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Process Development in Facilities Management Sector

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Process Development in Facilities Management Sector

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ABSTRACT

This capstone project focuses on the enhancement and optimization of different aspects within the facilities management department of Dubai Developments, which is a leading real estate company in Dubai. Considering the huge number of buildings owned by the company and that the facilities management department was recently formed, there are still opportunities of improvement in terms of saving energy, growing productivity, improving operations processes and promoting sustainability. To do so, this capstone project focused on developing four main aspects within the FM department to ensure achieving the abovementioned objectives. Firstly, a retrofit project was implemented on the cooling system of one building which resulted in saving 756,864 Kwh of electrical power per year which is equivalent to 320,000 AED of savings in bills per year. Secondly, a mobile application was developed using Google AppSheet to organize the inventory management process in different stores. Thirdly, standard operation procedures were drafted to standardize the technicians' work process and control the maintenance quality. Finally, a proposal of zero-waste buildings was submitted to the management to completely recycle the buildings' waste. The proposal is still under review by the management and will be implemented once a budget is allocated for it. If implemented, zero-waste buildings will be a remarkable start for the company towards green buildings and sustainability journeys. This report illustrates how each project was planned and implemented, as well as the results achieved.

Keywords: Retrofit, Power consumption, Inventory management, Standard operation procedure, Zero-waste, Recycling, Sustainability.

Table of Contents

List of Figures

List of Tables

1.0 Introduction

1.1 What is Facilities Management?

The number of high-rise buildings and towers has recently increased in Dubai in an exponential manner. The different systems in these towers are designed by engineers to operate for more than 30 years. Hence, ultimate care and maintenance is required for all these systems to withstand the long service period. Here comes the extreme importance of the facilities management function in any real estate company. As per the International Facilities Management Association (IFMA), "Facility Management is an organizational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business" (International Facilities Management Association, 2022)**.** Facility managers are responsible to implement the organization's strategies in terms of enhancing the operational efficiency of the building, saving energy, controlling risks related to residents, employees, facility's assets and business reputation, reducing environmental effect, encouraging sustainable strategies and ensuring security and comfort for residents.

1.2 Problem Statement

Dubai Developments is one of the leading real estate developers in Dubai with a portfolio of around 6000 units including villas, high-rise buildings, hospitals, shopping malls and hotels. These properties are spread all over Dubai and hence require a massive coordination between different teams within the facilities management department in order to operate these building in the most efficient way. The main objective of this capstone project is to collaborate with the facilities management department in Dubai Developments company and implement initiatives that will ensure an efficient operational performance, streamline work processes, reduce energy consumption and implement the concept of sustainable buildings. To achieve this objective, an inventory management application was developed to organize multiple stores that belong to

the company, standard operation procedures (SOPs) were prepared to support the daily maintenance work, a retrofit project was designed and implemented which will approximately save 320,000 AED electricity consumption per year and a zero waste initiative was proposed to recycle the completed waste of any building.

2.0 Project Description

2.1 Retrofit Project

This section discusses the retrofit project implemented in Oud Metha Plaza Building. The building consists of 8 floors and located in Oud Metha area in Dubai next to Shaikh Rashid Road.

Figure 1. Oud Metha Plaza Building

In most of the hot countries, including United Arab Emirates, 70% of the total electricity consumed by the country is due to the air-conditioning system (Mathur et al., 2018). Accordingly, optimizing the current cooling system in the building will have a huge effect on its electrical consumption and hence significantly decrease its monthly electrical bill. So, the retrofit part of this capstone projects focuses on reducing the electrical consumption of the

cooling system of the building only not the other systems. The cooling system of this building consists of water-cooled chillers along with a cooling tower and a set of pumps. These water-cooled chillers are charged with refrigerant R-134a which acts as the heat exchange medium with water. The picture below shows an example of a water-cooled chiller:

Figure 2. Water-cooled chiller

The two main components of any water-cooled chiller are the evaporator and the condenser. The evaporator is the cooler that uses cold refrigerant to cool the water which is then pumped to the fan coil units (FCUs) located in each apartment using a set of chilled water pumps. The fan coil unit is the equipment used to circulate room's air and blow it over the cold chilled water pipes passing through FCU body. Once air is passed over the chilled water pipes, heat exchange occurs allowing air to be cooled and chilled water to be heated. The heated chilled water, called as chilled water return, is then collected from all apartments and directed, through pipes, back to the chiller. As heated water passes through the evaporator side of the chiller it gets cooled again to be ready for another circulation within the building. The other main component of the water-cooled chiller is the condenser which has the hotter refrigerant side and is responsible for rejecting the heat collected from all apartments to the open-air. To achieve this, another water cycle, called as condenser water, is connected to the condenser side of the chiller. In this cycle, cold water is passed of the hot condenser where heat exchange

occurs allowing the refrigerant to be cooled and water to be heated. Heated water is then pumped to the cooling tower which is responsible for decreasing the water temperature. Once cooled down, water is then directed back to condenser side of the chilled to allow for another heat exchange. The following diagram describes the chilled water and condenser water networks explained above:

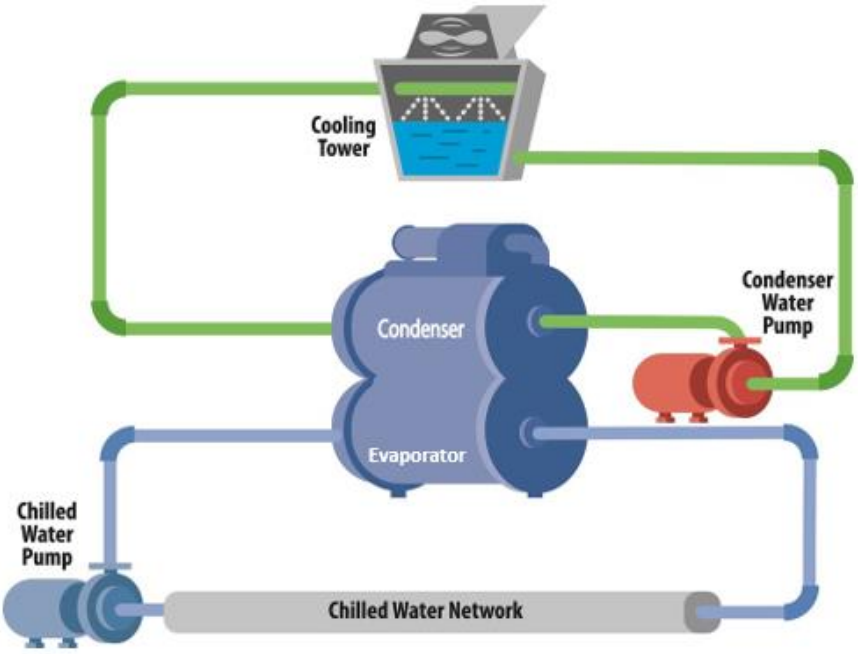

Figure 3. Chilled water and condenser water cycles

As part of the energy saving intention, the condenser water cycle was analyzed to investigate if there is an opportunity of reducing the size of the condenser water pumps and hence the power consumption. In case of closed loop water cycles, pumps are generally installed to overcome the losses in the pipes and the fittings. The building has two condenser pumps for each block, blocks A and B. The power rating for each existing condenser pump is 55 KW. The existing condenser water piping network at site was studied to evaluate the possibility of reducing the pipes length and fittings and hence the pumping power required. A new pumps location closer to the cooling tower was proposed and assessed based on the space available in the roof area of the building. Based on the selected new location, pipes lengths and equivalent lengths for fittings were calculated as per the calculation tables provided in appendices 1 & 2.

Head loss calculations were populated for each pipe length and fitting and total head loss was calculated starting for pump discharge line until the pump suction line. Based on the calculated total head loss, the required pumping power (electrical power) was calculated as per the equations below:

$$Pump\ Shaft\ power\ (Kw) = \frac{\rho \times Q \times g \times h_t}{pump\ efficiency}$$

Where:

$\rho\ is\ the\ density\ of\ water$

$Q\ is\ the\ mass\ flow\ rate\ of\ water$

$g\ is\ the\ acceleration\ due\ to\ gravity$

$h_t\ is\ the\ total\ head\ loss\ of\ pipes\ and\ fittings$

$$Pumping\ Power\ or\ Electrical\ power\ (Kw) = \frac{Shaft\ power}{motor\ efficiency}$$

As per the calculations done, based on the above equations, on the new pumps locations, it was found that the new pumping (electrical) power required is two pumps of 34 Kw in block A and two pumps of 26 Kw in block B. Based on the market survey and discussion with multiple pumps' vendors, 37 Kw and 30 Kw pumps were selected to be installed in block A and block B respectively. The pumps and the interconnecting pipes installation work was awarded to an installation company and the job was accomplished as per the predefined schedule. Currently, the newly installed pumps are working in a good operational condition with maintaining the design parameters, pressure head and flow, required to achieve an acceptable cooling level within the building. The tables below show the comparison of electrical power consumption (in AED) between the previous pumping and piping network and the newly installed one:

Previous Pumping Network							
Pumps	Pump Power (Kw)	Yearly (Hours)	Diversity	Running hours	Yearly Power Consumption (Kwh)	AED/Kwh	Yearly Cost (AED)
PUMP1-A	55	8640	90%	7776	427680	AED 0.42	AED 179,626
PUMP2-A	55	8640	45%	3888	213840	AED 0.42	AED 89,813
PUMP1-B	55	8640	95%	8208	451440	AED 0.42	AED 189,605
PUMP2-B	55	8640	45%	3888	213840	AED 0.42	AED 89,813
				TOTAL	1,306,800	TOTAL	**AED 548,856**

Table 1. Old Pumping Network - Yearly Electrical Consumption

New Pumping Network							
Pumps	Pump Power (Kw)	Yearly (Hours)	Diversity	Running hours	Yearly Power Consumption (Kwh)	AED/Kwh	Yearly Cost (AED)
PUMP1-A	37	8640	70%	6048	223776	AED 0.42	AED 93,986
PUMP2-A	37	8640	25%	2160	79920	AED 0.42	AED 33,566
PUMP1-B	30	8640	70%	6048	181440	AED 0.42	AED 76,205
PUMP2-B	30	8640	25%	2160	64800	AED 0.42	AED 27,216
				TOTAL	549,936	TOTAL	**AED 230,973**

Table 2. New Pumping Network - Yearly Electrical Consumption

As per the tables above, the yearly electrical power consumption for the condenser pumps will decline from 1,308,800 Kwh to 549,936 Kwh which is equivalent to 756,864 Kwh energy saving per year. It can be also concluded that 320,000 AED approximately will be saved yearly from the operational cost of the building. Considering the project cost of procurement and installation to be 1,280,000 AED, the return on investment for the project can be reached in 4 years ($ROI = \frac{1280000}{548856-230973} = 4\ years$).

To compare the actual energy saving achieved with the assumed and calculated saving, Electrical bills for October 2022 (72,154 AED) and October 2021 (108,982 AED) were compared considering that the new pumps were installed in September 2022. It can be noticed that in the month of October only, 36,828 AED were saved.

2.2 Inventory Management Application

Dubai Developments is considered a real estate company which owns the buildings under its portfolio. Even though the maintenance of some of these buildings is managed by outsourcing companies, a considerable number of other buildings are maintained by Dubai Developments' inhouse team. Inhouse maintenance teams require a huge number of tools, measurement devices, equipment and spare parts to maintain the facilities efficiently. Considering the wide spread of these building Dubai and the immediate need of these maintenance items in some cases, the company has built multiple stores in different areas to serve the nearby buildings. These stores were visited to thoroughly analyze and understand how efficient they are managed and if there is a possibility of process improvement. During these visits, it was concluded that there are four major issues to be looked at. The first issue is that stock data is entered manually into the excel sheets which increases the possibility of manual errors and misreporting the real stock level. The second issue is the absence of a centralized database for all stores which makes it hard for a storekeeper of a specific store to know if a needed item is available in another store. This increases the amount of unneeded orders and hence hits the waste operational cost heavily. The third issue is that the current store management approach does not track stock in and stock out transactions. For instance, if a specific item is pulled from a store, records will be only updated to show the new stock level but not the details of the borrower, the time and the site for which it was borrowed. The fourth issue is that items' detailed locations inside the store are not tracked and it is time consuming to look for items within these big stores.

To address the abovementioned issues and to automate the inventory management process, an inventory management application was developed using Google AppSheet application. The first objective of this application is to minimize the errors associated with manual data entry; the application is set in a way that supports data validation which does not allow the user to enter a text format value in the rack number field for example, and other restrictions can be set

in the application. The second objective is that supervisors in different stores can have the visibility over the inventory available in all other stores at one centralized platform. This will allow them to borrow needed items from other stores and avoid unneeded external purchase orders. The third objective is to track stock in and stock out transactions in order to reduce materials theft rate and to understand the items' demand rate in different sites. The fourth objective of the application is to decrease the time required to look for an item within the store. The application allows the user to enter the item's storage block and storage rack locations within the store once the item reaches the store.

To start the development of the application, the preliminary data of three main stores, The Village Mall, Al Qouz Camp and Almuntazah Complex, were used for testing purposes. The inventory excel sheets for each store were cleaned and uploaded to the application database. Three tables were created as the database for the application. The first table is the Items table which includes the following columns/fields: stock item name, the item store/location, the item storage block, the item storage rack within the storage block, the custodian who is the responsible storekeeper for this item and a picture of the item if available. In addition to these fields is the item ID which is an automatically filled and randomly generated field which is

used as the key to link between the three different tables. The picture below is a sample of the Items table:

	A	B	C	D	E	F	G
1	Item ID	Name	Location	Storage Block	Storage Rack	Custodian	Image
2	F73446E2	Spray Paint Light Blue (NOS)	The Village Mall	A	1	Radha	
3	f7c4988b	Spray Paint Black(NOS)	The Village Mall	A	2	Radha	
4	d59f5c85	Mirror 60X40cm (NOS)	The Village Mall	A	3	Radha	
5	56B9B09A	Mirror 94X59cm (NOS)	The Village Mall	A	3	Radha	
6	42B28CE3	PVC R/Bush 2"X1 1/2" H/P GF (NOS)	The Village Mall	A	2	Radha	
7	136E7657	CP Flexible 3' KM (NOS)	The Village Mall	A	1	Radha	
8	BBF53501	Jota Floor TC - 561 A&B (Drum)	The Village Mall	A	2	Radha	
9	50821E3E	Wall Tiles 15cm X 15cm White	The Village Mall	A	3	Radha	
10	A1DE96D2	Manhole Cover H/D 36X36cm (NOS)	The Village Mall	A	1	Radha	
11	8C865FAC	PVC Flexible Hose 1/2" (ROLL)	The Village Mall	A	1	Radha	
12	20A72F9C	Makita Table Saw 315MM 12-3/8" 2000W-2	The Village Mall	A	2	Radha	
13	95B21A32	Drier Filter 1/4" solder (Nos)	The Village Mall	A	3	Radha	
14	DDEAF36C	Wooden Door Handle Set	The Village Mall	A	3	Radha	
15	33851946	Contactor 40A 3pl 220v	The Village Mall	A	2	Radha	
16	8C04AA3F	Contactor 30A 2pl 220v	The Village Mall	A	1	Radha	
17	1E5CE2E7	Contactor 30A 2pl 24v	The Village Mall	A	2	Radha	
18	F7982D00	V Belt A46 (Nos)	The Village Mall	A	3	Radha	
19	C11ACF17	Capacitor 7.5ufd (NOS)	The Village Mall	A	1	Radha	
20	3B2F6C98	GI Clamp 1" (NOS)	The Village Mall	A	1	Radha	
21	AC3BF2AF	Rubber Hammer (NOS)	The Village Mall	A	2	Radha	

Table 3. Sample of the "Items" table in the inventory Management Application

The second table in the database is the Inventory table which provides the item ID, the date and time an item was borrowed or lent to the store, the quantity of item being added or removed from the store, the borrower name, the lender name and finally the inventory ID which is a randomly autogenerated field for each borrowing/lending transaction. The picture below is a sample of the Inventory table:

	A	B	C	D	E	F
1	Inventory ID	Item ID	DateTime	Amount	Borrower	User
2	7EF353DE	F73446E2	3/15/2022 9:18:34	1		
3	190D12F9	f7c4988b	3/15/2022 9:18:34	1		
4	6F69D590	d59f5c85	3/15/2022 9:18:34	1		
5	7EE95AF8	56B9B09A	3/15/2022 9:18:34	1		
6	8AD78508	42B28CE3	3/15/2022 9:18:34	1		
7	4D4C1D9F	136E7657	3/15/2022 9:18:34	1		
8	1089A28D	BBF53501	3/15/2022 9:18:34	1		
9	F9D5E9E9	50821E3E	3/15/2022 9:18:34	1		
10	02D86411	A1DE96D2	3/15/2022 9:18:34	1		
11	B09734AE	8C865FAC	3/15/2022 9:18:34	1		
12	1C17F2CF	20A72F9C	3/15/2022 9:18:34	1		
13	724B956B	95B21A32	3/15/2022 9:18:34	1		
14	BEB995B5	DDEAF36C	3/15/2022 9:18:34	1		
15	732678F1	33851946	3/15/2022 9:18:34	1		
16	27C9AF9B	8C04AA3F	3/15/2022 9:18:34	1		

Table 4. Sample of the "Inventory" table in the inventory Management Application

The third table is the Store table which lists down the stores' names to be displayed in the main window of the application. The picture below is a sample of the Stores table:

	A	B	C
1	Store ID	Stores	Image
2	1	The Village Mall	https://mybayutcc
3	2	Al Qouz Camp	https://lh5.google
4	3	Al Muntazah Cor	http://oslouae.ae/

Table 5. Sample of the "Stores" table in the inventory Management Application

After these three database tables were uploaded to the google AppSheet, rules and formulas were set in the application to control the following:

- Whether the field is editable or has fixed value.
- The initial value to be shown in the field.
- The field display name.
- Whether the field is searchable by the user or not.
- The type of data that is acceptable to be entered by the user.
- Formulas to calculate

Then user application views were set using the Primary Views option. Three main views were set which are "All DD Stores", "Change Log" and "search" views. The "All DD Stores" view provides the option of navigating through different stores' and check the complete stock details in each store. The "Change Log" view provides a real time list of stock in and stock out transactions showing the description and quantity of the item being borrowed/lent, the borrower/lender name, the date and time of transaction. The "Search" view provides the option of searching for an item or a specific detail by just typing what is needed in the search field.

The pictures below represent a snapshot of how the main views windows will appear to the user when the application is accesses through phone:

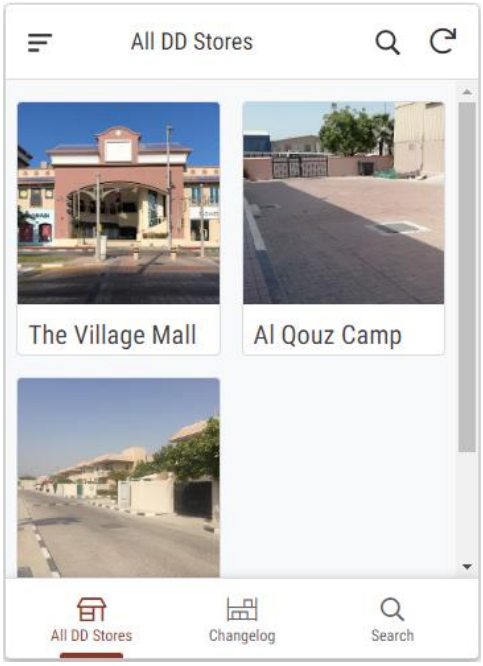

Figure 4. "All DD Stores" main view in the inventory management application

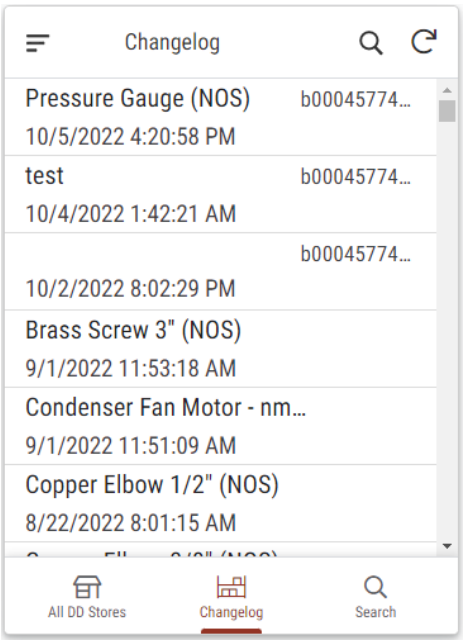

Figure 5. "Changelog" main view in the inventory management application

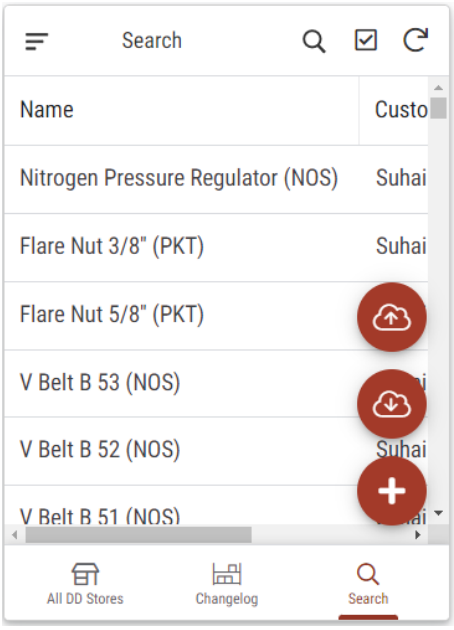

Figure 6. "Search" main view in the inventory management application

Additionally, to make the application as user friendly as possible, fast “actions” where added to the application in the form of icons to support the import and export of excel sheets as well as the addition of a new line item. These actions facilitate the modification of the current “Items” database table for many entries at one time by simply importing an excel sheet with all new entries. Export action also helps in reports generation purposes as required. The picture below represents the actions icons described above:

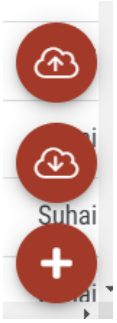

Figure 7. "Actions" icons in the inventory management application

Google AppSheet also provides the option of creating bots which are automated conditional actions. This option was utilized to create a bot that is responsible for sending automated email to the storekeeper and the property manager once an inventory record is created.

2.2.1 Potential Developments

Google AppSheet has a function which creates predictive models. This function can be utilized to create a forecasting model based on the demand rate of each store for each item. The forecasting model will help in understanding the size of future orders for each item within each store/site. However, this feature is not studied in this capstone project and yet to be analyzed and implemented in the future.

2.3 Standard Operation Procedure

Considering the huge number of buildings that are owned by Dubai Developments and the huge number of systems within these buildings, drafting standard operation procedure (SOPs) to control the maintenance activities of these systems and enhance productivity is essential. Every asset within the building undergoes a periodic maintenance check, known as periodic preventive maintenance (PPM), every predefined period. SOPs helps technicians achieving consistency in performing PPM activities as well as playing an important role in assuring quality and safety. Additionally, SOPs can reduce the time required to train technicians on how to perform PPM activities. A well written SOP helps newly hired technicians understand how their colleagues are performing their job and simplifying their onboarding procedure. SOPs also assist technicians in understanding what is expected from them and hence serves as a basis for technician's performance evaluation. Managers can have a regular check on technician's work at site and evaluate it by simply comparing it with the SOP's checklist and guidelines. Finally, SOPs saves manager's time and improves technician's autonomy by allowing him to refer to the approved SOPs when taking decisions instead of going back to the manager for reassurance. While reviewing the maintenance process in the company, Dubai Developments, it was noticed that there are no unified and consolidated guidelines for PPM activities within the different sites. So, to enhance the quality and productivity in PPM activities within the

department, a proposal to start the SOPs drafting was raised to FM HOD and the proposal was approved. Drafting SOPs was done by the technical expert of each engineering department, i.e. HVAC, Electrical and plumbing, in collaboration with the QHSE manager who is responsible to include all health and safety requirements in the SOP. The drafted SOPs content includes health and safety requirements, tools and materials to be used in PPM, schematics, approvals required prior starting PPM and a detailed list of steps for performing PPM. Appendices 3, 4, 5 and 6 show the SOPs drafted as part of the HVAC department. These SOPs were approved and distributed to all site supervisors for immediate implementation and to be included as part of the technician's performance evaluation.

2.4 Waste Management

Waste management is considered a major part of the soft services which lies under the responsibilities of the facilities management department in Dubai Developments. As per the monthly statistics of the soft services department, 1700 tons approximately of waste is being dumped from all Dubai Developments' buildings which is equivalent to 20,400 tons of waste per year. The types of waste produced includes papers, plastics, cans, food, printer cartridges, E-waste and furniture. The pie chart below shows the percentage wise waste production in DD:

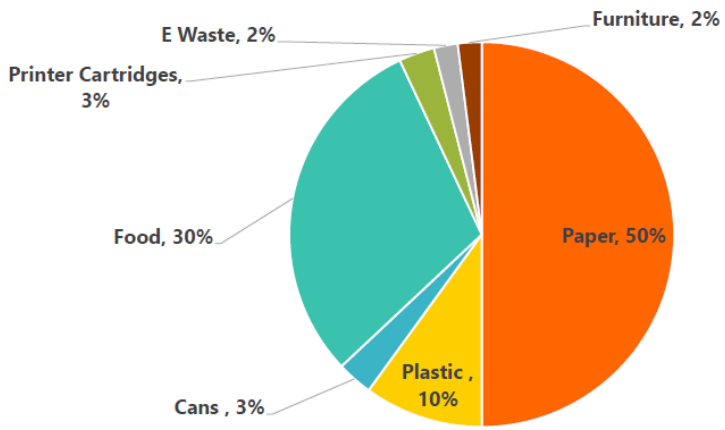

Figure 8. Waste production in Dubai Developments

It can be noticed that the bigger percentage of waste goes to papers then food then plastics. As part of the normal operations activities, the waste of each building is daily collected by a specialized garbage collection company which has an annual contract with the company.

In line with sustainability and green buildings drives of the company, a zero-waste proposal was presented to the FM HOD as part of this capstone project. The proposal is still under evaluation by the management and will be implemented once the budget is allocated for it. The target of the zero-waste proposal is to completely prevent waste by recycling, reusing or selling the waste to the recycling companies. To implement the zero-waste proposal, the following solutions were suggested:

1. Distributing 3 compartments dustbins which is used to segregate waste into papers, plastics and cans which helps reducing the recycling process time. The picture below shows a sample of the 3 compartments dustbin:

Figure 9. Three Compartments dustbin

2. Purchasing food waste compositing machines which converts food waste into compost/soil amendments. The picture below shows a sample of the food waste compositing machine:

Figure 10. Food waste compositing machine

3. Designating specific areas to dump E-waste and furniture waste and then selling and transporting this waste to recycling facilities.
4. Storing paper waste in boxes near printer area for recycling.
5. Storing empty printer cartridges in bins near printer area for recycling.

Implementing the zero-waste initiative has several benefits for the company such as saving waste disposal cost, improving the company's reputation in the market, focusing on waste prevention rather than waste management and as well as encouraging a healthier workplace.

3.0 Conclusion

To conclude, the field of facilities management is still considered recent, therefore this would lead to a plenty of opportunities when it comes to development and improvement. Specifically speaking, the FM department in Dubai Developments is still in the growth phase thus it has a huge potential of enhancements and new strategies to be implemented. This capstone project has successfully achieved positive results in terms of energy saving, inventory management, process development and sustainability management.

4.0 References

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5.0 Appendices

Appendix 1

Hydraulic calculations of the new pumping network in Block A

straight length	575	fitting	2,330	total.	2,905

CONDENSER PUMP-1750 GPM-BLOCK A

Section	Description of the pipe run	Diameter (in)	flow (GPM)	Straight length (ft)	Valves & Fittings	Qty	equivalent length of fittings (ft)	total equivalent length of Fittings (ft)	TOTAL EQT. LENGTH (ft)	head loss ft/100ft	friction loss in ft
A-B	PUMP DISCHARGE LINE	10	1750	3.7	Tee	2	25	336	339.7	1.46	4.96
					90 ELBOW	0	14				
					FLEXIBLE CONNECTOR	1	6				
					SWING CHECK	1	42				
					TDV	1	138				
					CONCENTRIC REDUCER	1	50				
					Tee	1	50				
B-C	PUMP DISCHARGE HEADER	16	1750	14	TEE	2	25	90	104	0.192	0.20
					90 ELBOW	2	20				
C-D	dischrge,line	16	1750	219	u bend	0	42	180	399	0.192	0.77
					90 ELBOW	9	20				
D-E	CONDENSER Inlet LINE	10	1750	14	90 ELBOW	2	25	302	316	1.46	4.61
					FLEXIBLE CONNECTOR	0	6				
					u bend	0	38				
					MIV	1	120				
					BV	1	32				
					STRAINER	1	100				
	CONDENSER										17
E-F	CODENSER outlet LINE	10	1750	9	45 ELBOW	1	13	183	192	1.46	2.80
					90 ELBOW	2	25				
					FLEXIBLE CONNECTOR	0	6				
					U BEND	0	100				
					VALVE	1	120				
F-G	condenser discharge header	16	1750	258	TEE JOINT	2	25	210	468	0.192	0.90
					90 ELBOW	8	20				

COOLING TOWER											25.00
K-L	CT-INLET	10	1750	8	90 ELBOW	1	25	175	183	1.46	2.67
					FLEXIBLE CONNECTOR	0	20				
					STRAINER	0	50				
					BV	0	30				
					MIV	1	150				
					U BEND	0	100				
L-M	CT-OUTLET	10	1750	10	TEE-branch	1	66	374	384	1.46	5.61
					VALVE	1	120				
					90 elbow	1	38				
					stariner	1	150				
M-N	PUMP INLET HEADER	16	1750	36	TEE	2	17	348	384	0.192	0.74
					elbow	3	63				
					stariner	1	75				
					tee-branch	1	50				
N-O	PUMP INLET LINE	10	1750	3.7	TEE	0	16	132	135.7	1.46	1.98
					BV	1	32				
					STRAINER	0	75				
						1	50				
					eccentric connection	1	50				
					elbow	0	25				
Total Head Loss in ft											62.62
Safety Factor										20%	12.52
Total Head Loss in ft (including factor of safety)											**75.15**
CATALOUGUE-PUMP EFFICIENCY											80%
CATALOUGUE-MOTOR EFFICIENCY											80%
PUMP FLOW											1550
LIQUID SG											1
OUTPUT											
PUMP shaft HP											**37**
PUMP EFFICIENCY											**80%**
WHP											**29**
ELECTRICAL HP INPUT-MOTOR											**46**
KW INPUT TO MOTOR											**34**
OVERALL EFFICIENCY											**64%**
NPSHA											**28**

Appendix 2

Hydraulic calculations of the new pumping network in Block B

	straight length	465.4	fitting length	2,383	total.	2,848	

CONDENSER PUMP-1530 GPM-BLOCK B											
Section	Description of the pipe run	Diameter (in)	flow (GPM)	Straight length (ft)	Valves & Fittings	Qty	equivalent length of fittings (ft)	total equivalent length of Fittings (ft)	TOTAL EQT. LENGTH (ft)	head loss ft/100ft	friction loss in ft
A-B	PUMP DISCHARGELINE	10	1530	3.7	90 ELBOW SHORT	0	13.4	244	247.7	1.1	2.72
					FLEXIBLE CONNECTOR	1	6				
					SWING CHECK VALVE	0	0				
					TDV	1	138				
					CONCENTRIC REDUCER	1	50				
					TEE-BRANCH	1	50				
B-C	PUMP DISCHARGE HEADER	16	1530	43	TEE	2	25	126	169	0.145	0.25
					90 ELBOW	2	38				
C-D	dischrge,line	16	1530	219	u bend	0	42	180	399	0.145	0.58
					90 ELBOW	9	20				
D-E	CONDENSER inlet LINE	10	1530	10	90 ELBOW short	1	38	618	628	1.1	6.91
					FLEXIBLE CONNECTOR	0	0				
					u bend	1	200				
					MIV	1	250				
					BV	1	30				
					STRAINER	1	100				
	CONDENSER										17
E-F	CODENSER outlet LINE	10	1530	8	45ELBOW bend	1	13	233	241	1.1	2.65
					90 ELBOW LONG	0	20				
					FLEXIBLE CONNECTOR	0	0				
					U BEND	1	100				
					DRV	1	120				
F-G	condenser discharge header	16	1530	120	TEE JOINT	2	17	159	279	0.14	0.39
					90 ELBOW	5	25				
	COOLING TOWER										25.00
K-L	CT-INLET	10	1530	8	90 ELBOW SHORT	1	25	175	183	1.54	2.82
					FLEXIBLE CONNECTOR	0	20				
					STRAINER	0	50				
					BV	0	30				
					MIV	1	150				
					U BEND	0	100				
L-M	CT-OUTLET	10	1530	10	TEE	2	16	120	130	1.1	1.43
					90 elbow	1	38				
					stariner	1	50				

M-N	PUMP INLET HEADER	16	1530	36	TEE	3	38	378	414	0.14	0.58
					elbow	3	63				
					stariner	1	75				
N-O	PUMP INLET LINE	10	1530	3.7	TEE	2	10	150	153.7	1.1	1.69
					BV	1	30				
					STRAINER	0	75				
						1	50				
					eccentric connection	1	50				
					elbow	0	25				
Total Head Loss in ft											55.11
Safety Factor										20.0%	11.02
Total Head Loss in ft (including factor of safety)											**66.13**
CATALOUGUE-PUMP EFFICIENCY											83%
CATALOUGUE-MOTOR EFFICIENCY											90%
PUMP FLOW											1550
LIQUID SG											1
OUTPUT											
PUMP shaft HP											**31**
PUMP EFFICIENCY											**83%**
WHP											**26**
ELECTRICAL HP INPUT-MOTOR											**35**
KW INPUT TO MOTOR											**26**
OVERALL EFFICIENCY											**75%**
NPSHA											**33**

Appendix 3

Standard operation procedure for PPM of Air Handling Units

SITE/DISTRICT:	Dubai Development		
Document Name:	Standard Operation Procedure – Air Handling Unit		
Document Reference Number:	DD-FM-SOP-HVAC-01		
Trade	HVAC		
Asset	Air Handling Unit		
Issue Date	Dec 2021	Effective Date	
Version	0	Revision	01

PREPARED BY		APPROVED BY	
NAME	Mohammad Aldiek	**NAME**	
DESIGNATION	FM Engineer	**DESIGNATION**	Operations Manager
SIGNATURE		**SIGNATURE**	

HEALTH AND SAFETY AT WORK ACT

Employee duty:

- To take care of his health & safety and of other employees who are affected by his actions or work commitments.
- To coordinate with his manager or any other individual so far as needed for the providing of the several relevant Laws which are required to be complied with.
- Familiarize himself with the electrical & mechanical hazards linked with the workplace.
- Un-plug the electrical equipment prior to the servicing activity.
- Report mechanical and electrical issues, including tripping breakers, damaged guard protection, and the flickering lights.
- Avoiding using any appliance which smokes, sparks, or becomes extremely hot, unless if it is designed to show these characteristics.
- Keep water away from electrical equipment, unless if it is intended for use around water, like the wet-dry shop vacuum.

Before performing service or maintenance work of Air Handling Unit:

- ISOLATE electrical supplies prior to removing covers, guards or accessories from any parts of Air Handling unit. Before the re-connection of the electrical supply, make sure that all covers, guards, and accessories are replaced correctly.
- DO NOT keep electrical gear in live status and unattended without a **WARNING NOTICE**.
- DO NOT attempt maintenance work or adjustment unless wearing suitable **PROTECTIVE CLOTHING.**

WARNING AND SAFETY NOTICES

- At all times safety and warning signs should be properly displayed, maintained and worked to give clear directions.
- Proper fire precaution must be observed within the area nearby.
- Smoking will not be allowed in any plant room. Display Notices which are stating **"NO SMOKING"** and **"SMOKING PROHIBITED IN THIS AREA".**
- All firefighting equipment must be marked clearly and accessible for use.

FIRE PROTECTION / ALARMS

- Fire alarms systems should be checked regularly and maintained in working order. Care must be taken.

ESCAPE ROUTES

- Escape routes and exits must be inspected periodically to make sure that doors are freely opening, and that there are clear routes without any obstruction.

LIGHTING

- In the TSE plant room, lighting must be maintained at a high level to enable maintenance to be carried out and prevent accidents due to badly lit areas.

PORTABLE TOOLS and HAND LAMPS

- Where power operated handheld tools or hand lamps are used these items together with their power supply must confirm to the regulations applying to the use of this type of apparatus.

PROTECTIVE EQUIPMENT

- Protective equipment (e.g. Gloves, Safety shoes etc.) must be provided and used where appropriate to the activity.

SAFETY CHECKS

- Permit to work (PTW).
- Isolate power source.
- Lock off Tag Out (LOTO) system.
- Test and confirm there is no power source available.
- Wear adequate P.P.E for doing the work.
- Do not wear any jewelry while working.
- Ensure adequate housekeeping on work area.

ABREVIATIONS:

ABREVIATION	FULL FORM
LOTO	Lock Out Tag Out
PTW	Permit to Work
MER	Maintenance Evidence Record
SOP	Standard Operation Procedure
PPM	Planned Preventive Maintenance

FIRST AID MEASURES

1. Call for help.
2. Conduct scene survey and make sure you are safe before touching the victim.
3. Make sure that there are no unsafe electrical power sources.
4. Isolate the supply source if possible or try to release the victim with adequately Insulated safe material if you are totally safe.
5. Never attempt to give any First Aid unless you are trained. And the scene is totally safe.
6. Never attempt to move the victim or administer first aid unless you are sure that the Victim sustains no spinal injuries and the scene is totally safe.
7. Check Air way, Breathing and Circulation and establish if possible, Arrest bleeding.

MAKE SURE

8. C.P.R. Mouth to mouth mask and latex gloves to be carried along with first aid provision
9. Administer C.P.R only if you are trained and the victim sustains no spinal injuries.

SAFETY INSTRUCTION:

1. Prior to any maintenance, shut off the electric power supply and lockout before starting the work.
2. Ensure that all measuring tools are in good working condition.
3. Record the last condition status before starting the work.
4. Restore back to the last condition status after work completion.

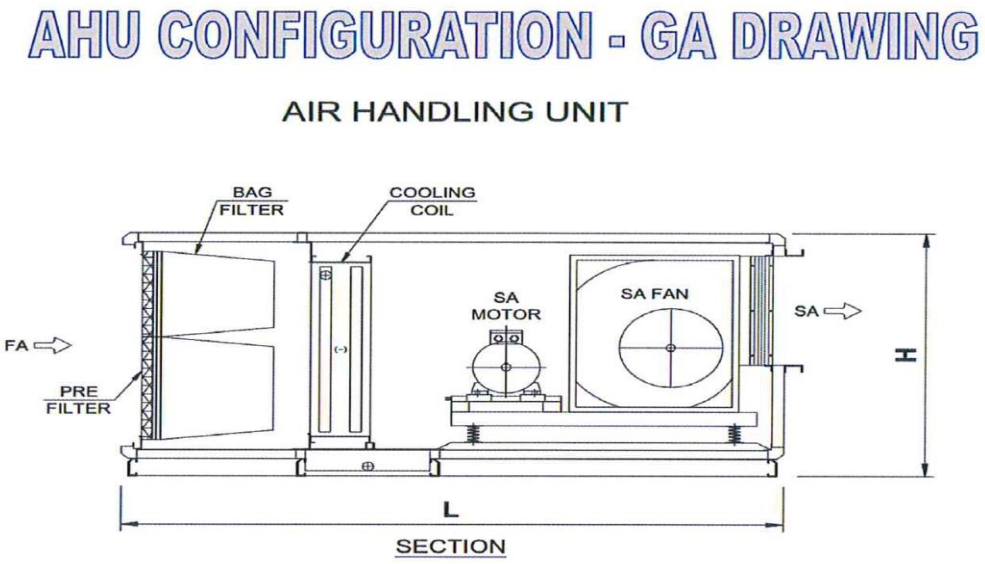
5. Before starting the job, inform BMS.

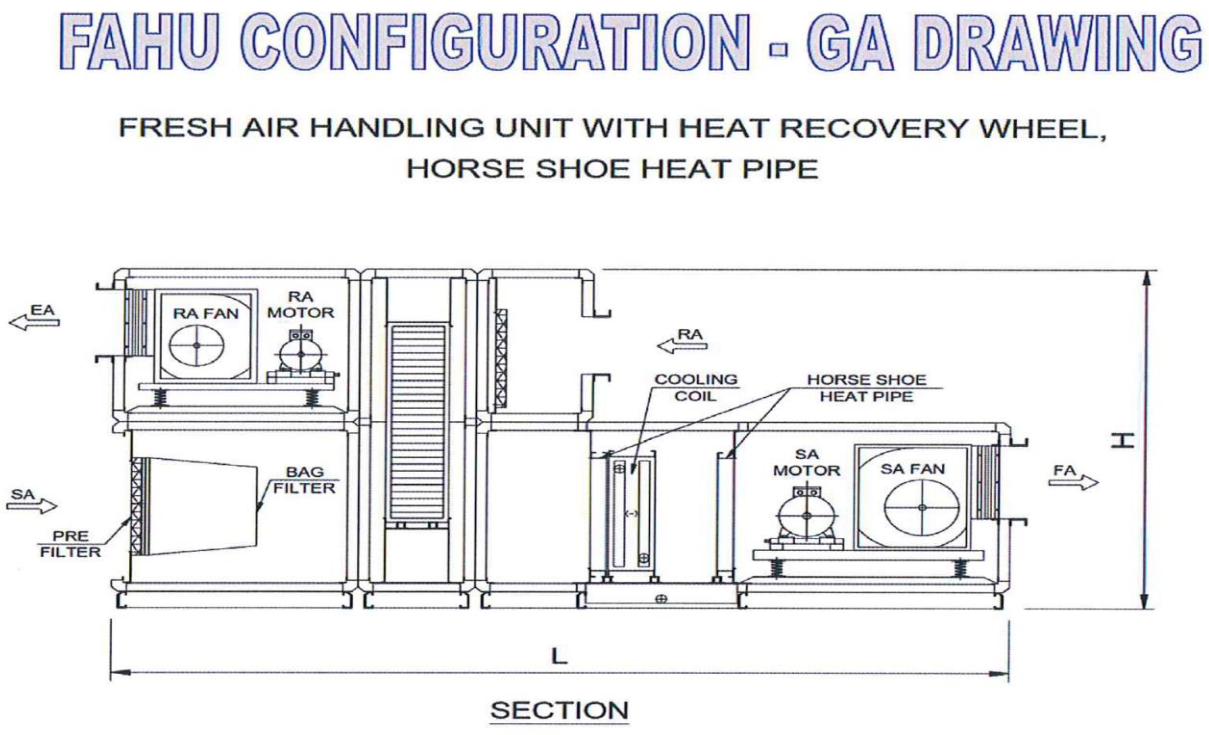
SPECIAL TOOLS/MATERIALS:

1. Multi-meter tester (VOM)
2. Air Blower
3. Vacuum Cleaner
4. Standard mechanical tool box
5. Ladder/ Scaffolding/ Man lifting machine
6. CRC contact cleaner
7. Degreaser/Cleaning product
8. Clean cotton cleaner
9. Hand gloves
10. Mask, goggles eye Protection
11. Warning Signs

1. INTRODUCTION:

AIR HANDLING UNIT:





2. SCOPE

This Standard Maintenance Specification covers the procedure of maintaining and servicing of Air Handling units with all safety requirements.

3. OBJECTIVE:

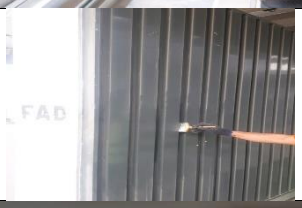
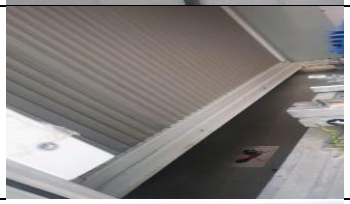
This Standard Operation Procedure is for guidance of staff/technicians who will be involved in carrying out the mechanical maintenance works for Air Handling units.

- This SOP is to ensure the works will be executed in an efficient and safe manner in accordance with all relevant contract documents.
- This SOP will, if deemed necessary, be revised and when required to accommodate circumstantial requirements.

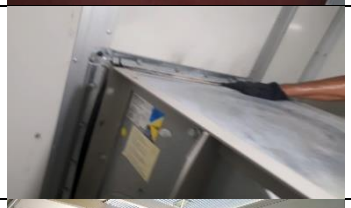
STEPS BEFORE STARTING THE AIR HANDLING UNIT MAINTENANCE:

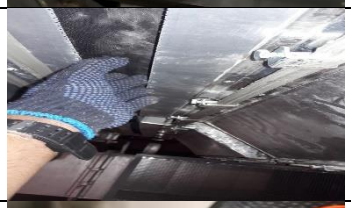
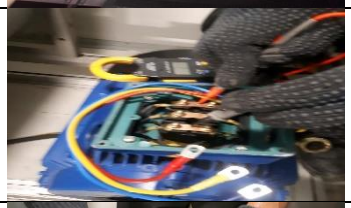
- PTW – Permit to work system (PTW) to be obtained from PTW department. PTW should keep or place where the activity is to be carried out.
- Briefing the activity to all technicians by supervisor through tool box talk.
- All necessary materials/tools should be ready at hand.
- Proper signage shall be placed to give warning of the work area.
- Ensure the Duct smoke detector is disabled.
- Technicians who are assigned to carry out the maintenance work should wear necessary PPE.
- Confirm that the asset tagging is referencing to the PPM task sheet
- Lock Out Tag Out the equipment

MAINTENANCE PROCEDURE:

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
1	Lock-Out Tag-Out Asset prior to start the work.	
2	Check all fans and motors. Ensure impellers are not fouling (Check Motors section for details).	
3	Check disposable filters and clean/ change if necessary.	
4	Check washable filters and clean if necessary.	
5	Clean sand trap louvers.	
6	Check guide vane actuators and motorized dampers for correct operation.	
7	Check condensate drain for carry over and ensure that drains are clean. Take appropriate action if necessary.	
8	Check and clean chilled water strainers.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
9	Vent any air from cooling coils.	
10	Check drive belts for tension, alignment and condition. Replace the belts if necessary.	
11	Check pressure drops across the coils and record.	
12	Check and record manometer reading and renew filter media as indicated.	
13	Check for condensate carry-over and ensure that drains are clear.	
14	Lubricate dampers and guide vane pivots and linkages.	
15	Clean cooling coils as per manufacturer's recommendations to ensure that no dust is accumulated on the coils.	
16	Check operation of motorized valves. Fully open and close the valve then reset to original setting to ensure that the valve is operating correctly.	
17	Thoroughly clean interior and check for corrosion. On re assembly check for air tightness. Include cooling coils, impeller and eliminator plates and other fittings.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
18	Inspect drain pan and clear/repaint any rusted portions.	
19	Flush out coils to remove any sediment.	
20	Check coil mounting bolts and replace any rusted bolts.	
21	Check anti vibration mountings and ductwork flexible connections.	
22	Check and comb cooling coil fins if necessary.	
23	Check tightness of lid retaining screws and replace if rusted.	
24	Check unit casing for evidence of corrosion and deterioration.	
25	Clean and check condition of heating and cooling coils.	
26	Open and close valves (fully open and close) and then reset at the original setting.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
27	Clean air handling unit interior and check for corrosion including blower vanes and other fittings.	
28	Check for air tightness on air handling unit re-assembly.	
29	Check and test motor windings.	
30	Check tightness of motor terminals.	
31	Check motor full load current.	
32	Check motor bearings for wear/tear.	
33	Replace lubricant in motor bearings if applicable.	
34	Carry out replacement of all pipe insulation, wrapping, and liners if applicable.	
35	Carry out cleaning of all filtration devices.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
36	Clean the VFD panel and inspect for any damage for the panel and switch gears.	
37	Check all point function with BMS is correct.	
38	Terminal IR complete for VFD panels (Yes / No).	
39	Photo Evidence Taken (Yes / No).	

Appendix 4

Standard operation procedure for PPM of Extract Fans

SITE/DISTRICT:	Dubai Developments		
Document Name:	Standard Operation Procedure – Extract Fans Maintenance		
Document Reference Number:	DD-FM-SOP-HVAC-3		
Trade	HVAC		
Asset	Extract Fans		
Issue Date	Feb-2022	Effective Date	
Version	0	Revision	01

PREPARED BY		APPROVED BY	
NAME	Mohammad Aldiek	**NAME**	
DESIGNATION	FM Engineer	**DESIGNATION**	Operations Manager
SIGNATURE		**Signature**	

HEALTH AND SAFETY AT WORK ACT

Employee duty:

- To take care of his health & safety and of other employees who are affected by his actions or work commitments.
- To coordinate with his manager or any other individual so far as needed for the providing of the several relevant Laws which are required to be complied with.
- Familiarize himself with the electrical & mechanical hazards linked with the workplace.
- Un-plug the electrical equipment prior to the servicing activity.
- Report mechanical and electrical issues, including tripping breakers, damaged guard protection, and the flickering lights.
- Avoiding using any appliance which smokes, sparks, or becomes extremely hot, unless if it is designed to show these characteristics.
- Keep water away from electrical equipment, unless if it is intended for use around water, like the wet-dry shop vacuum.

Before performing service or maintenance work of Air Handling Unit:

- ISOLATE electrical supplies prior to removing covers, guards or accessories from any parts of Extract Fans. Before the re-connection of the electrical supply, make sure that all covers, guards, and accessories are replaced correctly.
- DO NOT keep electrical gear in live status and unattended without a **WARNING NOTICE**.
- DO NOT attempt maintenance work or adjustment unless wearing suitable **PROTECTIVE CLOTHING.**

WARNING AND SAFETY NOTICES

- At all times safety and warning signs should be properly displayed, maintained and worked to give clear directions.
- Proper fire precaution must be observed within the area nearby.
- Smoking will not be allowed in any plant room. Display Notices which are stating **"NO SMOKING"** and **"SMOKING PROHIBITED IN THIS AREA".**
- All firefighting equipment must be marked clearly and accessible for use.

FIRE PROTECTION / ALARMS

- Fire alarms systems should be checked regularly and maintained in working order. Care must be taken.

ESCAPE ROUTES

- Escape routes and exits must be inspected periodically to make sure that doors are freely opening, and that there are clear routes without any obstruction.

LIGHTING

- In the TSE plant room, lighting must be maintained at a high level to enable maintenance to be carried out and prevent accidents due to badly lit areas.

PORTABLE TOOLS and HAND LAMPS

- Where power operated handheld tools or hand lamps are used these items together with their power supply must confirm to the regulations applying to the use of this type of apparatus.

PROTECTIVE EQUIPMENT

- Protective equipment (e.g. Gloves, Safety shoes etc.) must be provided and used where appropriate to the activity.

SAFETY CHECKS

- Permit to work (PTW).
- Isolate power source.
- Lock off Tag Out (LOTO) system.
- Test and confirm there is no power source available.
- Wear adequate P.P.E for doing the work.
- Do not wear any jewelry while working.
- Ensure adequate housekeeping on work area.

ABREVIATIONS:

ABREVIATION	FULL FORM
LOTO	Lock Out Tag Out
PTW	Permit to Work
MER	Maintenance Evidence Record
SOP	Standard Operation Procedure
PPM	Planned Preventive Maintenance

FIRST AID MEASURES

1. Call for help.
2. Conduct scene survey and make sure you are safe before touching the victim.
3. Make sure that there are no unsafe electrical power sources.
4. Isolate the supply source if possible or try to release the victim with adequately Insulated safe material if you are totally safe.
5. Never attempt to give any First Aid unless you are trained. And the scene is totally safe.
6. Never attempt to move the victim or administer first aid unless you are sure that the Victim sustains no spinal injuries and the scene is totally safe.
7. Check Air way, Breathing and Circulation and establish if possible Arrest bleeding.

MAKE SURE

8. C.P.R. Mouth to mouth mask and latex gloves to be carried along with first aid provision
9. Administer C.P.R only if you are trained and the victim sustains no spinal injuries.

SAFETY INSTRUCTION:

6. Prior to any maintenance, shut off the electric power supply and lockout before starting the work.
7. Ensure that all measuring tools are in good working condition.
8. Record the last condition status before starting the work.
9. Restore back to the last condition status after work completion.
10. Before starting the job, inform BMS.

SPECIAL TOOLS/MATERIALS:

12. Multi-meter tester (VOM)
13. Air Blower
14. Vacuum Cleaner
15. Standard mechanical tool box
16. Ladder/Scaffolding/Man lifts
17. CRC contact cleaner
18. Degreaser/Cleaning product
19. Clean cotton cleaner
20. Hand gloves
21. Mask, goggles eye Protection
22. Warning Signs

1. INTRODUCTION

BELT DRIVEN CABINET FANS
CVTT Series

Range of forward curved belt drive cabinet fans manufactured from galvanised steel sheet, internally lined with melamine acoustic insulation (M1). All models incorporate a double inlet low pressure centrifugal fan mounted on anti-vibration mounts and flexible coupling at the discharge. Supplied as standard in horizontal discharge (code H) configuration with motor, pulley and belt assembly on the right hand side of the unit when viewed from the discharge end.

Motors
All motors are IP55, class F insulation.
Electrical supply:
- Three phase 230/ 400V-50Hz, up to 3 kW. 400V-50Hz, for higher motor powers. (See characteristics chart)
- Single phase 230V-50Hz, with a maximum of 1,5 kW (CVTB version).

All motor up to 2,2 kW are mounted onto the fan casing scroll.
All motor above 3 kW are mounted onto an adjoining support frame.
All three phase motors are speed controllable by frequency inverter.

On request
The belt-driven assembly can be supplied at the left hand side of the unit (TI version), Vertical discharge (code V) configuration.
Models fitted with circular inlet flanges.
Double thickness (double skin) panels with acoustic fireproof insulation (M0) of 17mm thickness fiberglass.
Two speed motors (4/8 and 4/6 poles).

ATEX versions
On request, explosion proof versions in accordance to ATEX Directive, for three phase models up to 11 kW.
- ATEX Flameproof -Gas-
  - II 2G Ex d IIB T4
  - II 2G Ex d IIB+H2 T4 (with Ex d IIC T4 motor)
- ATEX Increased safety-Gas-
  - II 2G Ex e II T3

CVTT ATEX versions are supplied without melamine insulation.
To select CVTT refer to performance curves, or Easyvent.
The consumption data (A, W) of ATEX products may vary from the data shown in technical characteristic charts.

Low noise level
Acoustic insulation of 7 mm thickness flame retardant (M1) melamine foam reducing the noise level significantly.

Flexible coupling at the discharge
To reduce vibration and noise transmissions to the installation.

Robustness
Quality finishing, with aluminium corners providing a high robustness.

Versatile outlet discharge
Vertical discharge models available under request.

Anti-vibration mounts
The fan is mounted on base frame with silent-blocks to reduce vibration and noise transmissions to the installation.

Specific applications

ATEX versions

2. SCOPE

This Standard Maintenance Specification covers the procedure of maintaining and servicing of Extract Fans with all safety requirements.

3. OBJECTIVE:

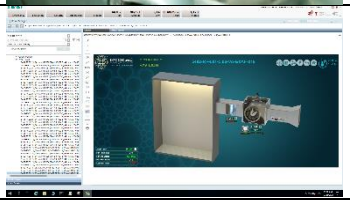
This Standard Operation Procedure is for guidance of staff/technicians who will be involved in carrying out the mechanical maintenance works for Extract Fans.

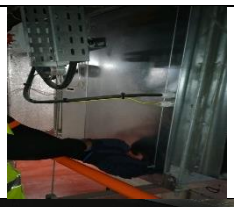
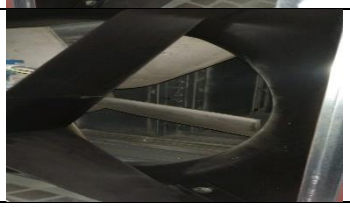
- This SOP is to ensure the works will be executed in an efficient and safe manner in accordance with all relevant contract documents.
- This SOP will, if deemed necessary, be revised and when required to accommodate circumstantial requirements.

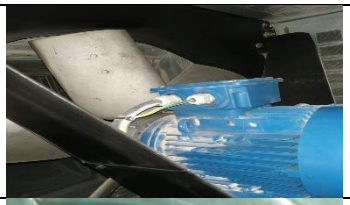
STEPS BEFORE STARTING THE EXTRACT FAN UNIT MAINTENANCE:

- Approved PTW is available for the task to be carried out by assigned person.
- Approved SOP & MER is available for the task to be carried out by the assigned technicians.
- Prepare all the materials that will required to carry out the task.
- Check all the tools are available which are mentioned in the tools list.
- Ensure instruments used are calibrated & valid.
- Assigned personnel is fully competent to carry out the task and aware of the HSE requirement
- Remove all your jewelry, watch, chain etc. before starting the PPM
- Carry out general inspection of nearby area & ensure area and Equipment are free from obstruction

4. MAINTENANCE PROCEDURE:

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
1	Cleaning and checking of corrosion on fan, boxes and accessories	
2	Clean impeller and ensure there’s no build-up of dirt	
3	Check Interface with BMS system	

4	Manual operation must be tested	
5	Check bearings and lubricate as necessary. Lubricate fan and motor according to manufacturer's instructions, 'Sealed for life' bearings should not be serviced	
6	Check housing and inspect for looseness and corrosion	
7	Inspect condition and alignment of drive and shaft. Adjust as necessary	
8	Check and clean fan wheels and ensure free rotation	
9	Check mounting bolts and tighten as necessary	
10	Check guide vanes and adjust as necessary	
11	Check operation of automatic changeover control where standby fan is provided	
12	Ensure that the unit is operating without excessive noise or vibration. Investigate cause and rectify fault if unit is not operating normally	
13	Check and ensure operation and integration of Motorized damper and non-return dampers wherever fitted with the fans	

14	Check anti vibration mounts and adjust as necessary	
15	Check impellers and clean as required. Ensure that there is no excessive grease on the wing roots. If there is dismantle impeller and replace seals after lubricating bearings	
16	Check and ensure terminal connections are proper and tightened	
17	Ensure all terminal box covers are fitted and no signs of overheating	
18	Check motor current does not exceed full load running current	
19	Check all flexible electrical connections and insulations	
20	Check anti vibration mountings (where fitted), belts and fixings for security	
21	Clean and check condition of motor casing and louvres	
22	Check linkages on motorized dampers for wear and lubricate if appropriate	

23	Ensure that blades on shaft are secure and are correctly aligned	
24	Check calibration, interrogation, control adjustment and operation of controls	
25	Isolate control panel and inspect for signs of overheating	
26	Check integrity of electrical insulation	

Appendix 5

Standard operation procedure for PPM of Fresh Air Handling Unit

SITE/DISTRICT:	Dubai Development		
Document Name:	Standard Operation Procedure – FAHU		
Document Reference Number:	DD-FM-SOP-HVAC-02		
Trade	HVAC		
Asset	Fresh Air Handling Unit		
Issue Date	Jan 2022	Effective Date	
Version	0	Revision	01

PREPARED BY		**APPROVED BY**	
NAME	Mohammad Aldiek	**NAME**	
DESIGNATION	FM Engineer	**DESIGNATION**	Operations Manager
SIGNATURE		**SIGNATURE**	

HEALTH AND SAFETY AT WORK ACT

Employee duty:

- To take care of his health & safety and of other employees who are affected by his actions or work commitments.
- To coordinate with his manager or any other individual so far as needed for the providing of the several relevant Laws which are required to be complied with.
- Familiarize himself with the electrical & mechanical hazards linked with the workplace.
- Un-plug the electrical equipment prior to the servicing activity.
- Report mechanical and electrical issues, including tripping breakers, damaged guard protection, and the flickering lights.
- Avoiding using any appliance which smokes, sparks, or becomes extremely hot, unless if it is designed to show these characteristics.
- Keep water away from electrical equipment, unless if it is intended for use around water, like the wet-dry shop vacuum.

Before performing service or maintenance work of Air Handling Unit:

- ISOLATE electrical supplies prior to removing covers, guards or accessories from any parts of Fresh Air Handling unit. Before the re-connection of the electrical supply, make sure that all covers, guards, and accessories are replaced correctly.
- DO NOT keep electrical gear in live status and unattended without a **WARNING NOTICE**.
- DO NOT attempt maintenance work or adjustment unless wearing suitable **PROTECTIVE CLOTHING.**

WARNING AND SAFETY NOTICES

- At all times safety and warning signs should be properly displayed, maintained and worked to give clear directions.
- Proper fire precaution must be observed within the area nearby.
- Smoking will not be allowed in any plant room. Display Notices which are stating **"NO SMOKING"** and **"SMOKING PROHIBITED IN THIS AREA".**
- All firefighting equipment must be marked clearly and accessible for use.

FIRE PROTECTION / ALARMS

- Fire alarms systems should be checked regularly and maintained in working order. Care must be taken.

ESCAPE ROUTES

- Escape routes and exits must be inspected periodically to make sure that doors are freely opening, and that there are clear routes without any obstruction.

LIGHTING

- In the TSE plant room, lighting must be maintained at a high level to enable maintenance to be carried out and prevent accidents due to badly lit areas.

PORTABLE TOOLS and HAND LAMPS

- Where power operated handheld tools or hand lamps are used these items together with their power supply must confirm to the regulations applying to the use of this type of apparatus.

PROTECTIVE EQUIPMENT

- Protective equipment (e.g. Gloves, Safety shoes etc.) must be provided and used where appropriate to the activity.

SAFETY CHECKS

- Permit to work (PTW).
- Isolate power source.
- Lock off Tag Out (LOTO) system.
- Test and confirm there is no power source available.
- Wear adequate P.P.E for doing the work.
- Do not wear any jewelry while working.
- Ensure adequate housekeeping on work area.

ABREVIATIONS:

ABREVIATION	FULL FORM
LOTO	Lock Out Tag Out
PTW	Permit to Work
MER	Maintenance Evidence Record
SOP	Standard Operation Procedure
PPM	Planned Preventive Maintenance

FIRST AID MEASURES

1. Call for help.
2. Conduct scene survey and make sure you are safe before touching the victim.
3. Make sure that there are no unsafe electrical power sources.
4. Isolate the supply source if possible or try to release the victim with adequately Insulated safe material if you are totally safe.
5. Never attempt to give any First Aid unless you are trained. And the scene is totally safe.
6. Never attempt to move the victim or administer first aid unless you are sure that the Victim sustains no spinal injuries and the scene is totally safe.
7. Check Air way, Breathing and Circulation and establish if possible Arrest bleeding.

MAKE SURE

8. C.P.R. Mouth to mouth mask and latex gloves to be carried along with first aid provision
9. Administer C.P.R only if you are trained and the victim sustains no spinal injuries.

SAFETY INSTRUCTION:

11. Prior to any maintenance, shut off the electric power supply and lockout before starting the work.
12. Ensure that all measuring tools are in good working condition.
13. Record the last condition status before starting the work.
14. Restore back to the last condition status after work completion.
15. Before starting the job, inform BMS.

SPECIAL TOOLS/MATERIALS:

23. Multi-meter tester (VOM)
24. Air Blower
25. Vacuum Cleaner
26. Standard mechanical tool box
27. Ladder/ Scaffolding/ Man lifting machine
28. CRC contact cleaner
29. Degreaser/Cleaning product
30. Clean cotton cleaner
31. Hand gloves
32. Mask, goggles eye Protection
33. Warning Signs

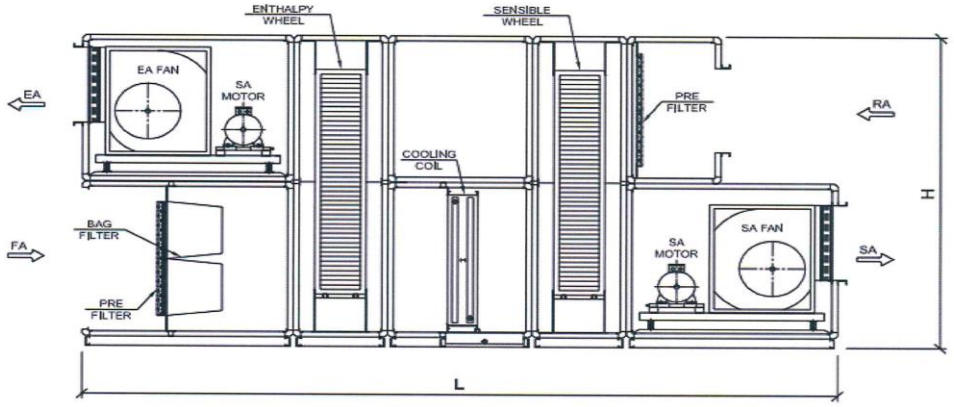
1. INTRODUCTION:

FRESH AIR HANDLING UNIT:

TROSTEN®

FAHU CONFIGURATION - GA DRAWING

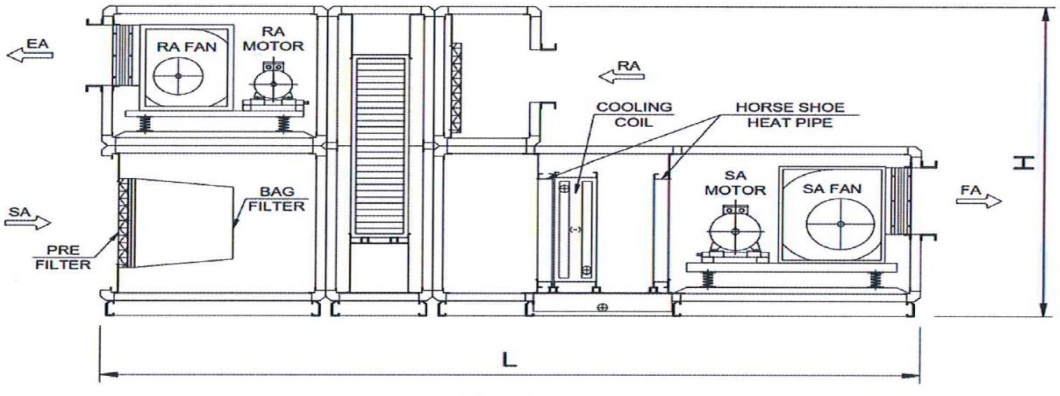
DOUBLE WHEEL TYPE



SECTION

FAHU CONFIGURATION - GA DRAWING

FRESH AIR HANDLING UNIT WITH HEAT RECOVERY WHEEL,
HORSE SHOE HEAT PIPE



SECTION

2. SCOPE

This Standard Maintenance Specification covers the procedure of maintaining and servicing of Fresh Air Handling units with all safety requirements.

3. OBJECTIVE:

This Standard Operation Procedure is for guidance of staff/technicians who will be involved in carrying out the mechanical maintenance works for Fresh Air Handling units.

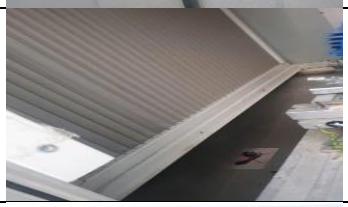
- This SOP is to ensure the works will be executed in an efficient and safe manner in accordance with all relevant contract documents.
- This SOP will, if deemed necessary, be revised and when required to accommodate circumstantial requirements.

STEPS BEFORE STARTING THE FRESH AIR HANDLING UNIT MAINTENANCE:

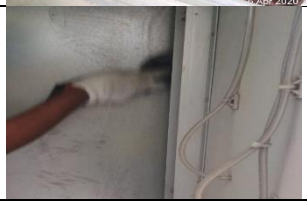
- PTW – Permit to work system (PTW) to be obtained from PTW department. PTW should keep or place where the activity is to be carried out.
- Briefing the activity to all technicians by supervisor through tool box talk.
- All necessary materials/tools should be ready at hand.
- Proper signage shall be placed to give warning of the work area.
- Ensure the Duct smoke detector is disabled.
- Technicians who are assigned to carry out the maintenance work should wear necessary PPE.
- Confirm that the asset tagging is referencing to the PPM task sheet
- Lock Out Tag Out the equipment

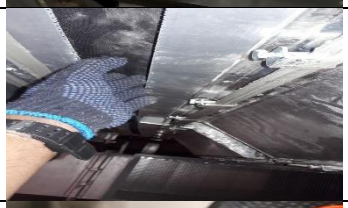
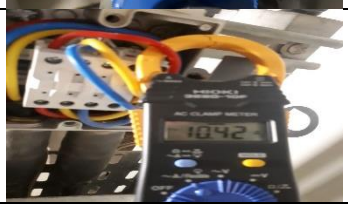
4. MAINTENANCE PROCEDURE:

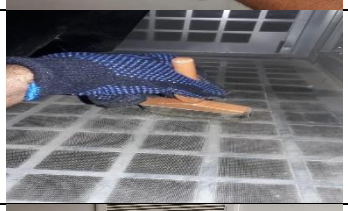
STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
1	Check all fans and motors. Ensure impellers are not fouling (Check Motors section for details).	
2	Check disposable filters and clean/ change if necessary.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
3	Check washable filters and clean if necessary.	
4	Clean sand trap louvers.	
5	Check guide vane actuators and motorized dampers for correct operation.	
6	Check condensate drain for carry over and ensure that drains are clean. Take appropriate action if necessary.	
7	Check and clean chilled water strainers.	
8	Vent any air from cooling coils.	
9	Check drive belts for tension, alignment and condition. Replace the belts if necessary.	
10	Check pressure drops across the coils and record.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
11	Check and record manometer reading and renew filter media as indicated.	
12	Check for condensate carry-over and ensure that drains are clear.	
13	Lubricate dampers and guide vane pivots and linkages.	
14	Clean cooling coils as per manufacturer's recommendations to ensure that no dust is accumulated on the coils.	
15	Lubricate bearing of thermal wheel if applicable and ensure free rotation.	
16	Check motor and connecting belt to heat wheel. Replace belt if required.	
17	Clean the heat wheel as per manufacturer's recommendation.	
18	Check operation of motorized valves. Fully open and close the valve then reset to original setting to ensure that the valve is operating correctly.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
19	Thoroughly clean interior and check for corrosion. On re-assembly check for air tightness. Include cooling coils, impeller and eliminator plates and other fittings.	
20	Inspect drain pan and clear/repaint any rusted portions.	
21	Flush out coils to remove any sediment.	
22	Check coil mounting bolts and replace any rusted bolts.	
23	Check anti vibration mountings and ductwork flexible connections.	
24	Check and comb cooling coil fins if necessary.	
26	Check tightness of lid retaining screws and replace if rusted.	
28	Check insulation resistance of each element and check continuity. Replace individual elements if required.	
31	Check external surface of thermal heat wheel.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
32	Check unit casing for evidence of corrosion and deterioration.	
33	Clean and check condition of cooling coils.	
35	Open and close valves (fully open and close) and then reset at the original setting.	
36	Clean air handling unit interior and check for corrosion including blower vanes and other fittings.	
37	Check for air tightness on air handling unit re-assembly.	
38	Check and test motor windings.	
39	Check tightness of motor terminals.	
40	Check motor full load current.	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
41	Check motor bearings for wear/tear.	
42	Replace lubricant in motor bearings if applicable.	
43	Carry out replacement of all pipe insulation, wrapping, and liners.	
44	Carry out cleaning of all filtration devices	
45	Clean the VFD panel and inspect for any damage for the panel and switch gears.	
46	Check all point function with BMS is correct.	
47	Terminal IR complete for VFD panels (Yes / No).	
48	Photo Evidence Taken (Yes / No).	

Appendix 6

Standard operation procedure for PPM of Fan Coil Unit

SITE/DISTRICT:	Dubai Developments		
Document Name:	Standard Operation Procedure – Fan Coil Unit Maintenance		
Document Reference Number:	DD-FM-SOP-HVAC-4		
Trade	HVAC		
Asset	Fan Coil Unit		
Issue Date	Feb-2022	Effective Date	
Version	0	Revision	01

PREPARED BY		APPROVED BY	
NAME	Mohammad Aldiek	**NAME**	
DESIGNATION	FM Engineer	**DESIGNATION**	Operations Manager
SIGNATURE		**Signature**	

HEALTH AND SAFETY AT WORK ACT

Employee duty:

- To take care of his health & safety and of other employees who are affected by his actions or work commitments.
- To coordinate with his manager or any other individual so far as needed for the providing of the several relevant Laws which are required to be complied with.
- Familiarize himself with the electrical & mechanical hazards linked with the workplace.
- Un-plug the electrical equipment prior to the servicing activity.
- Report mechanical and electrical issues, including tripping breakers, damaged guard protection, and the flickering lights.
- Avoiding using any appliance which smokes, sparks, or becomes extremely hot, unless if it is designed to show these characteristics.
- Keep water away from electrical equipment, unless if it is intended for use around water, like the wet-dry shop vacuum.

Before performing service or maintenance work of Air Handling Unit:

- ISOLATE electrical supplies prior to removing covers, guards or accessories from any parts of Fan Coil unit. Before the re-connection of the electrical supply, make sure that all covers, guards, and accessories are replaced correctly.
- DO NOT keep electrical gear in live status and unattended without a **WARNING NOTICE**.
- DO NOT attempt maintenance work or adjustment unless wearing suitable **PROTECTIVE CLOTHING.**

WARNING AND SAFETY NOTICES

- At all times safety and warning signs should be properly displayed, maintained and worked to give clear directions.
- Proper fire precaution must be observed within the area nearby.
- Smoking will not be allowed in any plant room. Display Notices which are stating **"NO SMOKING"** and **"SMOKING PROHIBITED IN THIS AREA".**
- All firefighting equipment must be marked clearly and accessible for use.

FIRE PROTECTION / ALARMS

- Fire alarms systems should be checked regularly and maintained in working order. Care must be taken.

ESCAPE ROUTES

- Escape routes and exits must be inspected periodically to make sure that doors are freely opening, and that there are clear routes without any obstruction.

LIGHTING

- In the TSE plant room, lighting must be maintained at a high level to enable maintenance to be carried out and prevent accidents due to badly lit areas.

PORTABLE TOOLS and HAND LAMPS

- Where power operated handheld tools or hand lamps are used these items together with their power supply must confirm to the regulations applying to the use of this type of apparatus.

PROTECTIVE EQUIPMENT

- Protective equipment (e.g. Gloves, Safety shoes etc.) must be provided and used where appropriate to the activity.

SAFETY CHECKS

- Permit to work (PTW).
- Isolate power source.
- Lock off Tag Out (LOTO) system.
- Test and confirm there is no power source available.
- Wear adequate P.P.E for doing the work.
- Do not wear any jewelry while working.
- Ensure adequate housekeeping on work area.

ABREVIATIONS:

ABREVIATION	FULL FORM
LOTO	Lock Out Tag Out
PTW	Permit to Work
MER	Maintenance Evidence Record
SOP	Standard Operation Procedure
PPM	Planned Preventive Maintenance

FIRST AID MEASURES

1. Call for help.
2. Conduct scene survey and make sure you are safe before touching the victim.
3. Make sure that there are no unsafe electrical power sources.
4. Isolate the supply source if possible or try to release the victim with adequately Insulated safe material if you are totally safe.
5. Never attempt to give any First Aid unless you are trained. And the scene is totally safe.
6. Never attempt to move the victim or administer first aid unless you are sure that the Victim sustains no spinal injuries and the scene is totally safe.
7. Check Air way, Breathing and Circulation and establish if possible Arrest bleeding.

MAKE SURE

8. C.P.R. Mouth to mouth mask and latex gloves to be carried along with first aid provision
9. Administer C.P.R only if you are trained and the victim sustains no spinal injuries.

SAFETY INSTRUCTION:

16. Prior to any maintenance, shut off the electric power supply and lockout before starting the work.
17. Ensure that all measuring tools are in good working condition.
18. Record the last condition status before starting the work.
19. Restore back to the last condition status after work completion.
20. Before starting the job, inform BMS.

SPECIAL TOOLS/MATERIALS:

34. Multi-meter tester (VOM)
35. Air Blower
36. Vacuum Cleaner
37. Standard mechanical tool box
38. Ladder/Scaffolding/Man lifts
39. CRC contact cleaner
40. Degreaser/Cleaning product
41. Clean cotton cleaner
42. Hand gloves
43. Mask, goggles eye Protection
44. Warning Signs

1. SCOPE

This Standard Maintenance Specification covers the procedure of maintaining and servicing of Fresh Air Fans with all safety requirements.

2. OBJECTIVE:

This Standard Operation Procedure is for guidance of staff/technicians who will be involved in carrying out the mechanical maintenance works for Fresh Air Fans.

- This SOP is to ensure the works will be executed in an efficient and safe manner in accordance with all relevant contract documents.
- This SOP will, if deemed necessary, be revised and when required to accommodate circumstantial requirements.

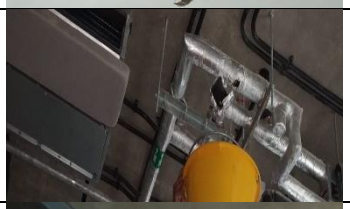
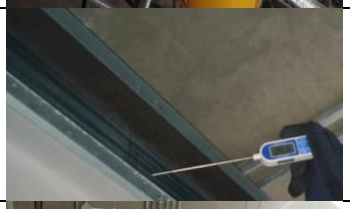
STEPS BEFORE STARTING THE FAN COIL UNIT MAINTENANCE:

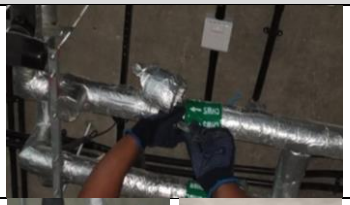
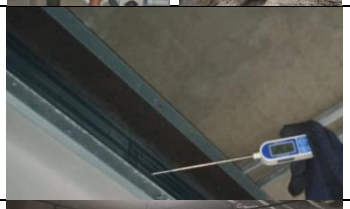
- Approved PTW is available for the task to be carried out by assigned person.
- Approved SOP & MER is available for the task to be carried out by the assigned technicians.
- Prepare all the materials that will required to carry out the task.
- Check all the tools are available which are mentioned in the tools list.

- Ensure instruments used are calibrated & valid.
- Assigned personnel is fully competent to carry out the task and aware of the HSE requirement
- Remove all your jewelry, watch, chain etc. before starting the PPM
- Carry out general inspection of nearby area & ensure area and Equipment are free from obstruction

3. MAINTENANCE PROCEDURE:

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
1	Check unit functioning with BMS/Thermostat	
2	Check temperature of room supplied by unit.	
3	Check unit for excessive heat, noise and vibration.	
4	Check the grill temperature before start of work	
5	Check unit for leaks and damage.	
6	Switch off the unit electrical isolation should be carried out	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
7	Check condition and security of filter.	
8	Remove air filter and clean if necessary, inspect coil for blockage and clean as necessary	
9	Ensure condensate drain connection is clear	
10	Remove the strainer and clean the strainer	
11	Flush the evaporator coil to remove any debris in the line and vent the line after the work	
12	Restore power supply and run unit, ensure grill temp is more than start of PPM	
13	Clean inside and outside of casing	
14	Clean grilles and diffusers using vacuum or alternatively remove and clean	

STEPS	DESCRIPTION	PICTORIAL REPRESENTATION
15	Vent air from the unit and clean the coil if necessary	
16	Close supply and return chilled water valves and remove and inspect strainer. Clean if necessary.	
17	Check the grill temperature ensure that the cooling temperature has improved after carrying out the line blow through and cleaning.	
18	Photo Evidence Taken (Yes / No)