AQUA-AIR

MARINE CHILLWATER AIR CONDITIONING

INSTALLATION
OPERATION
MAINTENANCE

AQUA-AIR
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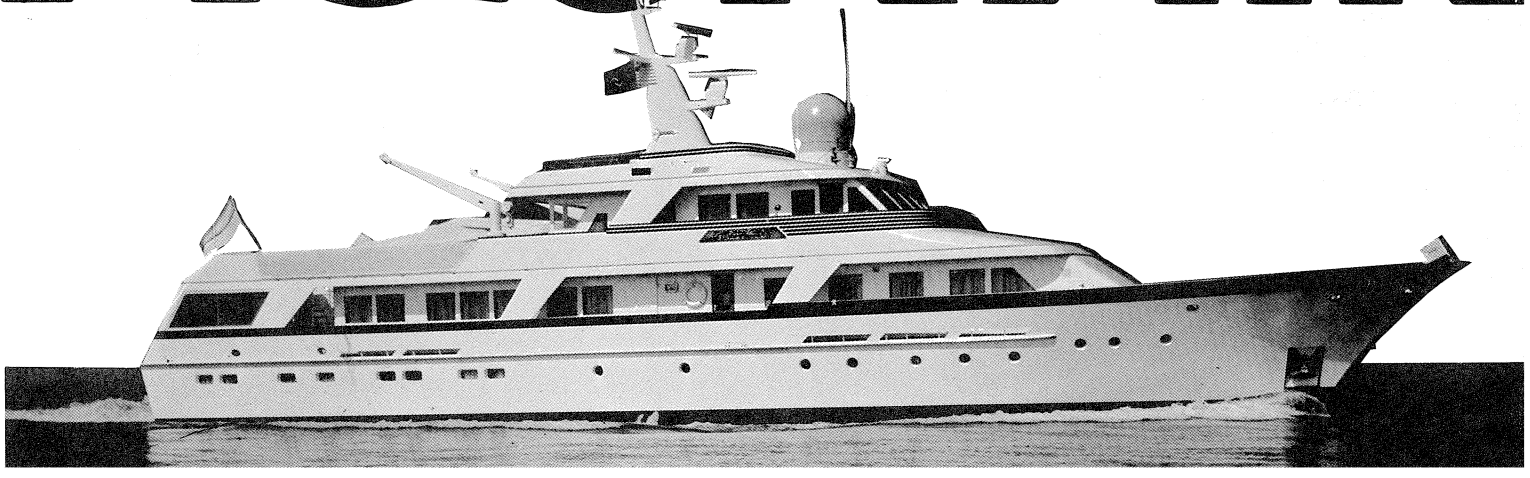
DIVISION of the JAMES D. NALL CO., INC. MIAMI, FL.



INSTALLATION, OPERATION AND MAINTENANCE OF AQUA-AIR® CHILLWATER MARINE AIR CONDITIONING SYSTEMS

I. INTRODUCTION

The purpose of this manual is twofold : (1) To give you an idea of what the basic chillwater system components are and (2) to give you the necessary information such as installation instructions, wiring diagrams, charts and start up procedures. This will enable you to install, test and operate an Aqua-Air® chillwater system.

Aqua-Air® chillwater systems come in standard 16, 24, 30, 36, and 60,000 BTU models. The 16, 24, and 36,000 BTU models can be supplied in cooling only or reverse cycle configurations. The 30, and 60,000 BTU models are supplied in the cooling only configuration with the option of adding a sidearm heater system to the unit. Fan coils are available in size from 3000 BTU (100 CFM) to 36,000 BTU (1200 CFM) in 115 or 230 volt, 60 cycle. All of the units can be run on 50 cycle current with a 17% decrease in capacity.

II. SYSTEMS OVERVIEW

There are basically three different chillwater systems available from Aqua-Air®:

1. Systems utilizing cooling only chillers with fan coils equipped with strip heaters
2. Systems utilizing reverse cycle chillers with fan coils
3. Systems utilizing cooling only chillers equipped with sidearm heaters and fan coils.

Each system will be briefly explained below.

A. Cooling Only Chiller — Fan Coils with Strip Heaters

In the cooling cycle, cold water that was chilled to a maximum low temperature of 42° F (6° C) is sent via a parallel piping system to the fan coils. This cold water passes through the fan coil, room air is blown or drawn across the coil and then discharged into the room. Room temperature is controlled by a thermostat that electrically opens or closes an electric water valve on the fan coil unit. As the room temperature reaches the desired setting on the thermostat, electric power is shut off to the water valve, bypassing the cold water back to the chiller and eliminating the cooling effect. In the heat cycle, the water valve remains in the closed position and the electric strip heater is energized. These remain energized until the thermostat reaches the set point. At that moment the strip heater is turned off. The advantage to this system is that you can have individual thermostatic control in each area. One room can be cooled while another one is being heated. Care must be taken when turning on the strip heaters to not overload the shoreline. The strip heaters can be turned on at the same time as the chiller.

B. Reverse-Cycle Chillers with Fan Coils

In the cooling cycle, cold water that has been chilled to a maximum low temperature of 42° F (6° C) is sent via a parallel piping system to the ship's fan coils. This cold water passes through the fan coil, room air is blown or drawn across it and then discharged into the room. In the heating cycle, the chiller goes into the reverse cycle mode. Water heated to a maximum of 120° F (49° C) is then sent to each fan coil. The thermostat senses the room temperature and sends an electrical signal to the aquastat. The aquastat is a SPDT thermostat that senses the temperature of the water that is passing through the pipes and turns the fan coil water valve on or off. With the thermostat in the cool position and cold water running through the pipes, the water valve remains in the open position. If the chiller is turned to the heat mode, hot water begins passing through the pipes. The aquastat senses this and turns the water valve off. If the thermostat is in the heat mode and cold water is passing through the pipes, the aquastat will keep the fan coil water valve closed. If the chiller is turned to the heat position and hot water begins passing through the pipes and fan coils, the aquastat will sense this and open the water valve. A summary of this is shown in the chart below:

CHILLER MODE	THERMOSTAT MODE	WATER TEMPERATURE	WATER VALVE STATUS
COOLING	COOLING	COLD	OPEN
COOLING	HEATING	COLD	CLOSED (BYPASS)
HEATING	COOLING	HOT	CLOSED (BYPASS)
HEATING	HEATING	HOT	OPEN

The major drawback of this system is that when the seawater temperature reaches 41° F, the unit loses 50% of its heating capacity. As the temperature decreases to 36° F, the unit will have lost almost all if its heating capacity.

C. Cooling Only Chiller — Sidearm Heating System

This system is very similar to the second system except for the method by which the water is heated in the heating mode. In the heat mode, the water passes through a sidearm heater (electric water heater) instead of the chiller. This water then is sent to the fan coils where air is blown or drawn across the coil, producing the heating effect.

III. GENERAL DESCRIPTION OF THE BASIC COMPONENTS

A chillwater cooling (and heating system) is comprised of the following main components:

1. Fan coils
2. Chiller units
3. Chillwater pump
4. Seawater pump
5. Thermostats and fan speed controls
6. Fan coil relays
7. Pump relays
8. Fresh water makeup system

The following paragraphs explain the function of each component.

A. Fan Coils

The fan coil, also referred to as an airhandler or cooling coil, is a water to air heat exchanger located in the space to be either heated or cooled. The fan coil is made up of the following major components:

1. Coil
2. Motorized water valve
3. Squirrel cage blower
4. Metal chassis.

The coil itself is constructed of aluminum fins and copper tubing. Water is piped into the bottom of the coil and then out of the top of the coil.

The regulating device that controls whether water is flowing through the fan coil is the motorized water valve. This motorized valve is energized by the thermostat in the room. There are two different types of valves: two way and three way. The two way valve is a simple on-off type valve. When electrically energized by the thermostat, the water valve opens and when the power is turned off the valve closes. The three way valve, when de-energized, bypasses the supply water back to the return line. When energized, the water passes normally through the fan coil. Three way valves are recommended for use on all of the fan coils. The two way valves can be used on fan coils that are part of a system that has at least one fan coil with a three way water valve or on a system that has two or more chillers connected together by a manifold with an internal check valve that bypasses the water if all of the fan coils were to shut off at once. The reason for this is that the chillers must have a constant supply of water returning to them. If two way valves are used on all of the fan coils and all of the valves were to shut off at once, there would be no water returning to the chillers. This could cause eventual failure of the chillwater pump plus also provide the chiller with an opportunity to freeze up internally if the fail-safe controls were to be defective. If there is at least one fan coil in the system with a three way valve then the water could still flow through that unit if all of the other valves on the other units were to turn off simultaneously. On a system with more than one chiller and a manifold system, the water could bypass through the manifold check valve and return back to the chillers if all of the two way water valves were to de-energize at the same time. These are the only two ways in which the two way water valve should be implemented into a system. They should NEVER under any circumstances be used on a system utilizing hot water heat. On a hot water system, an aquastat is placed on the incoming water line into the water valve. As previously discussed in the first section, the aquastat senses the temperature of the water in the pipes. If a two way valve is used and the valve shuts off, there is no flow of water past the aquastat. On initial startup of the system, the water valve might possibly never open because the aquastat would only be sensing the temperature of the water right at the water valve inlet rather than the temperature of the water that the chiller would be producing.

On each fan coil unit, there is a balancing valve installed on the water valve return line. This is used to regulate the total amount of water that a fan coil receives. Upon installation of the fan coil and when the system is running, the balancing valve is adjusted to provide for a ten degree temperature differential between the incoming water and the water that is leaving the fan coil. On the balancing valve, when the screw slot is in line with the tube, the valve is in the fully open position. When the slot is across the line, the valve is in the fully restricted position. In this position, the water flow is not completely shut off but is severely restricted. If there is less than a ten degree differential in the fan coil inlet and outlet water temperatures, water is passing too quickly through the coil. Turn the balancing valve toward the closed position to restrict the water flow until the ten degree split is achieved. If there is more than a ten degree temperature differential, the water is passing through the fan coil too slowly. The balancing valve should be opened up until the ten degree split is achieved.

All of the chillwater fan coils produced by Aqua-Air® utilize squirrel cage blowers. These provide for the necessary air velocity needed in duct systems while at the same time provide quiet air distribution.

There is an air bleeder on each of the fan coils. This is used to release any air that might become trapped in the system during the startup phase. The use of these bleeders is discussed later in the startup procedure section.

B. Chiller Units

Chiller units consist of the following basic components:

1. Compressor
2. Cupronickel condenser

3. Chiller tank
4. Electrical box
5. Reversing valve (if it is a heat pump model)

All of the above components are mounted on a metal chassis. This chassis can be fastened down directly or shock mounted.

Compressors on the AQF(H)-16CW and AQ-30-2 are 115-1-60 (100-1-50). The standard compressors on the AQF(H)-16CWC, AQF(H)-24CWPC, AQF(H)-36CWPC, AQ-30, AQ-30-2C and AQ-60 are 230-1-60 (200-1-50). They can also be supplied in 230-3-60 (200-3-50) on the AQF(H)-36CWPC, AQ-30 and AQ-60.

The systems function as follows: freon gas is compressed in the unit compressor and then piped to the seawater condenser. The seawater passing through the condenser absorbs the heat brought about when the gas is compressed. As the hot freon gas decreases in temperature, it changes in state from a gas to a liquid. This liquid is then piped to the chiller tank. Capillary tubes meter the liquid into the chiller. Before the liquid enters the chiller, it experiences a decrease in pressure while passing through the capillary tubes. When it enters the chiller coil itself it begins to absorb the heat in the water that is passing through the outer chiller jacket. As it absorbs this heat the liquid refrigerant begins changing back to a gas. It is then piped back to the compressor to start the cycle all over again.

The electrical box contains all of the starting components, terminal blocks, thermostats and power relays that are necessary for the operation of the unit. There is always a freeze-up and a cycling thermostat on the Unit. If it is a reverse cycle model there will also be a heating thermostat. The freeze-up control shuts the entire unit off if the temperature of the water in the chiller goes down to 38° F. Normally this will happen only if the water passing through the unit completely stops. The cycling thermostat normally would have shut the unit off at 42° F. On the AQ-30-2 and the AQ-60 (dual compressor models) the #2 compressor is set to go off when the chillwater temperature reaches 45° F. The #1 compressor goes off when the water temperature reaches 42° F. On reverse cycle units, the heating thermostat shuts the unit off at 120° F.

There should always be a water flow safety control (FSC-206 or 210) mounted on the chillwater outlet line leaving the chiller. This device senses if there is sufficient water flow passing through the chiller coil. It is tied into the unit control circuit so that if there is not enough water passing through the chiller the unit will not start. This acts as a back-up to the freeze-up control.

C. Chillwater Pumps

With the AQF(H)-16CW(C), AQF(H)-24CWPC and AQF(H)-36CWPC it is necessary to mount an independent chillwater pump. The AQ-30, 30-2, and 60 all have an internal chillwater pump. This pump is used to circulate the water through the chiller and then to the rest of the system. On systems that have more than one chiller, a single large chillwater pump is used to circulate water to the fan coils. This pump is located in the water supply line between the chillers (or manifold if used) and the fan coils. On the systems using the smaller AQF(H) units it is sometimes economically feasible to use a single large pump to pump the water through the chillers and then on to the system.

D. Seawater Pumps

The seawater pump is used to circulate the raw water (seawater in most cases) through the chiller condenser. A basic rule of thumb to follow is that you need about 4 GPM per 12,000 BTU of chiller capacity. An example of this is a 24,000 BTU chiller would require about 8 GPM or 480 GPH. The next seawater pump (500 GPH) is the appropriate choice.

All of the seawater pumps supplied by Aqua-Air® are of the centrifugal type and are not self priming. This means that they must be mounted below the waterline of the boat UNDER ALL CONDITIONS!

E. Thermostats and Fan Speed Controls

There are two basic types of thermostats supplies by Aqua-Air®:

1. Pilot duty
2. Line voltage duty

The thermostats that fall under the category of pilot duty are:

1. AQT39 Series
2. AQSD3W Series

On the AQT39 series, the water valve circuit should not exceed 1.0 amp @ 115 volts and the fan circuit 5.0 amps @ 115 volts.

On the AQSD3W series, the water valve circuit should not exceed 10 amps @ 115 volts, the fan circuit 4.0 amps @ 115 volts and the auxiliary circuit 15.0 amps @ 115 volts. On 230v systems the amperage carrying ratings are doubled (ex. 4 amps @ 115v would be 8 amps @ 230v). These thermostats are usually used with the fan coil relays to prevent overloading the thermostat circuits. All of the relay specifications are given in the section on fan coil relays.

The thermostats that fall under the category of line voltage thermostats are:

1. AQS1W Series — Cooling only
2. AQS3W Series — Heating and Cooling

On these thermostats, the water valve circuit and heating circuit (AQS3 only) are rated for 18.0 amps @ 115 volts, the fan circuit for 4.0 amps @ 115 volts and the auxiliary circuit for 20 amps @ 115 volts. Because of their large amperage carrying capacity, it is usually not necessary to use a relay with these thermostats. However, on applications where more than one fan coil is run off of a single thermostat, it may be necessary to use a relay system if the amperages of the equipment are greater than the amp carrying capability of the thermostat.

Fan speed controls are broken up into the following categories:

1. Two speed
2. Three speed
3. Variable speed

The two speed switches are available with or without an off position. These are used specifically on the AQOHW units. The maximum amperage load that can be placed on these switches is 15 amps @ 115 volts. The three speed switch is only available with an OFF-HI-MED-LOW switch and auxiliary set of points. These were used on the older Aqua-Air® fan coils with three speed fan motors, which are no longer in production. The maximum amperage load that can be placed on this switch is 10 amps @ 115 volts. The variable speed fan controls are available either with or without an off position. The maximum amperage load on these switches is 4 amps @ 115 volts. All of the above fan speed controls without an off position are used together with the AQT39A or H in areas where there is only a single fan coil being controlled by the thermostat. Fan speed controls with an off position are used in areas where there is more than one fan coil being controlled by a single thermostat. These fan speed controls can be used with any of the listed thermostats.

F. Fan Coil Relays

There are several different fan coil relay boxes used with the chillwater systems. Below is a chart outlining their use:

RELAY SELECTION CHART

APPLICATION	HR-100	HRS-100	MFR-100	FR-100	FRS-100
1. Single fan coil w/strip heat on a single thermostat	×				
2. Multiple fan coils w/strip heat on a single thermostat		×	×		
3. Multiple fan coils on a hot water heating system on a single thermostat				×	×

In the above systems where there are multiple fan coils on one thermostat in a single area, there is only one master relay (MFR-100 or FR-100) per area. One of the fan coils in the area is selected to be the master fan coil and is then connected to the master relay. All of the other fan coils in that area are connected to slave relays (HRS-100 or FRS-100). There is an individual slave relay for every fan coil in the area except for the master relay. Relays that are used with the strip heater systems are available with three pole heater contactors for three phase strip heaters. All of the relays are available with either 115 or 230 volt control circuits.

G. Pump Relays

A pump relay is necessary when one seawater pump supplies water to two or more chiller units. Aqua-Air® offers two different types of pump relays.

1. AQP2R

   This pump relay was designed for use on systems with one seawater pump and two chillers. It should also be remembered that both chillers should be on the same shore line if this type of relay is to be used. If they are not on the same shore line, then the AQP8R should be used. The AQP2R has an open point contact and is therefore not ignition protected. Because of this it should never be mounted in an area that might contain gasoline vapors. The AQP2R gets its power from the chiller units and therefore does not need an external power source.

2. AQP8R

   This relay is constructed entirely of solid state components. It can handle from 2-8 chiller units. For each chiller unit there is an individual trigger (PEC-115 or 230) used to energize the system. There can be a mixture of trigger voltages used in any box. The trigger voltage is based on the individual system control systems. The AQP8R requires an external power sources that is the same voltage as the pump. Because of its solid state construction, the AQP8R is ignition protected.

H. Fresh Water Make-up Components

On a chillwater system, there has to be a fresh water make-up system tied into the ships main fresh water system. This system is necessary during initial start-up to introduce water into the system. Also, certain amounts of water are lost through the normal operation of the chiller system. The water that is lost is replaced by the fresh water make-up system. The components that are included in this system are:

1. Pressure reducing valve
2. Expansion tank
3. Water pressure gauge.

The pressure reducing valve reduces the water pressure from the ship's main system to a pressure of approximately 12-15 PSI. The valve is set at the factory for 12 PSI. This is the normal system pressure setting. As water is cooled or heated it expands and contracts to a small extent. This expansion and contraction is compensated for by the expansion tank. The water pressure gauge is used to monitor the system pressure. There should be a gate valve separating the ship's fresh water system from the chillwater system fresh water make-up system. This should be left on at all times except when repair work is being done to the chillwater lines. If not left on the system can become air bound and then not operate at maximum efficiency.

IV. INSTALLATION OF BASIC COMPONENTS

★ ★ ★ **WARNING** ★ ★ ★

Failure to comply with the installation instructions given below could produce hazardous conditions resulting in the injury or death of the ship's occupants and destruction of the vessel itself. Make sure that the warnings that are listed at the end of this guide are fully understood and followed.

If there are any parts of this manual that are not fully understood, please contact Aqua-Air® so that we can further clarify the point.

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A. Fan Coil

In all applications, the fan coil should be installed so that the air discharge is at least three feet above the floor level. The best possible situation is to have the air discharge at or near the ceiling. The reason for this is that cold air is denser than air at ambient temperature. When the cold air is discharged from the grille, it begins to fall because it is heavier than the surrounding air. The cooling unit should be installed with the drain pan at the bottom of the unit. In this position it will be able to catch any condensation coming off of the fan coil itself. A drain fitting should be installed and a hose run from the fitting to a shower sump or overboard discharge. It should not be connected to a seawater discharge from any other pump as this will prevent the unit from draining. There should be at least a 1″ drop in the line as soon as it leaves the drain fitting. It is not advisable to run the drain into the bilge where the water could become stagnant and foul smelling. The two recommended places to send the drains is either into a shower sump or into an independent overboard fitting. On a hot, humid day, as much as several pints of water can be removed from the air by the fan coil.

It is important that there is adequate space for the air to travel to and from the fan coil. On type AQBHW, AQH, AQP and AQV fan coils, the cross sectional area of the discharge should equal to the fan coil area. On type AQBVW, AQCW, AQOCW, AQCW-L, AQOW and AQOHW fan coils, the discharge grille area should be equal to twice the blower flange area. This will not only reduce the amount of noise that is heard from the unit but it will also improve the air flow characteristics of the system. On most grilles there are numerous air restrictions such as blade, frames, levers, etc. When reference is made to the cross sectional area of a grille, it is speaking of the open, unrestricted area of the grille. On some grilles as much as half of the face area is obstructed. In this instance it would be necessary to double the size of the grille to get the necessary face area.

A return air filter should be in place on either the back of the return air grille, in the return air duct or on the cooling unit itself. These filters should be cleaned on a monthly basis if the system is used regularly. Suggested supply air and return air grille sizes are listed on the individual unit brochures.

The fan coil is wired to either the thermostat or the fan coil relay box. Please refer to the end of the manual for wiring diagrams.

If the water regulating valve is mounted directly on the unit, there must be access to it after the unit is installed. This will prevent any costly service problems from occurring later. On the AQH model fan coils there should be at least 2″ of clearance behind the blower housing. This will allow removal for servicing. All return air access holes to the units should be large enough to allow for removal of the filter (AQP, AQV) and/or the motor tray (AQH, P, V).

★ ★ ★ **WARNING** ★ ★ ★

To avoid an electrical shock from a piece of equipment that has shorted out, always ground an Aqua-Air® system in the manner outlined below:

1. **Use wire of a suitable size with a ground to feed power to the switch assembly terminal block or the fan coil relay box. Make sure that the ground wire is connected to the ground lug inside of the circuit breaker panel.**
2. **Connect the ground wire to the ground lug on the switch assembly terminal block or the fan coil relay box.**
3. **Connect the green wire from the fan coil to this same lug.**
4. **Connect a wire of suitable size with a ground wire from the circuit breaker panel to the ground lug on the chiller.**
5. **Connect a ground wire from the seawater pump, chillwater pump and pump relay (if used) to the chiller ground lug.**
6. **Connect the chiller unit ground lug to the ship's bonding system.**
7. **Check for continuity between all of the above points.**

Failure to comply with the above instructions can result in serious injury or death.

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B. Chiller Units

The Aqua-Air® chiller units are designed for installation in almost any area in the boat. They are unaffected by moisture,

AIR CONDITIONING SEAWATER SYSTEM

① Thru-hull fitting, speed scoop type. Should be located as close to the keel as possible (6″ away max.), forward of the stuffing box and aft of the foward engine room bulkhead.
② Sea-cock.
③ Seawater strainer. Must have a removeable internal basket for cleaning purposes. Can also be used with an outside strainer in areas where there is a heavy debris or jellyfish problem.
④ Seawater pump. Must be mounted below the waterline under all conditions.
⑤ Condensing unit seawater inlet (lower of the two fittings).
⑥ Condensing unit seawater outlet (higher of the two fittings).
⑦ System high point. There can be only one high point in the system.
⑧ Overboard fitting. No more than 1-2″ above the waterline to allow for quiet water drainage . Water discharge should be visible from deck. There should be a separate seawater overboard for each system.

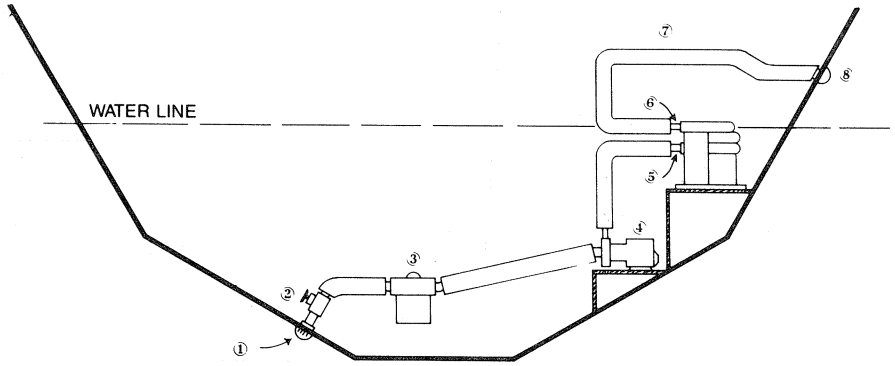

FIGURE 1

vibration or ambient temperatures up to 140° F. They are also designed to withstand the heavy jolts that a unit can experience in a boat when it is in a heavy sea. All of the refrigerant components are hermetically sealed.

The chiller units can be installed wherever there is sufficient space. The chiller should either be screwed or bolted down in a horizontal position. It is not necessary to mount the units on shock mounts because the compressors on the units are already shock mounted. The unit should be mounted in such a way that it is easily accessible for service work or maintenance. There should be a minimum of 18″ clearance over the top of the unit in case the compressor ever has to be removed. There should also be easy access to the electrical box. This is very essential.

When hard piping a chiller in, there should always be hose connections between the chiller and the pipe. There should also be a gate valve on the piping so that if the chiller has to be removed, the valve can be shut off and the flexible hose connections loosened. This will prevent losing all of the water in the system when the chiller is being worked on.

C. Pumps

In a chillwater system there are two types of pumps:

1. Chillwater pump
2. Seawater pump

The AQ-30, AQ-30-2(C) and the AQ-60 come equipped with their own internal chillwater pump. The only time that an external chillwater pump is used is when two or more chillers are manifolded together. In this application, the internal chillwater pumps are used solely to pump water through the chiller coil itself and then on to the chillwater manifold. The main chiller pump then circulates the water to the rest of the system. The AQF(H) chillers use a separate chillwater pump. This should again pump through the chiller tank and then on to the system or manifold. The only acceptable ways of mounting the chiller pump is shown in **Figure 2** below.

SHOWN BELOW ARE THE ONLY TWO ACCEPTABLE WAYS THAT A PUMP SHOULD BE MOUNTED. ANY OTHER WAY CAN CAUSE AIRLOCKS OR EXCESSIVE PUMP MOTOR BEARING WEAR.

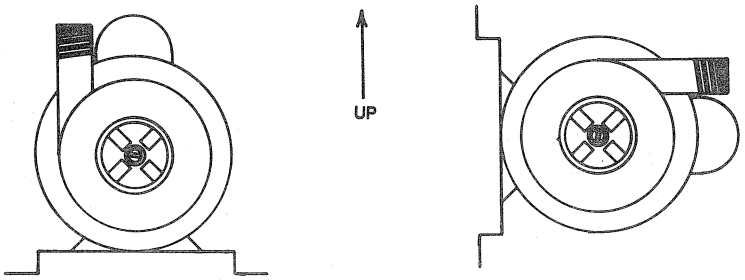

FIGURE 2

The seawater pumps used on the Aqua-Air® systems are centrifugal pumps. Because of this they are not self priming and therefore must be mounted in the following manner:

1. The pump must be securely mounted at a point in the hull that is below the water line of the boat under all conditions (see **Figure 1**). The position of the pump should be as close to the centerline of the boat as possible, no further forward than the front of the engine compartment and no further aft than the propeller shaft stuffing boxes. The pump should be mounted in a horizontal position and never on its head or end. The only two acceptable positions are shown in **Figure 2.**
2. To make the system self-purging, there must be a steady uphill run from the seawater inlet to the sea strainer to the pump through the chiller and then to the overboard. This will permit any air in the system to easily escape. If the pump should ever become air locked removing the hose from the outlet of the pump will release the air. The seawater inlet for this pump should have a clamshell type scoop over the inlet to force water into the thru hull when the vessel is moving. If this type is not used a suction can be created across the seawater inlet, starving the pump of water.
3. To wire a pump into a single chiller, connect the black and white wires coming from the pump to the proper lugs on the chiller unit. The green wire should be connected to the ground lug. On a system with a pump relay, connect the black and white wires to the terminal block marked "PUMP." The green wire should then be connected to the ground lug.

D. Thermostats and Fan Speed Controls

Thermostats and fan speed controls are the devices by which temperature is controlled, fan speed is regulated and system status indicated.

The thermostats supplied by Aqua-Air® have either an internal temperature sensor (AQT39A, B, H, HZ, M) or a remote temperature probe (AQSD3, AQSW1, AQSW3). Thermostats with internal temperature sensors should be mounted a minimum of 5′ above the floor. They should also be mounted in an area where the supply air does not blow directly on the thermostat. Mounting them on exterior walls, engine room bulkheads and in locations where the sun can shine directly on the thermostat is also discouraged. An electrical box should be placed over the rear of the thermostat to prevent the wires from being damaged.

Thermostats with remote temperature sensors are mounted over a suitable size hole and then fastened in place with four screws. The wire coming off of the thermostat end in a terminal strip which should also be securely mounted. After all of the wiring is completed, the covers that were supplied with the thermostat should be put over the terminal block and the rear of the thermostat.

The thermostat has a 10′ temperature probe. The bulb at the end of this length must be mounted in the return air flow going to the fan coil or in an area in the room where it will sense the average temperature of the room. The outlines given above for mounting the thermostats with internal temperature sensors should be followed with this type of installation. When mounting the sensing bulb near the unit, it should never come in direct contact with the unit itself. To do so would render the thermostat inoperative. It is also recommended that the bulb not be painted as this lessens the sensitivity of the thermostat.

Independent fan speed controls are usually mounted in an area very close to the fan coil that they are controlling. The wires and terminal block coming off the back of the unit should be securely mounted. All protective covers should be installed as soon as the wiring has been completed.

E. Piping

There are several different mediums by which chillwater systems can be piped. The most commonly used are:

1. Type L or M copper pipe
2. PVC (CPVC if it is a hot water heating system)
3. Single braid hose.

Regardless of the type of piping used, all of the pipes must be insulated. The recommended wall thickness for insulation on chillwater lines is ½″. All of the insulation joints should be sealed by first gluing and then taping them neatly with duct tape. If there are any areas where air can get to the pipes, condensation will start to form on the pipes. This condensation will eventually water log the insulation, rendering it worthless.

All of the drain lines from the fan coils should also be insulated with a minimum of ⅜″ wall insulation. If these lines are not insulated they can also sweat.

F. Relays

Fan coil relays (HR, HRS, MFR, FR, FRS) are used when the system amperage is too great for the thermostat to handle. These relays should be mounted in an easily accessible area near the fan coil that they serve.

Pump relays should be mounted as close as possible to the pumps but not in an area where they could get wet if there was to be a water leak form one of the pumps. Please refer back to the section where a description of the different types of pump relays were given. This will also help determine where a relay should be mounted, i.e. in the engineroom or in another location.

V. STARTUP PROCEDURES FOR AQUA-AIR® MARINE CHILLERS

A. Introducing Fresh Water into the Chillwater System

1. Make sure that there is sufficient fresh water in the pressurized fresh water system to fill the entire chillwater system.
2. Open the gate valve separating the main fresh water system from the chillwater makeup system and allow water to enter the chillwater system.
3. If there is a pressure gauge on the chillwater system it should indicate 12-15 PSI on the chillwater side. These are the normal operating pressures.

B. Chillwater Pump Startup

1. AQF(H)16, 24, 36CWPC
   A remote changeover switch (AQCWP series) is used to turn the chillwater pump on.
2. AQ-30, AQF(H) 16, 24, 36CWPC
   When the switch on the side of the chiller electrical panel is turned on, the chillwater pump will come on.
3. AQ-30-2, AQ-60
   Turn the top black switch on. This will energize the internal chillwater pump. On the AQ-60 there is a pipe plug at the top of the chillwater pump head. Remove this momentarily to release any trapped air. Before replacing, put pipe sealant on the plug threads.
4. If two or more chillers are used, turn the circuit breaker on for the main chiller pump. If it has a plug in the head, remove to allow air to escape. Replace as described above after only water comes out. Then turn on the individual pumps on the chillers as described above.

C. Bleeding Air from the System

1. Turn on each individual room thermostat to the full cooling position. Make sure that the water valve on the fan coil is open. This can be determined by looking at the water valve. With the lever at the top and looking at the top of the valve, the lever should be in the full left position.
2. Start with the lowest unit in the boat, progressing to the highest, begin bleeding each unit. On the units with schrader fittings, depress the pin inside of the fitting to release the trapped air. On the units with the screw type bleeder, turn the screw counter clockwise until air and/or water begins coming out of the bleeder outlet. After only water comes out, turn the screw clockwise to shut the bleeder off.
3. Continue this operation until no air is heard passing through the chillwater lines. Any air in the lines reduces the chillers cooling capacity.

D. Turning the Chiller Compressors On

1. Make sure that the seawater pump is properly connected to the chiller. Also be sure that the seawater inlet valve is open and the seawater strainer is not restricted in any way.
2. AQF(H)-16, 24, 36CWPC
   After the main chillwater pump switch has been turned on at the remote changeover panel the selector switch should be turned to the desired mode. On the AQCWP-01(C) unit turning the mode switch to either cooling or heating will energize the compressor on the chiller. On the AQCWP-02, 03(C) after the operation mode has been selected then the individual chillers can be turned on at the switch panel. The compressors will come on when there is sufficient water flow through the chiller. All units are set to cycle off at 42 degrees.
3. AQ-30
   When the switch on the unit is turned to the on position or cool position, the compressors will automatically come on when there is sufficient water flowing through the water flow switch (FSC-210). On the AQ-30 there is a standard 10 second delay. This is optional on the other units. All units are set to cycle off at 42 degree water temperature.
4. AQ-30-2, AQ-60
   The two switches below the top black switch control the compressors. The switch closest to the front is the #1 compressor while the other is #2. Either compressor can be turned on independent of the other. There is a standard 10 second delay on compressor #1 and 20 second delay on compressor #2. As long as all the air has been bled from the system, the compressors should come on after the time delay period. The #2 compressor will cycle off at 45 degree water temperature and the #1 compressor at 42 degrees.
5. At this point, if the unit does not come on and the wiring has been checked and all the air has been removed from the system, adjust the internal baffle inside the FSC flow switch so that it partially restricts the water flow. If the unit still does not come on, a competent air conditioning service mechanic should be brought it.

   The system is fully operational and will cycle on and off automatically. On systems that have a cooling only chiller with heat strips on the fan coils, it is not necessary to turn the chiller off when heat is desired. The individual airhandler water valves will shut off when the heat mode is selected. As the water temperature in the water lines decreases to 42 degrees the chiller will cycle off by itself. On a reverse cycle unit either heating or cooling must be selected at the chiller or at the remote changeover switch that is optional with this system.

VI. MAINTENANCE

A. Cooling Units

All of the fan motors (except the AQCW series units) should be lubricated on a yearly basis with SAE20 oil. At the beginning of the boating season, the cooling unit drain pan should be checked for proper drainage. This can be done by pouring a quart of water in the drain pan. It should completely drain within 30 seconds. Also, all of the return air filters should be cleaned. This should be done on a monthly basis when the system is in continual use.

B. Chiller Unit

The chiller unit requires no maintenance at all that can be provided by the boat owner. It is a sealed unit and there should never be a need to add any refrigerant to the system.

C. Seawater System

The seawater pump requires no maintenance. The seawater strainer should be cleaned on a monthly basis when the system is in use. This time period will vary based upon the surrounding water conditions.

VII. WINTERIZING

A. The Seawater Circuit

1. Chiller Unit — Remove the seawater hose running from the chiller unit condenser inlet to the seawater pump outlet. This will allow all of the water in the condenser to drain out.
2. Seawater Pump — Close the seawater inlet and loosen the screws on the head of the pump. This will allow the water to drain from the pump.
3. Seawater Strainer — Drain and clean the strainer.
4. Seawater Inlet — Remove as much water as possible from the seawater inlet.

B. The Chillwater System

At least 25% of the water in the chillwater circuit should be drained and replaced with propylene glycol anti-freeze. This mixture should then be circulated for several hours to make sure that the anti-freeze has adequately mixed with all of the fresh water in the chillwater circuit. This mixture can be left in the system under normal operating conditions.

CHILLER UNIT RECOMMENDED WIRE AND BREAKER SIZES

UNIT	VOLTAGE	WIRE SIZE	BREAKER SIZE
AQFH-16CW	115V	#10	30 AMP
AQFH-16CWCC	230V	#12	20 AMP
AQFH-24CWPC	230V	#12	20 AMP
AQFH-36CWPC	230V	#10	30 AMP
AQ-30	230V	#10	30 AMP
AQ-30-2	115V	#08	50 AMP
AQ-30-2C	230V	#12	20 AMP
AQ-60	230V	#06	50 AMP

AMPERAGE RATINGS FOR RESISTANCE HEATING LOADS

	SINGLE PHASE						THREE PHASE				
KW	120V	208V	240V	380V	440V	480V	208V	240V	380V	440V	480V
1	8.4	4.8	4.2	2.7	2.3	2.1	2.8	2.5	1.8	1.4	1.3
2	16.7	9.7	8.4	5.3	4.6	4.2	5.6	4.9	3.6	2.7	2.5
3	25.0	14.5	12.5	7.9	6.9	6.3	8.4	7.3	5.4	4.0	3.7
4	33.4	19.3	16.7	10.6	9.1	8.4	11.2	9.7	7.2	5.3	4.9
5	41.7	24.1	20.9	13.3	11.4	10.5	13.9	12.1	9.0	6.6	6.1
6	50.0	28.9	25.0	15.8	13.7	12.5	16.7	14.5	10.8	7.9	7.3
7	58.3	33.7	29.2	18.6	16.0	14.7	19.6	16.9	12.6	9.3	8.5

WIRE AMPERAGE RATINGS

(105° C — 600V — Copper-Stranded)

AWG Size	Amps/Conductor
#18	5 AMPS
#16	7 AMPS
#14	15 AMPS
#12	20 AMPS
#10	30 AMPS
#08	40 AMPS
#06	50 AMPS

★ ★ ★ WARNING ★ ★ ★

The James D. Nall Company, Inc. hereafter referred to as the "Manufacturer" makes the following warnings in regard to the use of its products. Even though these warnings are comprehensive, there are certain dangers that might arise which at this thime, are unforseeable. A thorough understanding of the dangers outlined below will help as a guide for spotting other potentially dangerous situations. This understanding is very important in assuring your safety.

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Electricity
Aqua-Air® products operate on voltages ranging from 115 v. to 440 v. AC power. Because of the danger involved with these voltages, all metal components (bases, cabinets, units), must be grounded in some way to the ship's grounding system. Some of the relays switches and thermostats used in the Aqua-Air® systems are not ignition proof. Because of this, the ventilations blower on a boat should be run for five minutes prior to and during the operation of any Aqua-Air® product or system. All electrical connections must be sealed or covered in such a way as to prevent contact by unauthorized personnel. Such contact could lead to permanent injury or death.

Electrolysis
Any electrical leakage of a component can cause electrolysis. This could lead to the deterioration of a thru-hull which could cause leakage of water into the boat which could result in sinking the vessel. All Aqua-Air® products must be kept clean and dry. They should be periodically checked for electrical leakage. If detected, the faulty component should be either repaired or replaced.

Gas
All Aqua-Air® systems utilize refrigerant number 22 (monochlorodiflouromethane). This gas is non-toxic and non-flammable. This gas contains no oxygen and will therefore not support life. When burned this gas deteriorates into potentially lethal gases. If a refrigerant gas leak is discovered, evacuate all personnel from the area and prohibit the use of any item using an open flame. Due to the high pressures involved in refrigeration systems, eye protection, gloves and long-sleeved clothes should be worn during servicing of a system. Extensive frost burns can occur to the eyes and skin if they come into contact with liquid refrigerant.

Ventilation
To either cool or heat air, Aqua-Air® systems move air through a heat exchanger by means of either a propeller fan or blower system. This process naturally causes a suction on one side of the unit and a pressurized area on the other. These heat exchangers or "cooling units" as they are referred to in our brochures must be installed so that this suction-pressure action does not (1) pressurize an area to the extent of causing structural failure of the area which could cause injury and does not (2) cause a suction in an area where vapors from batteries, fuel, and operating equipment exist. If a cooling unit were installed in this way then these vapors could possibly be discharged into a living space where they could be hazardous.

The best way to prevent the introduction of dangerous gases into a living space is to make sure all living spaces are carefully sealed from all other spaces. It is never advisable to completely seal an area without some sort of auxiliary ventilation in the event of lethal gas or fumes escaping from any source.

Condensate
All Aqua-Air® units produce water condensate from the air during normal operation in the cooling mode. This water must be drained overboard. If allowed to drip on wood, dry rot can form causing structural failure. If allowed to drip on electrical components, deterioration of the components can occur. When the cooling unit is in operation, a negative pressure is exerted on the condensate line. Always locate condensate outlets as far as possible from sources of fumes or dangerous gases. These fumes and gases could be drawn into the system due to this negative pressure resulting in a potentially hazardous situation.

★ ★ ★ WARNING ★ ★ ★

Never sleep in a closed area in a boat when any equipment, which functions as a direct result of the combustion of a volatile fuel, is in operation (such as engines, power plants, oil fired heaters, etc.). At any time their exhaust system could fail leading to a build-up of dangerous gases within the closed area.

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AQUA AIR
MARINE AIR CONDITIONING SYSTEMS

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