----ENEMALTA DPS IPPC APPLICATION - FORM C----

APPENDIX K - Sewer Discharge Permit
APPENDIX L – VOC Abatement System Report
APPENDIX M – Enemalta Noise Monitoring Method Statement
APPENDIX N – DPS Noise Monitoring Reports 2014 & 2015
APPENDIX O – NEC Emission Calculations Letter
APPENDIX P - Technically Competent Person - CV

0466 – Enemalta DPS IPPC Application

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TABLE OF CONTENTS

VOC ABATEMENT

on

HFO TANKS

SECTION 1 – ABSTRACT

Enemalta, the main energy provider for the Maltese Islands, has a fuel storage plant at Delimara Power Station consisting of two Heavy Fuel Oil (HFO) Tanks (dia. 40 m, height 20 m) each of nominal capacity 25,000 m^3 and one smaller tank (dia. 22m, height 14m) with a nominal capacity of 5600 m^3. These HFO tanks (uninsulated) are heated by bottom steam tank heaters to be kept at a temperature of approx. 50^{o}C. The HFO currently in use is the 380 Centistokes (but this may vary). The tanks are solely used for storage of HFO . The filling rate of the fuel tanks is limited to 1000 m^3/hr and this rate is usually kept quite constant.

Enemalta has been carrying out various tests and studies to mitigate and limit the impact of fugitive emissions and odours from its Heavy Fuel Oil Tanks. What follows is a report that summarizes these works and the results of the trials carried out.

Fugitive emissions are mostly present during unloading when fuel is transferred from the vessel to the HFO Tanks. This is mainly due to the ullage or headspace of the tank above the Heavy Fuel Oil which is vented to the atmosphere during the filling operation. This ullage amounts to the Volume of Empty Space inside the tank. For example, if one of the tanks is emptied and needs to be filled up with say 20,000 $m^3$of fuel oil, this same amount of contaminated air must be displaced. This air is atmospheric air that entered the tank to replace the fuel that was consumed.

In the past this contaminated air was vented out of the tanks to the atmosphere without any abatement. Enemalta has for quite some time now, been studying ways and means to capture these emissions before they are released to the atmosphere.

Various systems were considered and analyzed. A number of trials were carried out on experimental designs until one of these systems proved to be satisfactory. This system was then built on a larger scale as a fully functional system and was installed on one of the Heavy Fuel Oiltanks at Delimara Power Station. A 3rd party laboratory “CADA” in conjunction with ECOSERV was commissioned to carry out measurements on fugitive emissions with and without abatement. The results of the trial show that the design chosen proved to be very effective.

The system chosen utilizes the “Wet Scrubbing Technology”. In a wet scrubber, the contaminated gas stream is brought into contact with the scrubbing liquid. This can be done either by:
1) spraying the gas stream with the liquid (mist) or
2) forcing the gas stream through a pool of liquid.

Wet scrubbers which absorb gaseous contaminants require good gas-to-liquid contact.

The main function of a “Wet Scrubber” is to remove the contaminants from the polluted gas stream, by capturing, absorbing and dissolving these pollutants into the liquid. The resultant droplets are then captured and collected, therefore leaving the gas stream clean and free of pollutants.

In the abatement system developed both methods were utilized so as to try and capture the maximum amount of contaminants present in the fugitive emissions.

SECTION 2 – OPERATION PARAMETERS

The fuel tanks are located aboveground and are of the **Fixed Roof Type**

▪ Product Stored	Heavy Fuel Oil
▪ Pump rate inlet HFO (filling of tank)	1,000 m^3/hr max
▪ Pump rate outlet HFO max.	40 m^3/hr
▪ Stored Temperature (operational)	+ 50°C max
▪ Stored Temperature (out of service)	ambient (+40 °C max)

TANKS DESIGN

▪ Tank Height	20m (HFO1 & HFO2); 14m (HFO3)
▪ Tank Diameter	40 m (HFO1 & HFO2); 22 m (HFO3)
▪ Tank Volume	25,000 m^3 (HFO1 & HFO2); 5,600 m^3 (HFO3)
▪ Tank max allowable pressure	70 mmWG (water gauge)
▪ Tank max allowable vacuum	25 mm WG (water gauge)

The fuel tank is operated in the following modes:

Filling Mode where the tank is filled with fuel (same type and grade) from a ship at a filling rate of approx 1000m^3/hr;

Standby/Operation Mode where the fuel tank is heated by bottom steam space heating and kept at a temperature of about +50 °C max - the heated fuel is pumped out of the tank at a rate of approx 40 m^3/hr.

The tanks are completely filled about 6 times per year.

SECTION 3 – EXISTING TECHNOLOGIES

Enemalta considered various existing technologies that could be utilized for abatement of Fugitive Emissions from the Heavy Fuel Oil Tanks.
One of the first technologies that Enemalta considered to employ was the Activated Carbon Adsorption System.

This system which is considered as a Dry Scrubbing System utilizes Activated Carbon, which adsorbs the volatile organic compounds present in the gas stream. Such system is employed at the D3 Plant on the buffer and service tanks. However it was found that such system poses serious risks to the safety of the plant if these were to be installed in the larger tanks. This is due to the creation of "Hot Spots" which could result in instantaneous combustion of the Activated Carbon. This combustion can reach extreme temperatures and if uncontrolled can lead to a backfire inside the fuel tanks with dire consequences. To mitigate this danger the activated carbon abatement vessel for D3 was installed at ground level instead of on top of the fuel tanks. Besides various other ancillary devices had to be installed on the D3 Fuel Tanks, such as, Temperature Control, Flame Arrestors, Shut Off Valves, and Water demister.

The main heavy fuel oil tanks in question contain a much bigger volume of heavy fuel oil than the buffer and storage tanks of D3 which means that the risks of fire and explosion are much higher and the consequences much greater if the activated carbon system is utilized on these tanks.

It was then that Enemalta decided to consider other systems which still being very efficient would prove to be safer. The alternative was a "Wet Scrubbing System" which after a substantial amount of research and testing proved to be the best solution.

SECTION 4 – TESTING & DESIGN STAGES

The first design and testing stage were carried out at Marsa Power Station on the HFO tanks. The design was constructed as a prototype to verify the effectiveness and feasibility of the "Wet Scrubbing System". The preliminary studies showed that the system could give good results.

The vents of the Heavy Fuel Oil tanks at the Marsa Power Station were connected to a bowl containing a mixture of water and a chemical called "Amerscent" (see **Annex 3** for SDS). Amerscent is being used as the absorbent liquid which entraps the VOCs when the polluted gas stream passes through it. With such a system the venting gases are forced to pass and bubble through this mixture, thereby bringing into contact the compounds present in the gases with the mixture. It was immediately noted that as soon as the prototype was used the smell of HFO from the tanks was no longer present. After a number of trials were performed with the scrubber the equipment was opened up for an inspection. As can be seen in the pictures below the system is very effective in capturing the contamination from the gas stream. It can be clearly seen that the contaminants present in the gases were entrapped in the mixture, leaving the deposits behind in the equipment. This means that the venting gases being emitted into the atmosphere were much cleaner than they entered the scrubber

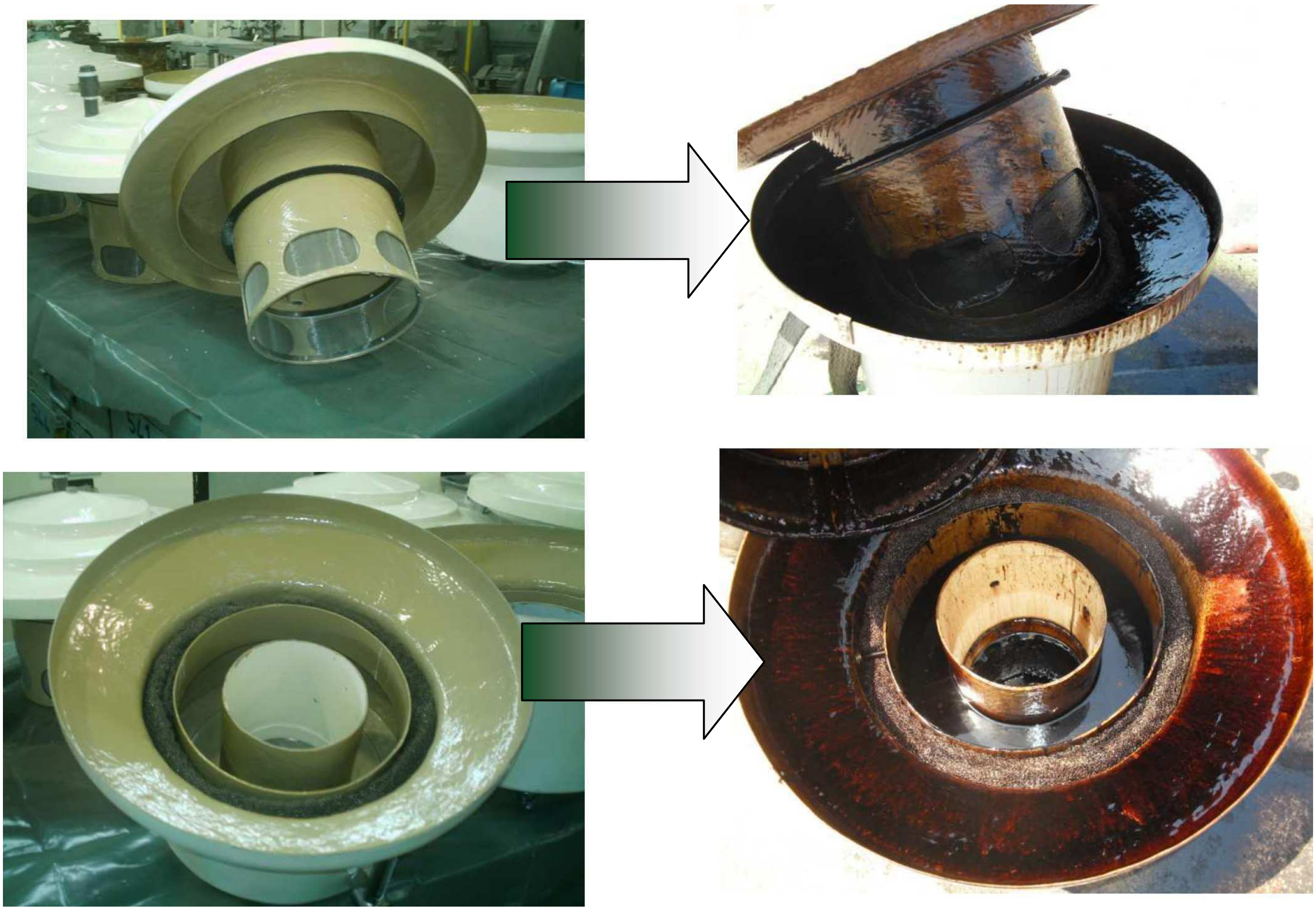


Fig 1 Preliminary Tests on the HFO Tanks at Marsa Power Station

SECTION 5 – VOC ABATEMENT SYSTEM DESIGN

Following the very promising results achieved at Marsa, it was decided to implement a similar system utilizing the "Wet Scrubbing" principles however on a much larger scale at Delimara. The abatement system was designed to cater for much larger fuel tanks. Preliminary drawings and testing were performed prior and during the construction of the system.

The designs utilized for the Delimara abatement system are as shown hereunder

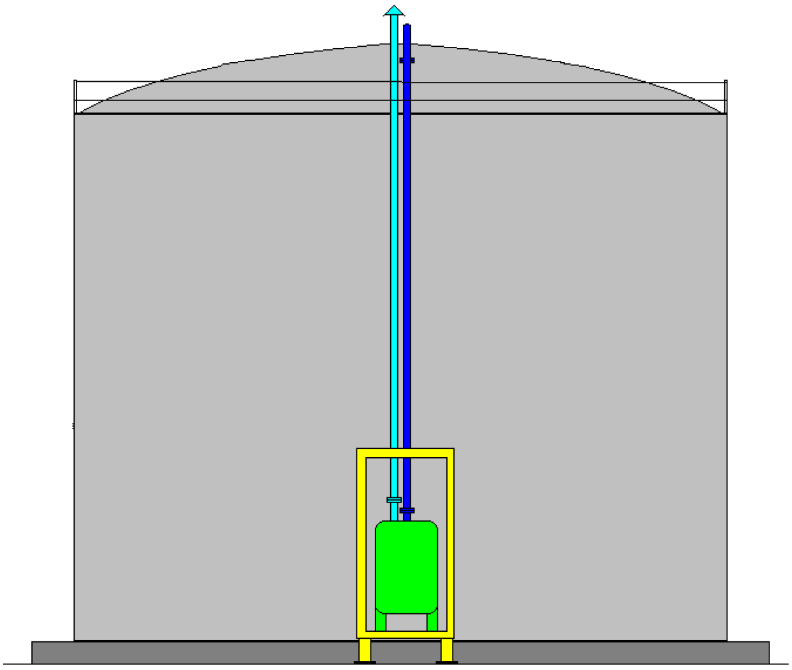


Figure 2 Abatement System Front View

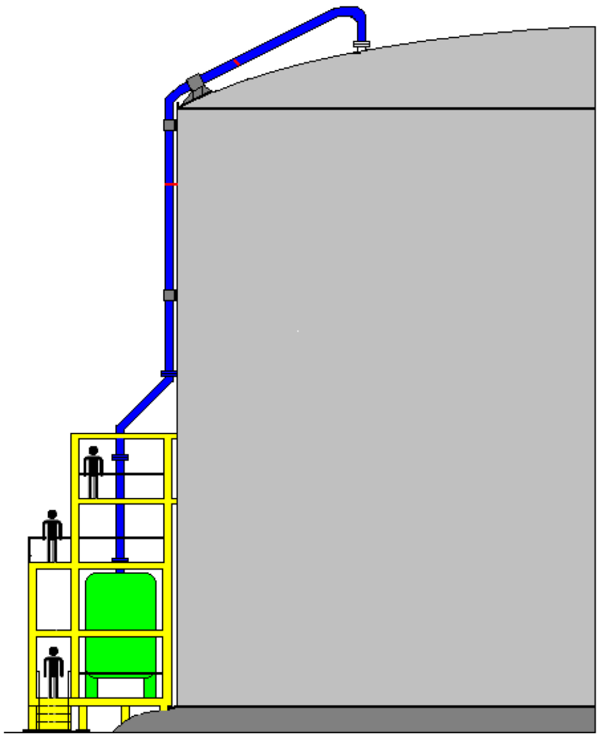


Figure 3 Abatement System Side View

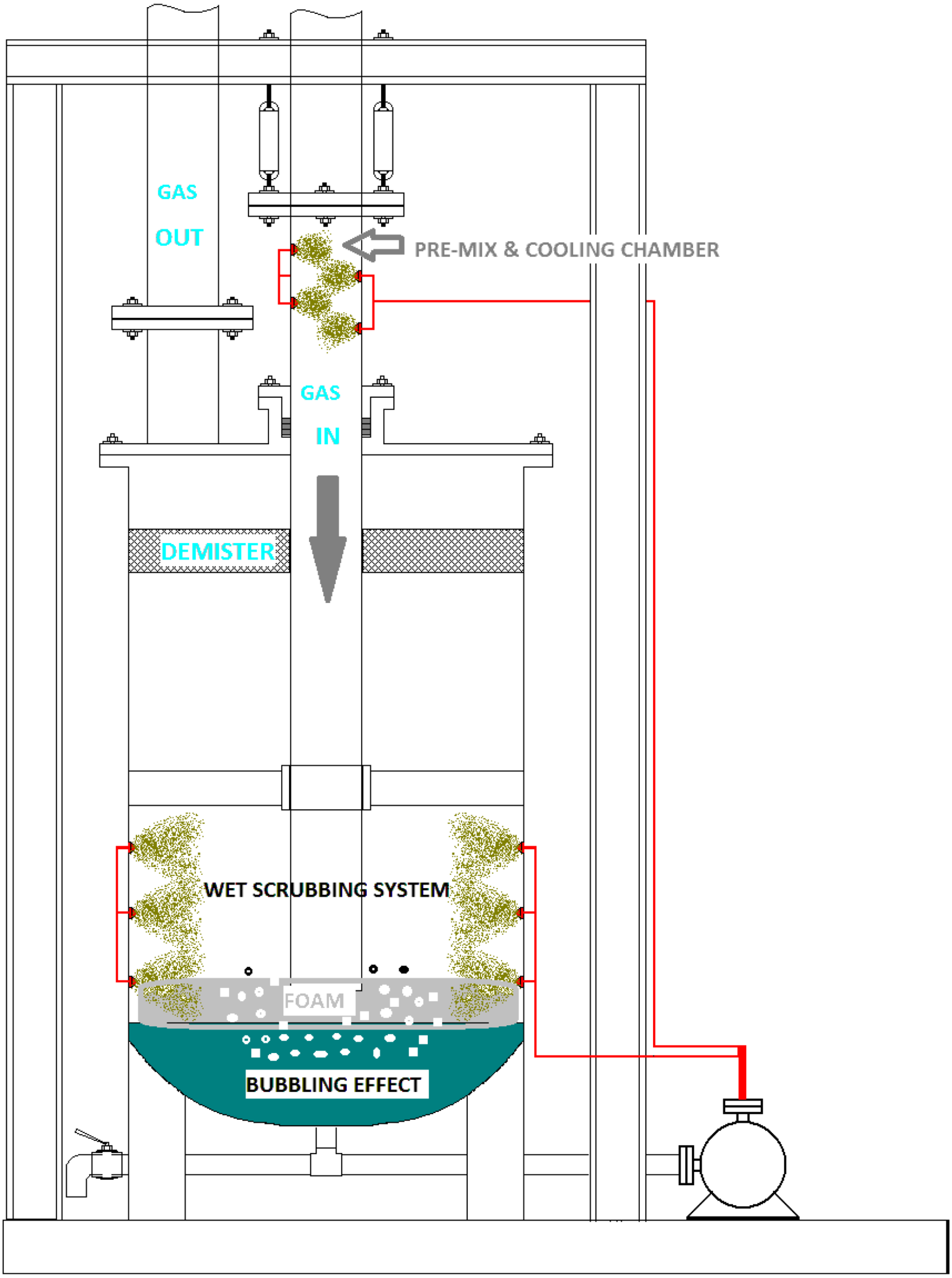


Fig 4 Abatement System: Principle of Operation

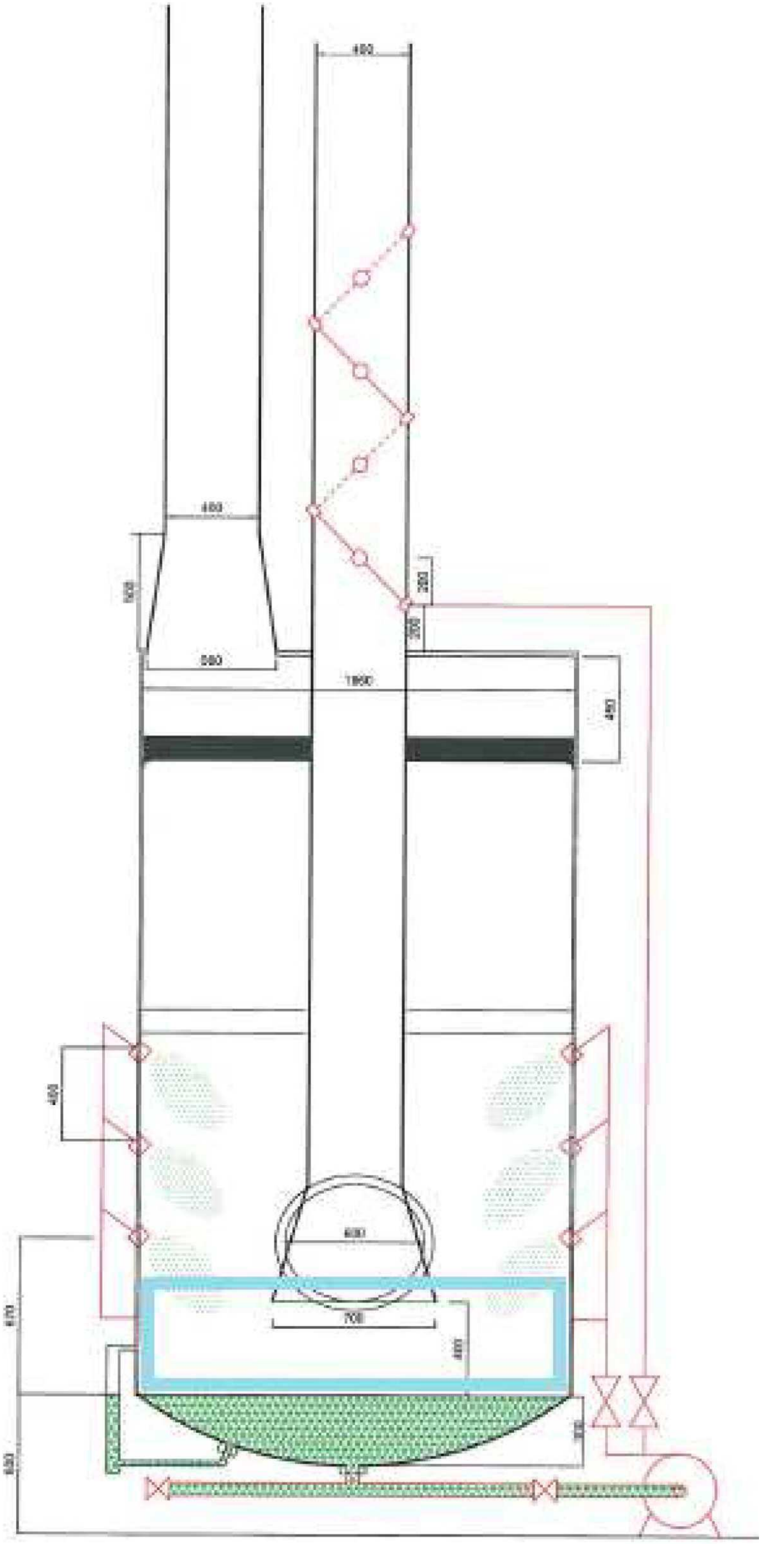
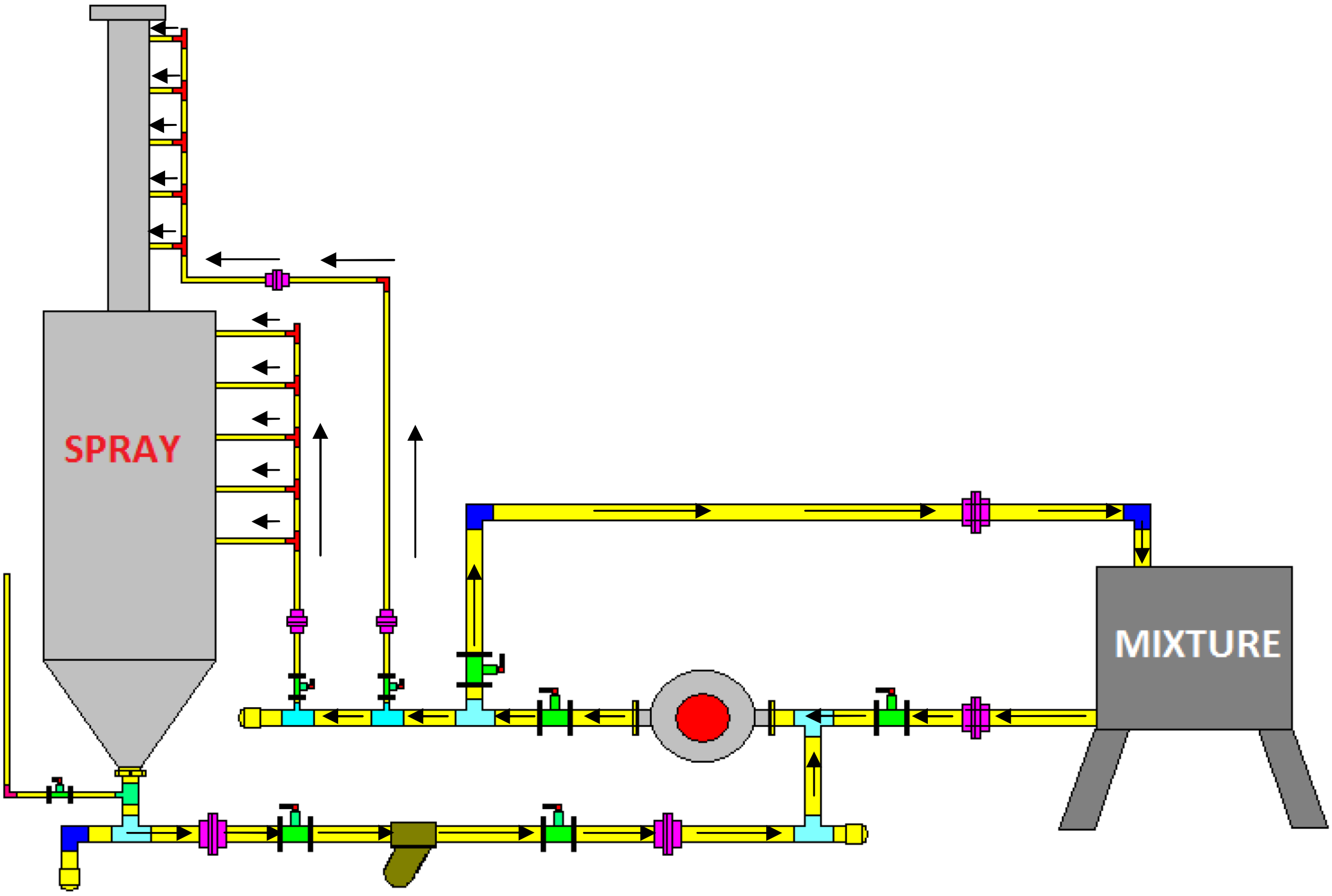


Fig 5 Abatement System Dimensions



Arrows show direction of flows. Please note that circulation pump can be used bidirectional – to spray water and to empty the spray chamber. The direction of flow will be controlled by the operating valves shown in green

Figure 6 Abatement System Piping Arrangement

SECTION 6 - ABATEMENT SYSTEM SETUP AND OPERATION

Following the design stages the system was then manufactured locally. The system was built in such a way so as to include both a spraying system (mist) and gas bubbling. The Abatement System was thus installed and tested on HFO Tank No 1 at Delimara Power Station.

Fig 7 HFO Tank 1 Before installation of Abatement System

Fig 8 HFO Tank 1 After installation of Abatement System

Fig 9 Installation of the Pre-Mix Chamber

Fig 10 Spray Nozzles: Location and Pumping

Figure 11 Scaffolding Works: Connection of the Tank Vents to the Scrubbing System

Figure 12 Recirculation and Spraying Pump

SECTION 7 – RESULTS AND CONCLUSIONS

Samples from fugitive emissions were taken by Ecoserv and CADA from the fuel tanks whilst these were being filled with fuel at the maximum unloading rate permissible of 1060 tonnes/hr(approx 1082 m^3/hr). The exercise was carried out first without the abatement system and then repeated with the abatement system in operation.

The results show that the system was very effective in reducing the level of VOC emissions from the tank vents as can be seen in the reports issued by CADA and Ecoserv in Annex 1 & 2.

Report by Ecoserv Reference No 155-13 (**Annex 1**) shows that the concentration of VOCs being vented to the atmosphere without any abatement was measured to be **350.6 mgC/Nm3.**

Report by Ecoserv Reference 066-14 (**Annex 2**) shows that the concentration of VOCs being vented to the atmosphere AFTER PASSSING THROUGH the abatement system was measured to be
42 mgC/Nm3.

This means a reduction of 350mgC/Nm^3 – 42mgC/Nm^3 = 308 mg/Nm3 of the VOCs to the atmosphere resulting in an 88% reduction in VOC emissions to the atmosphere which is a very indicative value for a Wet Scrubber System being run at the maximum flow of 1082 m^3/hr.

CONCLUSION

In an official communication dated the 15th of May 2012 (**Annex 4**), MEPA obliged Enemalta to be compliant to an emission value of 20mg C/Nm^3 for VOC emissions emanating from the vents of its fuel storage tanks.

The results show that the system utilizing "wet scrubbing technology" was very effective in reducing the VOC emissions from the tank vents during the unloading operation of fuel. Measurements show that the VOC emissions were reduced by 88%.
However this measurement is still higher than the 20mg C/Nm^3 imposed by MEPA.

Enemalta would like to reiterate that this emission limit for VOC emissions is applicable to industries using solvents and adhesives. In our opinion the emission limit for VOCs of 20mgC/Nm3 is way too low for fuel storage operations and should be increased to reflect the chemistry involved in this operation.