Liquid roofing installation instructions and user guidelines

Joakim Nylund

Bachelor´s Thesis

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BACHELOR'S THESIS

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Abstract

The objective of this thesis has been to develop a manual called "Liquid roofing installation instructions and user guidelines".

The purpose of this manual is to create a better knowledge of liquid roofing systems in general. The manual also provides the reader with installation instructions and guidelines for how to apply liquid roofing systems onto company specific roof types.

Furthermore the manual compares different manufacturers´ products, to see their benefits and drawbacks regarding storage life, application temperatures, warranties and ways of working during application.

I have also considered the use of the liquid roofing systems in power plant projects in generally, paying attention to the factors mentioned as well as the warranty periods that the manufacturers can provide. Since I have been working with one of the products in one project, I have a relatively clear picture of how some details should be done at site to reach the expected performance of the liquid roofing systems. This thesis can be found at Theseus.fi.

Language: English Key words: Liquid roof, Sika, 3M, BASF

EXAMENSARBETE

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Titel: *Liquid roofing installationsinstruktioner och applikationsanvisningar*

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Abstrakt

Målet med detta ingenjörsarbete var att utarbeta en manual kallad, ”Liquid roofing installations instruktioner och applikationsanvisningar”. Syftet med denna manual är att skapa en större förståelse för denna typ av produkter i allmänhet. Denna manual kommer också att tillhandahålla läsaren med installationsinstruktion samt vägledning i hur liquid roof -systemet appliceras på företagets specifika taktyper. Vidare kommer att jämföras olika tillverkares liknande produkter, med tanke på förvaringstider, appliceringstemperaturer, garantier och arbetsmetoder. I arbetet kommer även att övervägas användandet av liquid roof -systemet i kraftverksprojekt överlag, med tanke på ovannämnda faktorer samt de garantier de olika tillverkarna kan ge. Eftersom jag arbetat med en av tillverkarnas produkt i ett projekt, har jag redan en relativt klar bild av hur flertalet detaljer bör utföras för att uppnå de förväntade egenskaperna av liquid roof systemet. Arbetet kommer att finnas tillgängligt på Theseus.fi.

Språk: engelska Nyckelord: Liquid roof, Sika, 3M, BASF

Table of contents

1 Introduction

This chapter will shortly describe my background in Wärtsilä Power Plants and describe the objectives of the study. Finally I will explain the approach of the study.

1.1 Background

The need of a manual of this type comes from the fact that Wärtsilä is trying to find an alternative roof material to steel sheet roofs that can be used in their projects. Since the roof structure is quite complicated, due to the amount of steel trusses, beams, pipes and penetrations, it has shown that the use of a steel sheet roofing system is not always the best, since the risks of getting leaks are big with this system. Therefore some years ago Wärtsilä started to investigate other roofing materials that could be used in projects around the world. One type of material that was found was different types of liquid roofing systems. To try to find the most suitable product, this study will compare some manufacturers´ products. Wärtsilä has already used liquid roofing in one project, but an installation instruction based on their own designs is still missing.

1.2 Objectives of the study

Wärtsilä is searching for an easy to use roofing product that can fulfil the requirements regarding the quality as well as the warranty periods. After discussing with Mrs Eija Ollus, Manager of Civil Engineers and Mr Stefan Fogde, Engineering Manager, Civil, an agreement was made that this would be the subject of my thesis work. The layout of the manual was discussed and agreed upon with the departments involved in the sales and project management. From the sales department my contact person has been Mr Markus Sandås, Development Manager, Civil. The manual discusses the background, different materials, where to use the liquid roofing, warranty issues and the monitoring of the work. My report also presents an installation instruction, where Wärtsilä specific details and installation methods, as well as repair methods and maintenance are explained. From now on I will refer to the persons mentioned above as the “development team”.

1.3 Study approach

When starting to write this thesis, I had a clear picture of what I wanted to be the outcome of the report. The interesting thing was how to get there. Since this is more or less a company specific manual, the subject has been studied from a Wärtsilä point of view. The sources are mainly technical specifications from different manufacturers, as well as my own experience of using liquid roofing products.

2 Wärtsilä

This chapter gives an overview of the company and the different divisions in it. Wärtsilä was established in 1834 when the governor of the county of Karelia approved the construction of a sawmill in the municipality of Tohmajärvi on 12 April. Today Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. In 2011, Wärtsilä net sales totalled EUR 4.2 billion with approximately 18,000 employees. The company has operations in nearly 170 locations in 70 countries around the world. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland. The corporation consists of three divisions: Ship Power, Power Plants and Services[1].

2.1 Ship Power

Wärtsilä Ship Power is a market leader of ship machinery. Ship Power delivers engines and generating sets, reduction gears, propulsion equipment, control systems and sealing solutions for all types of ships. Ship Power’s net sales for 2011 were 1,022 million euro[2].

2.2 Services

Wärtsilä Services supports the customers throughout the lifecycle of the product. They provide service for both ship machinery and power plants. Wärtsilä Services´ main task is to supply spare parts and maintenance work for engines delivered by Wärtsilä. In addition to this, they provide training for customers. The net sales for Wärtsilä Services in 2011 were 1,816 million euro[3].

[1] Compass, Annual Report 2011 (pg. 9,17)
[2] Compass, Annual Report 2011 (pg. 10,17)
[3] Compass, Annual Report 2011 (pg. 10,17)

2.3 Power Plants

Wärtsilä Power Plants is a leading supplier of power plants. The product portfolio consists of gas, oil and bio fuel-fired power plants.

The two main power plant project types are EPC (Engineer, Procure and Construct), and EEQ (Engineered Equipment Delivery). The duration of a project can vary. It depends on the project type (EPC or EEQ), the engine output, and the complexity of the project as well as the customer requirements. In 2011 Wärtsilä Power Plants had a net sale of 1,365 million[4].

Wärtsilä Power Plants provides superior value to its customers by offering decentralised, flexible, efficient, and environmentally advanced energy solutions. Wärtsilä tried and tested power plants are modular and are provided with full lifecycle support. Wärtsilä Power Plants delivers four different main types of power plants, as listed below.

Flexible base load
Wärtsilä supplies flexible base load power plants mainly to developing markets, islands, and remote locations. Energy consumption growth in these markets is driving a steadily increasing demand for new power generation solutions. Wärtsilä customers in this segment are mainly utilities and Independent Power Producers (IPP). Typical customer needs include competitive lifecycle costs, reliability, world-class product quality, fuel and operational flexibility, as well as operations & management services. Wärtsilä is in a strong position to cater to all these needs. Flexible base load power plants are run on both liquid fuels and gas[5].

Grid stability and peaking
Wärtsilä grid stabilising power plants enable greater integration of renewables, such as wind, solar and hydro power. Wärtsilä offers dynamic solutions for system support, reserve power, peaking needs, and to meet requirements in regions with rapidly growing wind power capacity. Customers in this segment are mainly utilities and IPP's, as well as transmission system operators. The strengths of Wärtsilä products include their rapid start and ramp up, their ability to operate at varying loads, the competitive electricity generation and capacity costs, as well as 24/7 support service. These features are essential for successfully balancing systems that utilise solar and wind with constant variations in output. Grid stability and peaking plants are mainly fuelled by gas[6].

Industrial self-generation
Wärtsilä provides power plant solutions to industrial manufacturers of goods, such as cement, textiles and mining. These customers are mainly private companies, and reliability, reduced energy costs, and independence from the grid are among the key

[4] Compass, Annual Report 2011 (pg. 10,17)
[5] Compass, Annual Report 2011 (pg. 18)
[6] Compass, Annual Report 2011 (pg. 18)

factors in their decision making. Power plants in this segment are run on either gas or liquid fuel, depending on the fuel availability[7].

Solutions for the oil & gas and nuclear industries
Wärtsilä provides the oil and gas industry with engines for field power, gas compression stations and pumping stations. Typical customer needs include maximum running time, fuel flexibility, reliability, long-term engineering support, and 24/7 service. The solutions we offer can operate on natural gas, associated gas, crude oil and heavy fuel oil. Wärtsilä also provides emergency power applications for the nuclear industry[8].

2.4 Civil Pool

"Civil Pool is part of the Project Management in Wärtsilä projects. People working in Civil Pool are construction engineers who are part of the project team created especially for each project"[9].

[7] Compass, Annual Report 2011 (pg. 18)
[8] Compass, Annual Report 2011 (pg.18)
[9] Eija Ollus 12.11.2012

3 Developing the manual

In this chapter the ways in which I have been working with the manual will be presented. The concept and the layout are described and shown in chapters 4 and 5.

3.1 Planning

In October 2012, when it was agreed with the Manager of Civil Engineers that I was to make this manual I began brainstorming around it. After having a meeting with the development team, I had a rough draft of what the contents of the manual should be[10]. The table of contents was also discussed with colleagues in the Civil Pool, to hear what they thought should be presented in the manual. The comments given formed the base for this manual.

Since the subject of my thesis was changed in October 2012, the time schedule that was set in February 2012 was no longer valid. Instead I had to revise it at the beginning of November 2012.

The first step was to identify the different roof types that are used in Wärtsilä projects around the globe. There are differences depending on what type of plant that is built. The second step was to search for data related to the different products found in the market. Finally I needed to put together the installation instructions. After the company had given their comments as regards the layout for this kind of manuals, I followed these formats.

When all these steps were done I was able to start compiling the manual.

In early November 2012 a meeting was held with the development team to get things started. During this meeting we agreed that every two weeks we would sit down and go through my progress with the thesis. I also discussed the progress with my supervisor from Novia University of Applied Sciences Mr Kimmo Koivisto regularly.

3.2 Identifying the different roof types

To identify the different roof types used in Wärtsilä projects I had to search in the company database for drawings, as well as interview my colleagues in the civil department, to get the best knowledge of this[11]. After that I could start looking into the details of the different types of roofs used. It was very important to see in what type of projects the liquid roofing system could or could not be used. Since Wärtsilä power plants are delivered to different

[10] Meeting held in Runsor on 2 Nov 2012
[11] IDM (Integrated Document Management)

countries around the globe, the main areas to focus on have been the type of climate, temperature, humidity and the availability of the product in the region where the plants will be built.

3.3 Searching for material

Searching for material was mainly done by searching for different types of liquid roofing systems and technical specifications given by the different manufacturers. In the company database there was already a list of several manufacturers. From this list I chose some manufacturers and compared them. The selection was done together with the development team.

3.4 Identifying the format for the manual

Ever since I started to plan this manual, I had a clear picture about the layout. By discussing with the development team, the layout was fine tuned and we came to an agreement. What I wanted to create was an easy to use tool, by which it will be easy to find and understand what liquid roofing is all about and also how it should be applied in Wärtsilä projects. Practically this means that by reading this manual the user will be able to understand and use the product. The reader will also get the knowledge of how to monitor the works done at site[12].

3.5 Compiling the manual

To compile the material for the manual I collected as much information as possible from the different manufacturers´ technical specifications. The different materials were then compared and fitted into the manual in a way that gives the reader the right information in the right order. This included some challenges, since there were many different things that needed to be explained. The installation instructions were not too complicated to compile, since I had been working with one of the studied materials. This gave me some advantage in the work with the installation instructions and guidelines. The installation instructions and the guidelines have been made in a way that the use of them can be applied on all three liquid roof systems investigated during this thesis work. Consequently, the instructions were worked out to fit Wärtsilä roof details when cooling radiators are located on the roof.

[12] Agreed with development team 10 Nov 2012

4 Liquid Roofing in Wärtsilä projects

4.1 Background

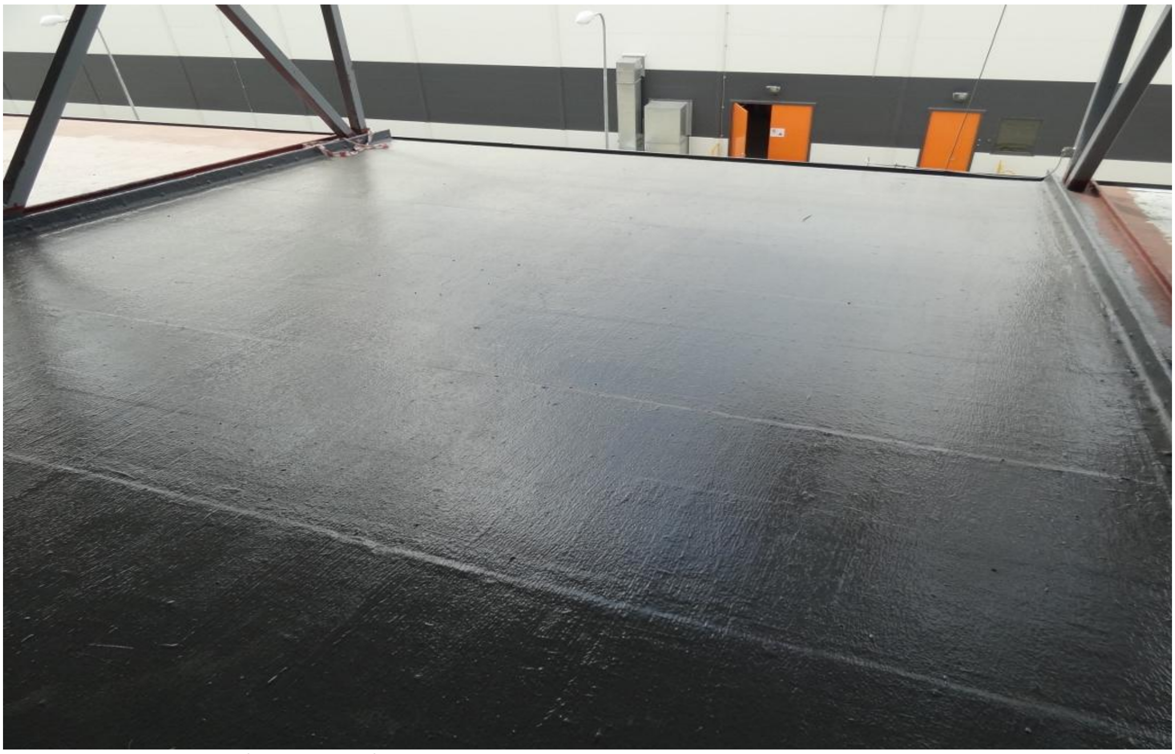

Figure 1. General view of a liquid roofing system

Wärtsilä projects are delivered to many different countries around the globe. This creates some challenges as to the delivery of different materials, the skills of local workmanship, climate and the availability of the material in the country where the projects are executed. Normally Wärtsilä delivers steel sheet roofs for the projects, since the knowledge in how to use this material is usually quite good in most countries. However steel sheets still create some problems with leaking roofs, mostly because of poor workmanship together with a roof design that includes a lot of penetrations, which leads to a need of many cuttings and flashings.

During the past few years Wärtsilä has been searching for new materials to use instead of steel sheets, and today the focus is on using some type of liquid roofing system (see figure 1). Liquid roofing systems are mostly urethane based products that are applied by rollers and reinforced with fibre glass mat. By using these kinds of products together with a clear installation instruction, Wärtsilä sees the possibility to overcome the problems with leaking roofs[13].

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[13] Background discussed with Eija Ollus and Markus Sandås on10 Nov 2012

4.2 Advantages and disadvantages of liquid roofing

The advantages of using these products instead of steel sheets with a lot of flashings are that the liquid roof is easily applied into inner corners and similar problem areas. A standard roof is shown in figure 2 below. The product is also easy to use with respect to the way of working. No heat is needed nor is there a need of many different tools. Liquid roof systems can be compared to painting the roof in different layers, which should not cause a problem during the application, since it is a straight forward system. After getting one day´s training local workers can learn how the product is applied.

The disadvantages with the liquid roof systems are that they cannot be applied in too high temperatures. Rain is also a factor that has to be taken into consideration. The delivery of materials can be a challenge in some parts of the world, due to long shipping times and problems with the control of the storage temperature during transport.

Storage at site is also a factor to consider, since some products´ shelf life times are only six months. As the liquid roofing systems are soft surface materials, the resistance against mechanical wear such as foot traffic is limited. Therefore it is recommended by the manufacturers to make walkways that are reinforced in certain ways or made of another material. To get the specific manufacturers´ recommended ways of doing the walkways the latest method statement or product data sheet for the product of use should be studied.

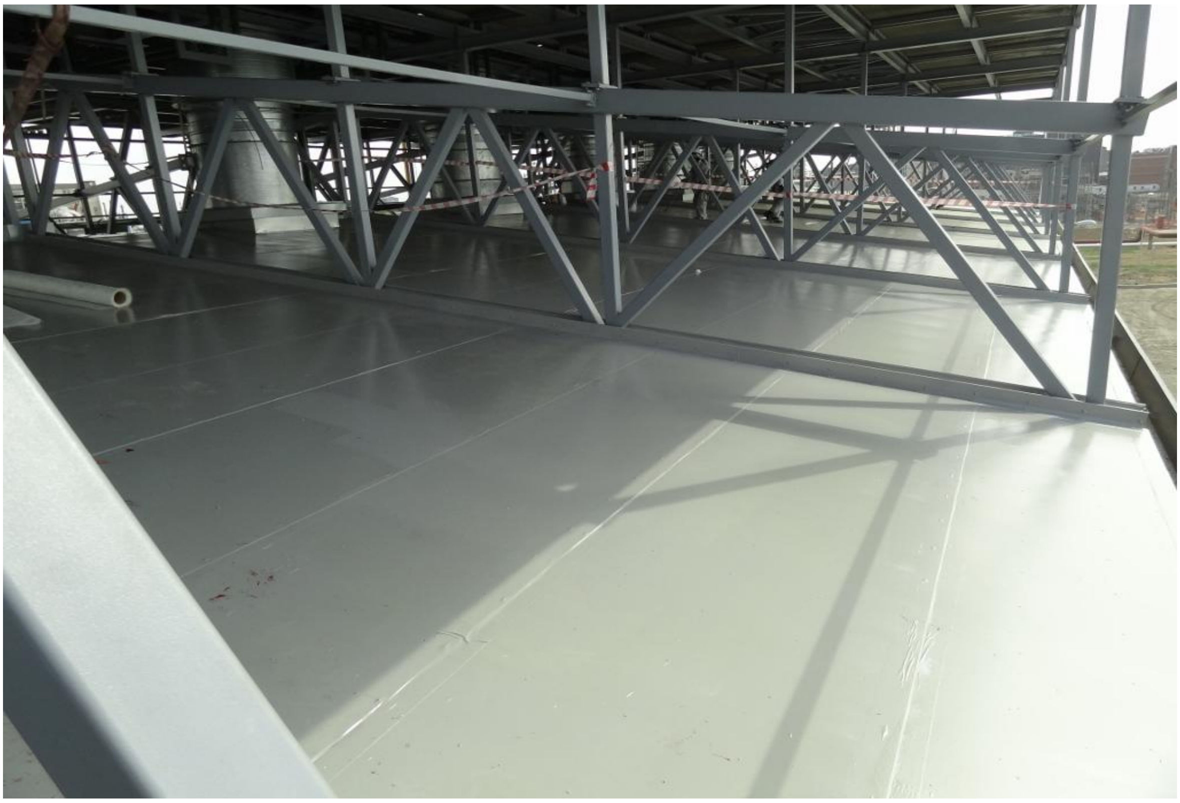

Figure 2. Wärtsilä roof design

4.3 Different manufacturers and their products

In this chapter, three different types of liquid roofing systems that are manufactured by 3M, SIKA and BASF will be described. There are many manufacturers of this kind of products. This study focuses on comparing the products of the above mentioned manufacturers. The reason for choosing these manufacturers is that their products cover many of the varieties in climate that can occur in the countries where Wärtsilä projects are executed.

4.3.1 3M

The product is named Skotchkote Poly-Tech EC 661. It is an elastomeric solvent based moisture trigged urethane coating system.
When applied, the 3M system requires a clean surface to start from. Then a primer is applied and, onto the primer comes a layer of base coat reinforced by fibre glass in given places. Finally a top coat layer named Skotchkote Poly-Tech UV 662 is applied to finalise the roofing system. By using the UV 662 as top coat the manufacturer states that the roof system can give up to 25 years of protection of the roof structures.
The 3M product has a storage lifetime of six months from date of manufacture and is supplied in 12.5 litres units. The reemat can be found in two different types, one is called Skotchkote Premier Reeinforcing Mat 050 and the other one is called Skotchkote Premier Plus Reeinforcing Mat 055. The difference in the types is the amount in weight of fibres to each square meter reemat. 3M uses 3M duct tape 1900 to over bridge any areas subject to moving, such as poorly fitted flashings, joints, cracks, overlaps and seams. More information can be found in tables 1 and 2.

Applying the system
Skotchkote Poly-Tech EC 661should not be applied when rain is falling or when rain is imminent, or when surfaces are less than 3^{o} above the dew point. The surfaces must be free of visible moisture.
The Skotchkote Poly-Tech EC 661 is the first of a two coat system which usually includes 3M™Skotchkote™Premier Reinforcing Mat 050 or the 3M™Skotchkote™Premier Plus Reinforcing Mat 055. The reinforcing mat should be secured into the Skotchkote Poly-Tech EC 661 immediately after application where necessary. The reinforcing must follow the contour of the surface and must not be pulled or stretched to leave hollow areas. Skotchkote Poly-Tech EC 661 should then be brushed/rolled through the reinforcing,

keeping the thickness of the coating as even as possible in accordance with the required coverage. The minimum overcoating interval depends on the roof temperature and drying conditions but is typically 6-8 hours.

Provided that the surface is clean there is no maximum over coating time. The average amount of used materials for the 3M 661/662- system is as follows: primer 0,11litre/m^2, poly-tech EC 661 2 litre/m^2 and poly-tech UV 662 0,5 litre/m^2 [14].

4.3.2 SIKA

SikaRoof MTC (moisture trigged chemistry)-system is a moisture triggered polyurethane liquid applied membrane in roofing. SikaRoof MTC uses atmospheric moisture to trigger the curing process. This means that the waterproof membrane can cure in a wide range of conditions, including extreme temperature ranges and humidity variations. Unlike traditional polyurethane systems they do not release CO_2.

The build up of the MTC-system is the same as of the 3M system, meaning that a primer is applied to a clean surface, onto that a layer of base coat, in where a reinforce mat is embedded, and to finalise the system the top coat is applied. Sika has several MTC-systems of various thicknesses. The product that will be presented below is the 601/621-system, called MTC18, which is the system that fits Wärtsilä needs best. The system has an expected lifetime of 15 years. Storage times for the Sika products are 12 months. The material comes in 5 litre pails and 15 litre pails. Sika also uses their own flexi strip and flexi tape for overbridging different types of gaps and joints. More information can be found in tables 1 and 2.

Figure 3. Application of Sika MTC system

[14] 3M 2012 MC135-0112, 3M 2010 Poly-Tech EC661-0711, 3M 2010 Poly-Tech UV662-1010

Applying the system.
The surface temperature during application must be at least +3 °C above dew point. The substrate and ambient temperatures should be +5 °C minimum or +35 °C maximum.

No visible water or moisture is allowed on the substrate and the relative air humidity is to be 5 % minimum or 85 % maximum.The MTC18-system is built up by using a primer (sikalastic metal primer)[15], a base coat (601 BC), a reemat of 225g/m^2 and finally a layer of UV-resistant top coat (621 TC). The thickness of the MTC-18 system is achieved by using: sikalastic metal primer 0,154 litre/m^2, reemat premium, 601BC 1 litre/m^2 and 621TC 1,1 litre/m^2. For the waiting time / overcoating, the latest product data sheet of the product is referred to[16].

4.3.3 BASF

Basf Masterseal 666 is a two-component, polyurethane, liquid applied, waterproof coating. The resulting membrane is an elastomeric waterproofing.

Masterseal 666 is recommended for waterproofing and damp proofing applications in basements, bathrooms, kitchens, pools, refrigeration storages, roofs and other wet areas. The substrate should be smooth, clean, and free of laitance, grease, oils and standing water. The two components should be mixed thoroughly using mechanical means. The mixing should be carried out in a separate container. Part B should be poured in a separate container and Part A should be added while stirring/agitating Part B. Mix thoroughly until uniform before applying to the substrate. The thickness of the coated film: In below ground structures, wet areas and roofs it should not be less than 1.2mm dft. Where a superior performance is required the material can be reinforced with a layer of woven glass fibre mesh. Each coat encapsulating the mesh should be 1mm dft. All liquid applications should be applied in at least two coats to achieve the desired thickness. One unit of 28kg will yield 21.53 litres, and should cover 16.16 m^2 for a 1.2mm dft (dry film thickness).

Applying the system

No obvious water accumulation should be present on the substrate. Any water should be removed at least 24 hours prior to application and the substrate should be substantially dry. The application temperature should be between 5°C - 40°C. The construction site should be well ventilated. After mixing the two components, material should be used within the gel time, which may vary depending on the temperature[17]. See tables 1 and 2.

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[15] Product Data Sheet Version 2012-07-26 Sikalastic Metal Primer
[16] Product Data Sheet Edition 5.16.2011 Sikalastic 601 BC and Sikalastic 621 TC
[17] 04/2010 BASF_CC-UAE revised 07/2012

4.3.4 Comparing materials

Table 1. Product information

Manufacturer		3M Poly-Tech661/662	SIKA MTC18 601/621	BASF Masterseal 666
Material		*polyurethane*	*polyurethane*	*polyurethane*
Ambient temperature	*Minimum*	--------------	*+ 5*	*+ 5*
	Maximum	--------------	*+ 35*	*+ 40*
Substrate temperature	*Minimum*	*3°C above dew point*	*+ 5*	*+ 5*
	Maximum	--------------	*+ 35*	*+ 40*
Humidity	*Minimum*	--------------	*5 %*	-------------
	Maximum	*90 %*	*85 %*	-------------
Consumption l/m^2	*Primer*	*0,11*	*0,154*	*Not needed*
	Base Coat	*2,0*	*1,0*	*Mixed components 1,33/layer*
	Top Coat	*0,5*	*1,1*	
Overcoating at 20°C	*Primer*	*16 h*	*6 h*	*Not needed*
	Base Coat	*6-8 h*	*1 h*	*24 h*
	Top Coat	*6 h*	*1 h*	
Reinforcement	*Fibre Glass*	*yes*	*yes*	*yes*
Warranties		*12 months on material*	*Depending on system used*	*Manufacturer does not give warranties*
Expected life time		*< 25 years*	*< 15 years*	-------------

As of November 2012

Table 2. Storage time

Manufacturer		**3M Poly-Tech 661/662**	**Sika 601/621 MTC 18**	**Basf Masterseal 666**
Storage Time	Primer	2 years	12 months	Not needed
	Base Coat	6 months	12 months	1 year
	Top Coat	6 months	12 months	
Storage Temperature	Primer	+5 - +32°C	+5 - +35°C	--------------
	Base Coat	+5 - +32°C	+1 - +20°C	Not mentioned
	Top Coat	+5 - +30°C	+5 - +35°C	

As of November 2012

4.3.5 Warranties

The manufacturers and suppliers of the different liquid roofing systems all have their own warranty systems. Since the application of the products, the conditions on site and the skills of the workmanship are very difficult to supervise by the manufacturers and suppliers. The warranties are to be agreed on before each project is executed.

4.4 Liquid roofing compared to steel sheet roofs in Wärtsilä projects

Wärtsilä projects normally consist of several buildings such as an electrical equipment building, an administration building, a workshop, a warehouse and an engine hall. For all the buildings except the engine hall there is no reason to consider the use of a liquid roofing system, since the design of these roofs are made in a way where liquid roof systems cannot give any benefits.

The roof in a Wärtsilä power plant can be made by one of the following methods:

- An in-situ built roofing system comprising a load bearing steel sheet, load bearing mineral wool slab and a corrugated roofing sheet.
- A pre-fabricated roof element

The in-situ built roofing system is used in buildings where the access on top of the roof is not of great importance. The roof elements are used in projects where the radiators are located on the roof of the engine hall and access to the roof is of essence. The roof elements also provide a temporary working platform for the mechanical installations of the cooling radiators. Once the mechanical installation is done, the final water proofing of the system is done[18]. When the cooling radiators are installed above the roof, Wärtsilä normally uses corrugated galvanized steel sheets as roof covering material. In these projects with radiators above the roof, the liquid roof can provide quick and easy water tightening of the roof.

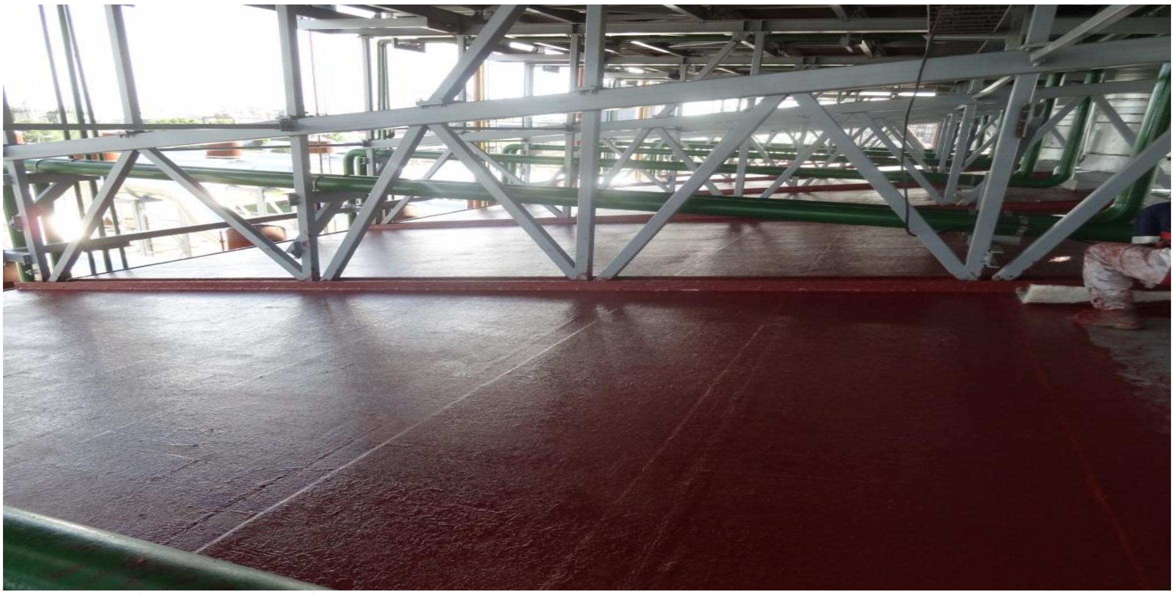

Figure 4. Roof design using roof elements

[18] Wärtsilä Compass, Ciwis

The benefits of the liquid roof system is that there is no need of covering flashings like in the case of using steel sheet roofing systems (see figure 5). In a four engine Wärtsilä plant with radiators located on the roof, at least 14 different types of flashings with a total length of about1200 meters should be used. When using such a big amount of flashings the risk of faulty assembled joints increases, which also means risks of leakage.

As in all construction works there is no such thing as a fully guaranteed system, since the workmanship always has an impact on the result of the work done. Therefore this study has to be seen as a comparison of different ways of doing water proofing.

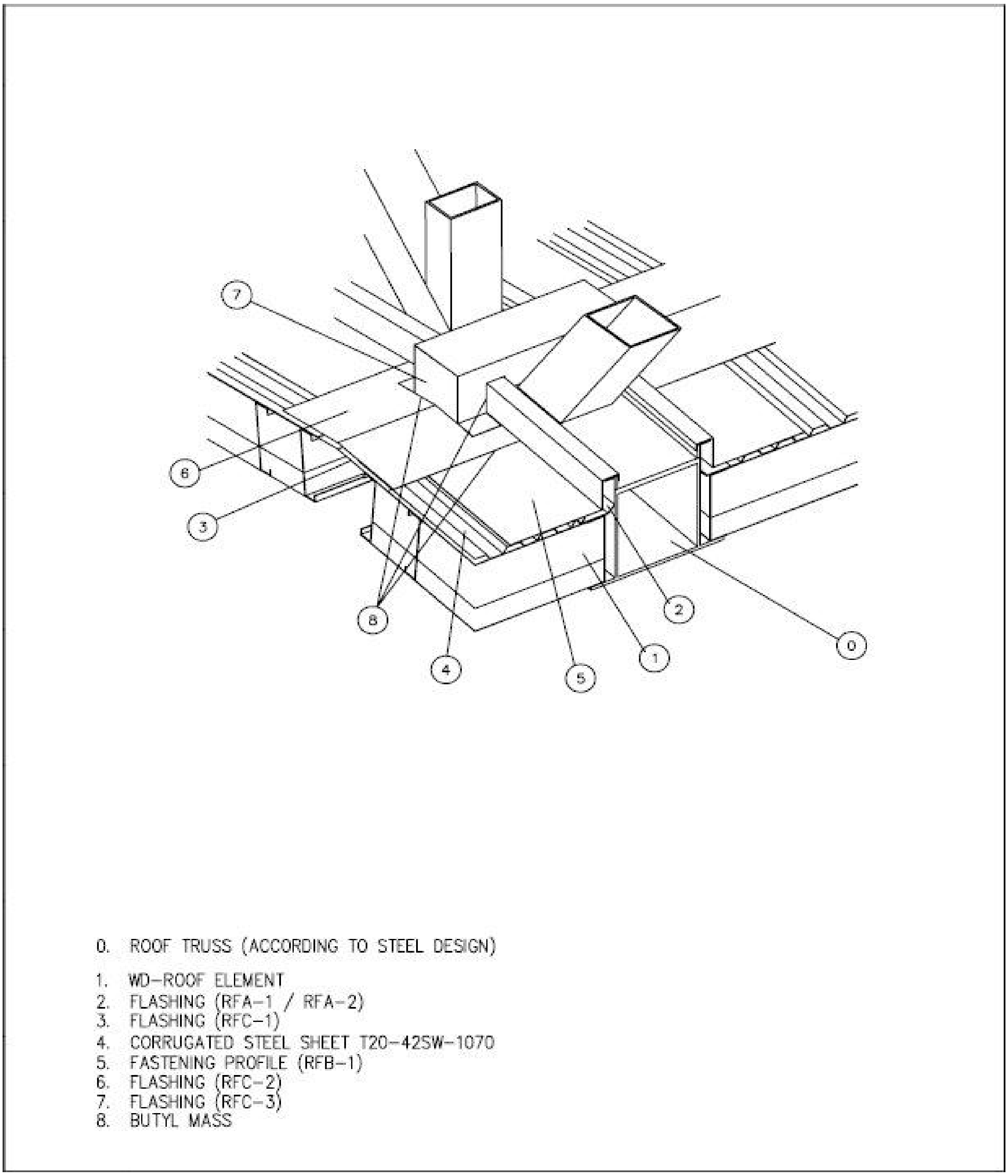

Figure 5. Standard roof detail when roof elements are used

4.5 Where to use liquid roofing systems, from a Wärtsilä perspective

Already at an early stage the sales department needs knowledge about which product to suggest to the customer, in case the temperatures and humidity in the specific country allow the use of a liquid roof system. The block chart below allows the sales department to check quickly if liquid roofing could be an option.

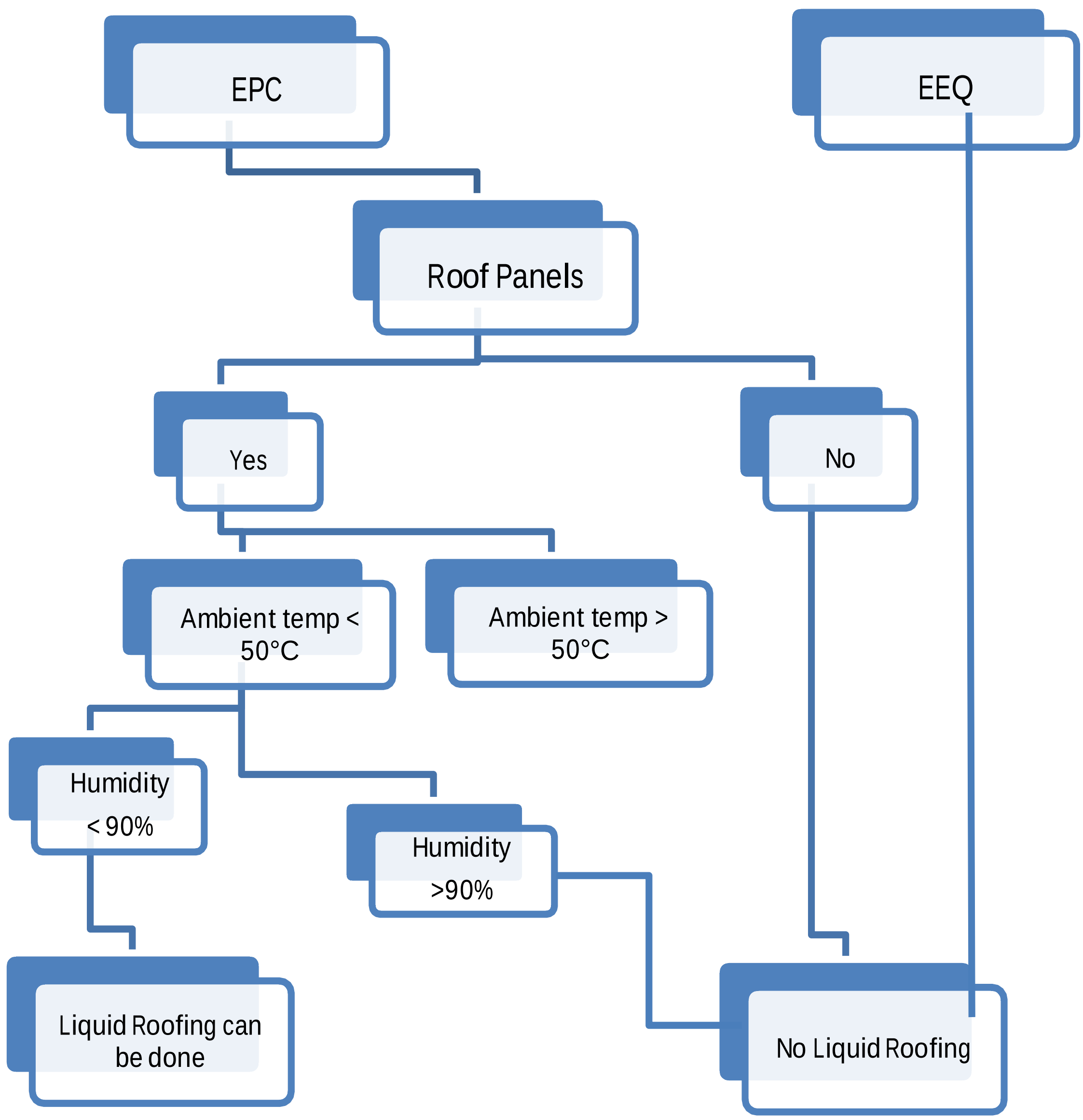

Figure 6. Quick check block chart.

5 Installation and inspections

5.1 Installation instructions and Wärtsilä specific details

When installing a liquid roof system, a clean substrate is needed. To clean the substrate, all loose objects are first removed. It is also recommended to use a high pressure washer to clean off all dust. In case the high pressure washing is not an option, the section can be cleaned by using a normal floor mop. If rust is found on the substrate, it needs to be grinded off, down to fresh metal surface[19] [20].

After washing the roof it needs to be cleaned with a solvent cleaner. The specific solvent cleaner to use is given by the manufacturer of the liquid roof system[21].

When the washing and solvent cleaning of the roof section are done, some manufacturers demand that bolt heads and joints in the substrate are covered or reinforced by a tape or some product specific strips or fibre glass. If this is required, the instructions given by the supplier of the roof system should be followed.

After preparing the substrate according to the manufacturer's specifications a primer is to be applied, one that the manufacturer has recommended.

The primer has to dry according to the supplier´s recommendations before the next layer of the roof system is applied.

In every project the use of shading nets or rain protection must be considered. The roof design allows an easy application of these, using the higher located roof trusses.

Base coat is spread by using short haired rollers and brushes. The spread rate has to be checked with the manufacturer of choice. All details of the roof such as joints, up stands and penetrations are to be done first. After applying base coat onto these areas the reinforce mat, usually made of fibre glass or nylon mesh, is embedded in the base coat. Important in this stage is to see that the reemat is worked into all corners and over and around up stands in such a way that it follows the contours of the substrate (see figures 7-10).

When the base coat is applied over all details the application can proceed in the bigger areas of the roof section. Important at this stage is to follow the stated and required curing times given by the manufacturer. After the base coat is applied and cured it is time to apply the top coat. Mostly the top coat is applied by using rollers and brushes. Some manufacturers provide top coats that can be applied by air spraying.

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[19] SFS-EN ISO 12944-2

[20] Peltikattojen kunnossapito

[21] Maalaustöiden yleiset laatuvaatimukset ja käsittely-yhdistelmät

When applying the different layers, it is generally necessary to follow up that the substrate is clean and prepared according to the instructions given by the manufacturer. When working with one or other manufacturers´ products, guidelines can also be found of how to make documentation in ETAG 005[22]

5.1.1 General details

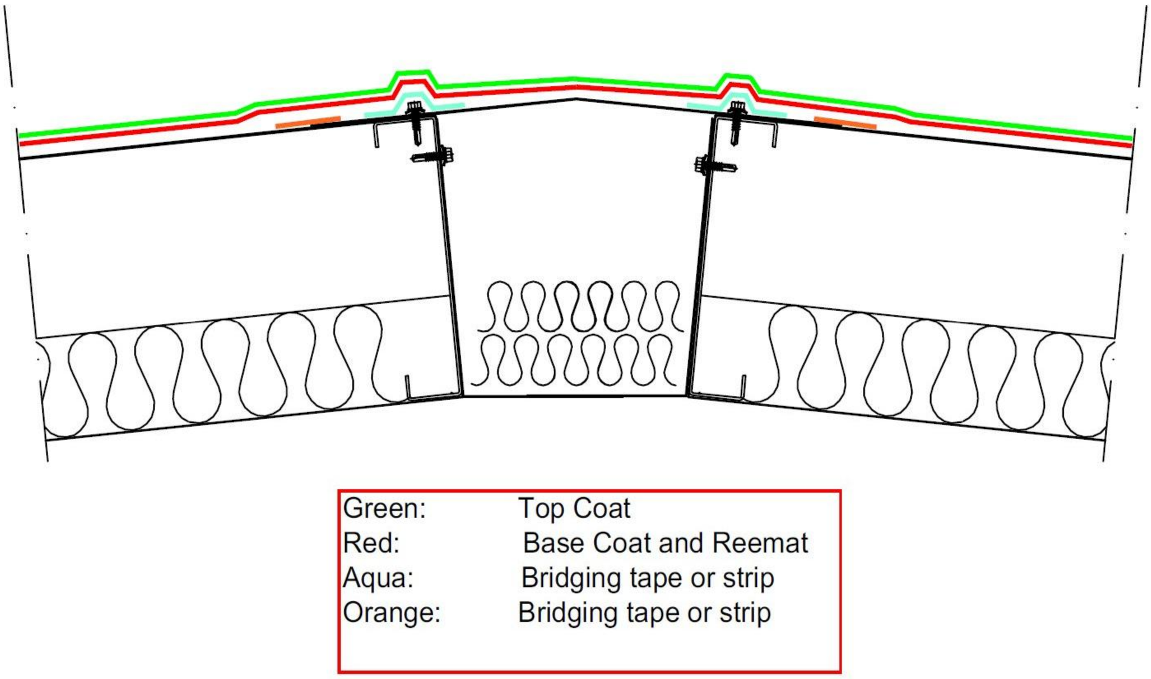

Figure 7. Detail of overbridging roof ridge.

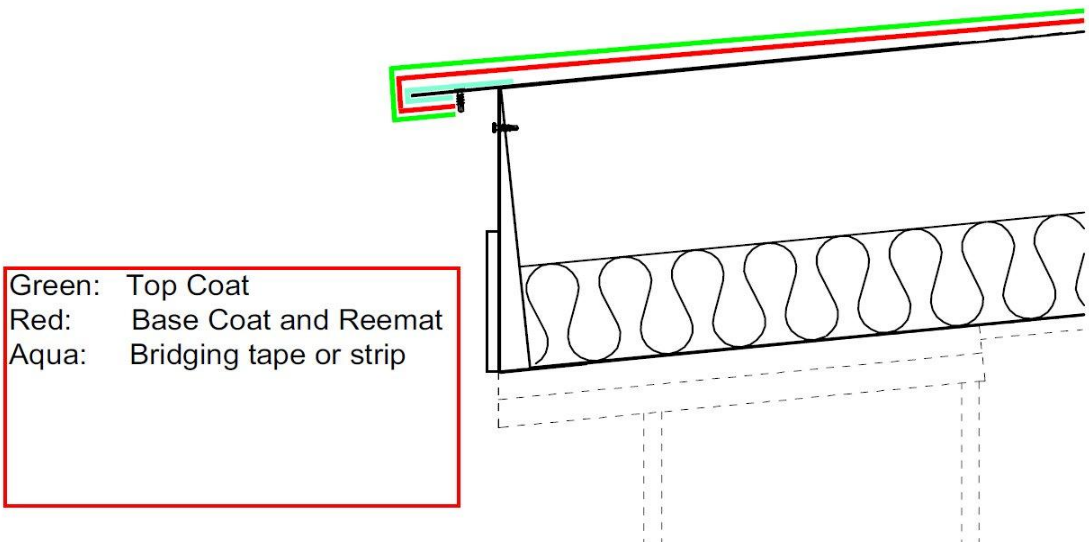

Figure 8. Detail of roof foot application.

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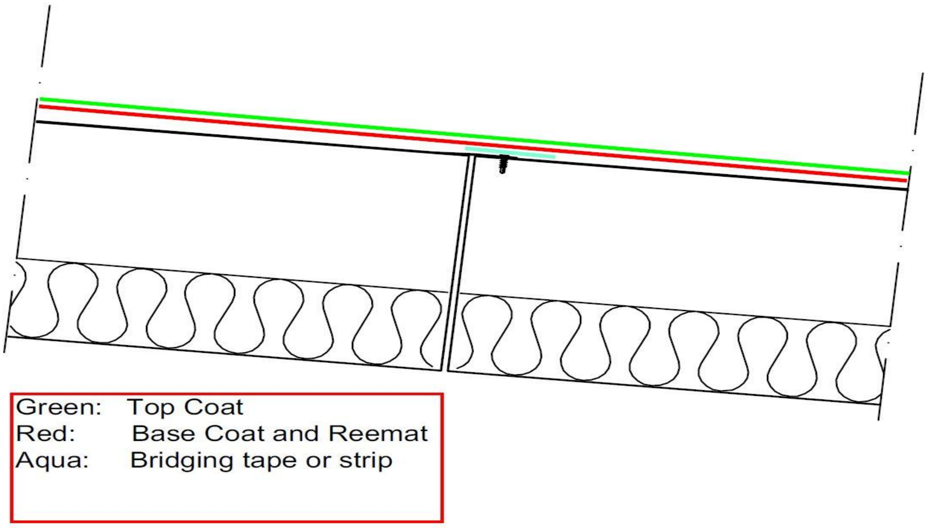

Figure 9. Detail of overbridging roof element joint.

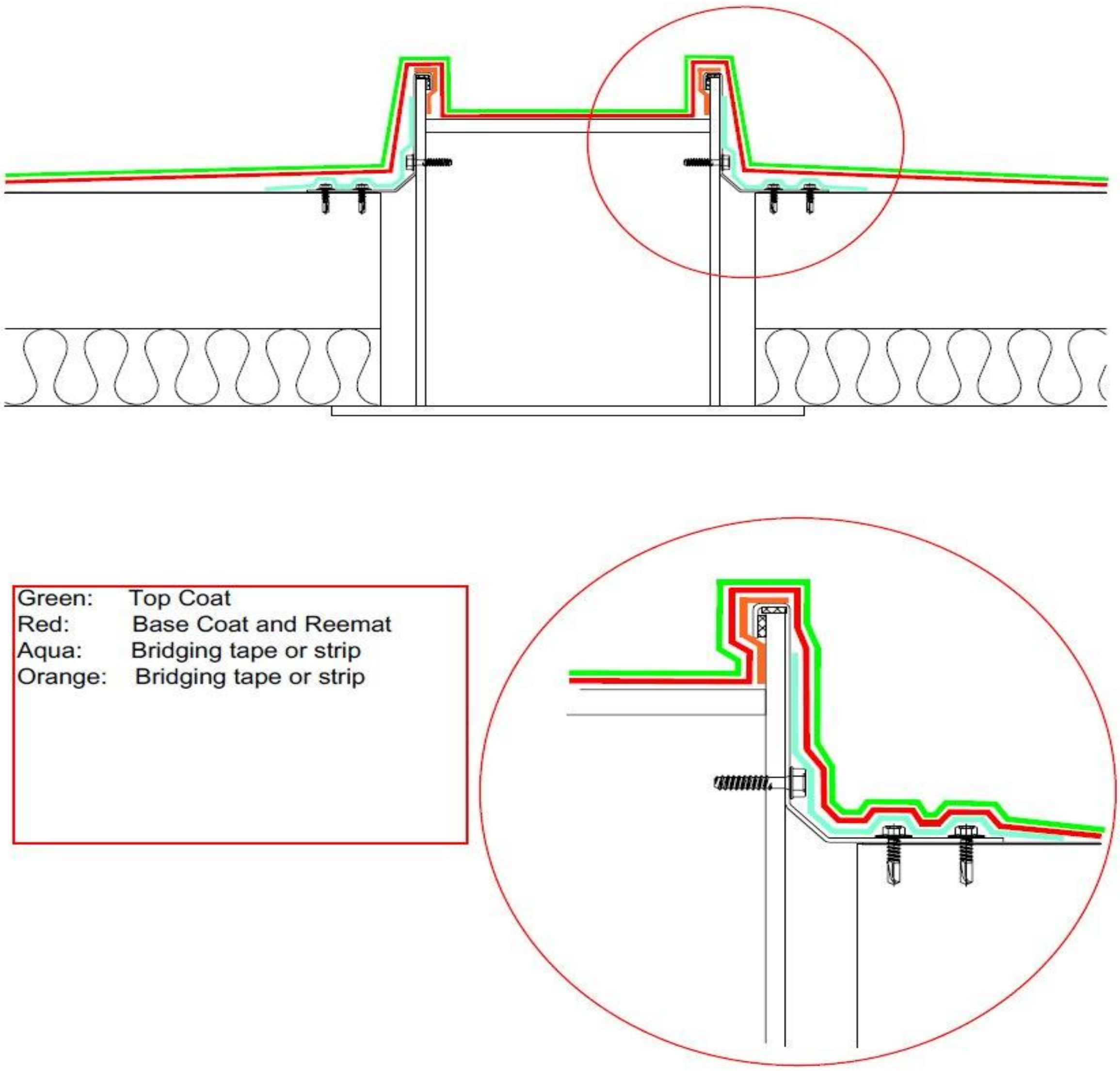

Figure 10. Detail of overbridging roof trusses.

5.1.2 List of tools

Jet washer, used for cleaning the roof.

Squeegee, useful for removing excess water from roof.

Drill and paddle, to mix components.

Pouring can, to spread components.

Scraper, useful when applying coating and reemat.

Medium pile roller, to spread components.

Short pile roller, to spread components.

Brushes, to apply different coats.

Knife, used to cut reemat.

5.2 Supervision, check points and documentation

Supervising the application generally means that one should ensure that the substrate is prepared in means of cleanliness (figure 11), and that all previous mounted roof details are done according to given designs. Also the humidity and dew point should be checked and monitored according to given methods by the manufacturer of the product to be used.

Figure 11. Solvent cleaning of roof elements

During the application of bridging tapes or strips (figure 12), it is important to see that the materials bond in an even and smooth way, to prevent unnecessary bubbles in the final roof surface.

Figure 12. Application of bridging tape over roof element joints.

The base coat application (figure 13) is a crucial step in the application of liquid roof systems, since the reemat will be embedded in this layer. It also creates the base of the top coat and the final outcome of the roof.

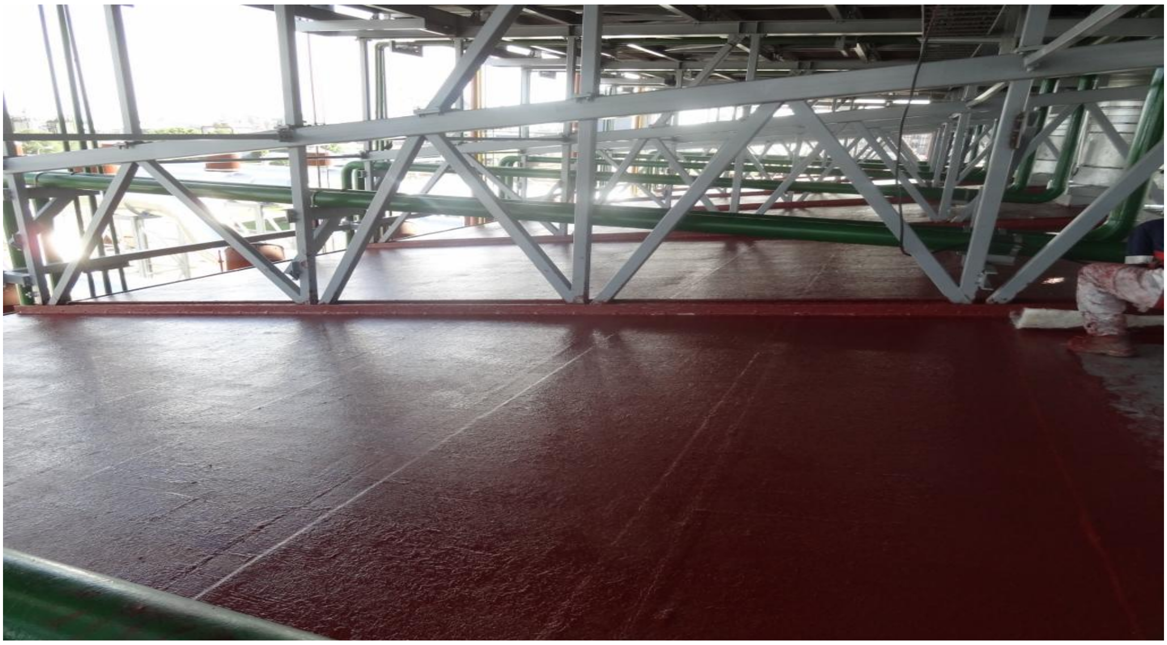

Figure 13. Base coat and reemat applied

During application, wet film thickness measuring is to be done on each area covered. To avoid thin coating at least one measurement for each area of ten square meters has to be made. The measurements are to be made with a certified wet film thickness meter (WFT meter). When the curing time of the base coat has been reached, the thickness is checked once again with a certified dry film thickness meter (DFT meter). If areas are found where the thickness is too low, an additional base coat is applied in that area, following the manufacturer’s recommendations.

When the final layer, the top coat (figure 14), is applied the same methods to check the dry film thickness are used, as during the base coat application.

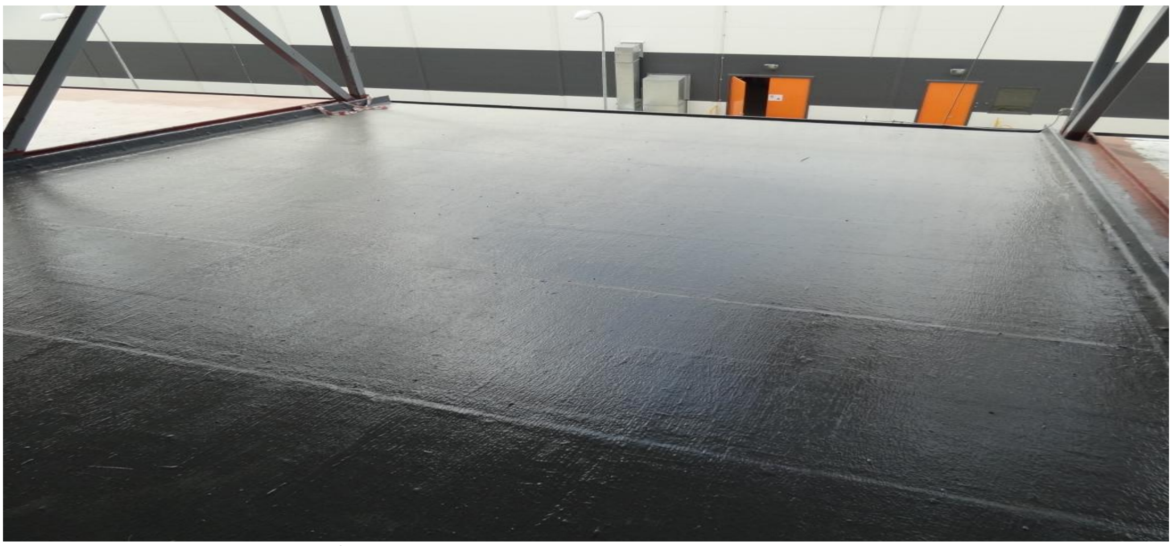

Figure 14. Top coat applied to roof section.

5.2.1 Check points

APPLICATION OF WATER PROOFING SYSTEM

IMPORTANT CHECK POINTS

1. **SURFACE CLEANLINESS**. After cleaning the surface with solvents the area must be kept free of dust and debris prior to the application of the primer.

2. **ROOF PANEL & ADJOINING STEEL TEMPERATURE**. Ensure that the steelwork does not exceed the minimum or maximum temperatures given by the manufacturer.

3. **LAPS** – All lapping of the base layer reemat to be minimum 50mm irrespective of whether this is horizontal or vertical.

4. **NARROW SECTIONS, OVER FLASHINGS AND UP TURNS**. The drawings must be followed strictly. All the strips over these areas must be done first before applying the final base coat layer. Refer to attached drawings.

5. **BRIDGING TAPE**. This must be implemented over all panel joints, flashing ends, up stands and similar details. Refer to agreed detail drawings.

6. **FIBRES / REEMAT**. Must be worked properly around protruding bolts and steel work ensuring that there are no “gaps” present. The use of extra coating material may be helpful for adhesion in tight areas. ALL over laps should be minimum 50mm.

7. **WET FILM THICKNESS**. Measuring this must be constantly done during application, records kept and issued in the handover pack.

8. **DRY FILM THICKNESS**. Must be done daily and records kept and issued in the handover Pack

9. **QUALITY CONTROL INSPECTION**. This must be done regularly during the application of the base and top coat.

5.2.2 Documentation

SUBSTRATE TEMPERATURE RECORD SHEET

DATE: ____________________

SECTION: ____________________

GRID: ____________________

ATM. TEMP: ____________________

	TEMPERATURE DEG. CELC.			
TIME	T1	T2	T3	REMARKS

COPIES TO: ____________________

____________________ ____________________

CHECKED AND APPROVED DATE

QUALITY CONTROL PROGRAM		DATE:	CONTRACT no.
Client/Contractor: Project:	Product:		QCP no. Roof section:

C/CS:	S/C:
WS:	WTC:

Checklist: Enter initials or n/a to appropriate block. C/CS- Client/Contractor Supervisor, WS- Wärtsilä Supervisor, S/C- Subcontractor, MTC- Material Technical Consultant				
	C/CS	S/C	WS	WTC
1. Clean surface with approved mordant				
2. Check that temperature before application is according to product specifications				
3.Prime surface with agreed primer at a rate of ________kg/m2				
4. Apply ______________base coat at average ______kg/m2 to a DFT of +- _____mm				
5. Apply reinforcement according to specifications				
6. Once basecoat has cured, coat with top coat ___________kg/m2				
7. Dry film thickness of _________mm				
Test-average dry film thickness				
Please note that the DFT may not always be exact and that there could be a variance of _____mm due to the nature of product and application				
Remarks:				

Signatures

Date:_______________________________

____
Client/Contractor Supervisor

____
Subcontractor

____
Wärtsilä Supervisor

____
Material Technical Consultant

5.3 Repair methods and maintenance

Maintenance periods[23] and methods vary according to the liquid roofing system that is used. When there is no risk of mechanical damages the manufacturers normally state that an annual check of the roof is enough.

Considering the fact that Wärtsilä projects are executed in different countries around the globe, there is in some places a higher risk of roof damages caused by pollution or heavy weather, such as hurricanes or even earth quakes[24]. Therefore the maintenance is to be executed every sixth month. Under no circumstances are the roof inspections to be left out after one or other heavy weather or suspicion of mechanical damage.

During inspections the inspector should look for cracks in the liquid roof. Places of high importance to be inspected are joints, up stands, penetrations and material edges, such as the base of roof.

Overall the repair methods for the materials compared in this study are quite similar. This means that if there are small local damages, the only thing needed is repainting with the top coat. However some of the manufacturers state that a reactivator is needed. The reactivator softens the old surface so that the new layer bonds to the old one.

To know which methods to use it is important to check out the latest product data sheet of the product to be used.

In case of bigger damages or damages to whole sections of the roof one should follow instructions given from the manufacturer of the roof product used in the specific project. In general it is recommended to cut out damaged areas to the point where there is no loose material, and from there add new layers of the roofing product.

[23] Rakennusmaalaus Rasitusluokat

[24] Ilmastorasitusluokat ja esimerkkejä tyypillisistä ympäristöistä

6 Summary

This chapter of the thesis deals with the challenges and possible improvements of the study. It also includes a summary and a discussion.

6.1 Challenges with the study

The challenges of this study were to make the layout for it, in such a way that the reader gets a good knowledge of the products. Since this installation instruction is based on company specific details and not done only for the purpose of using one manufacturer's product, I had to try to make it fit the three presented materials. Finding information about the products was a bit challenging in the beginning, since nobody in the company really knew what to search for or where. A great advantage in writing this thesis has been the fact that I had the possibility to go abroad to supervise the application of one of the studied materials. The reason why only three materials are presented in this study is simply that at the moment these three fit the company best, as far as their application methods and availability across the globe are concerned.

6.2 Improvements

This study could be improved by comparing the life time costs of steel sheet roofing and liquid roofing. Since liquid roofing systems are new to the company, there are no projects to compare at the moment. In the future this needs to be investigated, to see if the liquid roofing system is a competitive solution for water proofing power plant roofs. There also seems to be a lot of effort put into developing the product range in the companies that manufacture these types of products. Therefore this study has to be seen as a product of today, and the reader always has to find and refer to the manufacturers' latest product data sheets, to get the most recent information of the products and methods. The length of the maintenance periods is also to be revised when better knowledge is gathered in this area. As of today the company has no projects that exceed the maintenance periods given by the manufacturers. The materials´ abilities to withstand long term wear caused by weather phenomena, pollution and daily use in different parts of the world, still needs to be investigated. Then we could all get a better view of the need of maintenance as well as the suitability of the products to be used in Wärtsilä projects.

6.3 Discussion

Doing my thesis work was interesting in many ways. In the beginning the topic was something totally different from the topic of this presents study. Since my work description changed during the time I was writing, partly on my own request, it would still have been possible to accomplish the thesis with the first topic. However, during my stay on the site my interest in the liquid roof was born. When arriving back to Vaasa I had a discussion with Mrs Eija Ollus and Mr Stefan Fogde about my interest in this product and about the need of installation instructions for it. During this discussion it was agreed that the topic of my thesis was to be changed. However, the change of topic did not disturb my focus on finishing by December 2012, it just made the challenge more interesting. I also found the new topic more suitable, considering not only the fact that many work hours at site were spent preparing the installation and application of one of the liquid roof systems mentioned in this study, but also that my personal curiosity about the liquid roofing systems found on the market grew.

The final layout of the installation instructions is a product of the professional guidance given by the development team consisting of Mrs Eija Ollus, Mr Markus Sandås and Mr Stefan Fogde, as well as the guidance by my supervisor at Novia University of Applied Sciences, Mr Kimmo Koivisto.

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