CCG VESSEL EARL GREY

ACCOMMODATION DECK AND GALLEY HVAC EVALUATION

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FOR:

CONCEPT NAVAL
EXPERTS-CONSEILS | GÉNIE MARITIME

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DOCUMENT INFORMATION

DOCUMENT NO: P201404001-A1
ACCOMMODATION DECK AND GALLEY HVAC EVALUATION

REVISION DESCRIPTION

Rev	Date	Description	Prepared by	Reviewed by
0	July 14, 2014	Original document	R. Choudhury	M. Vidori
1	Nov. 10, 2014	Updated per CCGS comments on Aug. 2	R. Choudhury	M. Vidori

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APPENDICES

1. ABBREVATIONS AND ACRONYMS

HVAC	Heating Ventilation and Air Conditioning	CCG	Canadian Coast Guard
AC	Air Conditioning	TR	Cooling in tons of refrigeration
CFM	Cubic Feet Per Minute	SOR	Statement of requirements
ACH	Air Changes per Hour	FA	Fresh air
ISO	International Standards Organization	OA	Outside air

2. MANDATE

Aerisma Inc. has been commissioned by Concept Naval to investigate and evaluate the Heating, Ventilation, and Air Conditioning system on board the CCG vessel Earl Grey in order to recommend and select new HVAC equipment to meet the operational requirements of the vessel. This report summarizes the findings and analysis of the systems that were evaluated. This includes:

On the main deck and the galley area

- Heatload analysis (heating and cooling calculations for the main deck).
- Study of the galley cooling and ventilation issue.
- Main deck overheat issue.
- Air balance issue (vessel negative pressurization).
- System control and operation.
- Equipment selection.
- Feasibility of humidification system (presented in detail on a separate report).
- Thermal fluid heaters and controls (presented in detail on a separate report).
- Equipment installation support (presented separately in technical specifications and drawings).

On the boat deck and forecastle deck

- Air balance and ventilation review.
- Capacity calculations (heating and cooling calculations for the main deck).
- Forecastle laundry exhaust issue.
- System control and operation.
- Equipment selection.
- Feasibility of humidification system (presented in a separate report).
- Thermal fluid heaters and controls (presented in detail on a separate report).
- Equipment installation support (presented separately in technical specifications and drawings).

On the wheelhouse

- Equipment selection and installation based on existing unit specifications.

3. BACKGROUND

From June 2nd to 4th 2014, Aerisma Inc. personnel were granted access to the Earl Grey which was moored at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. A 2-day field survey was conducted. During the on-board investigation information was collected regarding the existing equipment condition and operational performance. Nameplate data of equipment was collected when present or accessible, observations were documented and informal interviews were performed with crew personnel.

4. SUPPORTING DOCUMENTATION

The following documents were provided and used to support the on-board investigation and the quantitative analysis afterward. This table does not represent the complete list of documents that were made available:

DOCUMENT TITLE	FILE NAME OR DRAWING NUMBER
Earl Grey Piping Renewals and Equipment Renewal	TIES Solicitation F7049_140005
Technical Specifications	Earl Grey original SOR parts 1 & 2
As Fitted HVAC System Drawings	VNEA2_761-014_HVAC SYSTEM
CCGS Earl Grey Equipment List	Wheelhouse_AccomHVAC_datasheet
Accommodation Deck Humidification System Feasibility	Aerisma Document P201404001-A2
Thermal Fluid Flow Rate	Aerisma Document P201404001-A4

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5. STANDARDS AND GUIDELINES

The following documents were referenced and applied during the analysis and preparation of this report:

DOCUMENT TITLE	REFERENCE
Ships and marine technology - Air conditioning and ventilation of accommodation spaces	ISO 7547
Ventilation and air-treatment of galleys and pantries with cooking appliances	ISO 9943
Transport Canada - Guide to structural fire protection	TP 11469E
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE handbooks
International Convention for the Safety of Life at Sea	SOLAS

6. APPROACH

The approach taken with respect to the analysis was to establish the capacity and operational condition and controls of the existing HVAC system. This information had to be corroborated with the field survey and the supporting documentation. With this baseline established we could then determine the deficiencies in the system and validate the complaints and observations made by the on-board crew and documented on the Statement of Work.

The analysis and calculations performed are based on current maritime standards and guidelines for the given design environmental conditions. The recommendations and selections are based on equipment service in a marine-duty environment.

7. OBSERVATIONS

Upon boarding the vessel, Aerisma Inc. personnel went about locating and identifying the key HVAC equipment as identified on the drawings provided. For the main deck this included the main air conditioning unit, the thermal fluid heat exchanger, the fresh air fan, the toilet exhaust fan, the galley exhaust fan, the ducting and dampers, the fire dampers on the ducts, the diffusers, the goosenecks and cowls and the controls.

Existing main air conditioning deck system

It was observed that the main deck HVAC system is comprised of a seawater-cooled AC unit with a nominal capacity of 8TR (28kW), see Figure 2. The unit is ducted on the discharge air side allowing conditioned air to be supplied to the various spaces on the deck. The return air to the AC unit is not ducted. Air from the corridor can return to the AC unit via the return air grille located in the corridor. Air conditioning for the space is controlled by a return air sensor located near the return air grille. There is one hermetic compressor that provides a single stage of cooling (ON/OFF). The heating for the space is provided by a thermal fluid heat exchanging coil located in the supply air duct downstream of the AC unit. It is controlled independent of the AC by a pneumatic modulating valve. Fresh air for the deck is supplied by a dedicated axial fan. The axial fan has a 2-speed motor and is supported between the air inlet louver and ducting, see

Figure 3. The ducting from the fresh air fan is diverted in two directions: a small duct brings air to the back of the return air grille of the AC unit. This permits some fresh air to mix with the return air before being cooled in AC mode. Another larger duct diverts fresh air past the AC unit but upstream of the heat exchanger. There are multiple control dampers on the fresh air ducts. These dampers are required because this operating system is manually controlled and requires human intervention to open/close dampers and start/stop heating and cooling equipment. Table 1 and Figures 1a,1b illustrate the control matrix in both the cooling and heating mode.

COMPONENT	IN COOLING MODE	IN HEATING MODE
Fresh air (FA) fan speed	High speed	Low speed
Manual (top) damper position	Closed	Open
Manual (bottom) damper	Open	Closed
AC unit power	ON	OFF
Heater valve position	Closed	Open *

Table 1. Operational condition of select HVAC equipment

* While energized, the heater valve will modulate to regulate sufficient flow of fluid to maintain the desired temperature set point conditions

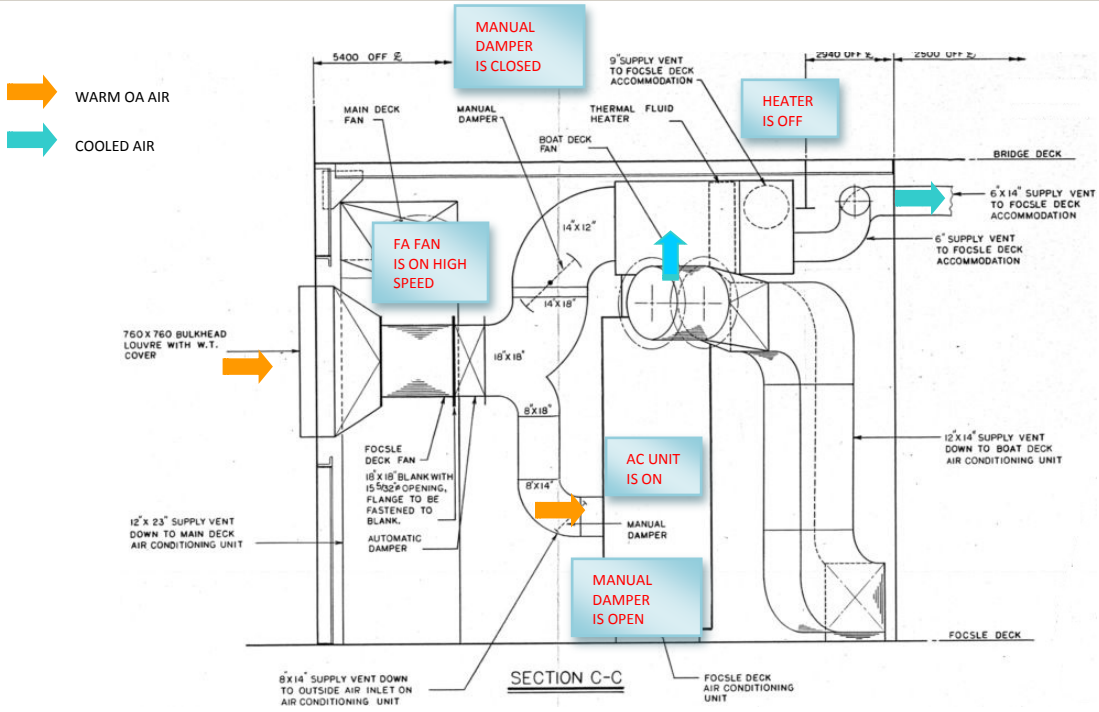

Figure 1a. Equipment and damper conditions in **cooling** mode

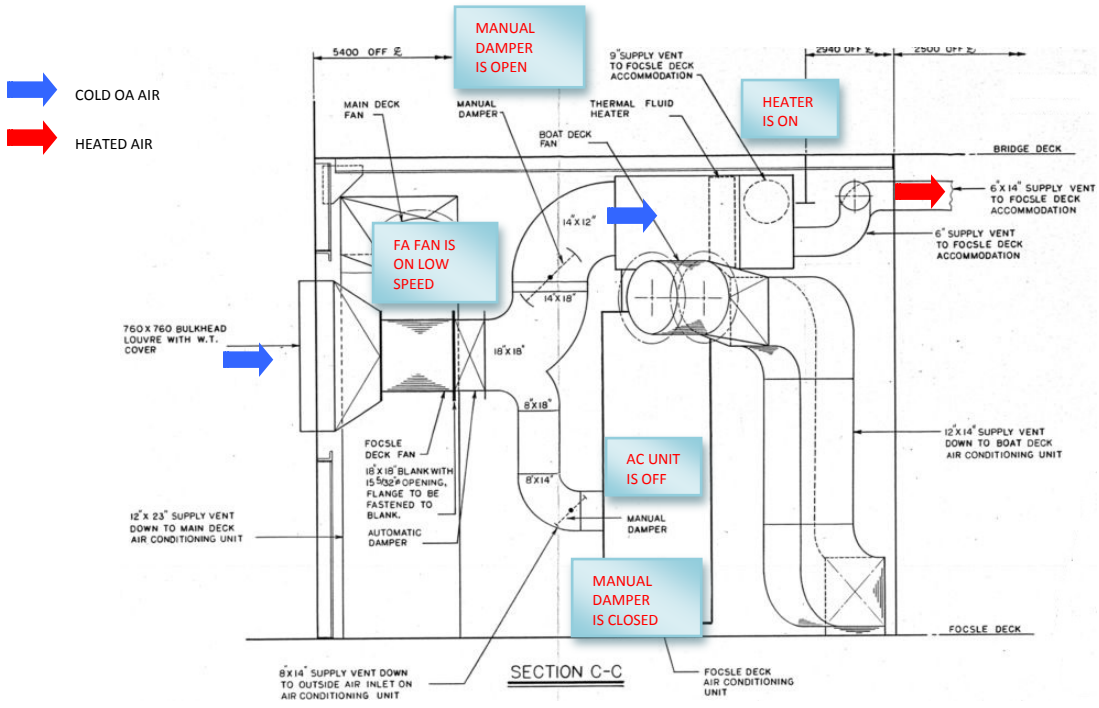

Figure 1b. Equipment and damper positions in **heating** mode

Figure 2. Main deck AC unit, with return air grille exposed

Figure 3. Fresh air fan ducted to louver

Existing galley cooling and ventilation

The Galley is located centrally on the main deck along with a Pantry area. The Galley is connected to the Crew's Lounge, Crew's Mess and the Canteen located on the starboard side. When the door or rolling shutter over the serving area is kept open, the air circulates between these spaces. The galley cooling is supplied by the main deck AC unit via two spot diffusers. These diffusers are not located in the immediate area of work and provide minimal amount of air. The galley is also ventilated by an exhaust hood which is equipped with a 2-speed fan motor. The operation of the fan can be selected on a panel in the Galley, see Figures 4 and 5. At low speed the fan will exhaust 750cfm (20ACH) of conditioned air while at high speed the fan will exhaust 1500cfm (40ACH). While there is a make-up air grille in the galley, there is no make-up air fan ducted to the hood to introduce make up air when the exhaust system is in operation. Therefore when operated, the galley will exhaust mostly conditioned air from the adjoining spaces and creates a high negative pressure, which can be observed by a force applied on the doors. It was commented that the main deck has significant issues with meeting the cooling demand. There are also complaints with air balancing and pressurization which can be observed by the force required to open some doors. The galley was not fully operational and the weather during the field investigation did not warrant full cooling. However, there is compelling evidence that the operation of the galley exhaust system is directly correlated to the cooling deficiencies and air balance issues on the main deck.

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Figure 4. Galley ventilation controls (fast-slow-stop)

Figure 5. Galley exhaust hood

8. ANALYSIS

Main deck and galley

A heating and cooling load analysis was conducted on the main deck based on:

- The design environmental conditions as provided by the technical specifications.
- The thermal properties and room dimensions as provided on the specifications and drawings.
- The occupancy level provided.
- The ventilation rate based on existing operating conditions and what is required per ISO recommended guidelines.

The analysis revealed that the required cooling capacity was considerably higher for the main deck, than would otherwise be required, due to the excessive galley ventilation rate. Under the existing operation with the galley and toilet exhaust systems running, the fresh air make up requirement for the AC unit reaches 70%. Consequently the mixed air conditions are warmer and more humid. This places a greater burden on the AC unit than it was originally designed for. Typically an AC unit is designed to handle no more than 30% fresh air. Where as the cooling capacity for the main deck AC unit is rated at 8TR (28kW), the total load could be as much as 21TR (74kW) under peak conditions. This would explain in part the complaints of overheat conditions experienced on the main deck.

COOLING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Cooling Capacity	
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	kW	Tonnes
New System	5693	28.6	1627	4066	21	50	30	95	2	23	44.3	24.9	64.0	39.9	11.3
Old System	5268	70.9	3737	1532	21	50	30	95	2	23	44.3	27.9	85.3	73.9	21.0

Figure 6. Comparison of existing (Old) cooling capacity requirements versus (New) requirements

Further investigation suggests that the current maximum exhaust rate in the galley of 1500cfm (40ACH) is not required by design. Under the original design SOR, the maximum ventilation rate for the air conditioned galley would not exceed 1125cfm (30ACH). By reducing the galley exhaust rate, we also reduce the make up air requirements, which has a corresponding benefit of lowering the cooling demand and lowering the heating requirements. This principle applies to all of the accommodation decks.

1 However, since the preparation of the original report, it has been determined that the new galley configuration and equipment proposed will necessitate a high rate of exhaust. The selected galley hood manufacturer has specified that an exhaust rate of 1500 cfm will be required. The hood prescribes a constant air velocity, therefore it will no longer be necessary to use a 2-speed exhaust fan. A single speed fan achieving 1500cfm is currently proposed. Since the exhaust rate is essentially unchanged from the original design, it will be necessary to provide means to ensure that adequate make up air is provided to the galley in order not to exhaust excessive conditioned air from the galley and adjacent spaces. This issue is discussed in detail under the recommendations.

An air balance and heat load calculation was completed based on the given design parameters and the recommended ventilation rate for the galley. Based on the revised calculations, the cooling capacity required for the main deck AC unit would be approximately 11TR (40kW). While this requirement is 37% higher than the existing unit capacity, it is significantly less than what would be required if the system was operated under the original conditions described for the galley. Therefore it has been demonstrated that the galley ventilation has an immediate and significant impact on the cooling requirements for the main deck. Proper control of the galley ventilation will have the benefit of reducing overall cooling demand and heating demand, meeting the comfort requirements of the other rooms and maintaining a stable air balance and pressure on the main deck.

Forecastle deck

An air balance study and capacity calculation based on the original system of operation was conducted and tabulated for the forecastle deck. It was found that the AC unit was operating with 44% fresh air, resulting in a total cooling demand of 8TR. However, the current AC unit is rated for approximately 5TR. Further investigations revealed that the electronics room is conditioned by its own dedicated AC unit. This would reduce the demand on the Forecastle AC unit and allow the fresh air percentage to be lowered to 32% and reduce the capacity requirement from 8TR to 6.3TR.

1

Boat deck

An air balance study and capacity calculation based on the original system of operation was conducted and tabulated for the Boat deck. It was found that the AC unit was operating with 18% fresh air requirement, resulting in a total cooling demand of 5TR. The current AC unit is rated for approximately 5TR, therefore the system is appropriately sized.

Thermal Fluid Heaters and Control Valves

1

The thermal fluid heaters on the accommodation deck provide the thermal comfort for the accommodations during the heating season. There is one heating coil and control valve each for the Forecastle, Boat and Main decks. The mandate for the heaters was to:

- Record the dimensional data in order to specify a replacement coil at their current location and configuration.
- Recommend a replacement control valve that operates electronically rather than pneumatically.
- Evaluate the heating load and verify the thermal fluid flow rate required.

The heating coil dimensional data and specifications were prepared on drawing number C14-40-512-06. The required heating capacities were calculated and are presented in Appendix 2. The current Leslie pneumatic control valves are recommended to be replaced with similar size valves, however they shall be operated using an electronic

actuator that will modulate flow to the heating coil. The actuator is proposed to be operated on 24V voltage and will interface with the new thermostat so that its operation shall be coordinated with the air conditioning unit and humidifier operation, with little or no human intervention. An analysis was performed to verify the required flow rate for the thermal fluid heaters. The Thermal Fluid Flow Rate report is available as a separate Aerisma document number P201404001-A4.

Humidification Feasibility Study

1

There is currently no humidification system installed on the vessel. This has led to complaints about dry air and crew discomfort during winter conditions. CCG has therefore requested a study be conducted to determine:

- The feasibility of installing a humidifying system for the three accommodation decks.
- The proposed location of the humidifiers.
- The location for the controls and humidistat for each deck.

An analysis was performed which concluded that a humidification system is feasible for the three decks. The current design proposal calls for a dedicated humidifier complete with its own steam generator, controller, and steam probe per accommodation deck. The unit shall be located in close proximity to the air handling unit on each deck, and the steam probe will be inserted into the air discharge duct. In order to support the humidifier, 575V power, cold water, and drainage connections are required. The details are available in the Humidification System report which is a separate Aerisma document number P201404001-A2. In addition, specifications and drawing C14-40-512-07 is available of the proposed units and their installation.

Accommodation Fans and Damper Control Units

1

For the accommodation decks, it will be necessary to replace the ventilation fans that bring in fresh air to the decks. The original fans are typically 2-speed motors with high speed used in the summer (into the AC unit) and low speed used in winter (bypassed overhead to the heating coil). The proposed new configuration will require only single speed fans to introduce a constant ventilation rate in both summer and winter. In

addition, the flow rate will be reduced in order to match the flow rate that is being exhausted. This has the double benefit of lowering the power consumption by the motors and addressing the air imbalance issue, particularly on the main deck. To assist with the air balancing issue, the existing electric actuated dampers downstream of the fresh fans shall be kept. These control dampers are currently in the Forecastle machinery space and shall be used to adjust the ventilation flow into the each accommodation deck.

Figure 7. Control Dampers in Forecastle Machinery Space

9. RECOMMENDATIONS

Main Deck and Galley

The analysis concludes that a cooling capacity of 11TR is required under peak conditions on the main deck, and we are recommending an AC unit that is appropriately for the following reasons:

- There are significant space constraints that will severely impede the installation of a larger unit.
- The recommended unit will comfortably satisfy the cooling demand in most conditions and will provide adequate cooling even under peak conditions.
- The unit will not be unnecessarily oversized which reduces efficiency and creates unwanted maintenance issues due to cyclical operation.

1 As described in the Analysis portion of the report, the manufacturer's prescribed galley exhaust rate must be 1500 cfm. In order to prevent exhausting the conditioned air from the adjacent Mess and Canteen, it is further recommended to install a dedicated make up air system for the galley. This would essentially make the galley ventilation independent of the AC unit (except for a small amount of galley AC air that would be exhausted). This system would necessitate a make up air fan that would operate in coordination with the galley exhaust. The exhaust and make up air should be ducted directly into the exhaust hood ducting. Based on the galley hood manufacturer's recommendation, the make-up air does not need to be pre-heated. However, to mitigate any risk of condensation, the make-up air duct is recommended to be thermally insulated.

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The dedicated galley ventilation system (make up and exhaust) will prevent valuable air conditioned air from being unnecessarily exhausted. To ensure that the conditioned air in the Mess and Canteen spaces return to the AC unit, it is recommended to install a small transfer duct in the overhead ceiling near the canteen. The dedicated galley ventilation will have the added benefit of lowering the fresh air requirements for the main AC unit. In addition, the fresh air fan can be kept at a constant speed rather than the current 2-speed system. This will lower the power consumption and cost. It will also eliminate the complicated array of control dampers and bypass ducts that required manual intervention every time the HVAC system is switched from heating to cooling mode and vice versa. A single speed fresh air fan will eliminate any manual intervention

and provide a constant rate of ventilation throughout the heating and cooling season while ensuring uniform indoor air quality.

In an attempt to further reduce the cooling requirements and improve system performance, it is recommended to remove the air conditioned air supply into the laundry room. In lieu of this, the laundry can be ventilated using return air from the adjacent central store or corridor. This air is eventually exhausted to atmosphere by the laundry exhaust system. Note that we did not have the natural ventilation drawings available to confirm the natural exhaust system from the central store.

Accommodation Deck AC Units and Controls

1

The current self-contained air conditioning units for the accommodation decks are Carrier series 90MA. These units are recommended to be replaced with similar units that use sea-water cooled condensers and respect the dimensional constraints for ease of installation. In addition, the new AC units should be selected based on other criteria such as:

- Ease of connecting the fresh air and return air ducting.
- Able to connect to existing seawater and condensate pipe connections.
- Uses the same refrigerant (R-410a) as the wheelhouse roof-top units.
- Can be controlled and operated with little or no human intervention.
- Can be integrated with other system components (ie. humidifier and heating coil).

Based on these criteria, the Thermoplus series KACE is recommended since it meets all of these requirements. The units are sufficiently small enough to minimize or eliminate the need to crop the doorways in order to install them. In addition, the units are fabricated in Canada and parts and servicing should not be an issue.

Along with the AC units, there will be associated sensors and controls required. These include items such as:

- Airflow switch.
- Outdoor air sensor.
- High limit humidity sensor.
- Discharge air temperature sensor.
- Heating thermostat.
- Thermostat with built-in humidity sensor.

These components shall be installed within the duct system, with the exception of the thermostats which shall be wall-mounted. Once integrated, the control assembly shall be capable of operating the AC unit, the heating valve, and the humidifier with little or no human intervention. The technical specifications and drawings describe the installation and operation of these units in greater detail.

The main deck HVAC recommendations are summarized and illustrated in Figure 8.

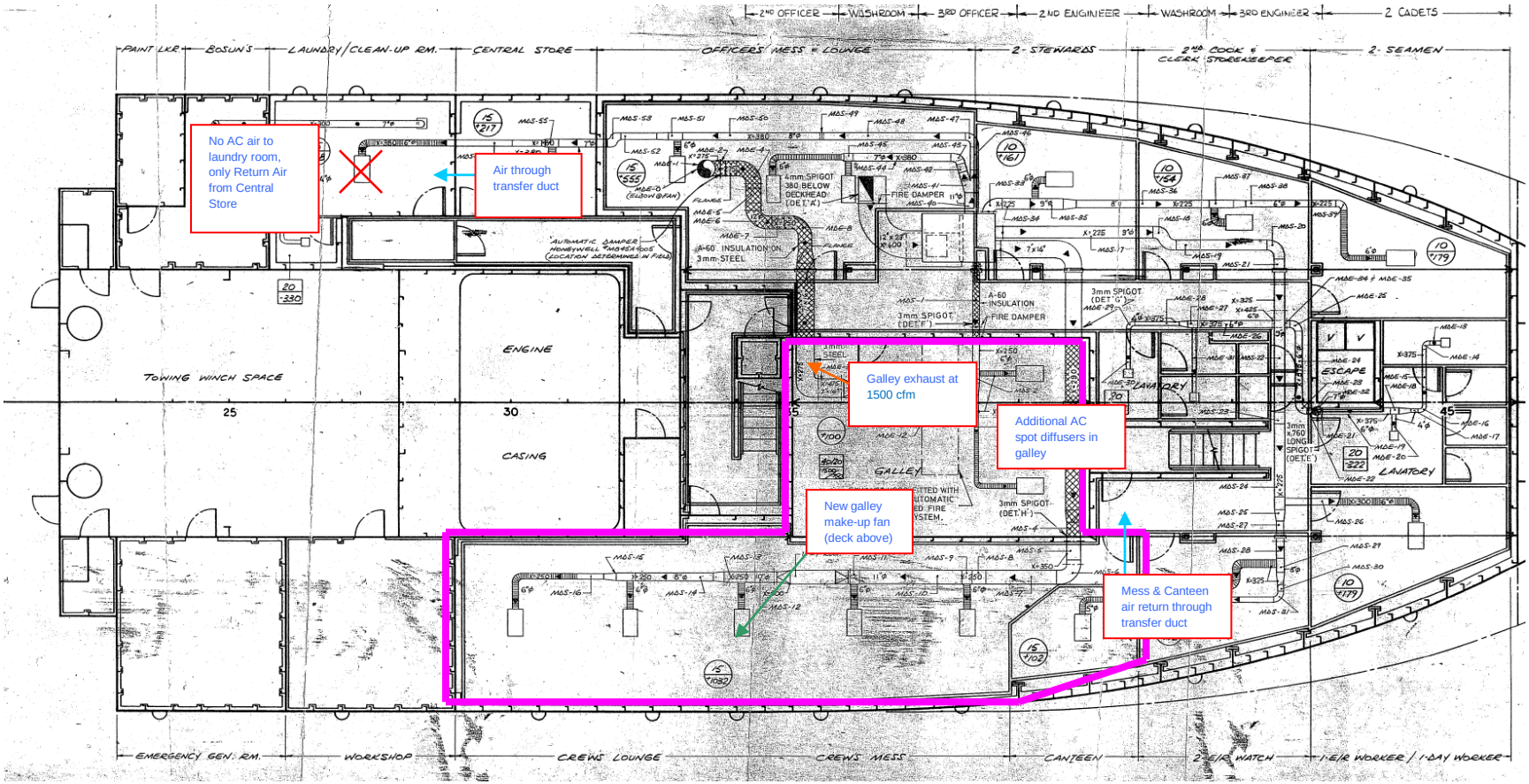

Figure 8. Illustration highlighting main deck recommendations

Forecastle Deck

1 The analysis concludes that a cooling capacity of 6.3TR is required under peak conditions on the forecastle deck, therefore we are recommending an appropriate sized AC unit for the following reasons:

- There are physical constraints that impede the installation of a AC unit larger than 6.3 TR.
- The recommended unit will comfortably satisfy the cooling demand in most conditions and will provide adequate cooling under peak demand conditions.
- The unit will not be unnecessarily oversized which reduces efficiency and creates unwanted maintenance issues and wear due to cyclical operation.

1 The analysis and conclusion is based on the assumption that the electronics room is air cooled by its own dedicated AC unit. Although the ducted AC leading to the room is not required, no modifications are recommended for this area.

The forecastle deck also contains a laundry room near the aft passageway. There have been complaints that the dryers do not work properly because the duct system does not adequately exhaust the air. Further investigation revealed that the dryers are currently ducted to the toilet exhaust system. This practice is generally avoided due to risks that the dryer may prevent the toilet exhaust from operating properly or possibly divert exhaust air back into a space. Based on the existing configuration, it is difficult to insure that the air cannot migrate and contaminate other spaces connected to the ducted system. Therefore the recommended solution is to isolate the dryer from the existing duct and ventilate it directly to the atmosphere. A route has been determined to install a four-inch pipe from the laundry room to the portside exterior bulkhead. This will also necessitate a closable weatherproof hatch.

Boat deck

1 For the boat deck, our analysis for the air balance and capacity calculations were consistent with the installed equipment and therefore no significant deviations are recommended from the original design specifications.

Wheelhouse

No quantitative analysis was required nor performed on the wheelhouse, and therefore the existing HVAC units shall be replaced in kind. The same manufacturer, Carrier is recommended for these units. The replacement wheelhouse units shall be virtually identical to the existing units in terms of physical and performance characteristics with one major difference being that the units shall use the same refrigerant R-410a which is proposed for the accommodation units.

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10. EQUIPMENT SPECIFICATIONS

After contacting the different equipment manufacturers, we are able to advise that the longest lead items are the three self-contained units. At the time of the quote, the lead time for the self-contained units was 10 weeks after receipt of purchase order. The rooftop unit for the wheelhouse has a lead time of 8 weeks after receipt of purchase order. The recommended equipment list is provided along with the electrical load analysis that compares the old and new units.

1

APPENDICES

Appendix 1. Air Balance Report – Main Deck, Boat Deck, Forecastle Deck

Appendix 2. Capacity Calculations – Main Deck, Boat Deck, Forecastle Deck

Appendix 3. Datasheet – Forecastle Deck AC unit

Appendix 4. Datasheet –Boat Deck AC unit

Appendix 5. Datasheet – Main Deck AC unit

Appendix 6. Datasheet – Wheelhouse AC unit

1 Appendix 7. Electrical Load Analysis – Old versus New Equipment

* While forecastle deck and boat deck AC units have similar physical and capacity characteristics, they will be slightly different due to fan motor requirements.

AERISMA
MARINE HVAC/R SOLUTIONS

AIR BALANCE STUDY

Project Earl Grey
Revision 4
Date 11-Jul-14

APPENDIX 1

FORECASTLE DECK

Space ID		Supply Air (cfm)			Exhaust (cfm)		Transferred (cfm)		Return (cfm)	Net	
Room #	Name	SCU	Fan	Natural	Fan	Natural	Passageway	W/C	SCU	Balance	Comment
FD01	Chief officer	313					205	108		0	
FD02	Chief eng. Day room	234					139	95		0	
FD03	Chief eng. night room	147					147			0	
FD04	Captain's night room	147					147			0	
FD05	Captain's day room	234					139	95		0	
FD06	Senior eng.	221					113	108		0	
FD07	Logistics officer	224					116	108		0	
FD08	Electronics Room	210			210					0	Air returned to AC Unit via transfer ducting
FD09	WC			108	108					0	
FD10	WC			95	95					0	
FD11	WC			95	95					0	
FD12	WC			108	108					0	
FD13	WC			108	108					0	
FD14	WC			45	45					0	
	Passageway			1006		45			961	0	

Original Balance				
SCU	Supply	Return	Fresh Air	Fresh Air %
cfm	1730	961	769	44.5
L/s	816.4	453.5	362.9	44.5
m3/h	2939.1	1632.7	1306.5	44.5

New Balance with Elec. Rm Returned				
SCU	Supply	Return	Fresh Air	Fresh Air %
cfm	1730	1171	559	32.3
L/s	816.4	552.6	263.8	32.3
m3/h	2939.1	1989.4	949.7	32.3

BOAT DECK

Space ID		Supply Air (cfm)			Exhaust (cfm)		Transferred (cfm)		Return (cfm)	Net	
Room #	Name	SCU	Fan	Natural	Fan	Natural	Passageway	other	SCU	Balance	Comment
BD01	2nd officer	145					145			0	
BD02	3rd officer	137					137			0	
BD03	Quartermasters	177					177			0	
BD04	Winchman&spare	179					179			0	
BD05	Seaman (2)	161					161			0	
BD06	Ships office	189					189			0	
BD07	Engine room watch&Da	166					166			0	
BD08	3rd engineer	149					149			0	
BD09	2nd engineer	137					137			0	
BD10	Chief cook	137					137			0	
BD11	Boatswain	145					145			0	
BD12	engineers office	124					124			0	
BD13	2 seaman	164					164			0	
BD14	Lavatory			217	217					0	
BD15	Toilet			49	49					0	
BD16	Toilet			49	49					0	
BD17	Toilet			46	46					0	
	Passageway			2010		361			1649	0	

SCU	Supply	Return	Fresh Air	Fresh Air %
cfm	2010	1649	361	17.96
L/s	948.6	778.2	170.4	17.96
m3/h	3414.8	2801.5	613.3	17.96

MAIN DECK

Space ID		Supply Air (cfm)			Exhaust (cfm)		Transferred (cfm)		Return (cfm)	Net	
Room #	Name	SCU	Fan	Natural	Fan	Natural	Passageway	other	SCU	Balance	Comment
MD03	Laundry&clean-up			260	260					0	2 Dryer at 375cfm each, air coming from central store.
MD04	Central Store	260						260		0	Through transfer duct going to MD03
MD05	Officers Mess&Lounge	628					628			0	
MD06	2-stewards	159					159			0	
MD07	2nd cook&clerk	136					136			0	
MD08	Seaman (2)	217					217			0	
MD09	Lavatory&laundry			230	230					0	Taken from passageway - dryer needs 230cfm
MD10	Cadets (2)	209					209			0	
MD11	Engine roomwatch (2)	131					131			0	
MD12	Lavatory - Female			108	108					0	
MD13	Galley & Pantry	360			360					0	
MD13	Galley & Pantry		740		740					0	740 makeup air required when galley fan at full.
MD14	Canteen	147					147			0	
MD15	Crews Mess & Lounge	1104					1104			0	
MD16	Passageway			2731		338			2393		

SCU without dryers running				
SCU	Supply	Return	Fresh Air	Fresh Air %
cfm	3351	2393	958	28.6
L/s	1581.4	1129.3	452.1	28.6
m3/h	5693.1	4065.5	1627.6	28.6

SCU with dryers running				
SCU	Supply	Return	Fresh Air	Fresh Air %
cfm	3351	1413	1938	57.83
L/s	1581.4	666.8	914.6	57.8
m3/h	5693.1	2400.6	3292.5	57.8

APPENDIX 2

AERISMA
MARINE HVAC/R SOLUTIONS

Capacity Calculation
Project Earl Grey
Revision 3
Date July 11,2014

CAPACITY CALCULATION FORMULA : (Total Airflow / Specific Volume of Mixed Air) X (Enthalpy of Mixed Air – Off-Coil Enthalpy)

FORECASTLE DECK

COOLING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil Enthalpy	Cooling Capacity	
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C @ 95%RH	kj/kg	kW	Tonnes
New System	2939.1	32.3	950	1989	21	50	30.0	95	2	23	44.3	25.2	66.3	0.863	59.4	1.0	0.9	0.8	14.0	13.2	35.8	22.3	6.3
Old System	2939	44.4	1306	1633	21	50	30	95	2	23	44.3	26.0	73.1	0.869	65.8	1.0	0.9	0.8	14.0	13.2	35.8	28.2	8.0

HEATING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil RH	Off Coil Enthalpy	Heating Capacity
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C	%RH	kj/kg	kW
New System	2939.1	32.31	950	1989	23	25	-40	10	-2	21	28	-2.0	85.0	0.771	4.8	1.0	0.9	0.8	24.0	25.2	13.7	32.2	29.0
Old System	1469.6	100.0	1470	0	23	25	-40	10	0	23	25	-40.0	10.0	0.661	-40.2	1.0	0.9	1.7	24.0	24.3	0.0	24.5	31.5

BOAT DECK

COOLING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil Enthalpy	Cooling Capacity	
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C @ 95%RH	kj/kg	kW	Tonnes
New System	3414.8	18.0	613	2802	21	50	30.0	95	2	23	44.3	24.2	57.1	0.857	52.0	1.0	0.9	0.7	14.0	13.3	36.1	17.5	5.0
Old System	3415	18.0	613	2802	21	50	30	95	2	23	44.3	24.2	57.1	0.857	52.0	1.0	0.9	0.7	14.0	13.3	36.1	17.5	5.0

HEATING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil RH	Off Coil Enthalpy	Heating Capacity
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C	%RH	kj/kg	kW
New System	3414.8	17.96	613	2802	23	25	-40	10	-2	21	28	7.7	52.2	0.800	16.4	1.0	0.9	0.7	24.0	25.3	17.1	34.1	20.9
Old System	1707.4	100.0	1707	0	23	25	-40	10	0	--	--	-40.0	10.0	0.661	-40.2	1.0	0.9	1.5	24.0	24.5	0.0	24.7	36.7

MAIN DECK

COOLING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil Enthalpy	Cooling Capacity	
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C @ 95%RH	kj/kg	kW	Tonnes
New System	5693	28.6	1627	4066	21	50	30.0	95	2	23	44.3	24.9	64.0	0.862	57.5	2.0	0.9	0.9	14.0	13.1	35.8	39.9	11.3
Old System	5268	70.9	3737	1532	21	50	30	95	2	23	44.3	27.9	85.3	0.881	80.0	2.0	0.9	0.9	14.0	13.1	35.6	73.9	21.0

HEATING	AIRFLOW				TEMP AND RH OF AIR BEFORE MIXING							MIXED AIR				FAN EFFECT				OFF COIL AIR			
SCU	Total Flow	Fresh Air	Fresh Air	Return Air	Indoor Air		Fresh Air		Return Heat Gain	Return Air		Mixed Air		Spec. Vol. of Mixed Air	Mixed air Enthalpy	Fan	Fan Efficiency	Fan Temp Rise	Room Induction Temp	Off Coil Temp	Off Coil RH	Off Coil Enthalpy	Heating Capacity
	m3/h	%	m3/h	m3/h	C	%RH	C	%RH	C	C	%RH	C	%RH	m3/kg	kj/kg	hp		C	C	C	%RH	kj/kg	kW
New System	5693	28.58	1627	4066	23	25	-40	10	-2	21	28	0.4	74.0	0.779	7.8	2.0	0.9	0.9	24.0	25.1	14.6	32.6	50.5
Old System	2975	100.0	2975	0	23	25	-40	10	0	--	--	-40.0	10.0	0.661	-40.2	2.0	0.9	1.7	24.0	24.3	0.0	24.5	63.7

APPENDIX 3

Datasheet – Forecastle Deck AC unit

SERIES: KACE
VERTICAL WATER SOURCE AIR CONDITIONER
SIZE:KACE-072V8LT-113G
PROJECT/TAG:

THERMOPLUS AIR INC.

JOB SCHEDULE	TOTAL BTUH	WATTS INPUT	SENSIBLE BTUH	HEAT/REJ BTUH	EER	GPM	EWT/LWT	EAT	EAT
COOLING	76,212	4,191	49,393	90,456	17.9	18	90/100	80/67	53/52

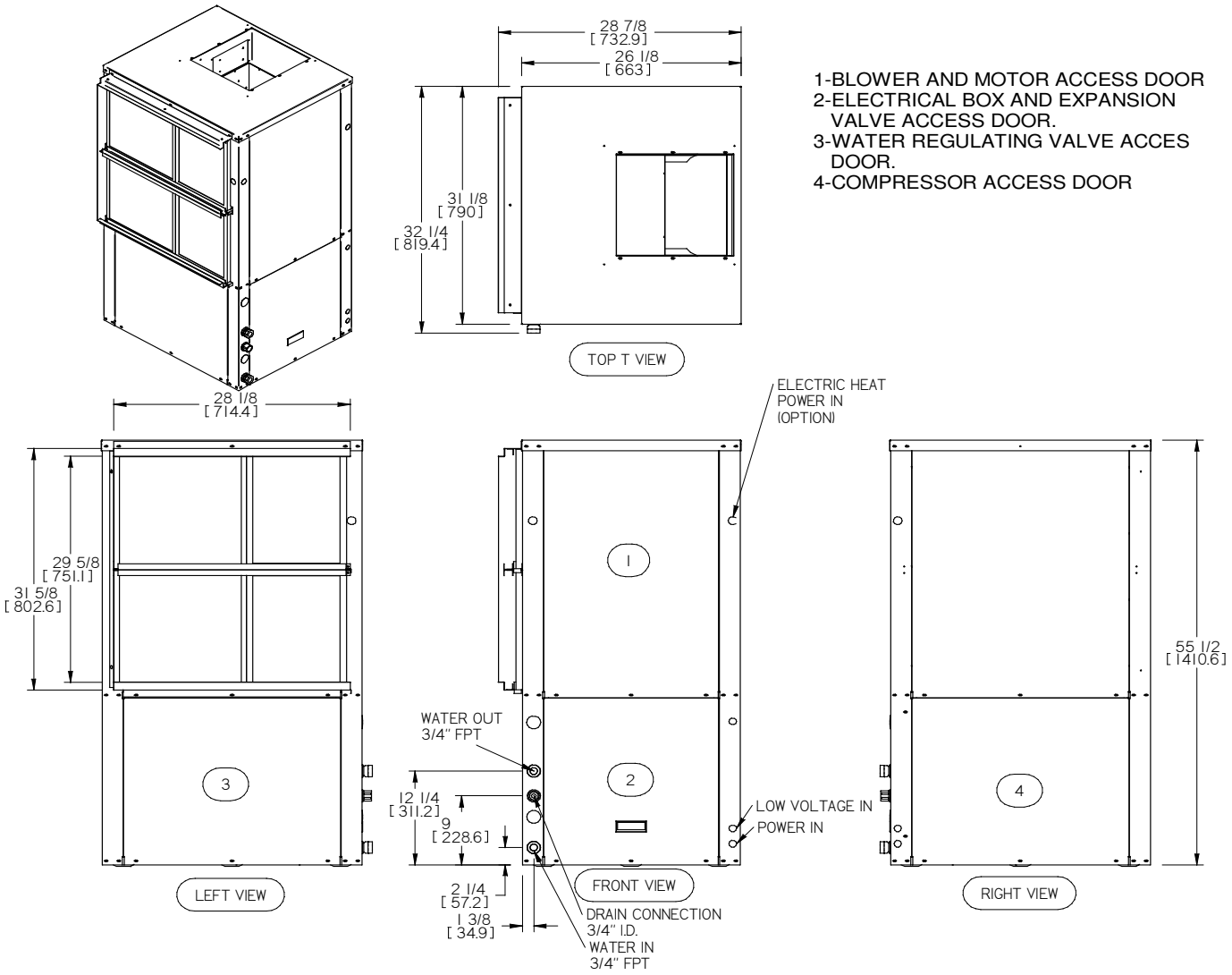
ELECTRICAL DATA		BLOWER		COMPRESSOR		MIN. CKT. AMPACITY	MAX. FUSE
VOLTAGE	PHASE/HZ	HP	FLA	RLA	LRA		
575	3/60	1	1.3	6.6	55.3	10	15

BLOWER PERFORMANCE		COMMENTS:	INSTALLED WEIGHT	
EXT. STATIC PRESS. I.W.G/PoH2O.	1.2		LBS.	394
CFM	1,730		KG.	179

SPECIFICATION:

Unit is complete package unit with a green refrigerant (R410a), unit comes with scroll compressor, tx valve metering device, air type evaporator, water regulating valve and coaxial type condenser. Also supplied with an electronic lock out board. Unit is insulated with 1/2" duct liner and enclosure is painted with a white powder paint. Unit c/w a standard 1" throwaway filter that can be field modified with a 2" filter by removing the angle in the filter frame.

OPTION INCLUDED: Cupro nickel condenser, marine water valve factory installed, heresite evaporator and acousticap on compressor.



FILTER	(2) 12" x 16" x 1" or (2) 12" x 16" x 2" (2) 16" x 16" x 1" or (2) 16" x 16" x 2"	DRAWING #	SHIPPING WGT.	LBS.	400
		KACE-072V8-113G		KG.	182

APPENDIX 4

Datasheet – Boat Deck AC unit

SERIES: KACE
VERTICAL WATER SOURCE AIR CONDITIONER
SIZE:KACE-060V8RT-113G
PROJECT/TAG:

THERMOPLUS AIR INC.

JOB SCHEDULE	TOTAL BTUH	WATTS INPUT	SENSIBLE BTUH	HEAT/REJ BTUH	EER	GPM	EWT/LWT	EAT	EAT
COOLING	66,458	3,416	46,645	77,670	20.2	15	90/100	80/67	58/57

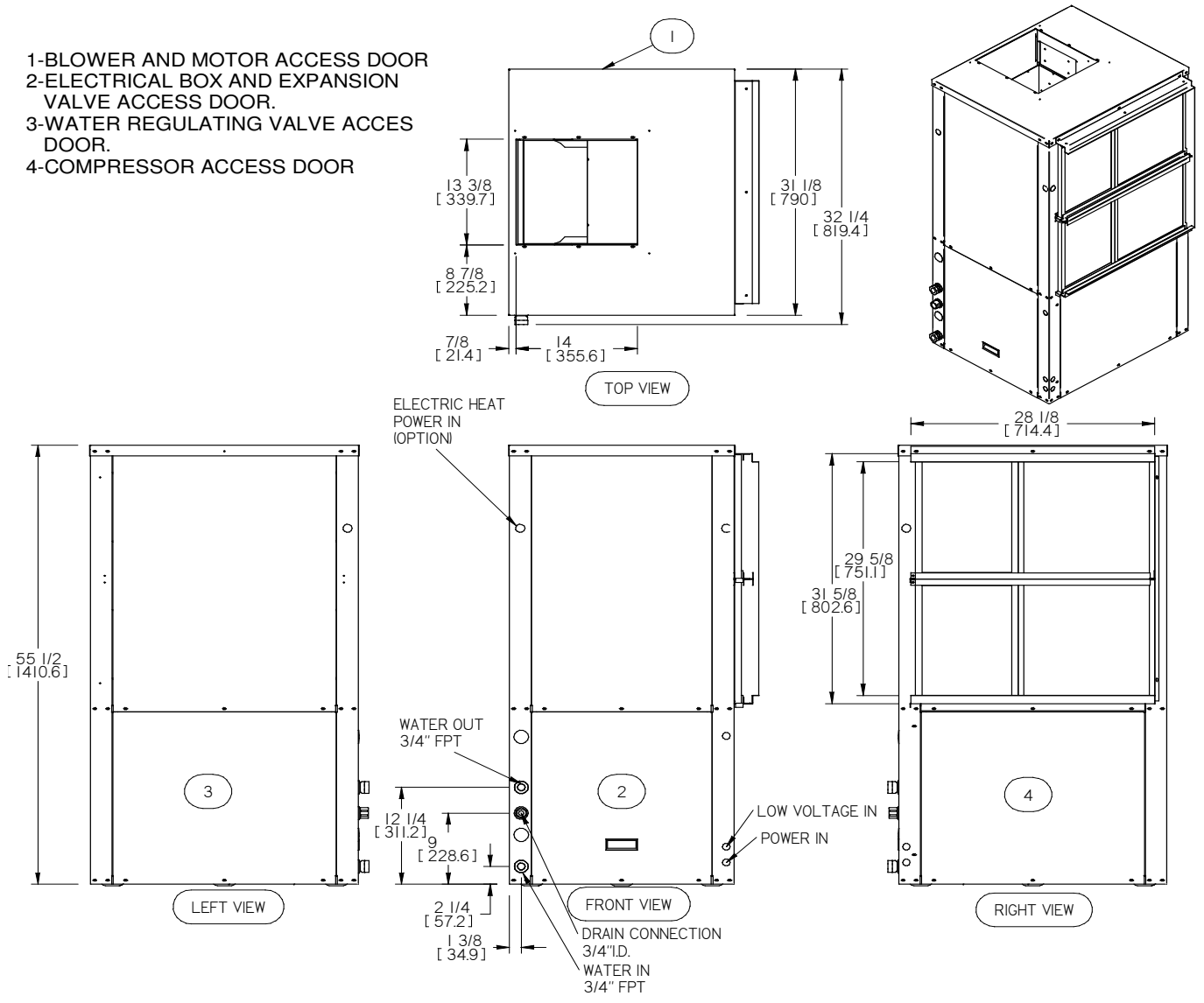
ELECTRICAL DATA		BLOWER		COMPRESSOR		MIN. CKT. AMPACITY	MAX. FUSE
VOLTAGE	PHASE/HZ	HP	FLA	RLA	LRA		
575	3/60	1 1/2	1.9	5.7	38.9	10	15

BLOWER PERFORMANCE		COMMENTS:	INSTALLED WEIGHT	
EXT. STATIC PRESS. I.W.G/PoH2O.	1.5		LBS.	382
CFM	2,010		KG.	173

SPECIFICATION:

Unit is complete package unit with a green refrigerant (R410a), unit comes with scroll compressor, tx valve metering device, air type evaporator, water regulating valve and coaxial type condenser. Also supplied with an electronic lock out board.
Unit is insulated with 1/2" duct liner and enclosure is painted with a white powder paint. Unit c/w a standard 1" throwaway filter that can be field modified with a 2" filter by removing the angle in the filter frame.
OPTION INCLUDED: Cupro nickel condenser, marine water valve factory installed, heresite evaporator and acousticap on compressor.

1-BLOWER AND MOTOR ACCESS DOOR
2-ELECTRICAL BOX AND EXPANSION VALVE ACCESS DOOR.
3-WATER REGULATING VALVE ACCES DOOR.
4-COMPRESSOR ACCESS DOOR



FILTER	(2) 12" x 16" x 1" or (2) 12" x 16" x 2" (2) 16" x 16" x 1" or (2) 16" x 16" x 2"	DRAWING #	SHIPPING WGT.	LBS.	388
		KACE-060V-113G		KG.	176

APPENDIX 5

Datasheet – Main Deck AC unit

SERIES: KACE
VERTICAL WATER SOURCE AIR CONDITIONER
SIZE:KACE-144V83RT-113G
PROJECT/TAG:

THERMOPLUS® AIR INC.

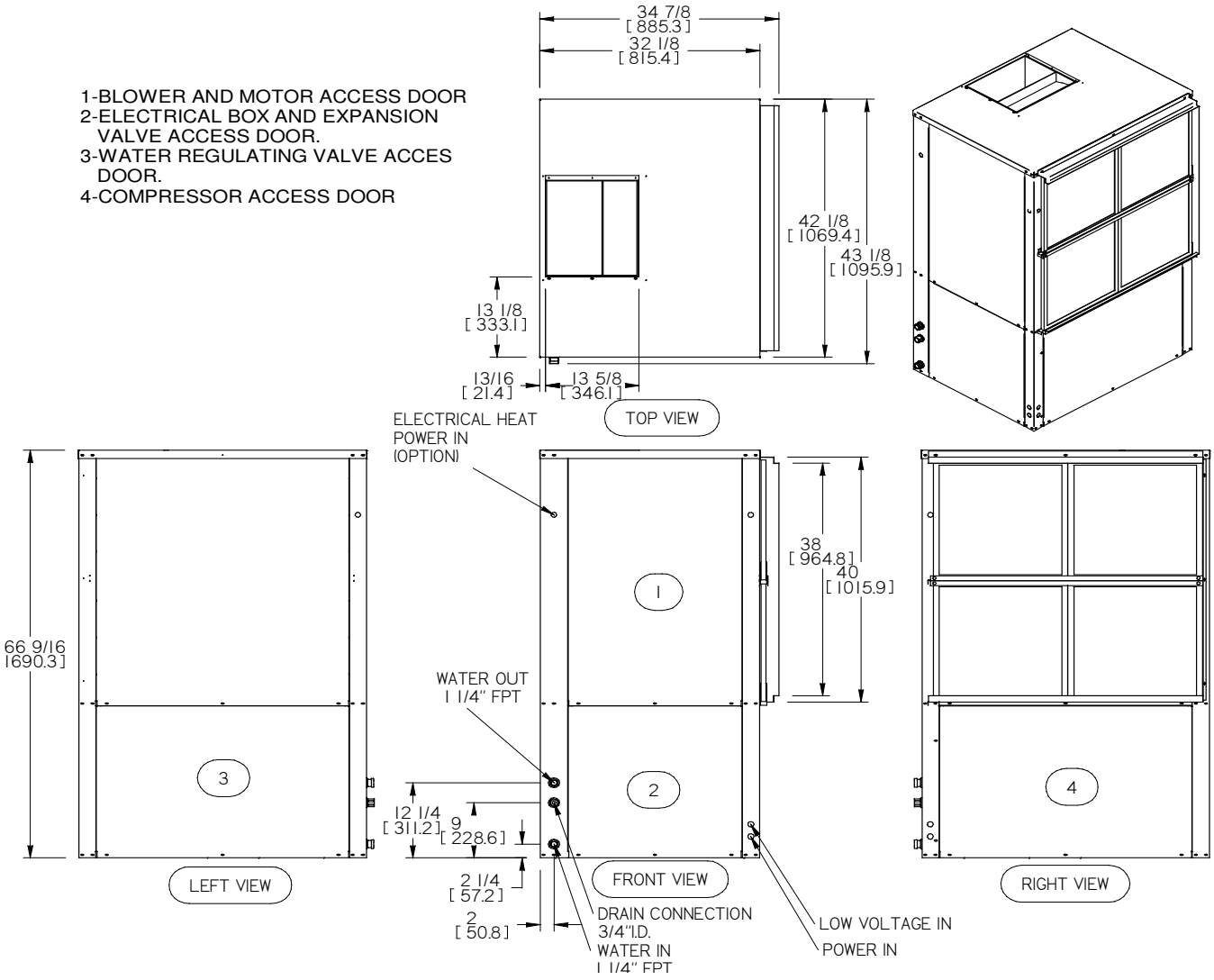
JOB SCHEDULE	TOTAL BTUH	WATTS INPUT	SENSIBLE BTUH	HEAT/REJ BTUH	EER	GPM	EWT/LWT	EAT	LAT
COOLING	137,387	7,930	87,621	164,234	18.6	35	90/100	80/67	56/54

ELECTRICAL DATA		BLOWER		COMPRESSOR		MIN. CKT. AMPACITY	MAX. FUSE
VOLTAGE	PHASE/HZ	HP	FLA	RLA	LRA		
575	3/60	3	3.5	2 x 7.6	2 x 54	21	25

BLOWER PERFORMANCE		COMMENTS:	INSTALLED WEIGHT	
EXT. STATIC PRESS. I.W.G/PoH2O.	2		LBS.	790
CFM	3,351		KG.	358

SPECIFICATION:

Unit is complete package unit with a green refrigerant (R410a), unit comes with scroll compressor, tx valve metering device, air type evaporator, water regulating valve and coaxial type condenser. Also supplied with an electronic lock out board.
Unit is insulated with 1/2" duct liner and enclosure is painted with a white powder paint. Unit c/w a standard 1" throwaway filter that can be field modified with a 2" filter by removing the angle in the filter frame.
The KACE-096 to 144 is a 2 refrigerant circuit completely independent.
OPTION INCLUDED: Cupro nickel condenser, marine water valve factory installed, heresite evaporator and acousticap on compressor.



FILTER	(4) 20" x 20" x 1" or (4) 20" x 20" x 2"	DRAWING #	SHIPPING WGT.	LBS.	810
		KACE-144V-113G		KG.	367

APPENDIX 6

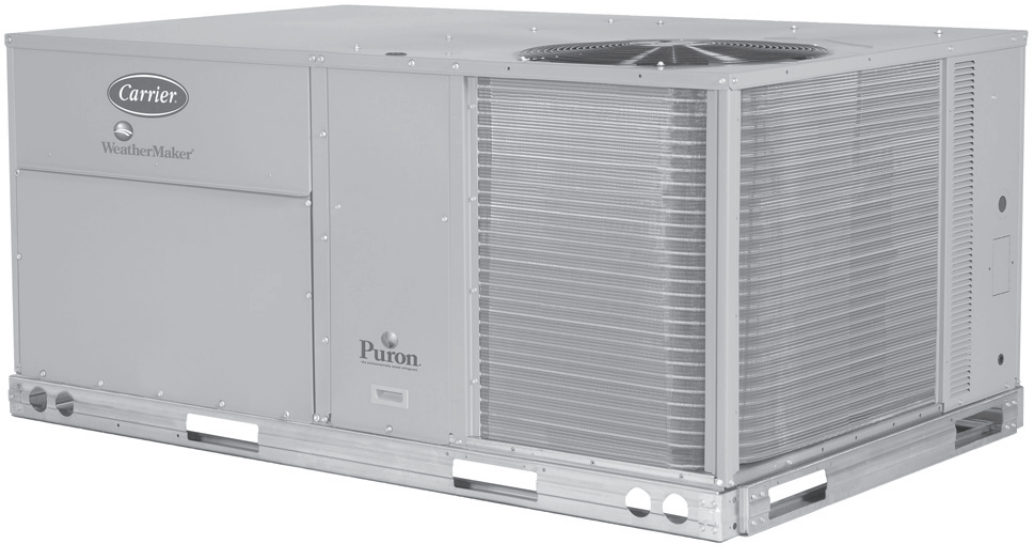
Datasheet – Wheelhouse AC unit

50TC
Cooling Only/Electric Heat
Packaged Rooftop
3 to 15 Nominal Tons

Carrier
turn to the experts

Product Data

WeatherMaker®



C08613

Puron™
the environmentally sound refrigerant

ASHRAE 90.1 COMPLIANT

e-coat sur condenseur et evaporateur	1	50TC-A04A2D5-0A0A0	Packaged Rooftop Electric Cooling Units 3 Tons Cooling 208/230-3-60 ♦ *Single Stage Compressor Models* ♦ *Round Tube Plate Fin* ♦ *Medium Static Option* ♦ *E-coat Al/Cu - E-coat Al/Cu* ♦ *Base Electro-mechanical controls*
	1	33CS2PP2S-03	Thermostat Carrier EdgePro commercial
	1	CRHEATER105A00	12.0/14.7/16.0 kW 208/230/240-3-60 Volt Electric Heater
	1	Transport	Transport au chantier
	1	CRSINGLE037A00	Single Point Kit

NOTES:

1. DIMENSIONS ARE IN INCHES, DIMENSIONS IN [ ] ARE IN MILLIMETERS.
2. CENTER OF GRAVITY
3. DIRECTION OF AIR FLOW

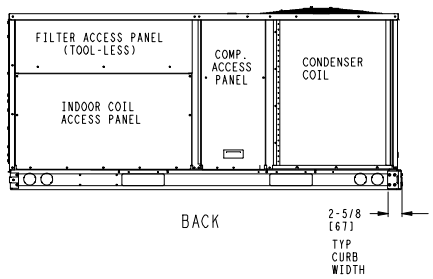
UNIT	J	K
50TC-A04	33 3/8 [847]	18 5/8 [472]
50TC-A05	33 3/8 [847]	14 7/8 [377]
50TC-A06	33 3/8 [847]	14 7/8 [377]
50TC-A07	41 3/8 [1051]	14 7/8 [377]

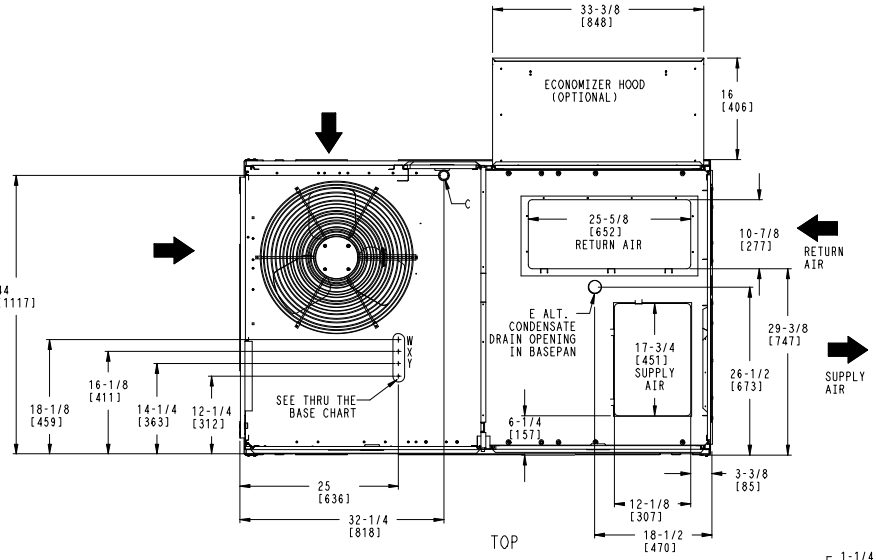
UNITED TECHNOLOGIES CARRIER P.O. BOX 4808 SYRACUSE, NY 13221

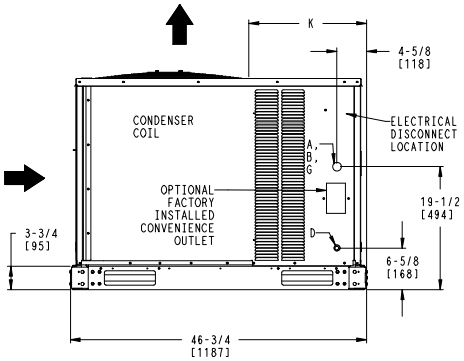
	CONNECTION SIZES
A	1 3/8" [35] DIA FIELD POWER SUPPLY HOLE
B	2" [51] DIA POWER SUPPLY KNOCKOUT
C	1 3/4" [44] DIA GAUGE ACCESS PLUG
D	7/8" [22] DIA FIELD CONTROL WIRING HOLE
E	3/4"-14 NPT CONDENSATE DRAIN
G	2 1/2 * [64] DIA POWER SUPPLY KNOCK-OUT

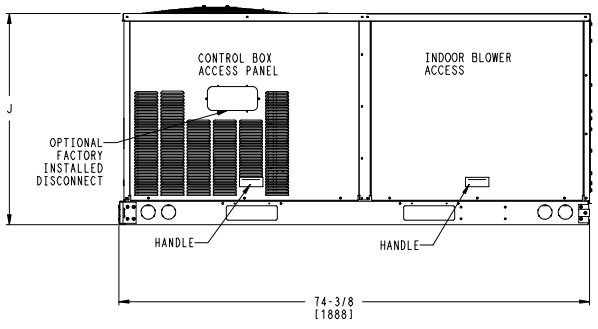
THRU-THE-BASE CHART
THESE HOLES REQUIRED FOR USE CRBTMPWR001A01

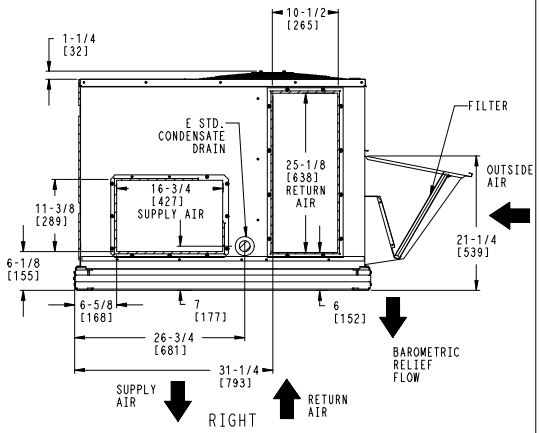
	THREADED CONDUIT SIZE	WIRE USE	REQ'D HOLE SIZES (MAX.)
W	1/2"	ACC.	7/8" [22.2]
X	1/2"	24V	7/8" [22.2]
Y *	3/4" (001)	POWER	1 1/8" [28.4]
	FOR "THRU-THE-BASEPAN" FACTORY OPTION, FITTINGS FOR ONLY X & Y ARE PROVIDED		
*	SELECT EITHER 3/4" OR 1/2" FOR POWER, DEPENDING ON WIRE SIZE		





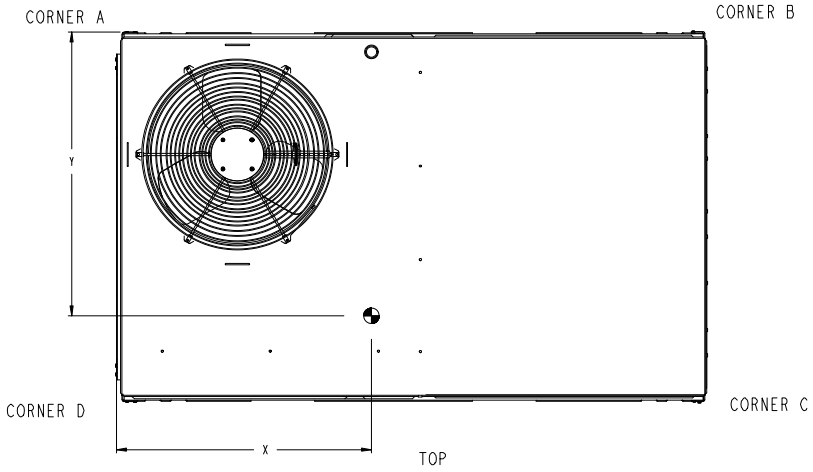


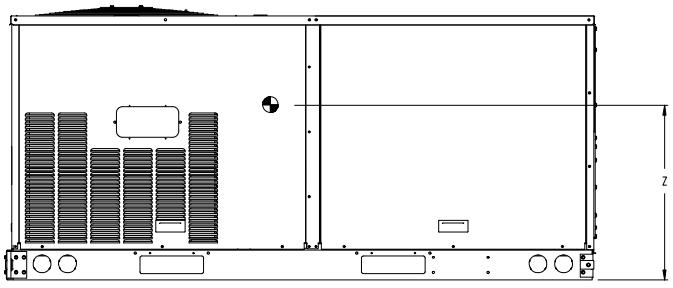




SHEET	DATE	SUPERCEDES			REV
1 OF 2	11-24-08	09-29-08	50TC 04-07 SINGLE ZONE ELECTRICAL COOLING WITH ELECTRIC HEAT	48TM500994	5.0

UNIT	STD. UNIT WEIGHT		CORNER WEIGHT (A)		CORNER WEIGHT (B)		CORNER WEIGHT (C)		CORNER WEIGHT (D)		C.G.		HEIGHT
	LBS.	KG.	LBS.	KG.	LBS.	KG.	LBS.	KG.	LBS.	KG.	X	Y	Z
50TC-A04	438	199	108	49	115	52	110	50	104	47	38 [965]	22 [559]	17 1/4 [438]
50TC-A05	494	224	122	55	130	59	125	57	117	53	38 [965]	22 [559]	17 1/2 [445]
50TC-A06	524	238	130	59	138	63	132	60	124	56	38 [965]	22 [559]	17 3/4 [451]
50TC-A07	607	275	150	68	160	73	153	69	144	65	38 [965]	22 [559]	20 3/4 [527]





SHEET	DATE	SUPERCEDES			REV
2 OF 2	11-24-08	09-29-08	50TC 04-07 SINGLE ZONE ELECTRICAL COOLING WITH ELECTRIC HEAT	48TM500994	5.0

APPENDIX 7

Electrical Load Analysis – Old versus New Equipment

HVAC Equipment List - CCG Earl Grey
Date: 10-nov-14

HVAC Equipment List							New Equipment (rated)				Previous Equipment (rated)					
Item No.	Description	Deck	Make / Model	QTY	Voltage	Ph/Hz	HP (kW)	FLA	MCA	MOP	HP (kW)	FLA	MCA	MOP	Remarks	Reference Drawing Numbers
1	Rooftop Packaged AC Unit	W	Carrier	2	208/230	1/60			49/55	50/60			49/55	50/60		C14-40-512-03
2	Self Contained Unit	F	Thermoplus KACE-072V8RT-113G	1	575	3/60			10	15			13.4	20	Based on nameplate info	C14-40-512-04
3	Self Contained Unit	B	Thermoplus KACE-060V8RT-113G	1	575	3/60			10	15			13.4	20	Based on nameplate info	C14-40-512-04
4	Self Contained Unit	M	Thermoplus KACE-144V83RT-113G	1	575	3/60			21	25			16.6	28.0	Based on datasheet info	C14-40-512-05
5	Supply Fan - Forecastle DK	F	Hartzell A25-M-85VA	1	575	3/60	0.5	0.8	1	1.8	2.0/0.5	2.6/1.0	3.3	5.9	Based on nameplate info	C14-40-512-08
6	Supply Fan - Boat DK	F	American Fan 31JM/16/2/5	1	575	3/60	1	1.44	1.8	3.2	2.0/0.5	2.6/1.0	3.3	5.9	Based on nameplate info	C14-40-512-09
7	Supply Fan - Main DK	F	American Fan 31JM/16/2/5	1	575	3/60	0.5	0.8	1	1.8	3.0/0.75	3.8/1.8	4.8	8.6	Based on nameplate info	C14-40-512-10
8	Exhaust Fan - Galley Hood	B	American Fan 40JM/20/2/6	1	575	3/60	1.5	1.84	2.3	4.14	2.0/0.5	2.6/1.0	3.3	5.9	Based on datasheet info	C14-40-512-11
9	Supply Fan - Galley Make Up	B	Hartzell A52-M-225	1	575	3/60	0.5	0.8	1	1.8	N/A	N/A	N/A	N/A		C14-40-512-12
10	Round closable hatch	F	Exterior Portside, near SAR locker	1												C14-40-512-15
11	Exhaust Fan - Lavatory	B	Canadian Blower (OEM)	1	575	3/60	3	3.3	4.125	7.425	3	3.4	4.4	7.7	Based on electric schematic	C14-40-512-13
12	Exhaust Fan - Laundry	M	American Fan 31JM/16/4/5	1	120	1/60	1	11.8	14.75	26.55		7.4	9.3	16.7	Based on datasheet info	C14-40-512-14
13	Humidifier - Forecastle DK	F	Nortec NHTC+020/550-600/3	1	550-600	3/60	7.5 kW	7.2	9	15	N/A	N/A	N/A	N/A		C14-40-512-07
14	Humidifier - Boat DK	B	Nortec NHTC+010/550-600/1	1	550-600	1/60	3.7 kW	6.2	7.75	15	N/A	N/A	N/A	N/A		C14-40-512-07
15	Humidifier - Main DK	M	Nortec NHTC+030/550-600/3	1	550-600	3/60	11.4 kW	11	13.75	15	N/A	N/A	N/A	N/A		C14-40-512-07
16	Heating Coil	F	In duct after Self Contained Unit	1												C14-40-512-06
17	Heating Coil	B	In duct after Self Contained Unit	1												C14-40-512-06
18	Heating Coil	M	In duct after Self Contained Unit	1												C14-40-512-06
19	Heating Valve	F,B,M	Leslie	3	24											C14-40-512-06
20	Thermostat	W	Near aft wall of wheelhouse	2	24											C14-40-512-03
21	Thermostat (main)	F,B,M	In passageway	3	24											C14-40-512-04, C14-40-512-05
22	High Limit Humdity Sensor	F,B,M	In duct after steam probe	3												C14-40-512-04, C14-40-512-05
23	Outdoor Air Temp Sensor	F,B,M	In fresh air duct before mixing box	3												C14-40-512-04, C14-40-512-05
24	Thermostat (heating)	F,B,M	Near Self Contained Unit	3	24											C14-40-512-04, C14-40-512-05
25	Duct Temp Sensor (heating)	F,B,M	In duct after heating coil	3												C14-40-512-04, C14-40-512-05
26	Spot Air Diffuser	M	In galley ceiling	4												C14-40-512-16
27	Airflow Switch	F,B,M	On wall or duct near Self Contained Unit	3												C14-40-512-04, C14-40-512-05
28	Airflow Switch duct probe	F,B,M	In duct after Self Contained Unit	3												C14-40-512-04, C14-40-512-05

Note 1: The electrical information for the existing equipment was taken from equipment nameplate when available. When such information was unaccessible, information was taken from datasheets provided by CCG. For the remaining information, existing electrical diagrams 218-E-1 sheets 1 and 2 (July 1984) were used.

Note 2: All current is in A.

Note 3: All motor power is in hp unless indicated otherwise.

Legend

W Wheelhouse deck
F Forecastle deck
B Boat deck
M Main deck
FLA Full Load Amps
MCA Minimum Circuit Ampacity. Used to determine the minimum wire size required for the field wired product
MOP Maximum Overcurrent Protection. If this number does not match the standard rating of North American circuit breakers, it is rounded down to the next lower standard rating.