temperzone

HWP-K Series

WATER SOURCED PACKAGED AIR CONDITIONERS

Applications Manual

June 2008

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While this Applications Manual has been prepared and provided in good faith, Temperzone Ltd takes no responsibility for its accuracy and resumes the right to make changes at any time.

1. LOCATION AND ACCESS

1.1 The co-ordination of various trades is essential in order to achieve maximum accessibility for the maintenance, servicing and possible removal of any air conditioner after it is installed.
Ensure easy access to :
- electrical access panels
- fittings and valves at the water connections
- air filter for removal
- drain pan for cleaning.

1.2 Pipework, electrical cables and other obstructions must not prevent the unit from being totally removed, if necessary, at a later date.

1.3 Specify ceiling access panels under all ceiling space mounted units. The size and position of these access panels should allow for servicing of the unit as mentioned above.

1.4 Position each unit so that the principal sound emission is outside the most frequently occupied space, e.g. locate it over a hallway instead of a room.

1.5. Locate the units as close as possible to the shared foyer/corridor of each floor of the building to minimise the length and cost of water piping, and electrical conduit. This arrangement often provides more acceptable sound levels and easier maintenance.

1.6 For apartment and hotel buildings, mounting the unit inside a bathroom ceiling space is a good idea for both acoustic and access space reasons.

2. NOISE CONSIDERATIONS

The manufacturing company has put in its best efforts into designing a quiet unit, but these efforts can only be appreciated when the unit itself is properly installed and the unit is part of a good overall system's design.

2.1 Ducts and Outlets

2.1.1 Ducts and outlets should be generously sized. The actual sizes are determined by the air flow volume requirement. Generally the main supply air duct velocity should be below 4 m/s. Any branch ducting should have a velocity below 3 m/s. Filter face velocity should be no more than 1.5 m/s.

2.1.2 Use an internally insulated 90° elbow to attenuate fan noise.

2.1.3 Do not locate a return grille under or near a unit - place it at least 1.5m away.

2.1.4 When possible, separate turns or fittings with straight duct about 4 or 5 duct diameters long.

2.2 Recommendations For Noise Isolation

2.2.1 Line the entire duct acoustically with 25 mm internal insulation to aid sound attenuation and prevent condensate formation on the external surfaces of the duct.

2.2.2 Always use canvas flexible connections between unit and rigid ducts.

2.2.3 Use vibration isolating mounts between units and structure.

2.2.4 In sound critical areas, minimise direct sound radiation by installing an acoustic barrier under the unit. Use dense materials with a covering area of about twice the size of the unit footprint.

2.2.5 Wherever possible, separate duct turns or fittings with straight duct, about 4 or 5 duct diameters long.

2.3 Fan Speed

For each unit, select the fan speed which gives the required air flow appropriate to the static pressure of the attached duct. Use of an unnecessarily high speed could mean a big increase in noise level and only a small increase in duty.

3. WATER TREATMENT

In an open cooling tower system, system water is kept in continuous contact with ambient air, exchanging heat and substances which commonly cause problems such as corrosion, scale formation, biological growths and suspended solid matter. Poor system performance will occur when scale builds up on the heat transfer surface inside the water cooled unit's condenser pipework. Because of the reduced effectiveness of the condenser heat transfer surface, a seriously scaled condenser will cause the heat pump to cut out in high pressure in the cooling mode or low temperature safety in the heating mode.

The complexity of water caused problems and their correction in cooling systems makes it important for the system's designer to obtain the advice of a water treatment specialist as early as possible in the design stage and to follow the specialists advice regularly thereafter during design, construction and operation.

There has been a significant improvement in water treatment chemistry in recent years. Currently used chemical compounds include crystal modifiers and sequestering chemicals.

It is recommended that a water analysis test be carried out and advice be sought from a water specialist on the results before doing a selection of heat rejection equipment and a water treatment method. The use of an open cooling tower is discouraged where scale and corrosion could be a problem.

4. WATER LOOP CONTROL

4.1 Water Loop Temperature

Proper water loop temperature control is critical to the operation of a hydraulic system. Loop temperatures outside the recommended range (i.e. 10°C - 40°C) will severely impact equipment performance.

Loop Temperature	System Function
5°C	Internal low temperature safety cuts off the heat pump operation
10 - 15°C	Run gas or electrical boiler to put heat into the loop
15 - 30°C	Balance, neither add nor reject heat from the loop.
	Run circulating pump only.
30°C	Start Cooling Tower water pump.
32°C	Start Cooling Tower fan.

Position the water temperature sensor downstream of the cooling tower and upstream of the water heater.

4.2 Interlock Control for Heat Pumps (Reverse Cycle Units)

Maintaining water flow is vitally important to water cooled heat pumps, as a loss of flow will put the water side heat exchanger in danger of freezing up.

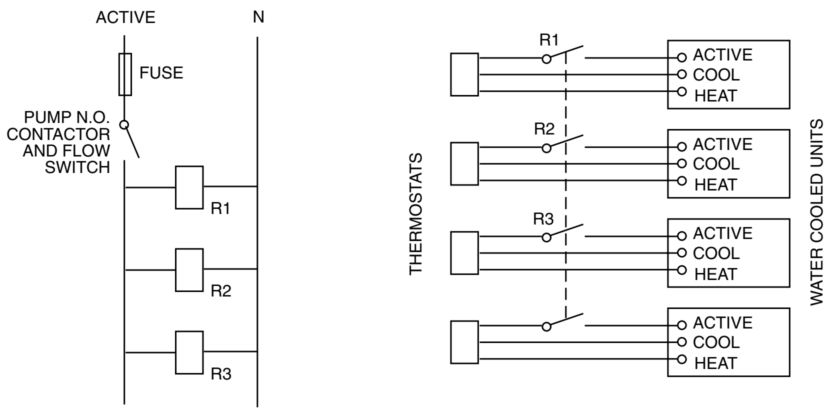
Low water flow may result in:

a. Tripping of the high pressure safety switch in every heat pump operating in the cooling cycle.
b. Tripping of the low temperature safety switch in every heat pump operating in the heating cycle.

In both cases, the units will remain off until each affected unit is reset - either by breaking the power supply to each unit or breaking the thermostat control circuit, i.e. by turning each unit off and on again.

There are several ways to provide the water flow interlock depending on the design of the overall System. For example:

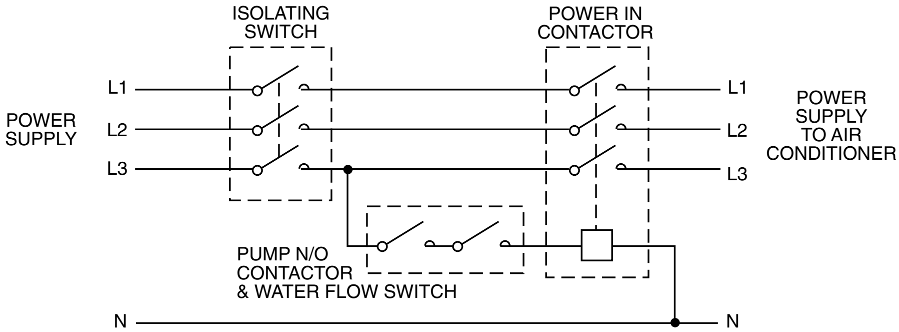
1. Heat pumps can only run when there is water flow, i.e. water flow is proven to exist.



Typical Single Relay Set-Up

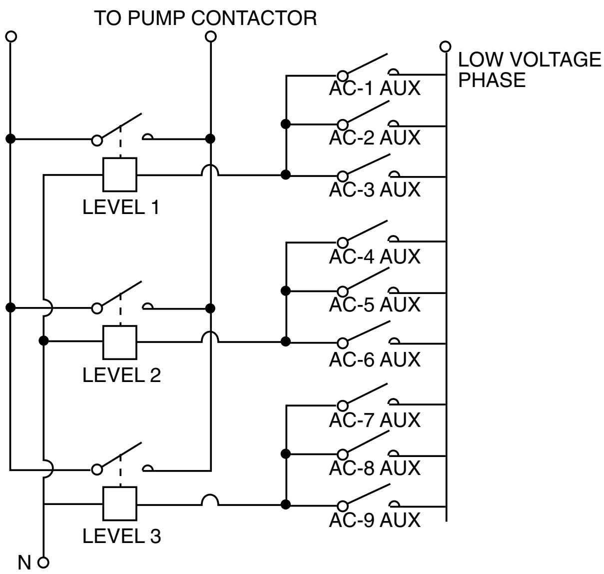
Also refer to *Installation and Maintenance* instructions for each **temperzone** unit as there are different requirements for different size units.

2. Install an interlock 'power in' contactor for the main power supply to the whole water cooled air conditioning system, or alternatively to each floor's group of units.



No pump running, no power supply to the units.

3. Water Pump Operated by Water Cooled Units.
The water pump will be started by whichever unit starts after hours in an office building or in a partially occupied residential building.
A spare normally open auxiliary contact in the compressor motor contactor can be used for this purpose. Have a common relay at each floor or tenancy. The relay's coil is wired to each individual unit on the floor shown in the wiring diagram.



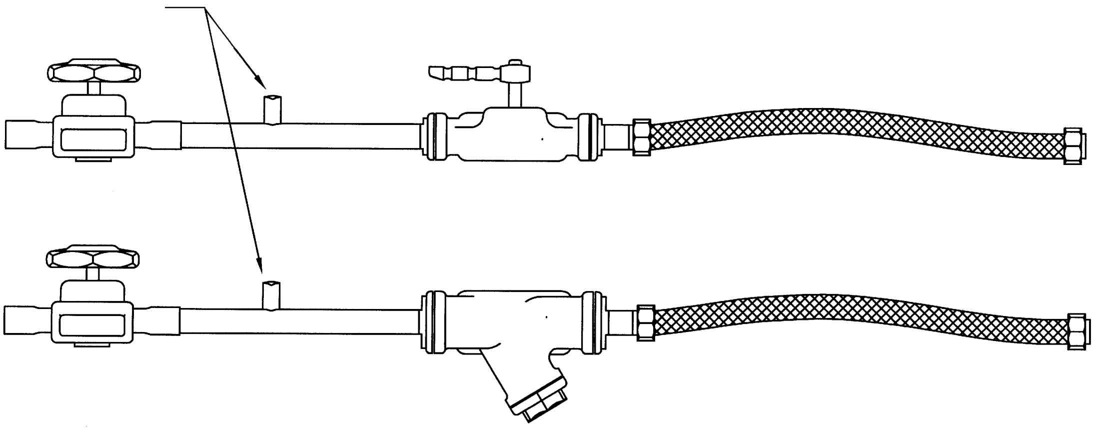
5. SELECTION OF BALANCING VALVES

On top of ensuring clean water in the right temperature range is flowing through each unit, it is essential to ensure the water flow rate meets each individual unit's requirements. Balancing valves are employed to balance pressure drops in each unit's circuit for the right water flow distribution. An ordinary shut-off valve or a gate valve is not suitable for this purpose.

Many different kinds of flow control valves can be used as balancing valves, but it is better accomplished with one of the following four types:

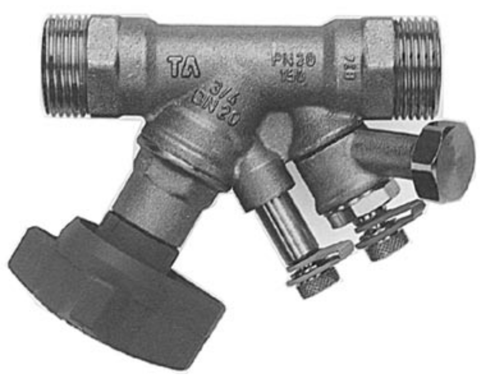
5.1 **Manual Ball Valves**

In simple systems, the water flow rate - which is inversely proportional to the temperature change across the unit - is determined from the entering and leaving water temperatures measured at the unit. During system balancing the ball valves are manually adjusted to achieve the desired temperature difference across the unit. In a direct return system, adjusting any ball valve changes the system conditions so that other valves must be re-adjusted to reach the correct setting. This re-adjustment procedure can be time consuming, therefore this set up is only suitable for installations with very few units. Refer to the typical set up below.



5.2. **STAD Valves**

These valves are precisely manufactured to give the same flow at a given opening for all valves of the same dimension. A pair of pressure tapping points allow the reading of flow rate.

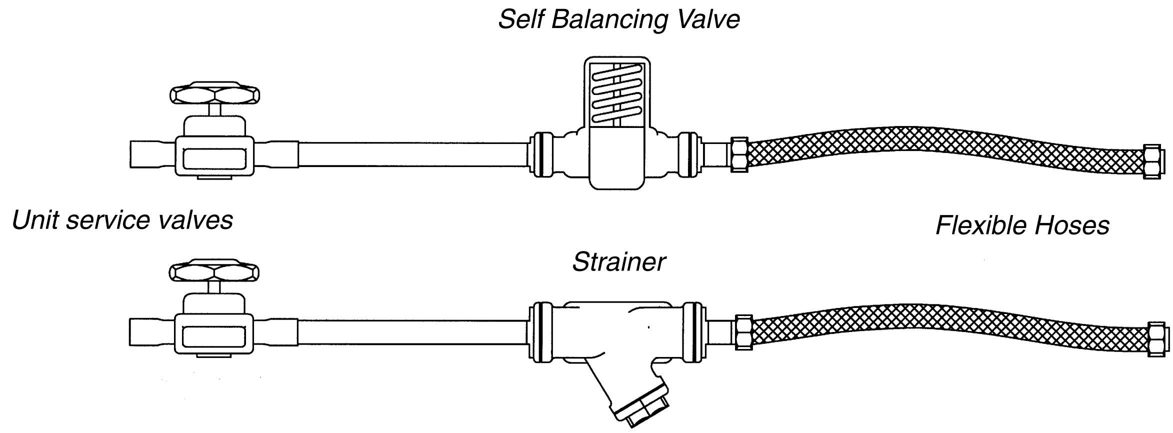


Digital meter for pressure

The valve manufacturer's can supply digital meters for pressure drop readings across the valve or even read converted flow rates. This type of valve has a memory stop hand wheel - the pre-setting of which needs to be sealed. When the valve is reopened after a service shut-off, the original valve setting is automatically obtained. Only one valve is required on the return water side for both balancing and servicing.

5.3 Automatic Flow Control Valves

This self-balancing type of valve eliminates the fiddly time consuming adjustments associated with manual flow controls. One size of valve body combined with a flow rate fixed cartridge provides the designed flow to each unit. The automatic flow controller immediately adjusts to water line pressure changes and compensates for any fluctuations to maintain constant water flow to the unit.



5.4 Water Regulating Valves

This head pressure controlled valve is often used -
(i) where the pressure of the system fluctuates,
(ii) where the temperature of the system fluctuates widely,
(iii) for precise control of large direct return system.
The valves can be calibrated to the units design flow rate before the units are installed. As long as the most distant units in the system are provided with enough water pressure, then every unit will have correct the water flow without the need for further system balancing.

A water regulating valve will shut off water flowing into the unit when the unit's compressor stops. The reduced total water flow in the system will equate to reduced energy requirements and lower running costs.

The disadvantage of the valve is that -
(i) in practice, it is only used in cooling only hydronic systems
(ii) it requires a higher pressure in the water pump, and
(iii) they are quite expensive.

Water Regulating Valve

6. HEAT REJECTION EQUIPMENT VARIATIONS

There are a number of different forms of Heat Rejection Equipment that can be applied to a water cooled air conditioning system to remove surplus heat. The three most widely used forms are :

1. Open Cooling Tower
2. Open Cooling Tower with Plate Heat Exchanger
3. Dry Air Cooler (Radiator)

There are some advantages and disadvantages when using each of the above types.

6.1 Open Cooling Tower

Advantages :

i. Of all the costs associated with heat rejection equipment the Cooling Tower is the least expensive.
ii. The Cooling Tower will take up the least amount of floor area.
iii. The Cooling Tower works on the evaporative cooling principal and therefore can cool water within a few degrees of the ambient wet bulb temperature. This enables a greater degree of cooling to be achieved by the cooling tower.
iv. Because lower air volumes are required this will mean lower power consumption and lower noise levels.
v. A cooling tower design is extremely flexible with counter and crossflow as well as axial and centrifugal fans.
vi. Part load running costs can be reduced by incorporating two speed motors.

Disadvantages :

i. A number of countries are insisting that Cooling Towers meet very stringent design considerations to offset the likelihood of an outbreak of Legionnaires Disease. This will increase the installed and maintenance costs quite considerably.
ii. Where the use of water is a major consideration the makeup and bleed water required in the use of a cooling tower can represent approximately 5 litres per kW/hour of cooling.
iii. The water to be cooled in a cooling tower is in direct contact with the air stream. Therefore the impurities in the air are washed out causing contamination of the cooling water. Where the water hardness is high, continuous makeup water requires continuous water softening. Without an expensive treatment system this can cause scaling and corrosion of the piping system.

6.2 Cooling Tower With Plate Heat Exchanger

Advantages :

i. All of the advantages of the cooling tower apply.
ii. The secondary loop in which the water cooled units are connected is totally sealed against accumulation of dirt and impurities, therefore there are no water quality associated problems after the initial water treatment.
iii. The open cooling tower can be placed outdoors, with the more temperature critical heat exchanger placed indoors.
iv. There are no water loop heat losses through the tower during the winter months.

Disadvantages :

i. The same Cooling Tower disadvantages apply.
ii. The initial cost is more than the Cooling Tower alone.

6.3 **Dry Air Cooler (Radiator)**

Advantages

i. The outdoor air has no direct contact with the water supply therefore this type of unit does not have any Legionnaires' disease concerns.

ii. As the outdoor air has no direct contact with the water supply water bleed is not required, nor is a water make-up to compensate for wind drift and water evaporation required. The water usage associated with a cooling tower is eliminated.

iii. The water loop is totally enclosed therefore: no harmful impurities, no make-up water, no scales.

Disadvantages

i. The dry cooler does not take advantage of the energy saving evaporative cooling principal but depends on sensible heat transfer.

ii. The units are physically larger in footprint than their cooling tower equivalent.

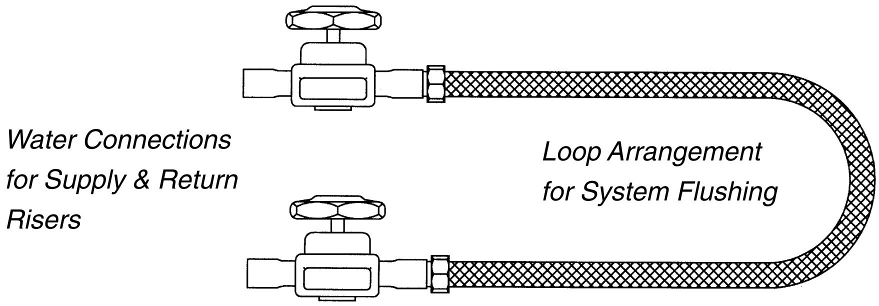
iii. Dry coolers require a higher air volume and consequently their fan noise levels will also be higher.

iv. The overall equipment cost is greater.

7. INITIAL CLEANING OF SYSTEM

It is extremely important to clean and flush the whole water system after installation is completed. The initial filling and cleaning of a water system should include the following options:

1. All equipment and piping should be thoroughly cleaned of iron cuttings and other foreign matter as they are installed.
2. All individual water cooled units must be isolated by looping the supply and return pipes with a flexible hose.



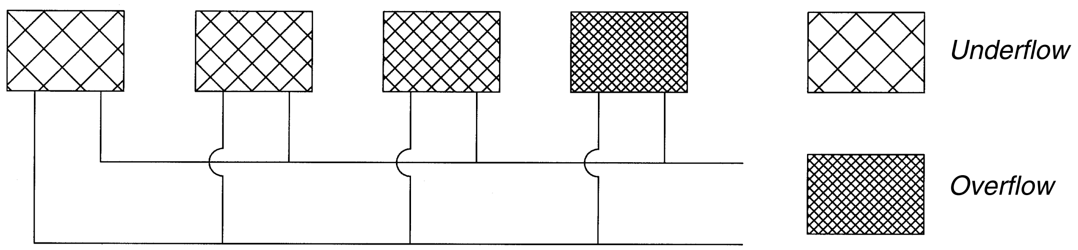
3. Open the air vents and fill the system with clean water. Monitor that the air vents do not overflow.
4. Check pump and its operation and ensure no leaks at the pump seals.
5. Make sure all strainers for the water pump have mesh (filters) inserted and all the 'Y' strainers, if fitted, for the units have their mesh out. Start the condenser water pumps and check the air vents. Add make-up water as necessary.
6. The lowest point of the water loop system should be fitted with a drain. Drain the system completely to flush out foreign matter.
7. If indications are found of excessive dirt, repeat the above flushing.
8. Check all strainers at pumps, and if a heavy accumulation of dirt is noted, reflush the system.
9. Replace all the Y strainer meshes at this stage, if fitted. Refill the system with clean water, venting all high points and equipment of air and gases. Add cleaner, such as tri-sodium phosphate. Check the loop water pH with litmus paper, it should be slightly alkaline (pH ≈ 7.5).
10. Remove the short-circuiting flexible hose now and make the correct supply and return connections to the units.

The system is now ready for a full test run.

8. WATER BALANCING

8.1 Why Balance?

It is obvious that in forced circulation water systems water flow can be too high in some circuits and too low in others in relation to the flows the designers intended them to have. Balancing is a matter of adjusting pressure drops to get precisely the right flows at each control loop and each terminal (air conditioner) under all operating conditions. However, if nothing is to compensate for it, the terminal closest to the pump will be favoured at the expense of the most distant circuits in a direct return system. Flows will be much too high close to the pump and much too low far from the pump. Even in a Reverse Return system, although each terminal is supposed to be at an equal distance (pressure drop) with the same flow rate, each individual water cooled unit can require different flow rates depending on its size.



8.2 Water Balancing Procedures

1. Before starting any water cooled unit , make sure the water system has been flushed. Ensure each unit has water and power connected to it and the water shut-off valves are fully open. Leave the water balancing valve in the mid position.
2. Balancing should start with the risers. Use each floor's flow control valve to balance the water flow at that floor and to ensure proper water distribution throughout the entire system.
3. On each floor, balance one horizontal branch completely before balancing another branch. Within each branch, balance the nearest unit to the riser first and work through towards the furthermost unit until the whole branch has been done. Then repeat the water balancing within the branch at least once more as above.
4. For every individual water cooled unit one of the methods below can be used to adjust its water flow rate to optimum :
    a. Measure and set the water flow through each unit to the nominal figure shown in the *Installation & Maintenance* instruction sheet. The compressor does not need to be operating. Run the compressor until the unit settles in.
    b. When the entering water temperature (EWT) is close to the designed condition, i.e. 35 ± 3°C, measure the outer surface temperature at the middle of the tube-in-tube condenser using an accurate digital thermometer (thermo couple type preferred). Adjust the balancing valve until the temperature is between 41 - 46°C.
    c. Adjust the water flow rate to achieve a 5 - 7°C difference between the leaving water temperature and entering water temperature (LWT-EWT) on cooling and accept 3–5°C on heating. Use an accurate thermometer combined with temperature wells placed inside the main stream of water pipe.
5. Once water balancing is finished, every balancing valve's position must be fixed to maintain the achieved water balance.

9. PRE START-UP CHECKS

Before commencing, both power supply and water supply should be connected and ready for all the water cooled units. The water loop pipes must have been flushed and cleaned.

Perform the following checks and record the results on a Commissioning Sheet (refer page 16) before start-up of a unit;

1. Water connections to the unit have been completed and the flow direction is the same as indicated on the unit. The service valves should be fully open and the balancing valve left in the mid position.
2. If an automatic flow control valve is used, check that the appropriate size cartridge has been inserted which complies with the units designated nominal flow rate (refer unit's *Installation & Maintenance* instructions).
3. Compressor locking devices have been removed and discarded (as per the installation instructions).
   HWP 33–49 models: Cut and remove the plastic cable ties holding the compressor against the electrical box.
   HWP 78, 95 models: Remove locknuts and washers from mounting studs and discard. Fit rubber isolating sleeves over mounting studs. Remove wooden shipping block from alongside compressor.
4. Check the drain by pouring water into the drain tray and ensuring that it clears.
5. Where spring mounts are used, adjust the spring on each of the four corners so they are evenly depressed. Check the unit is sitting on the springs freely.
6. Check air filtration is fitted in the system and is accessible for cleaning and/or replacement.
7. Check that the thermostat is correctly wired to the unit and is set at the desired temperature.
8. Check the supply voltage is between 200 - 252 volts.

10. TEST RUN

Test run the unit on both cooling and heating (if applicable) cycles and check the following :

1. Measure entering water temperature and record it on the Commissioning Sheet (refer page 16).
   If the water temperature difference (TD) method is used to balance the water distribution, the leaving water temperature is also to be measured. Set water TD at 5-7°C on cooling or 3-5°C on heating.

2. Measure the current draw on the compressor motor and the current draw of the fan motor. Check all readings against the specified valves in the *Installation & Maintenance* pamphlet or on the wiring diagram.

3. Measure the condenser surface temperature at its mid position. This temperature represents the condensing temperature.
   Note: The measuring of suction and discharge pressures is discouraged here.
   Each unit has been accurately pre-charged in the factory. Some units have only 400 grams refrigerant charge in total. Each unnecessary measurement will let out 20-40 g of charge which will affect the unit performance.

4. Measure the air temperature on to the unit and off the unit, and outside ambient temperature and record.

5. Check the supply air flow at each outlet. Balance the air distribution if necessary.

6. Listen for any unusual noises coming from the unit, unit mounting or ducting, and if there is any, correct them.

11. COMMISSIONING

WATER COOLED UNITS
Commissioning Sheet
(Sample)

Model No. : …………………………………… Start Up Date : ………………………………….

Serial No. : …………………………………… Unit Location : …………………………………

Checks Before Start-Up :

- Supply, return water piping connected ?…………………………………….
- Right Cartridge inserted ? ………………………………… (Auto flow control valves)
- Drain pipe drain water freely ? …………………………………..
- Mounting springs adjusted and balanced ? ………………………………….
- Air filter fitted ? ……………………………
- Room thermostat setting right ? …………………………………
- Supply voltage between 200-252V (1Ø) or 342-436V (3Ø) ? …………………………………………..

Cooling Cycle Operation :

- Compressor Amps ……………………………………
- Entering Water Temperature ………………………….. (Water temp. difference should be 5-7°C)
- Leaving Water Temperature ……………………………
- Mid Condensate Surface Temp …………………………………..
- Room Air On Temperature ……………………………………..
- Unit Air Off Temperature ……………………………………..
- Outside Ambient Temperature ……………………………………

Heating Cycle Operation :

- Compressor Amps …………………………………………
- Entering Water Temperature …………………………… (Water temp. difference should be 3-5°C)
- Leaving Water Temperature …………………………….
- Room Air On Temperature ……………………………..
- Unit Air Off Temperature ……………………………….
- Outside Ambient Temperature ………………………………….