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Study of Change Orders at Wärtsilä

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BACHELOR'S THESIS

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Summary

The purpose of this thesis is to study how Change orders are handled at Wärtsilä and suggest a standard general template to obtain high quality data, in order to increase the company´s effectiveness and profitability by making updated information about Change orders available and implemented in the company structure.

Gathering of data in favour of this thesis has been obtained from Wärtsilä´s internet web sites, data bases and interviews with project responsible. Because the seven projects, included in this thesis, only represent a fraction out of Wärtsilä's numerous projects, this thesis is not comprehensive.

As per the result of my study, I found deficiencies in the handling of Change orders. By using a standard general template, for all change orders, and documenting all Change orders in one specific place, it will lead to increase effectiveness and profitability for the company. By creating a common data base, to which, there is a link for checking updated Change orders and materials, it provides information that can be used for developing the company´s "know How" and reduce repetitive Change orders.

Language: English Key words: Cost comparison, Change orders, Template

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EXAMENSARBETE

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Titel: Hantering av Konstruktionsändringsorder på Wärtsilä

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Abstrakt

Syftet med det här examensarbetet är att studera hanteringen av konstruktionsändringsorder inom Wärtsilä och förslå en standardiserad mall för högkvalitativa data och därigenom öka företagets effektivitet och lönsamhet genom att göra uppdaterad information om konstruktionsändringsorder tillgängliga och implementerade i företagsstrukturen.

Information till grund för examensarbetet har inhämtats från Wärtsilä's intranät, databaser och intervjuer med projektansvariga. Eftersom de i den här studien, ingående sju projekten bara utgör en bråkdel av Wärtsiläs alla projekt, kan studien inte anses vara heltäckande.

Som resultat fick jag fram att det finns brister i hanteringen av konstruktionsändringsorder. Genom att använda en standardiserad och gemensam mall för varje konstruktionsändringsorder, att dokumentera ändringsorder på en för ändamålet specifik plats, kan Wärtsiläs vinna fördel i form av ökad effektivitet och lönsamhet. Vid genomförandet av en gemensam databas dit det finns en länk för kontroll av uppdaterade konstruktionsändringsorder och material kan denna information användas för att utveckla företagets ”know how” och minska på återkommande konstruktionsändringsorder.

Språk: Engelska Nyckelord: Kostnadsjämförelse, Orderförändringar, mall

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Content

ABBREVIATIONS

CO	Change Order
VO	Variation Order
WMC	Work Management Correspondence
LNG	Liquid Natural Gas
EPC	Engineering, Procurement and Construction
EEQ	Engineered Equipment delivery
ICS	Installation and Construction Services
IDM	Wärtsilä Integrated Document Management solution
HR	Human Resource
CPE	Chief Project Engineer
SAP	Systems, Applications & Products in Data Processing

1 Introduction

Final target of every energy solutions company is to complete their construction process and, to deliver the project construction to their customer within the agreed period. But, in reality the target is not so easy to achieve as several issues arise and need additional attention during construction progress. Change orders due to factors such as various changes in scope of supply, designs and material quantities are affecting the construction process timeline. In this study, I am focusing on change orders in seven selected projects in Wärtsilä Energy Solutions to identify common causes and effects of change orders, to be able to suggest a proper and structured general template to deal with change orders in future projects. It is needed to analyse and take necessary actions to minimize the Change orders in projects and to verify the common causes and effects of them. We can never expect a project with zero percent Change orders, because to some extent it's a normal occurrence in all projects. But, a clear framework with good control and proper management can lead to a better result for both supplier and the customer.

Change orders alter the original contract by adding or deleting the scope of supply and it leads to alteration actions within the project which can either reduce or extend the project schedule. Similarly, Change orders affect project Contract value. Change orders always mean additional costs due to management costs even if neither Contract value nor project schedule are changed. Because of this, the project team has to re-plan how to utilize their restricted resources, like manpower, materials, time and money for optimal usage.

1.1 Purpose

The purpose of this study is to find a way to handle the change order template situation for site management by means of following up costs and register change orders with a structured system. Cost follow up will help the disciplines of Mechanical, Civil and Electrical engineers to a better understanding of the process and implementing it for engineering purposes.

A common structured system can be used for all disciplines by the engineers to follow up their design challenges and to achieve improvements for engineering updates. Site feedback provides information regarding design changes, design errors or some other relevant information. If all data is structured in a way, that makes it accessible, it can provide vital information for all levels of the organisation. As well as it will be easy to follow up the life cycle costs for instance.

Main items of interest in this thesis is as follows.

- Focus on Change Orders for Mechanical, Civil and Electrical engineering.
- Change orders in seven selected projects in different areas are examined and followed up.
- Sub-contracting: The optimal way of handling change orders when doing sub contracts.

The objective of doing this thesis is to show what kind of costs that have been identified as Change Orders. There, I will consideration, the original Contract value in the project and how many percentage the Change Orders represent out of the contract value. I will then further categorize the Change order percentage in to Mechanical, Civil and Electrical engineering.

1.2 Research

Gathering of required information to the research was done by using problem studies, standard studies, collections of data, interviews, and meetings. Problem studies were done to find answers to questions arisen in this context.

Questions which are related to this study are summed up below.

- **What is a Change Order?**
- **How does a Change Order occur?**
- **Who has been given the responsibility to approve the CO?**
- **What is the proper process that should be followed for CO?**
- **Where to find Change Orders?**
- **Is there any written Change Order process?**
- **Who handle Change orders in a project?**
- **What is the most difficult issue when handling Change orders?**
- **Is there a standard template for Change orders?**
- **What is the Change order percentage, divided into Mechanical, Civil & Electrical when it is compared with the project Contract value?**
- **Which information need to be included in a general common template?**
- **How is Change orders handled regarding Sub-Contractors?**

Standard studies were analysed and mapped according to disciplines Mechanical, Civil and Electrical. Information for standard studies were collected from project Contracts, Site hand book, and Sub-contracts.

Data collections have been done, using both qualitative and quantitative methods. Data has been gathered and evaluated by individual interviews with site managers, Project managers, Project Controllers, Chief Project Engineers; Mechanical, Civil & Electrical in selected projects in Energy Solutions, focus group discussions, documentations like Site hand book, Site feedback, IDM (Wärtsilä Integrated Document Management solution) and Wärtsilä internal websites. Interviews and meetings were done to find answers to the Change Order process.

1.3 Limitations

This thesis is limited to seven Energy solutions projects at Wärtsilä. These projects were selected from both EPC and EEQ projects by Engineering Manager, Peter Bergqvist. Seven projects were assessed as an appropriate quantity for this study, otherwise no specific reasons were given for selecting the included projects. Wärtsilä has hundreds of Power plants projects all over the world and studying Change orders from all those projects is not doable within the time frame of this study. A complete study of Change orders would take years. The result of studying these selected projects might bring a general picture, or get an idea about the situation concerning Change orders at Wärtsilä.

A project team is appointed for every project, for completing the project on time. The team has to deal with the reality in respect to contracts during construction period. When I did my research, I limited my interviews and meetings with mostly Project managers, Site Mangers, Project Controllers, Chief Project Engineers; Mechanical, Civil & Electrical because they are the persons in a project who are involved with Change Orders.

My focus is here to study Mechanical, Civil and Electrical Change orders and therefore, I focused mostly on Change orders and I didn’t focus on the accuracy of other factors which are surrounding Change orders such as; cost calculations, book keeping, Claim procedure, and SAP updating.

1.4 Thesis structure

The structure of this thesis consists of several chapters. I decided to allocate the Second chapter for a summary introduction of the organization that this thesis is based on.

The Third chapter is based on the theoretical points, which are related to the title of the thesis.

The Fourth Chapter discusses change orders in general, including change order process, and legal aspects.

The Fifth Chapter features statistics of the selected projects. Change Orders in Mechanical, Civil & Electrical engineering and their impact on the original contract value are shown in tables.

Chapter six discusses the result and interpretation of the result.

Conclusion and proposals for further research is presented in Chapter seven.

All references can be found in Chapter 8.

2 The Organisation

Under this Chapter, I give a summary of Wärtsilä; the turnover, organisational set up, Energy solutions (earlier called Power Plants), and EEQ & EPC projects.

2.1 Wärtsilä

Wärtsilä is a company who provides advanced technologies and complete life cycle solutions for the Marine and Energy markets globally. The total net sales in 2016 was approximately 5 billion euro, which is optained by its three business areas; Services, Marine Solutions and Energy solutions as 45%, 35%, 20% respectively. Approximately 18 000 employees are working in Wärtsilä today in over 200 locations in more than 70 countries. (Wärtsilä 2017)

2.2 Mission, Vision and value

Mission: We shape the marine and energy markets with advanced technologies and focus on lifecycle performance, to enhance our customers' business and benefit for the environment.

Vision: We will be our customers' most valued business partner.

Value: Energy – Capture opportunities and make things happen.

Excellence – Do things better than anyone else in our industry.

Excitement – Foster openness, respect and trust to create excitement.

(Wärtsilä 2017)

2.3 Energy Solutions

Energy solutions is one of the main business areas in Wärtsilä as mentioned before. Energy solutions business lines includes; Engine Power Plants, LNG solutions and Renewables & Storage. The projects in my study are limited to Energy solutions projects.

Engine Power Plants are constructing power plants up to 600 MW globally that can run on gas, and liquid fuels. LNG solutions delivers LNG infrastructure solutions in small and medium scale and those are liquefaction plants, regasification plants, storage units and terminals. Presently, the company is focusing on solar and storage systems.

Energy solutions generated 943 million euro net sales in 2016, and 903 personnel on average were involved to achieve that sales goal. The number of personnel in Energy solutions, Finland by the 31 of March 2017 were 573 which represents 16.6% out of Wärtsilä's workforce in Finland. (Wärtsilä 2017)

Figure 1; sums up Energy Solutions business process in Wärtsilä.

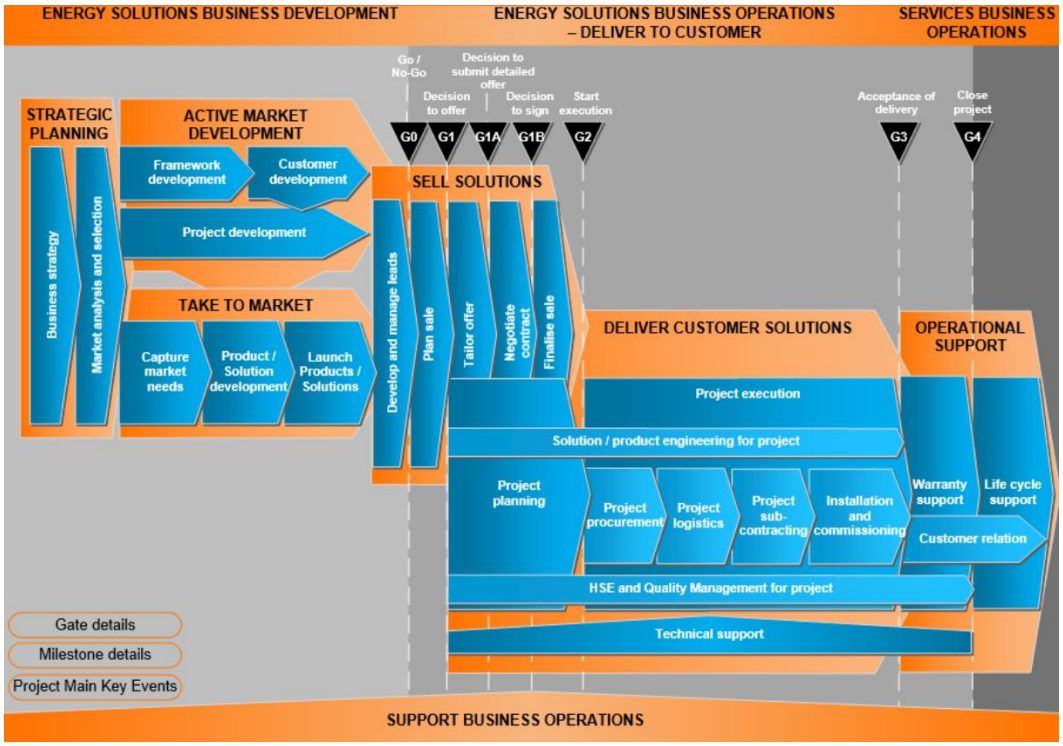


Figure 1: Energy Solutions business process (Wärtsilä 2017)

2.4 EPC & EEQ Projects

Wärtsilä projects in energy solutions deals with two types of projects. They are namely, Engineered Equipment delivery projects (EEQ) and Engineering, Procurement and Construction (EPC) projects. This study includes both EEQ and EPC projects, almost equally in number.

When EEQ projects are concerned, Wärtsiläs responsibility is limited to issues which are arising within their scope of supply and to the installation equipment that they provide for the project. But, in EPC projects, Wärtsilä has the entire responsibility to complete the project, such as planning, designing, transportation, construction, commissioning, and

finally handing over the project. The scope of supply for Mechanical, Civil and Electrical engineering departments are strictly categorised. (Wärtsilä 2017)

Examples of Mechanical, Civil and Electrical installation works are mentioned below. These installation works categorization will be used later in this report, for the purpose of identifying Change orders into Mechanical, Civil and Electrical engineering.

Mechanical installation works:

- Mechanical units installation
- Tank installations and/or constructions
- Pipe supports and piping works, cleaning and flushing of pipes
- Ducts and instruments installations, cleaning
- Doing necessary tests after installation and so on

Civil installation works:

- Excavations, formwork
- Concreting of foundations and site structures
- Erection of buildings as per design specification

Electrical installation works:

- Installation of cable ladders, electrical cabinets, cable pulling and connections
- Installation of earthling system under and above zero level
- Lightning protection
- Doing required penetrations to walls and roofs
- Installation systems like fire alarm, gas detection, Closed Circuit TV (CCTV)
- Building electricity connections

(Wärtsilä 2017)

3 Theoretical points

I shift my attention in this chapter to describe the theoretical aspects of this thesis. It includes knowledge management; why it is important to have high quality data, Change Order management; different classification of changes, documentation of Change orders and as well as, Cost control.

3.1 Knowledge management

Data is a foundation for making decisions in an organisation. Data is also important for strategic planning, product development, and customer interactions. Data is an important asset in a company which is needed to be protected in order to prevent a third party to misuse this data and the company´s specific knowledge in an inappropriate way. Structured data system helps a company to approach its data at the instant it is needed. Correct data and information in the correct place available at all time in a correct format, is an invaluable asset in order to make better decisions.

Recording the data in a specific place such as a Company data base or another available source that everyone can access, is more effective and thus profitable for the company, because it saves both employer and employees time, to select, find and access the correct data when it is needed. (Redman, Thomas C. 2008)

3.1.1 Common data quality issues

Management and operational levels need high quality data to secure that decisions are made on correct informational basis. Management levels may also find it hard to rely on low quality data and this situation creates a greater distance between the decision-making process and the real-life consequences. In an organisation where decisions are based on poor quality data, it results in impaired quality of decisions and poorer result, which in turn leads to poorer customer satisfaction and customer service, less effectiveness, less productivity and so forth. (Thorlund, J. L., & Gert H.N. 2010, p. 146).

Whether the company is big or small, private or public, local or foreign, it’s essential to have high quality data. There are common quality data issues. One is that people can’t find the data when they need. They have to spend several hours for searching needed data, resulting in minimizing working capacity, and efficiency. Poor data definition doesn’t give enough

information to interpret the credibility and the trustworthiness for second hand users. Poorly defined data is of less use for the company's management and as well as everyone who needs the data. Poorly defined data can occur because the base for the data might be undermined by lack of knowledge and/or experience. (Redman, Thomas C. 2008, p. 43)

High quality data is an asset to the organization. It improves good customer service, boosts company efficiency and finally, it leads to increased profitability. One way of obtaining high quality data, is to make important data updating obligatory, in the company's data source system. One common quality data issue is that the same data is updated to several source systems in the company. It is confusing to the second-hand user who might not be able to distinguish between which data is correct, which is newest one and so on. Designing a system where data is found in only one specific place might be the solution for this problem. (Thorlund, J. L., & Gert H.N. 2010, p. 180)

Poor data brings costs and risks to the company. Managers can not see through and valuate, the cumulative impact of the problem that they have, if the data is not orderly documented or not available.

Organisational confusion is also a common effect of data quality issues in a company. Even if a company recognizes data as the most critical asset in the company, but still is unable to answer data related questions directly, it means that the company does not have access to necessary data. Questions that the company must be able to answer are, What kind of data the company has? What are the data? Where does the data come from? What usage do you have of the data? Which are the most important data? What is the worth of those data? If the company are not able to answer these questions correct, this means the company doesn't have a high-quality data base. (Redman, Thomas C. 2008, p. 44-45)

3.1.2 Lean manufacturing standardisation

Every construction company must strive or an efficiency increasing strategy by valuating the company's objectives such as increasing of productivity, improving service, maintaining its existing clients and attracting new businesses, the company expresses its efficiency. By completing the project management objectives; Functional satisfaction, Aesthetic satisfaction, Completion the project in time, Completion and value for money, and at the same time fulfill the company's objectives.

Customers have their own objectives, and the construction industries and its professionals, encounter a variety of customer's objectives and through use of knowledge and professional

skills working to meet and fulfill the customer expectations. The project team, especially, needs to understand the customer's organisational structure, and what the customer's major business activities are to be able to interpret and implement the customer's objectives, in order to provide a satisfactory solution. The quality of the work that project team does depends on their knowledge, skills, techniques and technologies that they have at hands, and if they use them in its optimal way. (Walker, A. (2015)).

In some cases, one personal is completing many tasks simultaneously, where not all tasks are related to achieve the core goal of the project. Some production companies simply allocate more money and technologies in an effort to increase the productivity. Instead of above mentioned examples that often does not increase the productivity, it is important o work smart by defining and clarifying what are the tasks that the company really needs to do, and only focus on the tasks that are really needed in order to increase the productivity of the company. (Leopold & Kaltenecker, K. 2015, p. 11)

Lean manufacturing standardisation is a philosophy and concept that is useful in every company. The concept of lean, was developed by Japan Toyota Motor Company implemented in their Toyota Production System (TPS) during the post-war period. Initially, the Toyota Company had some concepts, such as standardized working, flow-based production processes.

There are three key aspects around lean concept. They are;

- Providing better value to the customer
- Doing more with less
- Prioritizing quality, safety, and the sustainability of the organization

The team who introduced the Toyota Production System, identified that there are three activities contribute to reduce company's performance. They are namely; Muda, Mura and Muri.

The Japanese word Muda, principally means "Waste". That is any activity in an organisation that does not add value to the customer. Mura means unevenness. Mura is used to improve the business process by using correct systems in the company (Ex: Just-in-time, pull system). Muri means overburden, unreasonableness. Working under standardized conditions; including high quality, high personnel morale, less waste and improved productivity, companies can avoid Muri. (Page, K. (2013)).

Figure 2; below shows key lean principles. These principles are used to ensure giving more value to the customer and as well as having a more profitable business with satisfied personnel and a secure future. (Wärtsilä 2017)

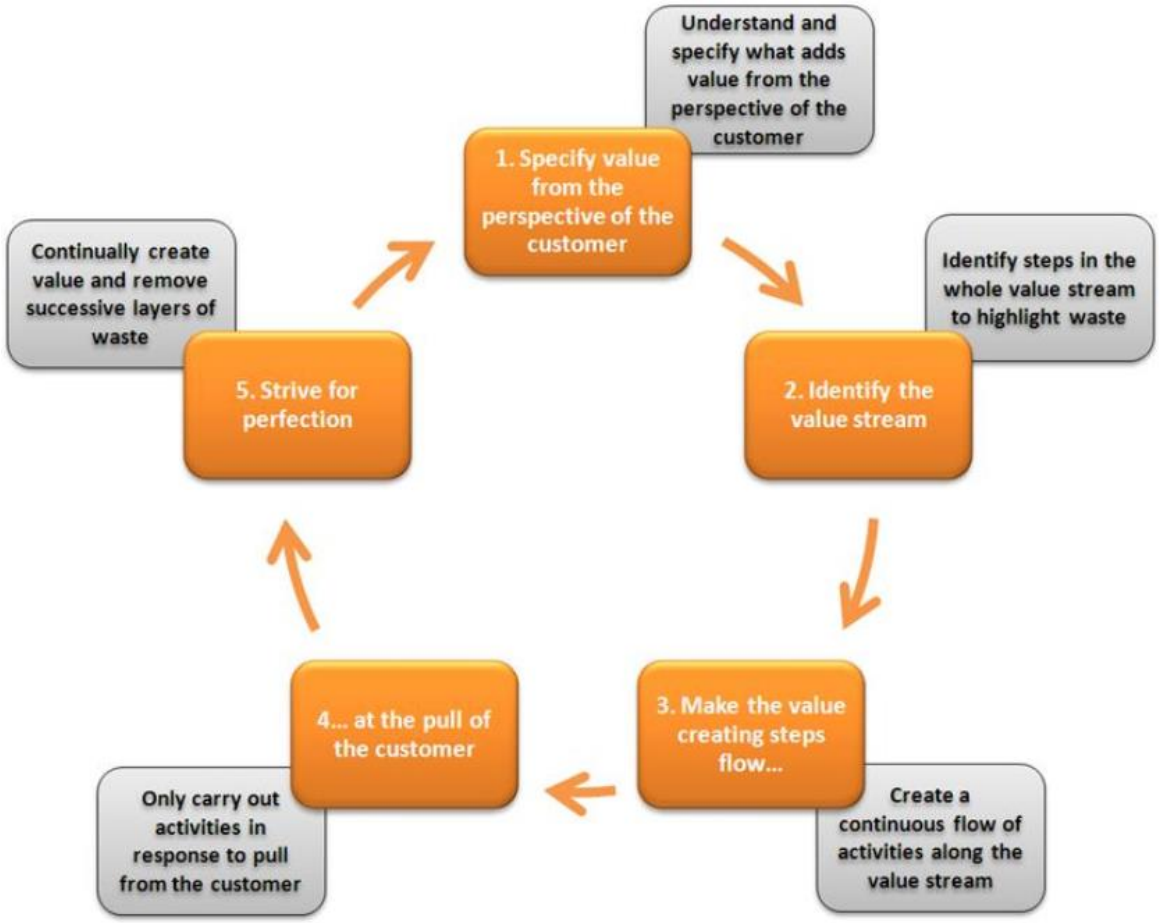


Figure 2: Five core principles of lean (Wärtsilä 2017)

Specify value from the perspective of the customer:

This means, understanding the customer from their perspective. Value is what customer need and what customer would like to pay. Anything that an organization does beyond customer needs would be a waste for the organization.

Identify the value stream:

Value stream is a series of events in a company which starts from the beginning of its raw material process, until the final finished product, or gathering of all the information and turning it in to a service. It is important to analyze and identify what events that brings value and what events that does not. The objective is to utilize the events which brings value and get rid of with the events which do not bring value to the product. Identifying the value

stream is not always easy because responsibilities might be unclear among employees, slow processes, resources are not properly dedicated, boundaries are not clearly defined etc…

Make the value creating steps flow:

The flow has to be created based on the steps in production that increase the value. If there are steps, which are not adding value, such as waste or rework, it is needed to be removed from the flow. Systems and/or processes which bring value, are needed to be added to the flow.

At the pull of the customer

The meaning of "Pull" is providing products or services according to customer's demand, meaning that pull is a demand-driven supply chain rather than forecast. The company takes in consideration what the customer needs and when the customer needs it. This is the strategy of having Just-in-time inventory management. According to this strategy, the company can reduce the waste of maintaining unnecessary inventory, and have a stringent process with less lead time to meet the customer expectations.

Strive for perfection

This principle means that there is a striving for being better tomorrow than today. This is a combination of all above four principles. To achieve this, it is necessary to understand the customer needs, try to remove waste constantly, identify the flow which are giving value and use pull supply chain to reduce waste. This is the process of continuous improvement. (Wärtsilä 2017)

3.2 Change Order Management

Change orders are common issues in construction projects. It's very rare to find a project without change orders. Change orders in a project can become necessary because of several reasons.

- Changes in project scope. This can be requested by the seller or the customer.
- Conditional changes in the Contract that occures after the contract is signed.
- When the customer or the Sub-contractor need to do extra work due to errors, omissions or inconsistencies in the contract, they make a claim because the extra work is beyond the project scope and it may result in a change order.

(Levy, Sidney M. 2009, p. 201)

3.2.1 Classification of changes

There are different kinds of changes that can be identified in a project. Classification of changes depends on the nature and effect of the changes to the project scope. Some researchers categorize Change orders in their own way.

Directed and Constructive changes:

Directed changes are changes that the owner informs direct to the other party in which the owner needs to do some changes which are not in the original contract. These changes may impact on project scope and/or schedule. These changes are clear and easy to identify. Constructive changes on other hand are almost indirect changes which can not be identified as changes as easily as Directed changes because they are t is based on informal conduct and thus do not follow formalised conduct. Constructive changes can also be a result of Directed changes, which can cause hidden costs like compensation, delay payments due to Directed changes. (Arain, F. M., & Low, S. P. 2009, p. 10)

Another classification of changes is Additive change, Deductive change, Rework and Force Majeure Change.

Additive change:

Additive change occurs in the situation that something adds to the original project scope; positive change order.

Deductive changes:

These kinds of changes occur if something deducts from the original scope.

Rework:

Rework needs to be done due to the deficiency of the quality and has no impact either on the project scope or on the project schedule. Rework is always an extra expense for the contractor and may threatens the time schedule.

Force Majeure changes:

This is a common clause in a contract. It is an act beyond the control of the parties to the contract and parties are not bound to fulfil obligations or liabilities due to unavoidable and extraordinary events. These changes may include situations like god of act (natural disasters like tsunami, flood, hurricane, volcanic activity, etc…) or war, strike, riot and so on. (Arain, F. M., & Low, S. P. 2009, p. 11)

3.2.2 Documentation of Change Orders:

It is important that all necessary information is thoroughly included in the Change Order template because all parties need to be aware of the nature of the Change Order. In turns it provides an opportunity for all parties to review and give their comments. Information that might be included in the Change Order template is the nature of the changes (a brief description of the changes), who initiates the proposal/changes (Ex: the seller, the customer or the Sub-contractor), Supporting documents to the changes such as; letter, sketch, statements, e-mails should be attached, impact on project scope; increasing or decreasing the Contract value (value of the previous contract should be included), impact on project schedule, all information about extra costs, such as labor costs, material costs and equipment costs which occur due to the changes. (Levy, Sidney M. 2009, p. 206-207)

3.3 Cost control

Cost control is a very important concept in a company regardless the size of the company. It is a risky situation for a small-scale company, not to maintain a proper cost control system because one loss from one project may highly affect the company's sustainability and profitability. When larger companies are concerned, loss from one project may not impact the company's profitability as a whole, but loss from several projects, the situation is not the same.

If a company has a well-organized cost and control system which is well designed, developed and implemented, the company has the opportunity to get immediate feedback when it is needed and compare results in project life cycle with its target objectives, and it is easy to calculate up-to-date usage regarding its resources. According to Harold Kerzner following requirements should be included, in order of having an effective control system.

- Good ahead planning to complete the project work to be performed
- Good estimating of time, labour and costs
- It is needed to have a clear communication about the tasks in the project scope.
- Control over project budget and the expenditures.
- Check timely physical achievements and cost expenditures.
- Re-estimate time and cost periodically, for the purpose of completing the remaining work in the project.
- Compare periodically actual progress and expenditures with the budget and schedules and compare as to how well it is proceeding according to the project completion schedule.

To win the battle without losing the war, the project team must analyse all three parameters; time, cost and performance as a group. A company with effective cost control system can measure expenditures against its budget, can identify its variances and take correct decisions and actions when it is needed. (Kerzner, H. K., & Harold R. 2013, p. 741-742)

There are basically two kinds of costs that are involved with Change Order work. They are; direct costs and indirect costs. Direct costs are the costs which are directly required to complete the work. Example of these type of costs: Material costs, labour costs, equipment costs, bond premium, insurance premium, rental equipment, photographs, redesign costs, Sub-contractor and vendor costs. Indirect costs are the costs associated with the seller and the customer filed expenses such as; Project Management, Project Engineers and Project Superintendent Costs, estimated costs to prepare a proposal Change Order.

There is another type of cost, which is called “Impact costs” which is also needed to be considered. This cost applies when it concerns delay costs or delay claims due to Change Orders. (Levy, Sidney M. 2009, p. 209)

Controlling project cost is a continuous process which need to be followed to ensure that the project is being completed within its budgeted cost, without facing risky situations. The project, has a specific budgeted sum for expenditures which is not allowed to be exceeded. In most cases these budgeted expenditures vary during the constructing period due to changes in the construction process. As an example, if the customer requires to enhance design specifications, then the seller needs to redesign the specifications, and the project team/design team needs to assess the cost and the time implications that is occurring due to the enhanced specifications. Normally, in construction projects, a separate contingency sum from the project budget is allocated to use for unforeseen work/expenditures. Unforeseen works could be categorized as additional work, design alterations. Communication between all the project team members is an essential part to control and maintain construction cost successfully. Construction cost records, regular financial reviews, cost discussions meetings must be accessible and available for all the project members in the project. (Hackett, M. S. 2016, p. 8-9).

4 Change Order

A Change order always has to be documented, and the responsible project manager and Project Controller must be informed, because it may impact the project value or the project schedule, meaning that it can increase or decrease the project value as well as the agreed time limit of the project. (Wärtsilä 2017)

CO can arise without causing changes neither in project value nor in the agreed project schedule. Still, it's essential that the responsible project manager/controller is correctly informed about each and every change order directly so that proper action can be taken and the management can be on top of the problem solving and deal with a proper solution and take necessary action in regard to the whole project.

Change orders can lead to disputes between the project owner and the customer. The project owner's objective is to complete the project on agreed time and to meet the customer expectations at the same time. Especially in regards of the time schedule, it is important that the project is delivered within the expected time frame. An effective structure to handle change orders is benefitting for both project owner and customer, because it clarifies the consequences up front for both parties.

The responsibility of the project owner is to control and manage the project budget according to allocated costs and time frame. Adequate managing of change orders by following up costs, claims on time frames, helps to make the project successful. Technically, a situation can occur where the owner has to pay contractual liquidated damages to the customer or to the contractor, caused by too many or to complicated change orders, caused either by the side of the owner or the customer. If the owner is unable to hand over the project on contractual completion date due to interfering change orders, it is important to have a tool set at hand to address these matters under the conditions of the original contract with the customer. Responsibility for change orders, and resulting costs and delays must therefore be addressed in the original contract to avoid disputes between parties.

4.1 The process

According to the information at hand from the research in this thesis, it is important to know how Change Order occurs in projects. The Change Order process and the parties involved, are different depending on what kind of project that is concerned. Mainly, there are two types

of Change Orders in a project, i.e. Customer Change Orders (Change orders between Wärtsilä and the Customer) and Sub-Contractors Change Orders (Change Orders between Wärtsilä and Sub-contractors). The personnel who are signing the Change Order is also varied according to the Change Order type.

As per the information that I have received from interviews and meetings with project teams, I could see that the experiences of handling Change orders are not similar between customer and Sub-Contractors Change Orders.

4.1.1 How does a CO occur?

According to internal stakeholders; customer Change orders arise when a customer make an offer and then it is up to the seller to accept or not. There are several forms for Change Orders. One form is used, when the customer wants to make a change. This means that they make an offer. There is another form that is used when Wärtsilä needs to do some amendments. Usually Wärtsilä hands over the Change Order template to the Customer with the Original Contract.

In practical, there are some cases that Sub-contractors complete the change order, and then make an offer for the done changes, and they argue that it's not so easy to deal with preparing documents to make an offer for changes while completing the work at the same time. Especially the Sub-contractors prefer to do work first and then they calculate how many man hours that they have used for doing changes, and then make a final offer for the work that they have already done. Wärtsilä however is not bound to accept their proposal as it is. Wärtsilä has to verify a valid value of the change order. The normal procedure in some countries is that Sub-contractors do their work first and make an offer later for changes.

When the customer change orders are concerned, there is also a strict procedure to follow. However, conditions differ between project contracts. Project team in some projects is maintaining a plus/minus (+/-) list during the whole project period and try to end up at zero at the end of the project. This list includes different work roles that the seller and the customer have agreed on. Example: Works that Wärtsilä is bound to do, are still left or forgotten to do (-), some components; material which are not possible to provide (+), and if the company has done some extra work etc…

According to the contract, the parties should make change orders formally as soon as changes occur. It's the best way too, because it prevents controversial situations between the parties.

4.1.2 Who has the responsibility for approving the CO?

Change Orders by the Mechanical Sub-contractors are dealt with by Mechanical supervisors in first hand, Electrical Sub-contractors are dealt with by Electrical supervisors and the Civil Sub-contractors respectively are dealt with by civil supervisors. Then, the matter it dealt by the respective Chief Project Engineers; Mechanical, Civil or Electrical.

Chief Project Engineers are responsible for having control over his/her own engineering side. All change orders should be handled by Project Manager because Project manager has been given Power of Attorney in project, to be able to sign documents on behalf of Wärtsilä. Project managers should follow up project cost. There is no definitive and clear procedure about how CO proceeds and it also depends on the project team. In some cases, project CPE's were given power of attorney to sign documents.

4.1.3 Common Change orders issues

As understood from information received from internal stakeholders, the most difficult things of handling Change orders are summarized here. When considering customer change orders; it costs both money and time for them to go through the process and the customer doesn't like it. But, there are customers that are easy to deal with too. There are several aspects for that. The customer should trust the seller and accept the proposal, the Change Order should be managed within the project time.

When it comes to sub-contractors Change orders; it is another aspect. If the Sub-contractor bring their proposal with in good faith, then would be easy to deal with them. But, sometimes some Sub-contractors bring their own lists for Change orders mentioning some false quantities and value. In such a case, it takes time to come to a good solution. It's important to have a good relationship with Sub-contractors. Even though the seller has a power to refuse all the Change Orders because the Sub-contractors have not done their works according to the Contract, the seller has to be fair with them Otherwise it may lead to disputes.

It's important to maintain the balance between the seller and customer or the seller and the sub-contractor. If you treat them bad when you have power, once they have power one day they will treat you the same.

Interview with internal stakeholders: The difficult situation of dealing with Change Orders is that if the customer do some proposals for changes when it comes closer to deadline. In

that case, the seller and the customer should agree with each other that Change order doesn't extend the project schedule. Otherwise in turns the situation can come to pay fines to the customer for the delay.

4.2 Legal aspect

Change Orders are bilateral agreements. One of the parties are making an offer and the other party is either accepting or denying the proposal. Most of the time Change Orders bring amendments to the original contract. That's the reason the construction companies should understand and need to have a structured system how to act legally and reasonably in dealing with Change Orders, in terms of protecting the relationship between parties, and as well as paying costs as needed for the changes which are done during the construction period.

For a change order to become valid, both parties' signatures must be there in the document and only then a valid offer and a valid acceptance are made. A Change Order is a practical issue, as well as a legal issue, because change order is a normal process which can not always be avoided in the project. Most of the cases the parties may not go for litigations to solve the matter, instead they prefer to solve the matter with discussions and negotiations. The seller need their customer and the seller need their sub-contractors. Litigations and arbitrations processes are not practical because they are costly, take time and not good for future businesses.

Following are some words which are important to this study. Definitions have been taken from one EPC project Contract, which signed between one customer and Wärtsilä dated 23rd of June 2016. (Wärtsilä 2017)

Subcontractor:

" ***"Subcontractor"*** *means any person (or other legal entity) named in the Contract as a* subcontractor*, manufacturer or supplier, or any person (or other legal entity) appointed as a subcontractor, whether directly by the CONTRACTOR or at any lower tier (including any subcontractors or vendors of materials) for a part of the Works and the legal successors in title to such person (other than by merger or acquisition not consented to by the OWNER), but not (except with the consent of the OWNER) any assignee of such person."*

Variation:

" ***"Variation"*** *means any change, modification, addition or deletion to, in or from the Specification or the Works or a change or restriction in the CONTRACTOR's sequence,*

timing, conditions or methods of working, which is instructed or approved as a variation under a Variation Order issued pursuant to Clause 30 [Variation]"

Variation order:

""***Variation Order"*** *mean any written order, identified as such, issued to the CONTRACTOR by the Owner pursuant to Clause [Variations]"*

Claim:

If the parties are not agreed with the changes occur in a project and in turns with its compensation, those disagreed changes may lead to a claim. All the claim in a project need to document, take actions and manage. Claim management is also an important tool of a company same as Change management. Claim is to be settled with parties without delaying with negotiations between parties. If it is necessary, parties can get help from their senior management to come to a settlement. If the parties are still not satisfied with an amicable settlement, the dispute may resolve by arbitration procedure. (Wärtsilä 2017)

Legality of the Change order:

If the Owner or the Contractor needs to vary, alter or modify the works in Scope, it can be done only after submitting a proposal for variation or direct submitting a variation Order to the other party. Such kind of proposal for a variation or an offer for a variation is valid up to 28 days and if the other party has not accepted the offer within 28 days, the offer has to be withdrawn by the offeror. If the offeree has accepted the offer for a variation, the offeror shall issue a Variation Order.

Both parties must act reasonably and in good faith when it concerns the amendments to the Contract time and the Contract value.

Before printed out the Change Order template, all the necessary information needs to be filled and the both parties should be signed. Without parties' signatures, the Change Order can not consider as a valid document. (Wärtsilä 2017)

4.3 Site hand book

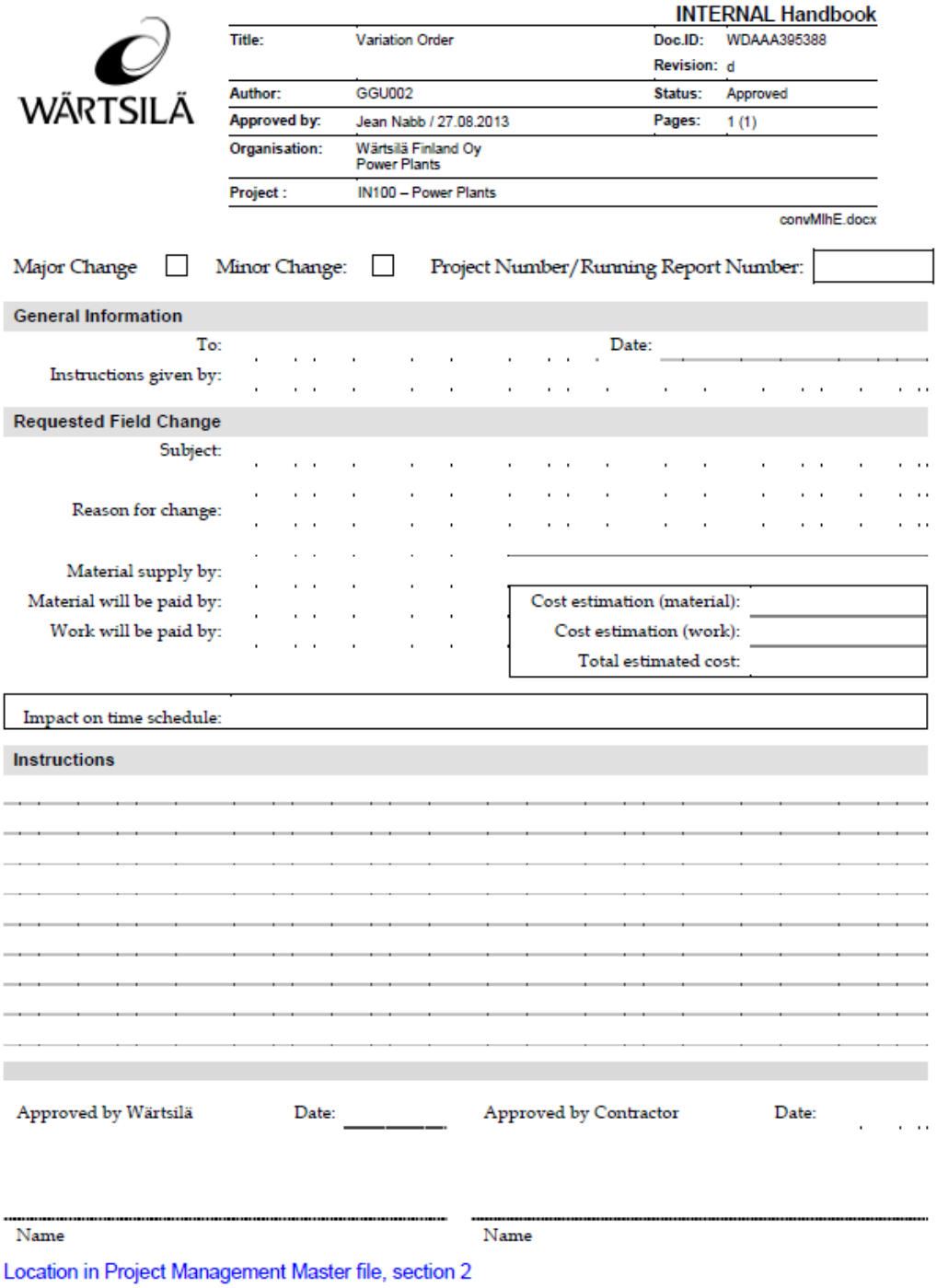
The Site hand book is maintained by the Installation and Construction Services (ICS). The object of having a Site hand book is to provide information about the working processes of the project during the whole construction period. Information in the Site hand book comes from both Integrated Document Management (IDM) and compass. All information that the

project team needs from the beginning of the project until the project is handed over to the customer; such as Human Resource (HR) matters, Project management, Site management, Site administration, Site reporting, Manage Sub-contractors, Site book-keeping, Change Order template, … are included in the Site hand book. (Wärtsilä 2017)

When Wärtsilä and/or the customer need to do any changes to the original design in a project, the Figure No: 3 shows the template that should preferably be used by both parties. This template is only one of several templates that I have encountered during this CO study.

Identified shortages of this template:

- No summary of original Contract value changes. It's good to have, Example: Original Contract value, Sum of previous Change Orders, New Change order value and Contract value after the present Change order.
- No link to information/materials which are related to Change Order.
- No mentioning from which engineering department the Change order originate, Ex: Mechanical, Civil or Electrical.



WÄRTSILÄ

INTERNAL Handbook

Title:	Variation Order	Doc.ID:	WDAAA395388
		Revision:	d
Author:	GGU002	Status:	Approved
Approved by:	Jean Nabb / 27.08.2013	Pages:	1 (1)
Organisation:	Wärtsilä Finland Oy Power Plants		
Project :	IN100 – Power Plants		

convMlhE.docx

Major Change ☐ Minor Change: ☐ Project Number/Running Report Number:

General Information

To: Date:

Instructions given by:

Requested Field Change

Subject:

Reason for change:

Material supply by:

Material will be paid by:

Work will be paid by:

Cost estimation (material):

Cost estimation (work):

Total estimated cost:

Impact on time schedule:

Instructions

Approved by Wärtsilä Date: Approved by Contractor Date:

Name Name

Location in Project Management Master file, section 2

Figure 3: Change Order template (Wärtsilä 2017)

4.4 Site feedback

Site feedback comes from the project team, considering the reasons for the Change Order approval or not. Site manager in the project takes the decision himself most of the time to accept the Change Order, or not. The Site manager has been given the right to accept change order up to a given monitory value. If the value of the change order is beyond the Site manager authority, he has to bring the matter to Project manager. The Project Manager has the right to approve the Change Order up to a certain monitory value.

Site feedback which is related to Change order determines if it is due to design error or manufacturing error or something else. Site feedback is a decision support to the project team. Feedback is a vital support as a ground for making decisions that can lead to a Change Order. A Change Order in turn can lead to a claim. General site feedback about systematic design errors are supposed to have corrections made, and thereafter be updated as a new corrected standard design.

In general, a good site feedback should consist of a written report with an included picture which is related to the matter in question, a brief explanation in text and the references to the design or relevant issue.

4.5 Sub-contracts

In general, selecting of Sub-contractors to a project starts in the beginning of project planning i.e in the preparation step in the project. Site manager in the project, with the cooperation of the Project Manager, Civil Work Supervisor, Electrical and Mechanical Supervisors select the potential sub-contractors locally after justifying relevant criteria. The scope of the Sub-contractors may vary from project to project. In EPC projects Wärtsilä rely on Sub-contractors service for the purpose of providing standard construction materials, hiring labour and equipment, transportation etc… (Wärtsilä 2017)

Figure 4; sums up the sub-contracting work process in a project. Change management comes under the phase of “Contract Administration”. It mentioned that the contract itself should include how to handle the change orders and Where to find the Change order template in relation to Sub-contractors.

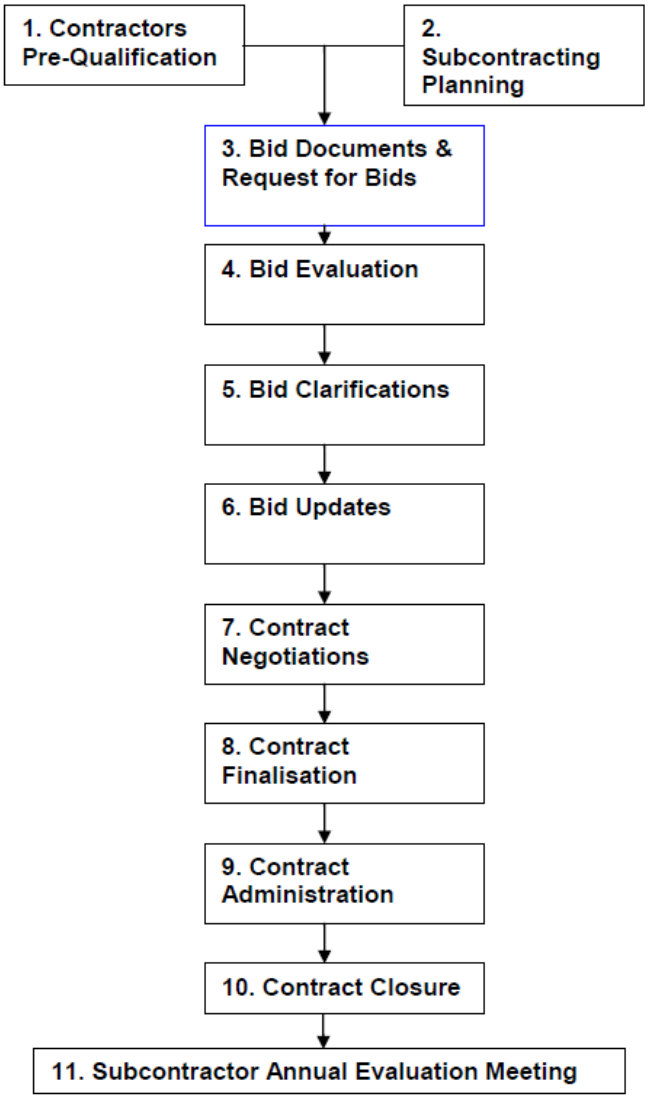


Figure 4: Work Process chart (Wärtsilä 2017)

5 Projects included in this research

This Study is a case study limited to seven Energy Solutions projects in different areas in the world. The projects have been selected by the supervisor Peter Bergqvist – Engineering Manager, Wärtsilä Finland Oy.

5.1 EEQ - 1

Project background:

This project is an Extended EEQ project which is located in South Texas, USA. The power plant is powered with 12 Wärtsilä 50SG (12x18V50SG) engines and the total expected output would be 225 MW. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: JAROWICZ Anna
Project controller: Norah Lynne Davlin
Chief Project Engineer - Mechanical: Joseph Koshy
Chief Project Engineer - Civil: Joni Vares
Chief Project Engineer - Electrical: Jukka Kuitunen

Information from internal stakeholders:

The plant has already been handed over to the customer. Three Change orders; one from Mechanical scope (No: 015) and two from Electrical scope (No: 013 & 014) are still under pending status. The reason for that is Wärtsilä and the customer is still negotiating with +/- list. Change Order No: 16 has been cancelled after negotiating between parties.

Below in Table 1; shows how Change orders have been categorized. Here we set the original Contract value to 100 X. Calculating Change Orders impact in this project on the original contract value, shows that the Contract value has increased to 101,09 X. This equals a plus 1,09 % added to the original Contract value.

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value (X)				100,00		
001	Rupture Disc Assemb + Exhaust gas Ducting	0,21			100,21	0,21	None
002	ABB Generator 6 months maintenance at ports		0,05		100,26	0,05	None
003	Storage fees (SCR equipment, Auxiliaries & Generators, Engines	0,16			100,43	0,16	None
004	Storage fees (SCR equipment, Auxiliaries & Generators, Engines	0,15			100,58	0,15	None
005	Storage fees (SCR equipment, Auxiliaries & Generators, Engines	0,06			100,64	0,06	None
006	MV Switchgear Storage Fees		0,01		100,65	0,01	None
007	Equipment Storage Fees	0,06			100,71	0,06	None
008	ABB Generator 6 months maintenance at ports		0,05		100,77	0,05	None
009	Final Storage Fees Equipment & Gen	0,07			100,84	0,07	None
010	ABB Generator 6 months maintenance at ports		0,04		100,88	0,04	None
011	Final Gen Storage and Delivery costs	0,13			101,01	0,13	None
012	ABB Generator 6 months maintenance at ports		0,02		101,03	0,02	None
013	Control System updates		0,01		101,04	0,01	None
014	15kV Switchgear Modifications, Parts and labor		0,03		101,07	0,03	None
015	Charge Air Filters	0,02			101,09	0,02	None
016	Additional WOIS/WISE signals / future historian computer		0,00		101,09	0,00	None
	Added percentage to Original contract due to Change Orders	0,87	0,22		1,09	1,09	

Table 1: Customer Change Order list

Conclusion:

The total percentage of the Change Orders represent 0,87% in Mechanical engineering and 0,22% in Electrical engineering. No Change Orders under Civil scope.

This is an EEQ project and therefore no Sub-Contractors Change orders. Change Orders which are shown in the Table 1, from No: 001 to No: 015 are Customer Change Orders.

The project budget is split between Wärtsilä Finland Oy (WFI) and Wärtsilä North America (WNA). WNA carries the full value of the contract which includes the costs allocated to WFI and WNA and WFI entered into an Inter-corporate agreement to purchase the WFI scope.

5.2 EPC - 1

Project background:

This project is an EPC project which is running in base-load mode. It's a second extension to one existed project with further installation of 1xW18V46 engine model. EPC - 1 is one of Wärtsilä´s project in Morocco. The expected net output in the project is 17.6 MW. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: Julien Brudi

Project controller: Robin Högkvist

Chief Project Engineer - Mechanical: Julien Brudi

Chief Project Engineer - Civil: Lacroix Sébastien

Chief Project Engineer - Electrical: Robalo Jorge

Interview with internal stakeholders:

Change order differs between projects, customers and sub-contractors. Change Orders which are registered under Integration Management in IDM are typically finalized Change orders; including contractual agreement and some similar situations. Sub-contractors change orders are categorized under Supply Management. Citec Change Orders are categorized under Integration Management.

Integration Management in IDM is usually a natural place in most projects where Change Orders are documented.

EPC -1 project doesn't have any formal change order up to date. Some Change orders are under pending status. This is why still no Change orders from this project can be found in IDM.

There is a long procedure before a Change order is finalized and there is no specific place to register ongoing change orders. Furthermore, there is no written process to follow Change Order procedure. The process also depends on what kind of Change order that is handled. Customer change orders handling depend on the contract between Wärtsilä and the customer. The contract itself describes how to handle customer change orders; meaning that the Contract provides conditions and steps to follow, what documents that should be presented, what kind of changes can and can not be as Change Orders. In addition, the original contract provides that the parties can not make any amendments to the contract value or to the contract time, unless otherwise both parties agree. In case, both parties agree, a Change order can be issued.

If a customer in an EPC projects propose to do some amendments, the seller has to strictly follow the conditions of the contract. If some change order should derive from sub-contractors, Contracts with Sub-contractors have to be applied.

In the present EPC - 1 project, there is no formal change orders and there are some ongoing change orders can be noted.

Sub- contractor change orders are still under discussions. Basically, Sub-contractors provide different kind of documentation. Firstly, they send a one big table including all the modifications that they have done. Then the seller has to check if all these modifications really are change orders or not because sometimes this list contain work that does not sort under Change orders.

Some of these Change Orders are still not finalized and thus the percentage of Change order in this project so far is preliminary and the final value and percentage of the Change orders in relation to the original Contract value can be calculated when the Change order handling is terminated.

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original contract value - Semind S.A.R.L.				100,00		
	Piping installation	9,50			109,50	9,50	None
	Tank erection	1,63			111,13	1,63	None
	Mechanical installation	1,80			112,93	1,80	None
	TS Janvier-Février	1,23			114,16	1,23	None
	Super Structure			6,79	120,95	6,79	None
	Added percentage to Original contract due to Change Orders	14,16	-	6,79	20,95	20,95	
	Original contract value - Acrobeton				100,00		
CO01	Fire fighting modification			0,79	100,79	0,79	None
CO02	Fire fighting cabinet in concrete as exisiting			0,42	101,20	0,42	None
CO03	Steel Structure	2,81			104,01	2,81	None
	Added percentage to Original contract due to Change Orders	2,81	-	1,20	4,01	4,01	
	Original contract value - EPMC Electric				100,00		
CO01	Discrepancy between cable quantity on the Bill of Quantity and cable schedule		19,14		119,14	19,14	
	Added percentage to Original contract due to Change Orders		19,14		19,14	19,14	

Table 2: Mechanical, Civil & Electrical Sub-Contractors Change Orders

Conclusion:

Table 2; shows Mechanical, Civil & Electrical Sub-Contractors Change Orders. Change Orders derive from three different Sub-contractors; Semind S.A.R.L., Acrobeton and EPMC

Electric. The seller has separate agreements with different Sub-contractors for specific engineering scope. As summarised in the Table 2; Semind S.A.R.L. is the Mechanical Sub-contractor for Mechanical installation work, Acrobeton is the Civil Sub-contractor for Civil installation work and so on.

The Change order No: 03 in Table 2; CO03 – Steel Structure is related Civil Sub-contractor Actrobeton, but due to some issues during roof erection, it has been decided to put this Change order in to mechanical scope in order to have better coordination at site.

Mechanical Change orders represents 14,16 % in Semind and 2,81 % in Acrobeton. The high percentage, 9,50 % of Semind is because of piping installation. The total impact on the Semind original contract value is almost 21 %, i.e. one fifth of original contract value has been increased because of change orders.

CO01in Table 2; in relation to Electrical engineering is from Sub-contractor, EPMC Electric and the original contract value has been increased due to that Change order with 19,14%. This is the only electrical change order which has been agreed and signed by both parties; the seller and the Sub-contractor.

5.3 EPC - 2

Project background:

This is an EPC project which is powered by 15 Wärtsilä 20V 34DF engines using duel fuel oil; natural gas and Fuel oil as alternative. The expecting output of the power plant is 135 MW. Power plant is situated in Oman. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: JAROWICZ Anna/Milton Dasgupta
Project controller: Nasser Cedric/ Hannu Kuivamäki
Chief Project Engineer - Mechanical: Sandesh Salunke
Chief Project Engineer - Civil: Amjad Al Amir
Chief Project Engineer - Electrical: Milton Dasgupta

Interview with internal stakeholders:

No Customer Change orders in this project because this project is a full EPC project and the customer scope is limited only to fuel oil and Natural Gas according to one Wärtsilä internal stakeholder.

Result:

Change Order No:	Description	Mechanical %	Electrical %	Civil %	Contract value in %	Impact on the Contract %	Impact on the time schedule
	Mechanical Sub-contractors						
	Advanced Oilfield Technology Co L.L.C (AOTC)	11,12			111,12	11,12	None
	Civil Sub-contractors						
	Premier International Projects L.L.C. (PIP-CIV)			19,33	119,33	19,33	None
	Fire Fighting - Yousuf Bin Ahmed Al Aamri Trdg. L.L.C (FF-UG)			6,89	106,89	6,89	None
	Fire Fighting - (FF-AG)			4,89	104,89	4,89	None
	Electrical Sub-contractors						
	Special Technical Services L.L.C. (STS)		14,42		114,42	14,42	None
	Majees Technical Services		11,04		111,04	11,04	None

Table 3: Sub-contractors Change orders

Conclusion:

The percentage are shown in the Table 3 are from Appendices 1-6.

5.4 EEQ - 2

Project background:

EEQ - 2 is a basic EEQ project in USA. IT is a Gas Power Generation with 2 Wärtsilä 20V34SG engines. The expected output of the power plant is 18000 kW. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: JAROWICZ Anna

Project controller: Norah Lynne Davlin

Chief Project Engineer - Mechanical: Joseph Koshy

Chief Project Engineer - Civil: Joni Vares

Chief Project Engineer - Electrical: Jukka Kuitunen

Interview with internal Stakeholders:

This project is an EEQ projects and therefore no Sub-Contractors Change orders.

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value (X)				100,00		
001	Additional capacity to 125VDC system and spill containment		0,22		100,22	0,22	None
002	MRO PSS Tuning/Field Test/Test Plan/Analysis & Report		0,37		100,59	0,37	None
003	Supply Lube Oil Mist Coalescer	0,02			100,61	0,02	None
004	Genset Security & Releated Expenses	0,08			100,69	0,08	None
005	Emission & Noise Testing	0,63			101,32	0,63	None
006	Spare Parts - Electrical & Mechanical	0,41	0,35		102,07	0,75	None
	Added percentage to Original contract due to Change Orders	1,14	0,93		2,07	2,07	

Table 4: Customer Change Orders

Conclusion:

As per the result in the above Table 4; there are no any Civil Change orders in the project and Mechanical Change orders represent 1.14 % out of 2.07 % change orders. High percentage of Change orders percentage in Mechanical engineering was because of Emission and noise testing.

5.5 EPC - 3

Project background:

This EPC – 3 is a Mexican EPC project with 7 Wärtsilä W18V50SG engines. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: Hannes Ampiala

Project controller: Magnus Lundell

Chief Project Engineer - Mechanical: Toni latva salo

Chief Project Engineer - Civil: Timo Toivanen

Chief Project Engineer - Electrical: Tuomaala Ville

Interview with internal Stakeholders:

The Power of Attorney to be able to sign Change Orders with Sub-contractors in mechanical engineering side is given to CPE-Mechanical.

Interview with internal stakeholders: The Change Order process is written in the contract. The conditions, provided in the Contract between Wärtsilä and the customer have

information about the Change order process. Conditions in the Sub-Contractors contract do not provide sufficient information about the change order process.

The seller could not hand over this project to the customer before deadline. Because of this reason, Wärtsilä had to pay delay payments after negotiations with the customer. (Wärtsilä 2017)

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value - Onshore				100,00		
002B	Workshop extension - Onshore			0,09	100,09	0,09	None
005B	ESD valve - Onshore	0,04			100,13	0,04	May affect
008	Workshop fence, shelf installation and septic tank modification - Onshore			0,01	100,14	0,01	None
010	Laboratory room - Onshore			0,11	100,25	0,11	None
011	Supply and Installtion of water line - Onshore			0,06	100,31	0,06	None
012	Supply and Installtion of a washing place cooling water - Onshore			0,01	100,31	0,01	None
013	Potable water pit with booster pump - Onshore			0,07	100,38	0,07	None
014	CCTV, 70 000 MXN Onshore		0,02		100,40	0,02	None
	Added percentage to Original contract due to Change Orders	0,04	0,02	0,34	0,40	0,40	
	Original Contract value - Offshore				100,00		
001	Office IT design basic engineering - Offshore		0,01		100,01	0,01	None
002A	Workshop extension - Offshore			0,04	100,06	0,04	None
005A	Installation of Emergency Shut Down valve - Offshore	0,04			100,09	0,04	May affect
006	5 barrels of oil - Offshore	0,00			100,10	0,00	None
007	12.5 m3 of lube oil - Offshore	0,04			100,14	0,04	None
	Added percentage to Original contract due to Change Orders	0,08	0,01	0,04	0,14	0,14	

Table 5: Customer Change orders

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (€)
	Mechanical Sub-contractors					
	AMISA Group S.A. de C.V.	12,80			112,80	12,80
	Civil Sub-contractors					
	BS DE MÉXICO, S.A. DE C.V - Below 0 level			11,64	111,64	11,64
	BS DE MÉXICO, S.A. DE C.V - Above 0 level			6,63	106,63	6,63

Table 6: Sub-contractors Change orders

Conclusion:

Information which is summarised in Table 6; above are available in Appendices 7-9.

5.6 EEQ - 3

Project background:

EEQ – 3 is a USA project which is generated by five Wärtsilä engines. One generator set has a 9,8 MW capacity and accordingly the power station output generates 46 MW. This is an EEQ project and therefore the Wärtsilä scope is limited to supply Engine Generator sets and other auxiliary equipment and in addition supplying gas conditioning system, emission system, supervision installation, heat recovery system for hot water, etc… are also under the Wärtsilä scope. (Wärtsilä 2017)

Internal Stakeholders:

Project manager: Ulf Stoor
Project controller: Thomas Högnabba /Lynne Davlin
Chief Project Engineer - Mechanical: Mathias Södergård
Chief Project Engineer - Civil: Joni Vares
Chief Project Engineer - Electrical: Jukka Kuitunen/Toni Haarala
Site manager: Mats Lärka

Interviews with internal Stakeholders:

In this project Wärtsilä has not signed any contracts with Sub-contractors and instead the customer has their own sub-contractors which are providing service/work to Wärtsilä. Wärtsilä has approved those Sub-contractors as Wärtsilä approved suppliers for specified works.

For every projects the seller needs to get service/work done using other contractors. But, in this project, because the seller doesn’t have their own Sub-contractors, Wärtsilä had to pay for the invoices that were given by the Customer’s Sub-contractors for the changes that they have done. Example: Change order 004 - For platform in Table 7.

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	The difference with CO value (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value (X)					100,00		
001	LNG project							
002	Radiator type chnaged, Exhaust gas Silencer + Design update, Additional MV Feeder, Station Transform, Charge air Filter, EGM Steel Structure etc...	1,36	1,16	0,09	0,44	103,05	3,05	
003	Cancelled							
004	Urea injection Point Platform + Redesgin of Filter Platform, EGM Delivery - Overtime cost, Lube oil Transfer pump, Design, Pipe rack re-calculation	0,49	0,02	0,02	-0,02	103,55	0,50	
005	Negative: Lube Oil, Glycol & Urea 1st Fill, Electrical Material Settlement, Electrical Troubleshooting, etc... And Positive: Additional Mandays, Urea tank installation	-0,14	0,81	-1,25	0,00	102,97	-0,59	
	Added percentage to Original contract due to Change Orders	1,71	1,99	-1,15	0,42	2,97	2,97	

Table 7: Customer Change orders

Conclusion:

Change order NO: 01 is related EEQ - 3 project and it is a different project. Therefore, I have not included that Change order value in to Table 7.

5.7 EPC - 4

Project background:

This power plant consists with 10 Wärtsilä W18V50DF engines and is designed for Base load operation to be driven with natural gas and crude oil as main fuel. The project is situated in Saudi Arabia. Expected output 176 MW.

Internal Stakeholders:

Project manager: Niklas Dahlgren

Project controller: Hannu Kuivamäki

Chief Project Engineer - Mechanical: Björn Gull

Chief Project Engineer - Civil: Robert Sigfrids

Chief Project Engineer - Electrical: Ted Östersund

Interviews with internal Stakeholders:

Change Orders in this project have been divided into Onshore and Offshore, but both Change Orders have been documented with the same chronological order. All Change orders in between Wärtsilä and Customer can be seen under Communication Management (WD-P4.7).

Result:

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value - Onshore				100,00		
03	Waste water pit (Onshore)	0,00			100,00	0,00	None
05	Gas pipe line (Onshore and offshore Split)	0,00			100,00	0,00	None
	Original Contract value - Offshore				100,00		
01	Downsizing of LV breaker - Offshore		0,00		100,00	0,00	None
02	Line differential protection to Switchgear - Offshore (€)		0,00		100,00	0,00	None
04	Removal of 2500A outgoing cubicle in MV SWG - offshore		-0,10		99,90	-0,10	None
	Added percentage to Original contract due to Change Orders	0,00	-0,10		-0,10	-0,10	

Table 8: Customer Change orders

Conclusion:

Change Order No: 01 is related to Electrical Basic design in which the customer confirmed MV-SLD main breaker was downsized. The correct breaker size was replaced and parties agreed to a zero value for the Change Order.

Change Order No: 02 has occurred for the reason of adding line differential protections to switchgear outgoing feeders. The project scope was increased due to the seller needed to install additional equipment. Parties agreed to have a Change Order with zero value.

Chnage Order No: 03 also occurred due to customer requested changes other than mentioned in the original scope. Because of the Change order No: 03, Mechanical, Civil and Electrical Detailed Designs needed to be re-designed.
Change order No: 04 is a negative change order and because of that the original contract value has been decreased with 0,10%. The Change order is about removal of 2500A outgoing Cubicle Breaker from the Wärtsilä scope.

Change order No: 05 is about Gas pipe line and it has been split to both Mechanical and Civil. Gas pipe line needed to re-route due to GPRS location was changed with the new scope. Basic and Detail design drawings were also changed accordingly. Parties finally agreed that the value of the change order was zero euro.

Change Order No:	Description	Mechanical (%)	Electrical (%)	Civil (%)	Contract value (%)	Impact on the Contract (%)	Impact on the time schedule
	Original Contract value - Crown Contracting Compnay Ltd				100,00		
001	Installation of Wall panel, roof, process ventilation and doors & windows			16,34	116,34	16,34	May affect
	Added percentage to Original contract due to Change Orders			16,34	16,34		
	Original Contract value - Al Muzn Arabia Construction				100,00		
003	Deviation of Bill of Quantity between actual and agreed concrete pump costs (Engine hall slab)			1,62	101,62	1,62	None
	Added percentage to Original contract due to Change Orders			1,62	1,62		

Table 9: Civil Sub-Contractors Change orders

When doing my research regarding this project, I could find Sub-contractors Change orders deriving from Civil engineering according to Table 9.

6 Result

This chapter sums up Change orders common issues, problems around Change orders, summary of the result and proposals which I have found and finally, why it is needed to have a standard template for change orders.

6.1 Change orders common causes

In my research, I discovered several common causes of change orders among the selected projects. These causes may, or may not differ significantly from Change orders in other projects not included in this study. Nevertheless, the findings that I present in this study, are probably applicable for many more recent, and earlier projects in Wärtsilä. I would here like to mention common causes for Change orders, according to this research regarding Sub-Contractors, and Customers.

In general, Customer Change orders percentage is higher in Mechanical engineering than in Civil and Electrical engineering. The reason for this finding may be that Mechanical engineering has been given a larger part of the construction work. Civil engineering has much less Change order percentage compared with the other two engineering systems.

Sub-Contractors Change order percentage on the other hand, is differently divided. The most abundant Change order regarding Sub-contractors are related to Civil engineering according to this study. Important here is note that Sub-Contractor Change orders relate to only to EPC projects.

Registered causes for customer Change orders

Mechanical installation works:

- Exhaust Gas Module (EGM) Steel structure, Charge air filter, Genset security & related Expenses, Units storage fees, Emergency Shut down valve, etc…
- Urea tank installation
- Exhaust gas ducting and Rupture disc installation
- Emission and noise testing

Civil installation works:

- Workshop extension, Workshop fence & shelf installation
- Water line installation
- Washing place cooling water installation, etc…

Electrical installation works:

- Control system updates
- Installation of Low Voltage Power Circuit Breaker
- Installation of additional VDC system (VDC: Volts Direct Current)
- Installation or changes to MV Switchgear (MV: Medium Voltage)

Here follow the registered causes for Sub-Contractors Change orders.

Mechanical installation works:

- Piping installation, supplying of high pressure & ventilation pipes, Piping modification
- Steel & Support structure installation
- Installation of Firefighting system (steel pipe, fabrication of supports)
- EGM and Turbocharger repair
- Welding procedure changing

Civil installation works:

- Firefighting modifications,
- Additional earthling works
- Discrepancy of concrete pump costs between actual and agreed Bill of Quantity (BOQ)
- Installation of wall panel, Exhaust gas platform and Exhaust gas duct supply
- Additional layer paintings in pipes and engine hall
- Rain water pipes for Drainage system

Electrical installation work:

- Supply of cable and accessories
- Discrepancy of cable quantity between Bill of Quantity (BOQ) and Cable Schedule

Register Change order costs in order and in correct way, helps to follow good Accounting Principles and policies in the company as well. If the costs have not been accounted for under correct book keeping account, or if the costs are under, or over stated in accounts, it is questionable if Accounting Principles such as data reliability, objectivity and verifiability are followed. Not following the Accounting principles strictly, affects the Financial Statements (the Balance sheet, Income Statement, and notes to Financial Statements) in the

company. This means that the company is not able to see the correct figures about net sales margin and earnings before interests and taxes (EBIT).

Many of the identified Claims in the included projects have been found without having a value. Example in EEQ – 1, only 22 out of 131 claims have a value. Site sends information about Claims to non-conformity manager. Most of the claims only contained a brief information about the claim with no monitory value added.

6.2 Problems regarding the handling of Change orders

The company does not maintain a written change order process other than the conditions in the Contracts between Wärtsilä and the Customer or Wärtsilä and the Sub-contractor. There is no proper process description on how to follow up and document Change Orders. Every project team is following their own way of handling and documenting Change Orders.

As given by information received from interviews and meetings, there is no specific person in the project management that is handling Change orders. Instead several people are involved with handling change orders and the documentary process is in several cases unclear and in some cases incorrect. To properly handle a change order, one must possess specific understandings of the conditions of the Contract, and furthermore, the economic aspect of how to document change orders in a correct way, as well as the engineering background in terms of being able to determine costs and labour value of the change order etc. In some projects only project manager or site manager has all the information about change orders. Mechanical, Civil and Electrical Change Orders, in some projects in this research, are separately handled by their respective Chief Project Engineers.

Change Orders don’t have a specific place for documentary in the project. Sometimes in some projects, the project team uploads their Change orders in the IDM in different places, but still, every Change orders in the projects are not documented in the IDM. As a result of this situation it is needed to contact several people in the project to collect all data about the Change Orders.

Collecting information was sometimes rather difficult due to the reason that some people who had been working with these selected projects are not available anymore, because the persons might have been promoted or the project team had changed members or had changed their careers or of some other reason.

There are many change orders/claims that were found in projects without having a monitory value. It doesn't mean that those Change Orders/claim don't have any value, but for some reason, the value has been missed or in some kind of agreement for some reason been set as zero value.

One project, related to my research is documented in French language due to the customer interest. It was difficult for me to go through documents due to lack of language skills.

There is, up to date, no specific documented place which can find out all information about change orders.

6.3 Summary of the study and proposals

According to the information which I have received from the interviews, only change orders which are affecting the contract value, are sent to book keeping department. If, the change order brings amendments to the contract value, the parties need to clearly agree about the Change order value. When parties have agreed on the matter, the Business controller is informed, and a new amended contract is made with the agreed value.

Because of change orders, the project team has to adapt their work plan to the new circumstances. If the customer is responsible for the change order, the cost of that change order subsequently must be added to the contract value. In reality, negotiations are held in many cases to settle practical and monitory amendments during construction progress. Theoretically, a situation can occur where the contract dead line is threatened because of complex change orders which could cause delay payments, especially if change orders and responsibilities regarding these are not handled correctly.

One Wärtsilä internal stakeholder's opinion is that the best way of getting payment is by bargaining with customer without forcing them to be paid for change orders. It makes it easier to deal with the customer as well as both parties can be more satisfied at the end of the project. It's not possible to go for litigation processes every time parties are not agreeing with each other. The cooperation and negotiation approach are a flexible way of getting correct payment from the customer.

Every Claim needs to be registered in its correct template and the value must be correctly documented in the claim document itself. There should be a system to document and to

update every Claim correctly. There does not exist any link to the background information due to the claim at present time. If there is an updated link to check and verify about Changes and claims, it would be very easy to follow up the cost and all other beneficial advantages that follow with accessible high quality data.

Every project need to document all change orders according to standard procedure and the agreed specific place in IDM or another agreed database. It is preferable and easier to use a standard template so that every member in all project teams can use the same form all the time. Follow up, evaluations and research will be easily done when data are accessible and up to date. In worst case change orders cause reduction of the profit margin. It's profitable to have someone in the project to handle all change orders. It helps to maintain proper change order processes, as well as to increase control over total amount and value of the change orders. If properly handled, and someone is taking care of all change orders, the projects management can stay on top of the situation and make better decisions.

Change orders not only affect the contract value, but also the project schedule. It's necessary to stay on top of how CO affects the project schedule, to be able to adjust work plan and resources to complete the project within its deadline.

Planning of the project beforehand and taking advantage of earlier experiences from previous projects contribute to minimizing the quantity of change orders in projects. Every change orders take its time for administration, discussions, material, man hours, time, and money.

To be able to have a stringent handling of change orders, with a good possibility to follow up result, and further develop routines demands a proper structured common handling.

Whenever a change order is being handled it is of obvious importance that all facts concerning the need for a change order are established and verified, so that a proper evaluation according to the contract, and a proper cost evaluation can be undertaken. If change orders are handled differently in many locally favoured ways, Wärtsilä lose a lot of valuable information, as well as there is a risk of causing pressure on the individuals who are handling these matters without a complete set of tools for the matter.

I propose to use two separate chronological order number for change orders when a project has two contracts with two Contract values for Onshore and Offshore. In this way, it will be possible to follow up change orders cost related to on- or offshore since on- and offshore

have separate budgets and contract values. Book keepers, as well as anyone else who needs information about change orders, can this way obtain updated information and correct figures about the change orders, without spending unnecessary time digging into the matter.

Site staff need proper and complete instructions for Mechanical, Civil & Electrical engineering installations. They must have all the material that they need specified in the work descriptions. It helps them to understand what they have to do, and how to do. Proper and clear installation instructions minimize the costs as well as the time spent doing the work

6.4 The need for a standard template

Wärtsilä has different kind of templates for change/ variation orders to use at sites when a Change / variation order is needed. The official Change order template is included in the site hand book (Figure 3) and there are several others in Excel form.

Even though there are many templates available, some high-quality data needs to be added to the template. Examples:

- Link to the material that the change order is related to. It may work by using “hyperlink”.
- Secondary impact, due to the change order may be included with attached document.
- What stage or phase in the contract period did the change order occur.
- Information such as; What is the Contract value before this Change order? What is the value of this change order? New contract value after the current change order. (There are several project teams that have used this system, but only for the first change order in line, not for the following change orders).

It is enough to have one standard change order template that is liable to use for everyone who are involved in making change orders. By taking a system in use which are common for all users and change orders, it will increase the efficiency of handling change orders in all levels in the company.

It was discovered that, one project had two contracts with two different contract values divided into Onshore and Offshore, Change orders were documented in chronological order mixing on- and offshore, causing problems in the follow up situation. Cost in SAP (Systems,

Applications & Products in Data Processing) could be seen separately for Onshore and Offshore.

Because of the time limitation in this thesis, I have not created any proposal Change order template. But, further discussions to create a standard change order template will be continued with Wärtsilä supervisor of this thesis, Peter Bergqvist.

7 Conclusion

This chapter contains a reflection of how well I could achieve the goals of this thesis and issues dealt with during this thesis work as well as proposals for further research. The chapter ends with my Final words about this work.

7.1 How well could I achieve the goal of this thesis?

This thesis is based on seven Wärtsilä Energy solution projects. Therefore, the result does not give the whole picture of all Energy solutions projects at Wärtsilä. However, the result can be used to understand some of the problems around handling change orders.

I am not working with change orders during my work at the company. When I selected this subject for my thesis, I did not have any idea where to start. Theory studies, and as well as my earlier educations and knowledge helped me to understand the facts related to Change orders, and concepts which surrounds Change orders. The information that I received from interviews and meetings with internal stakeholders, from company internal websites, and databases were analysed and assembled to achieve the goal.

At the beginning, it was decided that I should study Change orders in Mechanical engineering disciplines, because my tasks in the company are related to Mechanical Engineering department. Later, it was decided to include Civil and Electrical Change orders as well to get the overall picture about Change orders in a project.

I feel that I could achieve my purpose to study the way of handling Change orders in the company within the limitations of this study. Result and problems that I found, as well as proposals to have a well-structured system for Change orders are mentioned in Chapter 6. Following are the three main proposals.

1. All Change orders from all disciplines needs to be registered in a specific common way, with specified high quality data, in a specific agreed place in the company's IT-system, for instance the IDM program. In starting to do so, all advantages in terms of accessible updated information will be at hand for book keeping and accounting, decision making processes at sites and project planning stages, and it will also become an important resource for developing the company by providing information of previous problems, mistakes and solutions.

2. A standard template is of great value in terms of being able to gather high quality data so that no information is lost during handling the change order.

3. A link that accesses all updated change orders where you can access specific data would become an effective tool to implement this beneficial knowledge; stored "Know how", in research, book keeping and avoiding repeating unnecessary change orders in future projects.

Updating Change orders in a proper manner as mentioned in proposals 1-3 above, will help the company to save time and money. Resulting in increased effectiveness due to less time spent on searching for necessary information concerning Change orders, and reducing repetitive Change orders by implementing easy access of updated high quality data as a basis for decision making. As a global actor Wärtsilä has hundreds of projects going on. A crude mathematic hypothetic example; if there are a hundred Change orders per project, and every change order has a value of 1000 euro, applied to 100 projects, gives at hand a staggering amount of 10 million euros worth of Change orders. It is easy to understand that it is important to deal with Change order in a beneficial structure.

7.2 Issues dealt with during thesis work

Gathering data was a big issue here because data accessibility was poor, I had to contact several people in every project to get all information needed. In some cases, project team members had been re-appointed and updated information about the project team had not been updated in the database.

Information was not available when needed. I had to spend several hours sometimes to find data. Some information that I received were not clear and it was difficult to interpret.

Most of the documents in one project which was included into this research were in French language and it was not so easy to read and understand the information in those documents.

There are several Change order templates that could be identified. It was confusing sometimes, to try to identify what the Change order was related to.

7.3 Proposal for further research

The study of Change order procedure is very comprehensive and my study is almost just like a scratch of the surface in this matter. There are several areas that need further research. Cost calculations, Claim management, book keeping, as well as SAP updating are some of them.

Study of Site Cost:

Calculations of costs in relation to Change orders at site is one research area that is profitable to work further with. In regards of change orders it is important that the Site manager is aware of how much the site costs per day to be able to calculate the consequences of a change order, and as well as it minimizes the problems/disputes between parties.

Claim management:

Claim management is also something that needs further attention in research according to the information that I have received. I also found, that there is no proper documentation of claims in the company. The poor documentation and reporting of claims directly affects the project budget. If the parties can settle claim disputes in early stages, both parties can save unnecessary costs, otherwise spent in arbitration or litigation matters.

Studies of book keeping:

If there are problem handling Change orders, then it is obvious that there are problems with book keeping Change orders as well. The data given in regards of change orders are sometimes not sufficient to understand from what discipline the correspondent change order relates to, which in turn affects budgetary issues between disciplines.

Actions for Site feedback:

There are plenty of site feedbacks that can be identified due to design/drawing errors in modules, units and materials. If the same error happens repeatedly without the error being corrected, and actions being taken to avoid the error, by changing the design as needed, or updating standard design accordingly, it spends unnecessary time and money of the company. And if the changes are not updated using site feedbacks, the time and energy spent for making site feedback is also not effective. This is also one research field where it would be useful to do some further studies i feels useful to be done.

7.4 Final Words

It was rather hard to gather information regarding change orders in this thesis. I had to search in various places and spend many hours before all the information was obtained.

Because of the work in line with this thesis I got the opportunity to get to know new people that I otherwise would not have encountered. I want to thank all of them who cooperated with me in order to achieve the goal of this thesis.

I would like to thank my supervisors; Mikael Ehrs at Novia UAS and Peter Bergqvist at Wärtsilä for supporting me and providing me with their ideas and thoughts to improve this thesis.

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Appendices

Appendix 1: Mechanical Sub-contractor AOTC Change orders

CO No:	Description	Impact on the contract in (%)	Contract value in %
	Original Contract value		100,00
001	Delivery and installation of Support steels for firefighting pipes in Cable trench 1, 2 & 3	0,28	100,28
002	Fabrication and supply of Generator duct support structure (duct steel frame)	0,26	100,55
003	Fabrication and supply of DN600 flanges	0,01	100,56
004	Fabrication and supply of GPRS vent pipe and caps	0,35	100,91
005	Fabrication and supply of CEMS emission nozzles	0,15	101,06
006	Fabrication and supply of EH nozzles	0,23	101,29
007	Fabrication and supply of U bar	0,05	101,34
008	Supply of Man Power for Engine Alignment Works at site as per the BOQ	0,23	101,57
009	Supply of additional material list for steels for firefighting piping	0,07	101,64
010	Fabrication and installation of high pressure pipe, seamless 8"	3,16	104,80
011	Fabrication and installation of high pressure pipe, seamless 8"	0,01	104,81
012	Supply of additional material - Pipe Size 40, 120 mitre	0,02	104,84
013	Supply of additional material - Penetration plate for storage tank area dyke wall	0,03	104,86
014	Supply of additional material -steel for EGS, Painting System C5-M, total weight 731 kgs	0,14	105,01
015	Supply of additional material -Vent cap assembly DN-25. Qty 31 Pcs & DN80. Qty 16 pcs	0,02	105,02
016	Fabrication and supply of Handrail for Engine Maintenance platform work Qty - 15 Nos	0,01	105,03
017	Fabrication and supply of Angle 50x50x5 - 6 mtr long Qty 10 pcs with Epozy primer with 60 microns DFT	0,18	105,22
018	Fabrication of supports for FF system in Step up transformer area	0,79	106,01
019	Additional pressure testing, flushing and preservation	0,84	106,85
020	GPRS unit erection	0,04	106,89
021	Supply of VCB/901 treated water tank 10 M3	0,15	107,04
022	supply of additional steel & material for FF system	0,06	107,09
023	Supply of CS 10" Elbow, Graphite Gasket, CS 14" Elbow, Bolts, MS Globe Valve 2"	0,61	107,71
024	Pipe bridge support, stairs towers for fuel Unloading Station, 120 mm Sleeves 50 Nos	0,01	107,71

025	Supply of man power for the erection of extra support for engine auxiliary area platform grating	0,03	107,75
026	Supply of man power for the erection of temporary fuel connection of BSDG	0,10	107,85
027	Supply of man power for the modification work of LFO tank cooling ring modification	0,03	107,88
028	Supply of man power for the Engine Maintenance platform handrail modification work at generator bridge	0,01	107,89
029	Supply of man power the additional work in water treatment area inlet connection modification work	0,03	107,91
030	Supply of man power for the pressure vessel support fabrication and erection	0,02	107,94
031	Supply of man power for the temporary unloading pump erection and piping works	0,01	107,95
032	Supply of man power for the Handrail modification near engine stop lever	0,10	108,04
033	Supply of manpower for the Engine auxiliary area platform modification 13 Nos due to wrong supply	0,12	108,16
034	Supply of manpower for the additional work 30 Nos bellow box fabrication and erection	0,17	108,33
035	Supply of manpower for the gas ramp vent pipe connection modification work in all 15 engines	0,01	108,34
036	Supply of manpower for the handrail modification work near engine 1 and 8 side	0,05	108,39
037	Supply of manpower for the modification work of DN 250 Vent Pipe Modification in LFO 4000 & 5000 Tanks	0,02	108,41
038	Supply of manpower of the modification in temporary unloading pump piping modification	0,05	108,47
039	Supply of manpower of Supply crane flatbed trailer with rigger for load bank offloading works	0,07	108,53
040	Scaffolding erection and dismantling work for turbocharger repair and EGM repair work	0,23	108,76
041	EGM Dismantling & Dismantling and assembly of structure and piping for Turbocharger air repair work	0,02	108,78
042	Fabrication and Erection of sleeve box 4 Nos for Jetty fuel line	0,02	108,80
043	Modification of SS and DSS Line water treatment container for FF tank	0,11	108,91
044	Dismantling and removal of damaged metering from GPRS	0,03	108,94
045	GPRS Vent line modification - 2”-line modification & 1" line modification	0,04	108,98
046	GPRS Wall panel removal scaffolding erection and dismantling & supply of 25T crane for GPRS wall panel removal and erection	0,02	109,00
047	GPRS filter unit drain piping & Air vent piping modification	0,25	109,25

048	Damaged wall panel removal and replacement (GPRS)	0,52	109,77
049	Supply of Nitrogen Gas, 16 Cylinder horizontal racks, total 5 racks Supply of flange 8" CL600 SCH40, QTY 1 no	0,03	109,79
050	Gas line earthling Bose installing from inside GPRS to EH	0,01	109,80
051	GPRS Metering room temporary skid installation	0,32	110,12
052	Scaffolding for rupture disc replacement and disc replacement	0,05	110,17
053	Additional work for jetty pipe vertical part modification at gabion wall	0,24	110,40
054	scaffolding for rupture disc replacement and disc replacement for engine #3 - 3 pcs	0,10	110,51
055	scaffolding erection and dismantling work for turbocharger modification work for 14 engines	0,17	110,67
056	Shifting, Loading & Offloading Materials for Workshop. Manpower supply	0,01	110,68
057	SS Line modification water treatment container	0,01	110,69
058	EH1 scaffolding assembly & Dismantling for Crank case vent pipe #6,7,8	0,03	110,73
059	EH1 crank case 6" & 1”-line modification for #6,7,8	0,01	110,73
060	Supply of Crane for GPRS wall panel removal & erection by 25 T crane	0,08	110,81
061	New instrument air compressor with associated piping to Tie-in existing header & drain	0,01	110,81
062	Sludge line modification work near tak farm area	0,01	110,83
063	Scaffolding erection for compressor room piping works	0,01	110,84
064	Fabrication and erection for radiator and upper level vent pipe support	0,07	110,90
065	Grating modification work near BGA panel	0,01	110,91
066	A/C installation of CEMS panel	0,01	110,92
067	6" Exhaust pipe modification for BSDG Scaffolding erection and dismantling Exhaust pipe modification for BSDG	0,01	110,94
068	Additional BOQ for installation of new sludge line from EH to day tank area	0,17	111,10
069	Load bank shifting works DG	0,01	111,12
070	Supply of 25T Crane for GPRS wall panel erection	0,01	111,12
	Total	11,12	11,12

Appendix 2: Civil Sub-contractor PIP-CIV Change orders

CO No:	Description	Impact on the contract value in (%)	Contract value in %
	Original Contract value		100,00
001	Procurement of Fastening plates	0,03	100,03
002	Repair Work o storage tanks	0,01	100,04
003	Additional earthling works	1,35	101,39
004	Beam HEA 100 in transformer area	0,60	101,99
005	Additional works for earth pits	0,72	102,71
006	Excavation, sand bedding, backfilling & compaction for firefighting trench	1,52	104,23
007	Laying of CCTV conduits	1,13	105,36
008	Modification works for transformer	0,44	105,80
009	HVAC equipment supply for MV/Control room	-3,19	102,61
010	Installation of HVAC in LV room	0,91	103,51
011	Construction of Permanent roads on north side between MGP and MIPP	4,04	107,55
012	Laying of UPVC conduits for GPRS building	0,21	107,76
013	Fire rated paint - two hour rated	0,27	108,03
014	Laying of UPVC, HDPE pipes	0,54	108,57
015	Excavation, Sand bedding, backfilling & Compaction for Gas pipeline. Guard house construction	1,73	110,30
016	Steel structure modification works	0,16	110,46
017	Modification structure works for different area	5,46	115,92
018	Material procured for HVAC & Steel structure, Fixing Dampers	0,16	116,08
019	Excavation, sand bedding, laying, placing of concrete tile, backfilling & compaction for street light cable trench (inside power plant)	0,79	116,86
020	Excavation, concrete sand bedding for FRP Tank	0,14	117,00
021	Application of fire rated materials for penetration in Cont./MV room, EH	0,42	117,42
022	Quantity variation for the structure as per	0,36	117,78
023	ON HOLD	0,00	117,78
024	Epoxy painting of W&W, Fixing grating in W, Penetration in FF building, Core cutting in MV to LV trench, Extra foundation for AOTC, Extra foundation for YAAT, Extension of trench at emergency exit	0,38	118,16
025	Installation of Nos 13 of Dewatering pumps at main cable trench and pipe trench	0,02	118,18
026	Procurement and installation of Tank sealant CEMTEC 227 P.U	0,02	118,20

027	Procurement of extra fire rated material for Control, MV room and EH	0,07	118,27
028	Extra work for civil	0,42	118,69
029	Additional HVAC works as per DWG DBAD315837b & DBAD315997b	0,40	119,08
030	Additional work for 40" container, foundation. (Chemical storage)	0,10	119,19
032	Additional miscellaneous civil works	0,14	119,33
	Total	19,33	19,33

Appendix 3: Civil Sub-contractor FF-UG Change orders

CO No:	**Description**	**Impact on the contract in (%)**	**Contract value in %**
	Original Contract value		100,00
001	Supply of ACID proof bolts	2,50	102,50
002	Supply of HDPE Fittings and replacement charges	4,39	106,89
	Total	6,89	6,89

Appendix 4: Civil Sub-contractor FF-AG Change orders

CO No:	**Description**	**Impact on the contract in (%)**	**Contract value in %**
	Original Contract value		100,00
001	Supply of Tank Ring Material / Fabrication and installation	0,29	100,29
002	Fire Rated Doors for LV & Station Transformer Rooms	0,58	100,86
003	Tank roof modification, Measurement change in Sprinkler 120 Metres at EH, Tank ring nozzle modification works, additional spray paint work, NEGATIVE VO supply of rivets at EH	0,13	100,99
004	Supply of new explosion proof flasher	0,23	101,22
005	Cable trench-03 FF system support installation	0,16	101,38
006	Cable trench-03 FF system modification work	0,05	101,43
007	Supply of spare for FF and FA	1,98	103,41
008	Supply of nitrogen cylinders with racks on hired basis	1,48	104,89
	Total	4,89	4,89

Appendix 5: Electrical Sub-contractor STS Change orders

CO No:	Description	Impact on the contract in (%)	Contract value in %
001	Original Contract value		100,00
	Supply of cables and accessories	14,42	114,42
	Total	14,42	14,42

Appendix 6: Electrical Sub-contractor Majees Change orders

CO No:	Description	Impact on the contract in (%)	Contract value in %
001	Original Contract value		100,00
	Additional items according to BOM#DBAD755737	11,04	111,04
	Total	11,04	11,04

Appendix 7: Mechanical Sub-contractor AMISA Change orders

Change Order No:	Description	Impact on the Contract (%)	Contract value (%)
	Original Contract value		100,00
001	Materials providing for underground gas pipe	0,53	100,53
1	Not approved	0,00	100,53
2	Stainless steel tank unloading	0,01	100,54
3	Cutting of additional IPR steel beam	0,01	100,55
4	Material supply (2" Stainless steel union nut)	0,01	100,56
5	Polishing of un-galvanized pipe support	0,08	100,63
6	Dummy fabrication	0,00	100,64
7	Low boy rent for internal transportation	0,03	100,67
8	Guard duty and forced reworks	0,04	100,71
11	Underground gas pipe additional material	0,12	100,83
12	Underground gas pipe additional welding	0,05	100,88
14	Welding procedure changed	3,46	104,34
15	WTB maintenance platform modification	0,15	104,49
16	Steel support fabrication for cable tray	0,05	104,54
17	Steel structure correction area F	0,04	104,58

18	Engine maintenance platform modification	0,16	104,74
19	Steel flange (4mm thick) fabrication	0,00	104,74
20	Stainless steel material supply	0,03	104,77
21	Reel fabrication and installation (gas pipe)	0,05	104,82
22	Water supply system pipe modification	0,00	104,82
23	Firefighting container pipe modification	0,14	104,97
24	Insulation of silencers 1-4 (968114,70 MXN)	1,85	106,81
25	Material supply (valves, gasket, flanges etc)	0,07	106,88
26	Anchor bolt chairs for tanks	0,48	107,35
27	Insulation of Exhaust gas silencers 5-7	1,27	108,62
28	Pipe rack modification	0,29	108,92
30	ESV installation	0,01	108,93
31	DN500 pipe support modification(smaller)	0,05	108,97
32	Rupture disc duct flange welding	0,12	109,09
33	Blind plate fabrication for boilers 5-7	0,16	109,24
34	Support fabrication for engine control cables	0,03	109,28
35	Installation of FF extinguisher steel plates	0,04	109,32
36	Installation of FF steel pipe TP 316L in STB	0,58	109,90
37	Stainless steel pipes installation cooling tower	0,30	110,20
39	Fuel gas line testing and Teflon tape install (65816,88 MXN)	0,13	110,33
40	Insulation additional working hours	1,15	111,48
41	Steam trap fabrication and installation	0,04	111,52
42	Additional material for various works	0,03	111,55
43	Painting of firefighting pipes in engine hall	0,36	111,91
47	Boilers 1-7 modification	0,10	112,01
48	Boilers 1-7 manholes insulation	0,80	112,80
		12,80	12,80

Appendix 8: Civil Sub-contractor, BS DE MÉXICO - Below 0 Level Change orders

Change Order No:	Description	Impact on the Contract (%)	Contract value (%)
	Original contract value		100,00
01	Structural filling, material to Day tank, Engine hall and foundations for pipes	0,25	100,25
02	General filling material to Day tank and Engine hall	0,19	100,45
03	Excavation and filling for underground pipes, Installation of firefighting pipes for Day tank	0,14	100,58
04	General filling material for Engine hall & Boiler day tank	0,10	100,68

05	General & Structural filling, material to Main access and Engine hall	0,17	100,86
06	PLATES TYPE ANCHORS 20*15 for Main access	0,02	100,87
07	Structural filling, material and backfilling with excavated material for Main access	0,20	101,08
09	Rain water pipes for Drainage system, normal precipitation	0,68	101,75
09B	Rain water pipes for Drainage system, normal precipitation	0,34	102,09
09C	Rain water pipes for Drainage system, normal precipitation	0,43	102,52
09D	Rain water pipes for Drainage system, normal precipitation	0,27	102,79
09E	Rain water pipes for Drainage system, normal precipitation	2,63	105,42
09F	Rain water pipes for Drainage system, normal precipitation	1,38	106,80
09G	Rain water pipes for Drainage system, normal precipitation	0,34	107,14
09H	Rain water pipes for Drainage system, normal precipitation	0,41	107,55
09I	Rain water pipes for Drainage system, normal precipitation	0,30	107,85
09J	Rain water pipes for Drainage system, normal precipitation	0,16	108,02
11	Excavation, structural filling material, formwork, concrete, reinforcement for Principal foundation	0,84	108,85
12	Site works, oil work handling, engine foundations, concrete	1,02	109,87
13	spiral augers 4⅘4" includes rod positioning, APPLICATION OF INTERIOR WALLS PAINT EPOXY INCLUDES CLEANING CONCRETE	0,56	110,43
14		0,00	110,43
15	CONSTRUCTION OF BRICKS WALL 150 MM ANCHOR ROD N° 10 TO CONCRETE WALLS, COVER OF GROOVED SHEET 4MM	0,02	110,45
16	CONSTRUCTION OF BRICKS WALL 150 MM ANCHOR ROD N° 10 TO CONCRETE WALLS, OVER OF GROOVED SHEET 4MM	0,05	110,50
17A	SUPPLY AND APPLICATION FOR ADITIONAL LAYER PAINT IN AREA UNDER THE PIPES AND MOTORS AT ENGINE HALL: INCLUDES:SWEEPING AND VACUUMING , Material & labour supply	0,98	111,49
18	Refine and yellow material	0,15	111,64
	Total	11,64	11,64

Appendix 9: Civil Sub-contractor, BS DE MÉXICO - Above 0 Level Change orders

Change Order No:	Description	Impact on the Contract (%)	Contract value (%)
	Original contract value		100,00
1,1	Installation of exhaust gas duct supports TYPE 1 (6 PCS) AND TYPE 2 (4 PCS)	1,14	101,14
1,2	Installation of exhaust gas duct supports TYPE 2 (10 PCS)	0,69	101,84
2	Installation of ventilation unit 6 m3/s (1 piece) gen side	0,04	101,88
3,1	Installation of Feed Water Tank Support Structure	0,46	102,34
3,2	Installation of Feed Water Tank Support Structure and steps	0,13	102,47
4,1	Installation of engine platforms B bank module	0,32	102,78
4,2	Installation of engine platforms	1,87	104,66
6	Installation of plates type anchor 20*15	0,02	104,68
	Grimosa		
1,1	Installation of roof monitors (3 pcs)	0,03	104,71
1,2	Installation of roof monitors (9 pcs)	0,10	104,82
	AC system		
10	Electric material for installation of AC system	1,16	105,98
14	Supply electric material and 1 minisplit for Admin Building	0,65	106,63
		6,63	6,63