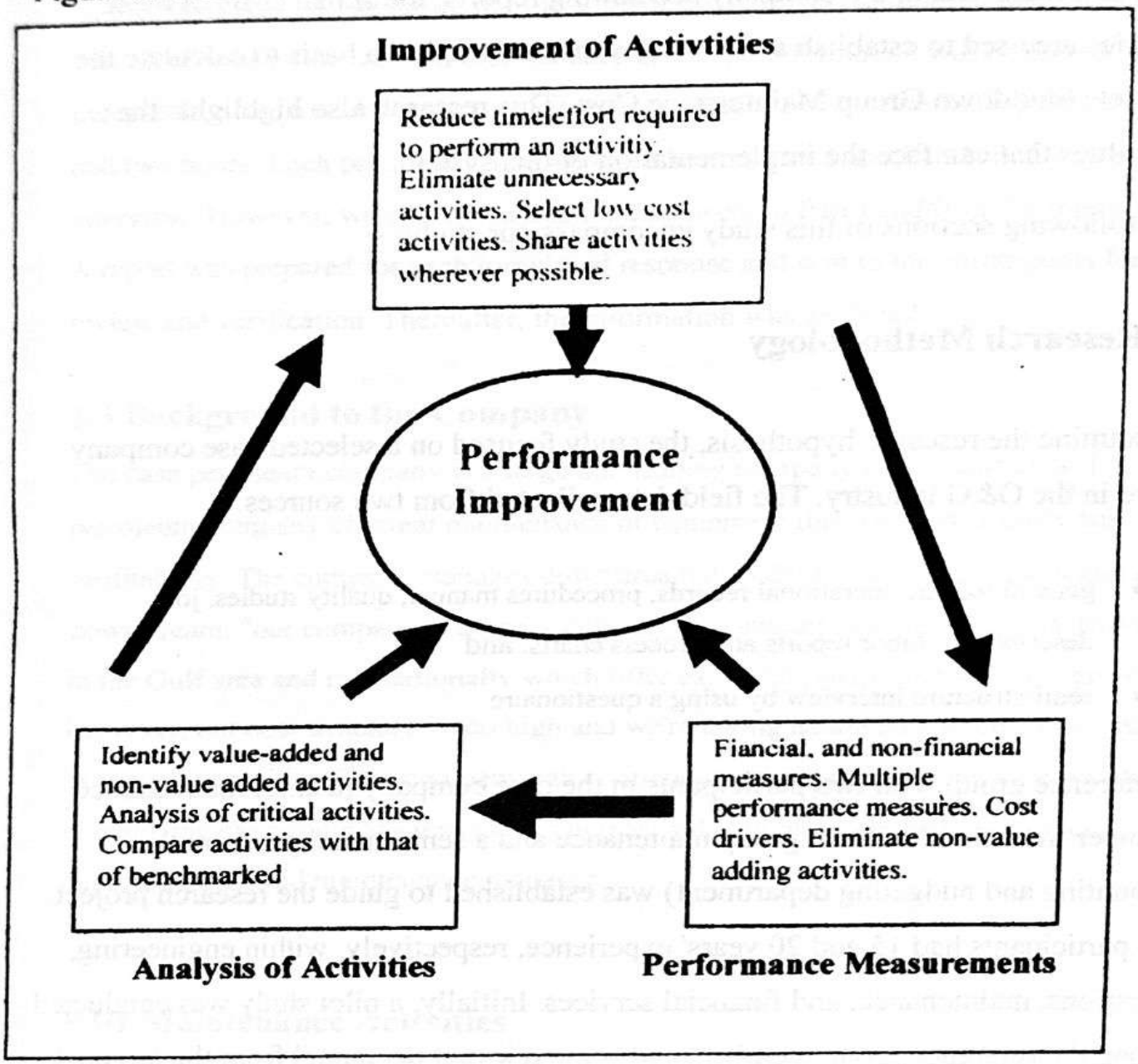
orders or the number of engineering changes, are used as a part of the performance measurement system. Some companies use physical meaures, but others monitor the unit cost per driver e.g. the cot of a purchase order. Performance measures should be selected carefully and tailored to the individual processes or organization. Each company must consider the activities which are critical to its business success (Kaplan and Atkinson, 1998).

Green and Flentov (1991) suggest certain general guidelines for selecting performance meaures:

- The performance measures chosen should assist in monitoring the progress of controlling activity costs. These include throughput time, and the number of engineering changes and production sechedule changes
- The performance meausres selected should be reviewed periodically. As the busiess ad the iternal and external environments of a business chage, performance measures may have to also chage accordingly.
- Everyone should be able to understand the performance measures. These not only must be clearly defined, but also the relationship to the company's strategic objectives must be explained.
- The performance idicators relevat for one individual or group should not be too many.
- Daily perations should be managed on the basis of these key measures.
- The evaluation of employees should be linked to the performance indicators selected.
- The selection of these performance indicators is a critical process and the success of this process depends upon a sound analysis of the critical activities for that particular business.
- Whilst activities-based approaches are not a panacea nor even an end in themselves, they do at least recognize the to effectively manage the activities of a business. This should be refelected in the way the costs are reported and performance measures are employed (Marrow 1992).

The analysis of activities as value-added and non-value-added is the basis of ABCM. The main task of ABCM is to direct improvement efforts in eleminating or reducing the volume of non-value-added activities and improving value-added activities.

Figure 2. Performance Improvement Process in ABCM System.



3. The Field Case study

3/1 Introduction

This field study proposes a baseline to apply Activity Based Cost Management System on Shutdown Group of the Oil Field in order to enhance the process of maintenance cost allocation in Oil Field Production Department. The system mainly analyses the various activities carried by Shutdown Group and classifies them into major activities. Using the company accounting reports, the actual costs of these activities are used to establish activity rates that are used as a basis to calculate the complete Shutdown Group Maintenance Cost. This research also highlights the difficulties that can face the implementation of this system.

The following sections of this study encompass our study: -

3/2 Research Methodology

To examine the research hypothesis, the study focused on a selected case company active in the O&G industry. The field data collected from two sources:

- general ledger, operational records, procedures manual, quality studies, job descriptions, labor reports and process charts. and
- semi-structure interview by using a questionaire

A reference group with two participants in the case company (a chief maintenance engineer from the shutdown group maitenance and a senior manager from the accounting and budgeting department) was established to guide the research project. The participants had 15 and 20 years' experience, respectively, within engineering, operations, maintenance, and financial services. Initially, a pilot study was conducted among the reference group members and some relevant personnel from the targeted company to improve the quality of the questionnaire. Participants were chosen based on their knowledge, competence and experiences in the O&G industry. They were requested to give their feedback concerning ambiguity, comprehensiveness and relevance. Their comments were related to the formulation of questions, the scale of the study, as well as selection of participants. They also suggested some additional

questions. The comments and suggestions were considered and implemented. The same questionnaire was used for the participants in the study. Participants were selected based on their understanding of this research area, knowledge of providers'/consumers' maintenance services, experience within maintenance services and contracts from either customer or provider side.

The questionnaire was divided into three parts. In Part I, we mapped the existing maintenance service activities carried in the Shutdown Group of the Oil Field.. In Part II, the focus was on validating the influencing cost derivers and rating them based on their degree of influence on a maintennace cost. The information was collected using indepth face-to-face semi-structure interviews. The interview time varied between one and two hours. Each participant was asked to answer Part I and Part II before the interview. However, we also discussed their answers in Part I and II in the interview. A report was prepared for each individual response and sent to the participants for review and verification. Thereafter, the information was analyzed.

3/3 Background to the Company

The case petroleum company is a large and leading company in the Gulf area. For this petroleum company efficient maintenance of equipment directly affects costs and profitability. The company manages downstream distribution using an oil enterprise downstream. "our company is a financially strong company with high-quality assets in the Gulf area and internationally which offer excellent prospects for future growth. However, our cost structure is too high and we're taking action now to cut costs and be more competitive. This company can continue to grow profitably because we are redeploying our people to focus on our highest value exploration and production opportunities." said maintenance manager.

3/3/1 Maintenance Activities

Maintenance of equipment and weels played a vital role in the petroleum company. Maintenance is the coordinated integration of the operations, maintenance, engineering support, training, and administrative areas of any process in order to increase the efficiency, reliability, and safety of the process. The failures of equipments have led to high maintenance and operation costs (Dunn,1998).

We focused especially on external and internal services needed to support (or perform) O&G operation and maintenance activities. Examples of such services include:

- insourcing of specialists to conduct work that is outside the competence area of the company (e.g. expertise from an original equipment manufacturer needed to diagnose or repair an advanced piece of equipment/machine/system);
- outsourcing of a part of the operation or clearly defined activities that are not part of the company's core focus area (e.g. maintenance and modification contracts of limited duration, design of a new module);
- outsourcing of large-scale activities with an extended scope as part of a company strategy (e.g. operation and maintenance of an entire platform in the tail-end phase.
- delivery of services related to product support (field service, spare parts, training, diagnostics services, remote support, etc.); and
- remote support requiring specialist services not normally available at the site.

Sourcing of services

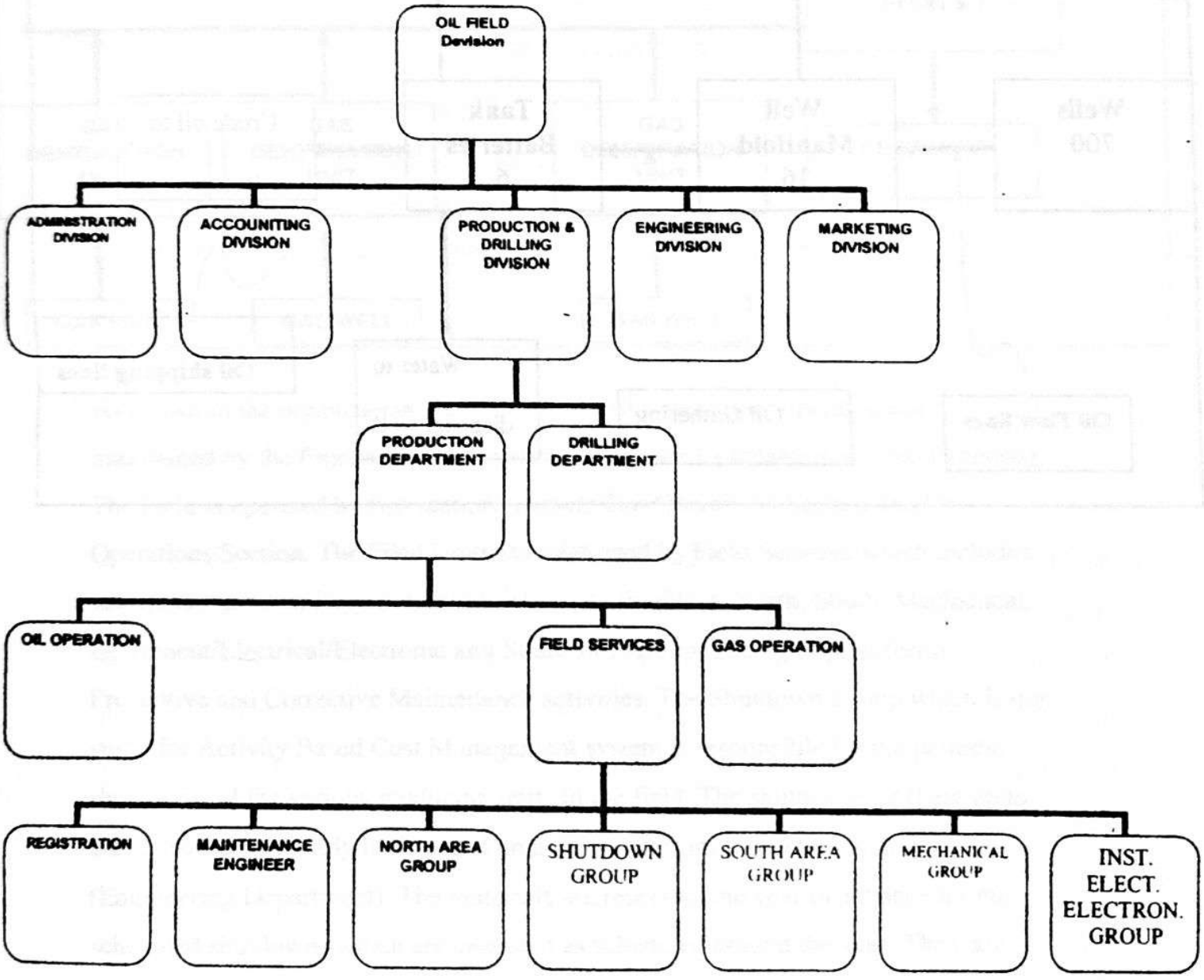
The study shows that the company outsource services related to non-core activities. The company chooses to outsource these activities because they would not be profitable in the long run, even though the company would be capable of developing all kinds of required skills and competence. They indicated it could be interpreted as a weakness in the market if they were to choose to outsource parts (or the whole) of their services. The participants stated that they outsource services like drilling and well services, information technology services, inspection, maintenance and modification services, engineering study and analysis services, certification services, etc. In some cases specialists and/or tools in these services were insourced and integrated with their own employees for a shorter or longer time based on needs and workload. One also retains responsibility and control of the activities within the company. In some situations, co-sourcing is employed, in which a company and a service provider cooperate to solve a problem and share risks. In this case the company keeps control over activities but uses external expertise to enhance

performance and to reduce costs. Responsibility and control in this case is shared between the parties

3/3/2 The Current Operating System

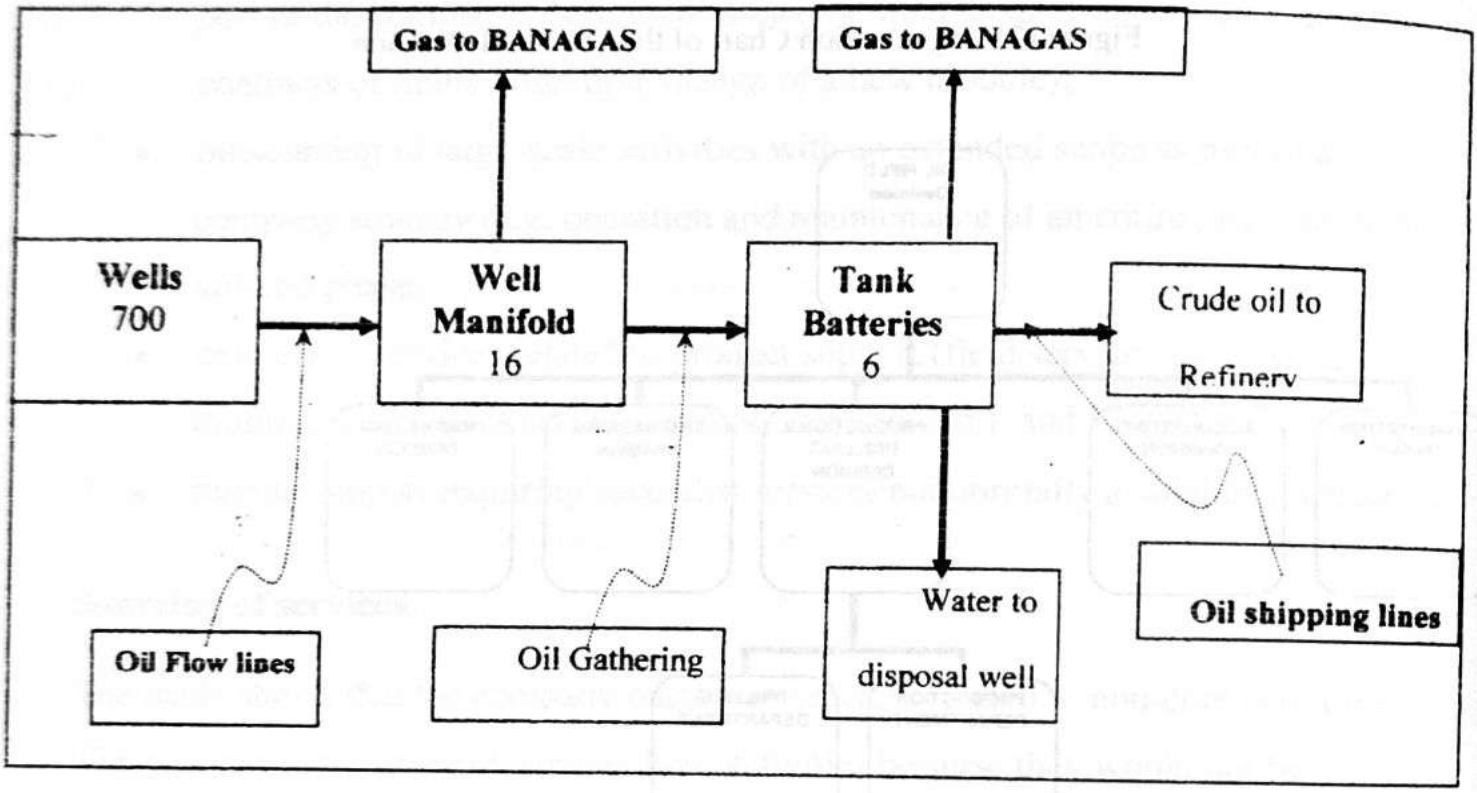
The Case Company is divided into two main divisions: The Oil Field Division and the Refinery Division. In this study, our focus will be on the Oil Field Division. The organization chart of the Oil Filed Division is shown below in Figure(3).

Figure (3) Organization Chart of the Oil Filed Division



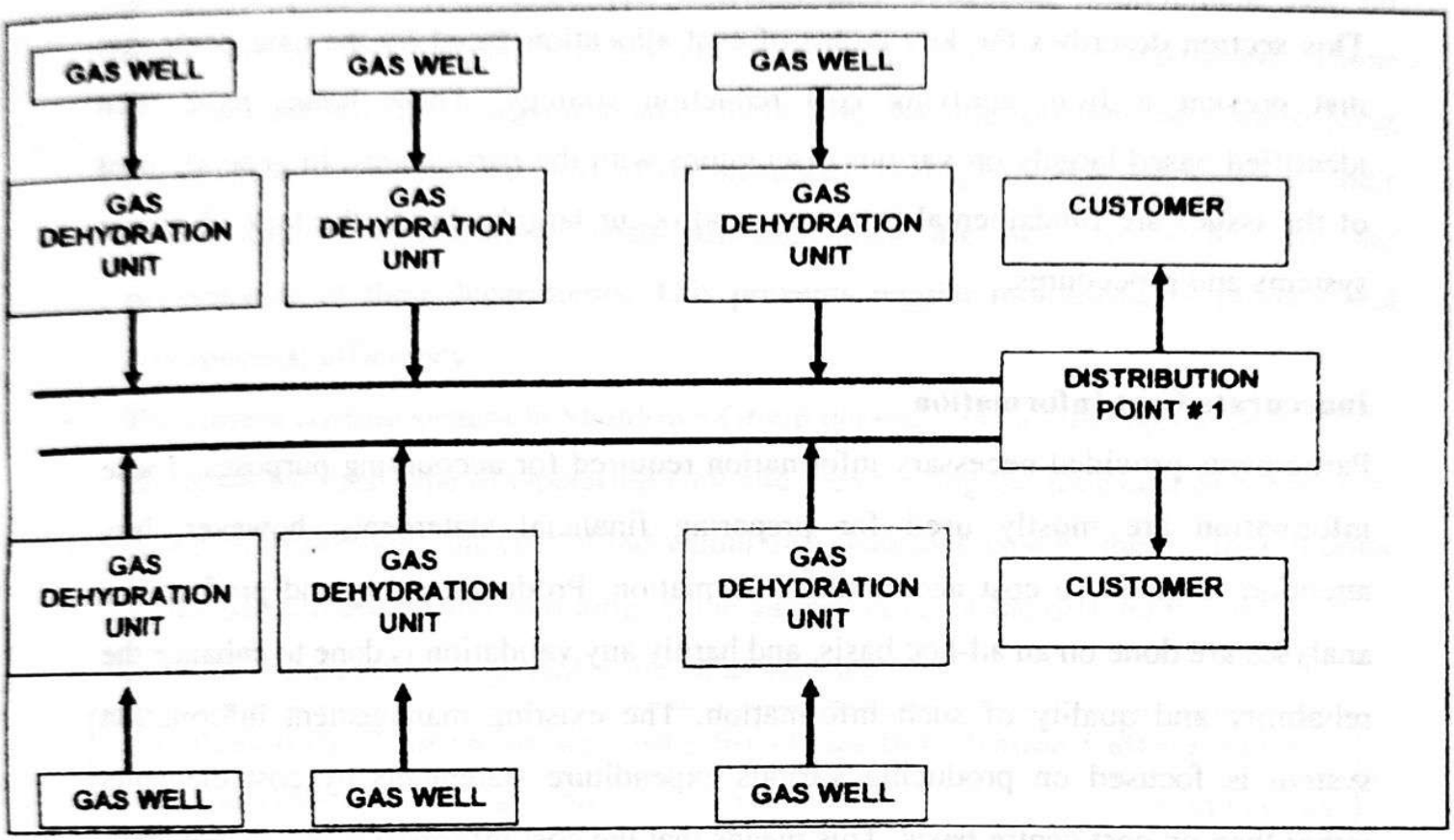
At present, the oil production from the Oil Filed Division is approximately 38,000 BBL/day. The oil production system as schematically shown in Figure (4), consists of 700 Oil Wells, 16 Well Manifolds (WM), 6 Tank Batteries (TB), and the vast network of Oil Flow Lines (OFL), Oil Gathering Lines (OGL) and Oil Shipping Lines (OSL) scattered through out the field up to the Refinery.

Figure (4) Oil Production System



The gas production system produces 1000 million cubic feet and consists basically of 29 Gas Wells, 28 Gas Dehydration Units, Gas Transmission lines, six Distribution tions and distribution lines. The gas production system is shown in Figure (5).

Figure (5) Gas Production System



As shown in the organization chart, the Oil Filed is managed, operated and maintained by the Production Department in the Case Company (Oil Field Division). The Field is operated by two sections namely Gas Operations Section and Oil Operations Section. The Filed Units is maintained by Field Services which includes seven main groups: Registration, Maintenance Engineer, North, South, Mechanical, Instrument/Electrical/Electronic and Shutdown Group. Each group performs Preventive and Corrective Maintenance activities. The Shutdown Group which is our study for Activity Based Cost Management system is responsible for the periodic shutdowns of the various producing units in the field. The shutdowns of these units are scheduled on yearly basis based on a feedback from Inspection Activity (Engineering Department). The materials are reserved one year in advance for the scheduled shutdowns which are executed as scheduled around the year. The Case Company uses both in-source manpower and contractor manpower to execute these

shutdowns. Vessels and Gas Dehydration Units are the main units taken for shutdowns every year.

3/3/3 The Existing Cost Allocation Model

This section describes the key issues of cost allocation faced by the case company, that prevent it from applying cost reduction strategy. These issues have been identified based largely on various discussions with the participants. In general, most of the issues are fundamental in nature, and occur largely due to the lack of proper systems and procedures.

Inaccurate Cost Information

Participants provided necessary information required for accounting purposes. These information are mostly used for preparing financial statements, however, less attention is given to cost accounting information. Product costing and profitability analyses are done on an ad-hoc basis, and hardly any validation is done to enhance the reliability and quality of such information. The existing management information system is focused on producing various expenditure statements by cost elements rather than on cost centre basis. This means that the cost information is only generaly available for broad categories of expenditure elements such as raw materials, labour, overhead etc., while pooling of these cost elements by departments is not a practice. Other reason for inaccurate cost information is due to the incorrect allocation of cost among products. We understand that allocation of labour and common cost is based on certain judgmental bases and oes not have a direct link to the actual activities involved. The departmental performances are measured on an informal basis, and such efforts are not linked to the actual achievements of the departments. Although some budgeting activities are carried out, it is limited to projecting future operational costs, rather than considering it as a vital performance-monitoring tool.

Absence of Regular Cost Information

The financial and budgeting department is located in the head office, while all the operating departments are located at the project site. The data required by the financial and budgeting departement are collected from the project site to prepare product cost information reports. According to this structure there is a natural delay in

collecting data, processing and sending cost reports to the company management. In addition, there is a greater chance for misallocation of costs among products, as the financial and budgeting department does not have direct access to the project management to clarify and validate the issues relating to the source data received from the project. Moreover, the financial and budgeting departement has no supervisison over the quality of the information delivered to the department. These problems prevent the company management from having real-time accurate costing information. Therefore, in most of the instances, management is not aware of their produt and/or departemental costs although they are held responsible for the performance of their departments. This prevents regular monitoring of product and departmental efficiency.

The current costing system in Shutdown Group depends on calculating the cost of shutdown for each type of Operating Unit and then finding the total cost of Shutdown Group by multiplying the cost of individual unit shutdown cost by the number of units of that particular type and summing up the various costs of the different varieties of units. This calculation is typically shown as following:

Gas Dehydrator Unit Shutdown Cost x No. of Gas Dehydration Unit	**= xxxxx.xxx**
Oil Vessel Shutdown Cost x No. of Oil Vessels	**= xxxxx.xxx**
Gas Vessel Shutdown Cost x No. of Gas Vessels	**= xxxxx.xxx**
Total Shutdown Group Cost	**= xxxxx.xxx**

The individual unit shutdown cost is calculated by estimating the required resources to carry the shutdown. Basically each unit shutdown will require the following resources:

1. Contract Services
2. Company Manpower
3. Materials

The break up cost of these resources in general will follow the following Pattern:

- Shutdown Services (Contract Manpower): This is a term contract to provide contractor manpower that is utilized to carry the annual shutdowns on various oil and gas operating units. Manpower like Metal-trade, Laborers, Welders,

Fabricators, Grit Blaster ... etc are provided through this contract to carry out various piping works during the shutdown at unit. Using the established contract rates for each category of manpower and the required man-hours from each category during Gas Dehydration Units and Vessels Shutdowns, the total cost of this contract service is calculated.

- Heavy Equipment Supply: This is another term contract to provide heavy equipments that are required to carry out works during the shutdown period of Gas Dehydration Units and Vessels, like Cranes, Welding Machines, Air Compressors and Pumps. Again, using the established rates in the term contract for these equipments and by estimating the required machine-hours during each shutdown the cost of this service is calculated.
- Electrical/Electronic/Pneumatic Services: Another term contract to provide electricians, Electronic Technicians and Instrument Technicians and the total cost is calculated in the same manner of the previous term contracts.
- Hydro jetting Services: Also a service contract to provide jetting services and its cost is calculated in the same way.
- Insulation Services: A service contract with established measured rates to remove and replace / reinstall thermal insulation inside gas and oil units. The requirement for each shutdown is estimated and according the cost is calculated.
- Scaffolding Services: A term Contract to erect, modify, hire and remove scaffolding inside units during shutdown. The measured rates for this contract along with the estimated quantities for each shutdown are used to calculate the total cost for this service.

- Internal Coating Contract: A contract used to coat the vessel internally and the shutdown cost for this service is estimated using the teem contract established measured rates and the estimated quantities required for the individual shutdown.
- Heat Exchangers Overhaul: A term contract to overhaul heat exchangers with established measured rates for each shutdown. The quantities required for each shutdown and the measured rates in the term contract is used to calculate the cost of this service during shutdown.
- Relief Valves Overhaul: An activity carried by the Company's Manpower and machines. The cost of this activity is determined from the historical data of each shutdown.
- The Company's Manpower: The direct manpower used to overhaul equipments and carry works during shutdown are charged to shutdown cost using the company labor allocation system.
- Materials: The direct materials used in the shutdowns are charged to each shutdown using inventory system of the company

These are the main cost elements of each Shutdown carried by Shutdown Group. Hence the total Shutdown Group Maintenance cost is calculated by summing the various cost of shutdowns carried out during the year. However, a considerable amount of cost is accrued by hidden costs (indirect activities) that are not catered for using this system of costing. Although this system is based on major activities carried during the shutdowns, it does not represent a typical activity based costing system. The following activities are examples for hidden activities that contribute for a major portion of the actual shutdown group cost:

1. Equipment Depreciation
2. Indirect Manpower: Some the case's manpower and contract manpower accomplish many works for Shutdowns but indirectly and their cost is not

charged at all to Shutdowns. To illustrate, Operation and Engineering Manpower are not charged to shutdowns although they participate in shutdown works

3. Indirect Materials: Many materials are used as supplementary materials for shutdown but they are not charged to shutdown cost

Because of the hidden costs that the existing system does not take into account, this system does not provide a good accuracy for the actual cost of shutdowns and Shutdown Group.

3/3/4 Applying ABCM System on Shutdown Group

The previous system did not cater for many activities that have a major role in shutdown group work and total cost. Therefore, reorganizing the classifying the shutdown activities into major activities can be a good baseline to an activity based costing system for shutdown group. ABCM is a scientific method of accurately allocating costs to cost objects (products / client profiles / branches). It aims at avoiding the arbitrary allocation of overheads to cost objects. Generally the following steps are followed to establish any ABCM Model (as shown in Figure 6):

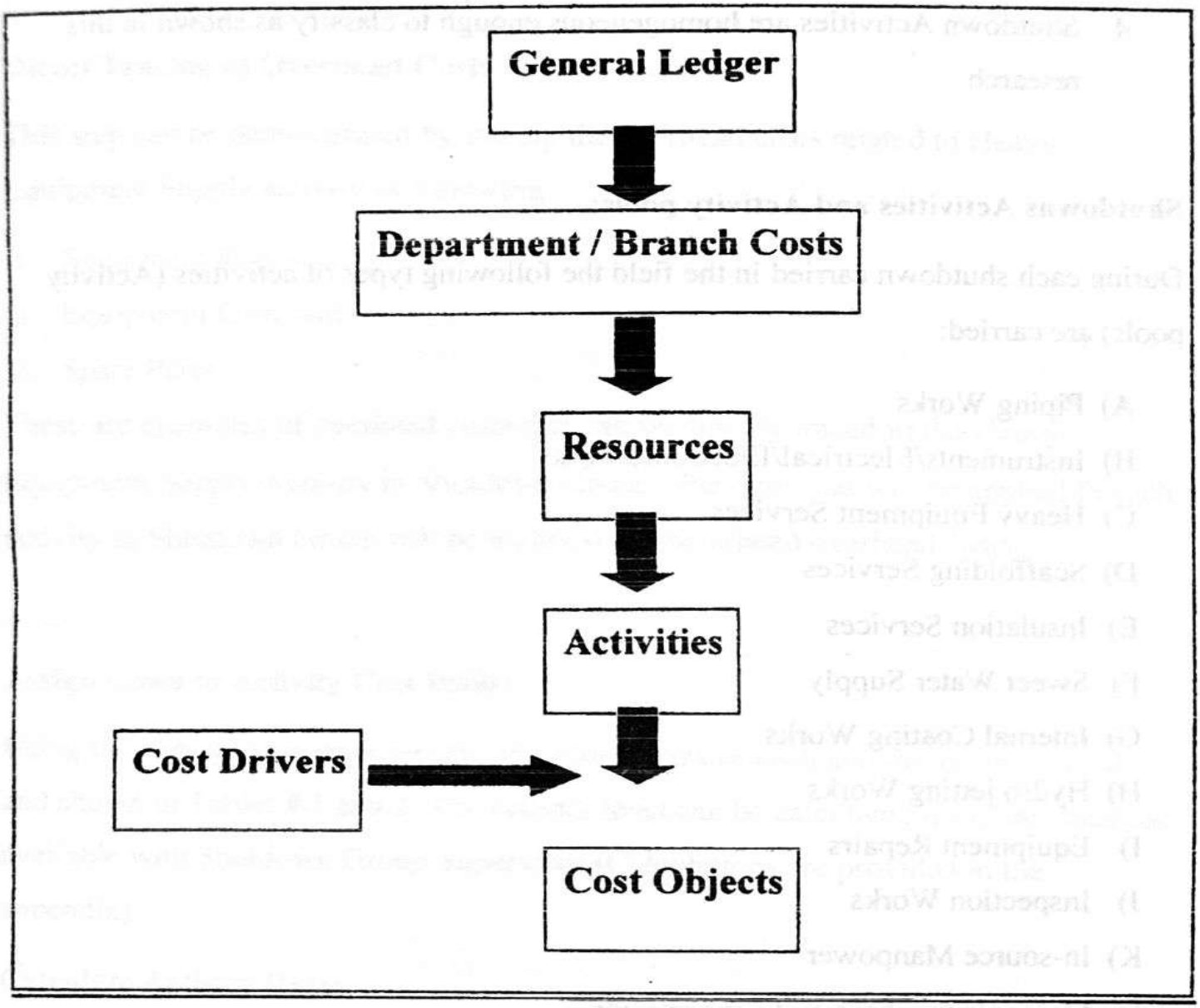
1. Identify and define activities and activity cost pools
2. Find out the proper activity cost drivers
3. Wherever possible, directly trace costs to activities and cost objects
4. Assign costs to activity cost pools
5. Calculate activity rates
6. Assign costs to cost objects using the activity rates and activity measures
7. Prepare Management Reports

These steps are applied to implement an activity based cost management system to find the cost of individual shutdowns and the annual Shutdown Cost. To build ABCM model in the Case Company, data collection is required for the following:

- Accumulating cost data from General Ledger

- Resources are used to perform activities: people / property / services / machines
- Cost drivers are applications / approvals / payouts / receipts / credit control
- Activities are performed to cost objects

Figure (6) Activity Based Cost Management Model



To develop the current cost accounting system on Shutdown Group in the Case Company. ABCM model will be applied to calculate the cost element of shutdown Group that is a part of the total maintenance cost in the Oil Production Field. Maintenance is considered as an overhead activity that should be correlated to the final product of the company (i.e. Oil Barrel and Cubic Feet of Natural gas).

Limitations:

1. The ultimate products of Oil Field are Oil (in Barrels) and Natural Gas (in Cubic Field) only
2. All Gas Dehydration Units and Production Vessels are typical, hence the same shutdown costs will be incurred
3. The Activity Levels and their actual costs remain unchanged for a long period and fixed for each type of Shutdowns in this period
4. Shutdown Activities are homogeneous enough to classify as shown in this research

Shutdowns Activities and Activity pools:

During each shutdown carried in the field the following types of activities (Activity pools) are carried:

A) Piping Works
B) Instruments/Electrical/Electronic works
C) Heavy Equipment Services
D) Scaffolding Services
E) Insulation Services
F) Sweet Water Supply
G) Internal Coating Works
H) Hydro jetting Works
I) Equipment Repairs
J) Inspection Works
K) In-source Manpower
L) Materials purchase and consumption

All these major activities can be divided into minor activities that have the same nature as the major activities. To illustrate the piping works are divided into the following activities:

- Mechanical Isolation of the unit
- Disconnection of the piping works
- Cleaning of the piping works

- Repairs of Piping works
- Re-installation of piping work

Basically, the major activity cost is calculated by calculating the costs of the various minor activities that belong to it. For simplicity, the breakdown of each major activity will not be considered in this report and the final activity rate will be used to show how ABC system is implemented.

Direct Tracing of Overhead Costs to Activities:

This step can be demonstrated by tracing the overhead costs related to Heavy Equipment Supply activity as following:

1. Equipment Depreciation
2. Equipment Overhaul
3. Spare Parts

These are examples of overhead costs that can be directly traced to the Heavy Equipment Supply Activity in Shutdown Group. The rates that will be applied to each activity in Shutdown Group will be inclusive of the related overhead costs.

Assign Costs to Activity Cost Pools:

Using the company expense reports, the actual costs of each activity is determined and shown in Tables # 1 and 2. The activity level can be calculated using the database available with Shutdown Group Supervisor (Calculations are provided in the appendix).

Calculate Activity Rate:

Using the information in step # 3, the activity rate can be calculated simply by dividing the activity cost by the activity level. This step is shown in Table # 1 and 2

Assign Costs to the Cost Objects

Each activity rate is used to calculate the total shutdown cost of individual Production Units in the Oil Field. Summing the individual Shutdown Costs will at the end provide a very close estimation to the shutdown group actual maintenance cost.

Figure (7) ABCM Model for Shutdown Group

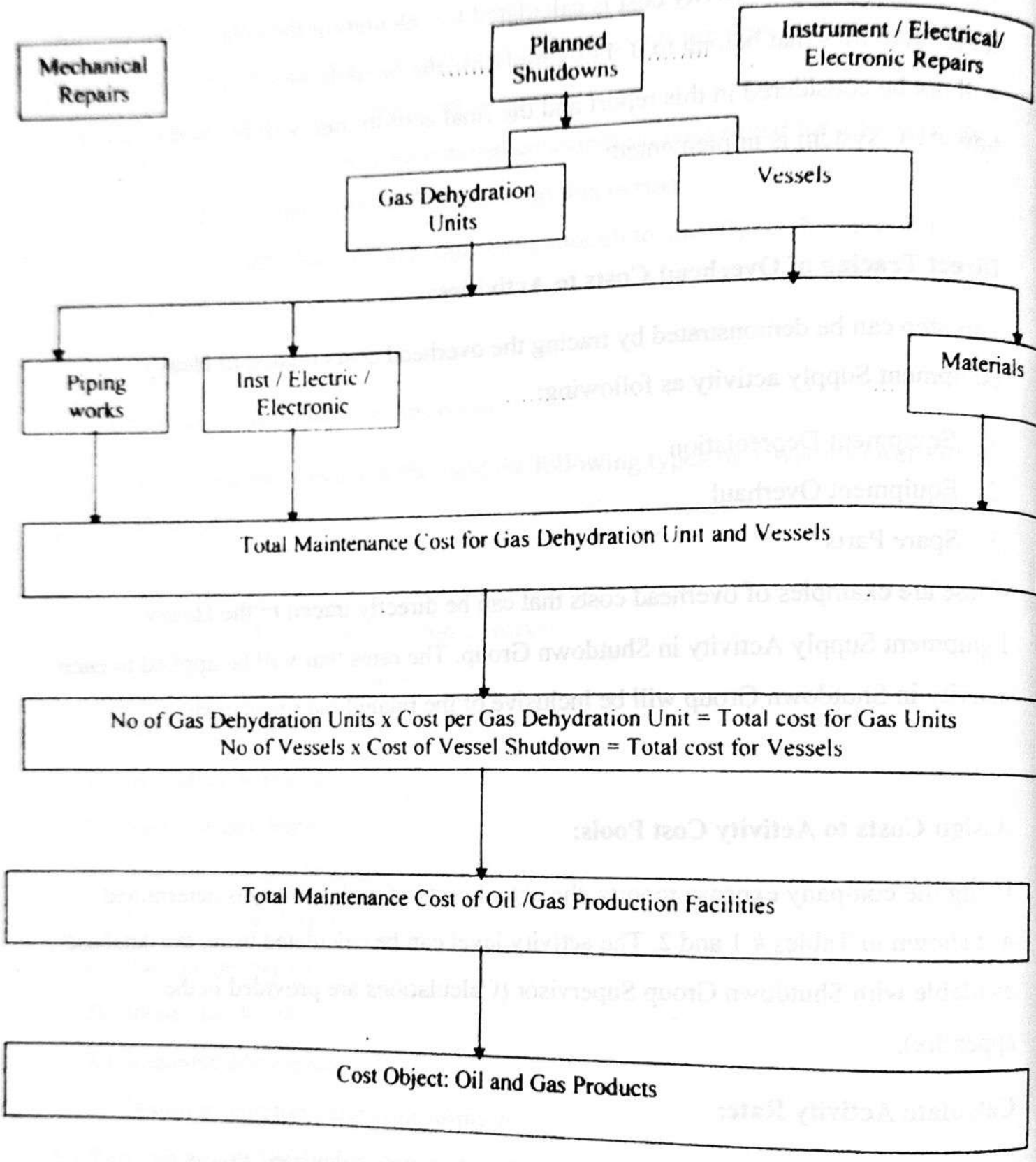


Table # 1 ABC Calculations for a Typical Gas Dehydration Unit Shutdown

Activity Cost Pool	Activity Measures	Activity level	Activity Cost (BD)	Activity Rate BD/Unit
Piping Works	Man Hours	4032	12000	2.976
Inst / Electric / Electronic	Man Hours	624	3000	4.807
Heavy Equipment	Machine Hours	432	3500	16.203
Scaffolding	Number of Hire Days	30	1200	40
Insulation Services	Area in Meter Square	40	1200	30
Sweet Water Supply	Gallons	15000	75	0.005
Internal Coating	Area in Meter Square	0	0	N/A
Hydro jetting works	Time in Machine & Man-hour	0	0	N/A
Equipment Repairs	Man-Hour	160	12000	75
Inspection Works	Man hours	480	4000	8.333
Bapco Manpower	Man hours	704	15000	21.307
Materials Purchase and consumption	Not Applicable	N/A	N/A	N/A

Refer to Appendix A and Appendix B for Activity Levels Calculations

Table # 2 ABC Calculations for a Typical Pressure Vessel

Activity Cost Pool	Activity Measures	Activity level	Activity Cost (BD)	Activity Rate BD/Unit
Piping Works	Time in Man hours	1088	3500	3.217
Inst / Electric / Electronic	Time in Man hours	0	0	N/A
Heavy Equipment	Time in Machine Hour	128	900	7.031
Scaffolding	Number of Days	18	450	25
Insulation Services	Unit Area	0	0	N/A
Sweet Water Supply	Gallons	0	0	N/A
Internal Coating	Unit Area	120	3500	29.167
Hydro jetting works	Time in Machine & Man-hour	64	600	9.375
Equipment Repairs	Man-Hour	64	3000	46.875
Inspection Works	Man hours	288	1200	4.167
Bapco Manpower	Man hours	336	6000	17.857
Materials Purchase and consumption	Not Applicable	N/A	N/A	N/A

Refer to Appendix A and Appendix B for Activity Levels Calculations

Conclusions

Maintenance plays a vital role in the petroleum industry because it provides the reliability the industry needs to ensure its supply of crude oil and refined product is adequate, and to support the logistics of distributing product to service stations. Without the proper maintenance the industry might produce and distribute too much product, incurring unnecessary costs, or too little product, losing sales opportunities to the international competitors. This study revealed that the company's current cost accounting system does not play any role in determining and eliminating the company's non-value-added activities. ABCM approach is one of the most effective tools of cost management that provides new insights to manage costs. ABCM is a useful tool for costing non-value-added activities by focusing on other cost drivers than unit-level ones. This study examined the applicability of using ABCM approach in the petroleum industry. The field data collected by semi-structure interview and other different sources The findings indicated that information provided by ABCM system expose better improvement opportunities in the process of cost allocation of maintenance than the current cost accounting system in the case company. ABCM provided reliable data that can be used to both quantify cost of activities and assess performance. ABCM highlighted the hidden costs of maintenance that can be classified as non-value added costs that should be eliminated including:

- Breakdowns and unplanned shutdown losses
- Excessive set-up, changeovers and adjustments losses
- Running at reduced speed
- Startup losses and
- Quality defects

Appendixes

Appendix (A)

Calculations for Activity Level for Gas Dehydration Unit Shutdown:

1. Piping Works:

= 208 1 Foreman x 8 Hrs / Day x 26 Days Shutdown
= 1664 8 Metal-trade x 8 Hrs / Day x 26 Days Shutdown
= 1664 8 Laborers x 8 Hrs / Day x 26 Days Shutdown
= 208 1 Welder x 8 Hrs / Day x 26 Days Shutdown
= 208 1 Fabricator x 8 Hrs / Day x 26 Days Shutdown
= 80 1 Grit Blaster x 8 Hrs / Day x 10 Days
= 4032 Man-Hours Total

2. Instrument / Electrical / Electronic:

= 416 2 Pneumatic Technicians x 8 Hrs/Day x 26 Days
= 104 1 Electronic Technicians x 8 Hrs/Day x 13 Days
= 104 1 Electrical Technicians x 8 Hrs/Day x 13 Days
= 624 Man-Hours Total

3. Heavy Equipment:

= 40 1 No x 75 Ton Crane x 5 Days x 8 Hrs
= 56 1 No x 35 Ton Crane x 7 Days x 8 Hrs
= 40 1 No x 22 Ton Crane x 5 Days x 8 Hrs
= 120 1 No x 7 Ton Hiab x 15 Days x 8 Hrs
= 80 Welding Machine x 10 Days x 8 Hrs
= 80 Air Compressor x 10 Days x 8 Hrs
= 16 Grit Machine x 2 Days x 8 Hrs
= 432 Machine Hours Total

4. Scaffolding:

= 3 Days No of Pre shutdown Days
= 26 Days No of Shutdown Days
= 3 Days No of Post Shutdown Days
= 30 Days Total Days

5. Insulation

= 5 Area of Heat Exchangers

= 15 Area of Reboiler

= 10 Area of Storage Tank

= 5 Area of Still Column

= 5 Piping Area

= 40 Square Meter Total Area

6. Sweet Water Supply:

Volume per Load = 3000 Gallons

Number of Loads= 5 Loads

Total Volume = 3000 x 5 = 15000 Gallons of Sweet Water

7. Equipment Repair:

= 16 1 No Senior Machinist x 8 Hrs x 2 Days

= 48 1 No Machinist x 8 Hrs x 6 Days

= 96 2 Nos Laborers x 8 Hrs x 6 Days

= 160 Man Hours Total

8. Inspection Works

= 208 1 No Inspection Engineer x 8 Hrs x 26 Days

= 160 1 No Ultrasonic Technician x 8 Hrs x 20 Days

= 112 1 No Radiographer x 8 Hrs x 14 Days

= 480 Hrs Total

8. Bapco Manpower:

= 208 1 No Shutdown Supervisor x 8 Hrs x 26 Days

= 56 1 No Mechanical Supervisor x 4 Hrs x 14 Days

= 80 1 No Electrical Supervisor x 4 Hrs x 20 Days

= 104 1 Nos Pneumatic lead Technician x 4 Hrs x 26 Days

= 240 2 Nos Pneumatic Technicians x 8 Hrs x 15 Days

= 16 x 8 Hrs x 2 Days 1 No Rigger

= 704 Man Hours Total

Appendix (B)

Calculations for Activity Level for Vessel Shutdown:

1. Piping Works:

= 96 1 Foreman x 8 Hrs / Day x 12 Days Shutdown
= 384 4 Metal trade x 8 Hrs / Day x 12 Days Shutdown
= 384 4 Laborers x 8 Hrs / Day x 12 Days Shutdown
= 96 1 Welder x 8 Hrs / Day x 12 Days Shutdown
= 96 1 Fabricator x 8 Hrs / Day x 12 Days Shutdown
= 32 1 Grit Blaster x 8 Hrs / Day x 4 Days
= 1088 Man-Hours Total

2. Heavy Equipment:

- 16 1 No x 75 Ton Crane x 2 Days x 8 Hrs
= 24 1 No x 35 Ton Crane x 3 Days x 8 Hrs
=8 1 No x 22 Ton Crane x 1 Days x 8 Hrs
= 32 1 No x 7 Ton Hiab x 4 Days x 8 Hrs
= 16 Welding Machine x 2 Days x 8 Hrs
= 16 Air Compressor x 2 Days x 8 Hrs
= 16 Grit Machine x 2 Days x 8 Hrs
= 12 8 Machine Hours Total

3. Scaffolding:

= 3 Days No of Pre shutdown Days
= 12 Days No of Shutdown Days
= 3 Days No of Post Shutdown Days
= 18 Days Total Days

4. Internal Coating:

Vessel radius = 1.9 Meter

Vessel Length = 10.5 Meter

Total Area for Vessel = 3.14 x 10.5 x 1.9 x .19 = 119.32 Meter Square

4. Hydro jetting:

= 32 1 Hydro-jet Operator x 8 hrs x 4 Days
= 32 1 Laborer x 8 Hrs x 4 Days
= 64 Man-hours Total

8. Equipment Repair:

= 8 1 No Senior Machinist x 4 Hrs x 2 Days

= 32 1 No Machinist x 8 Hrs x 4 Days

= 24 2 Nos Laborers x 8 Hrs x 3 Days

= 64 Man Hours Total

9. Inspection Works

= 96 1 No Inspection Engineer x 8 Hrs x 12 Days

= 96 1 No Ultrasonic Technician x 8 Hrs x 12 Days

=96 1 No Radiographer x 8 Hrs x 12 Days

= 288 Hrs Total

10. In-source Manpower:

= 96 1 No Shutdown Supervisor x 8 Hrs x 12 Days

= 16 1 No Mechanical Supervisor x 2 Hrs x 8 Days

= 16 1 No Electrical Supervisor x 2 Hrs x 8 Days

= 48 1 Nos Pneumatic lead Technician x 4 Hrs x 12 Days

= 96 2 Nos Pneumatic Technicians x 8 Hrs x 12 Days

= 64 Hrs 1 No Greaser x 8 Hrs x 8 Days

= 4 Hrs 1 No Rigger x 4 Hrs x 1 Day

= 336 Man Hours Total

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