MCLEAN GARDENS

Guide to the Heating and Cooling Systems at McLean Gardens

How They Function and Their Maintenance

Version 1.0

5/21/2013

This document explains the McLean Gardens heating and cooling system and recommended maintenance for proper functioning of the equipment involved. Potential problems related to the operation of these systems are discussed.

Version 1.0 May 21, 2013

Table of Contents

List of Figures

Version 1.0 May 21, 2013

Summary

McLean Gardens residents should be familiar with the Association's heating and cooling system and how to operate and maintain their individual systems. This document provides information on how these systems work. A summary of salient facts follows, with additional details provided in the attachments.

Heat pumps in individual units cool or heat the units. They require professional service and maintenance every six months and are subject to stringent operating conditions. Experts recommend that heat pumps be replaced when they reach the end of their useful life, estimated at from 12 to 15 years, but it may be shorter or longer. Individual parts may require periodic replacement. Maintenance, repair, and replacement of heat pumps are at the owner's expense.

Heat pumps require heated or cooled water, which is provided through PVC pipes from the McLean Gardens six central plants. The connections to the central plants involve pipes and valves located within the individual unit; these should be examined as part of routine maintenance for soundness and replaced by the owners, as required.

Heating and cooling depend on the operation of the central plants. When the plants are not in the appropriate operational mode the heat pumps, if used, can be damaged and/or the pipes that support heating and cooling can be damaged as well. If heat pumps are set to cooling while the plants are set to heating, the PVC pipes can melt.

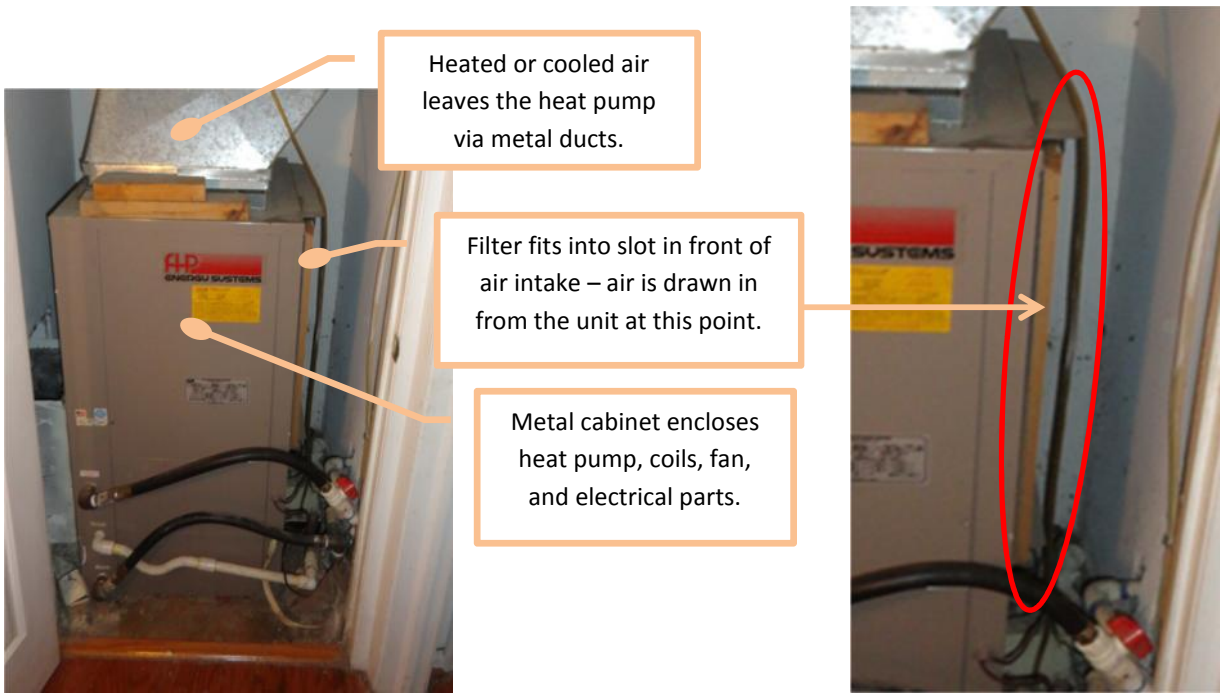
Central plants may not function due to season (e.g., cooling towers are shut down for the winter), maintenance, mechanical failures, or lack of electricity or water. McLean Gardens management issues written notices (paper notices delivered to each unit and via e-mail) as to the status of the plants and actions that should be taken to control the heat pumps when the plants are not operational.

Version 1.0 May 21, 2013

How Your Residence is Cooled and Heated

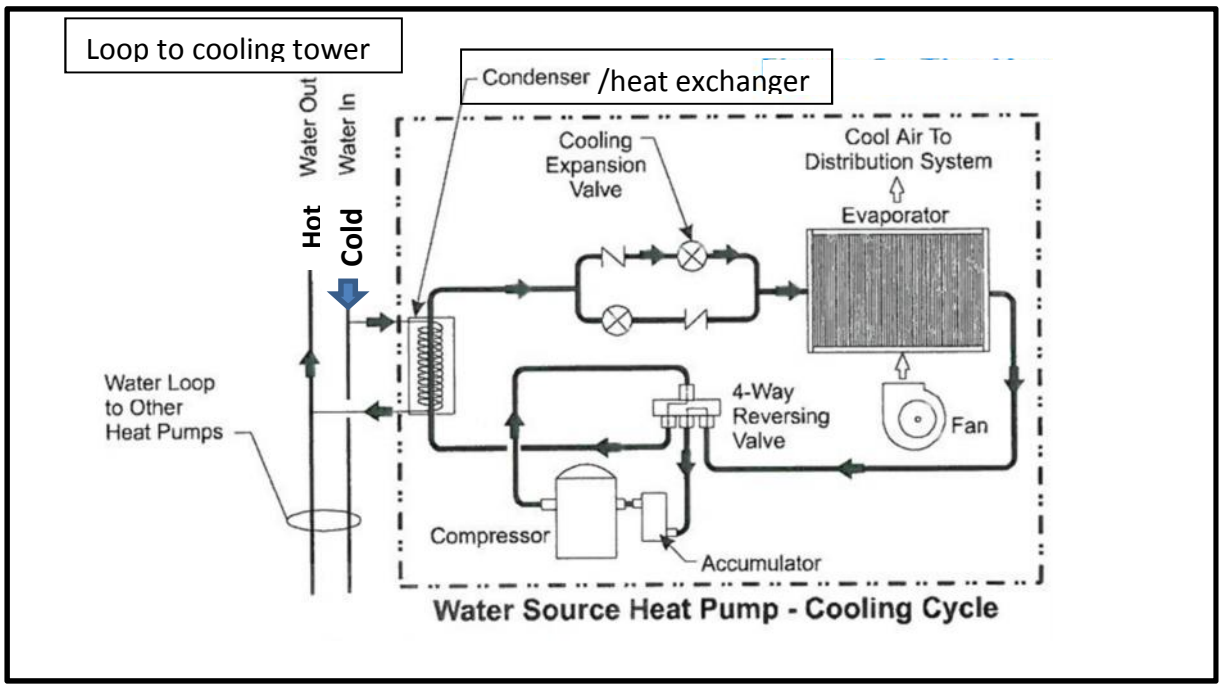
Each apartment has a water source heat pump, which provides heating or cooling depending on the season. This heat pump is owned by the unit owner, who is responsible for its operation, maintenance, and replacement. Figure 1 shows a typical unit heat pump system. Figure 2 is a diagram of the heating and cooling cycles related to heat pump systems. Heat pumps have an estimated useful life of 12 to 15 years; some estimates are as high as 20 years.

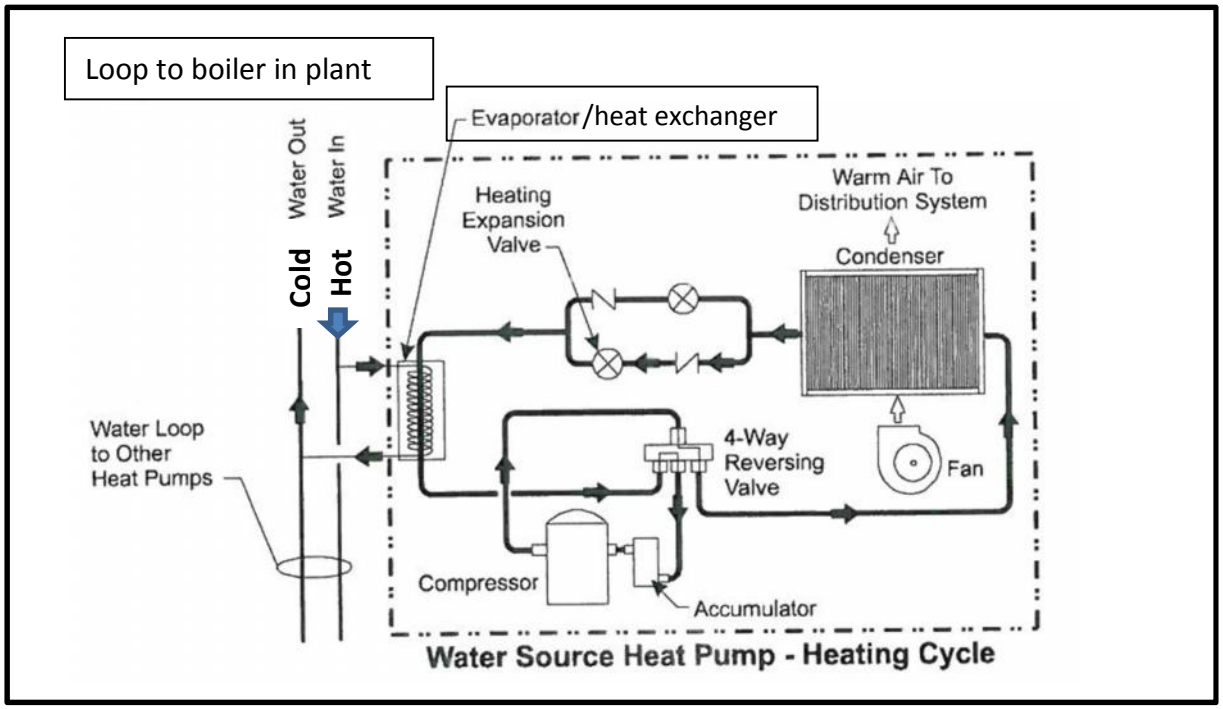
Figure 1. Typical Unit Heating and Cooling System



A water source heat pump generally is more efficient than an air source heat pump, but requires water that meets the conditions required by the heat pump – cooled or heated to the extent required by the heat pump to do its job. The heat pump is the machine that transfers heat to or from the unit to the water in the pipes connected to the plants via a loop. In the heating mode, the heat pump absorbs heat from the hot water in the loop (which action cools the water in the loop) and transfers the heat to the unit. In the cooling mode, the heat pump extracts heat from the apartment and heats the cooled loop water. The loop water, in turn, is heated by the boilers and cooled by the cooling towers. Figure 2 illustrates this cycle, which is basically the same as that of a refrigerator. **Note that serious and costly damage will result if the heat pump is set to cool when heated water is provided or is set to heat when cooled water is provided.**

Figure 2: The Heating and Cooling Cycles





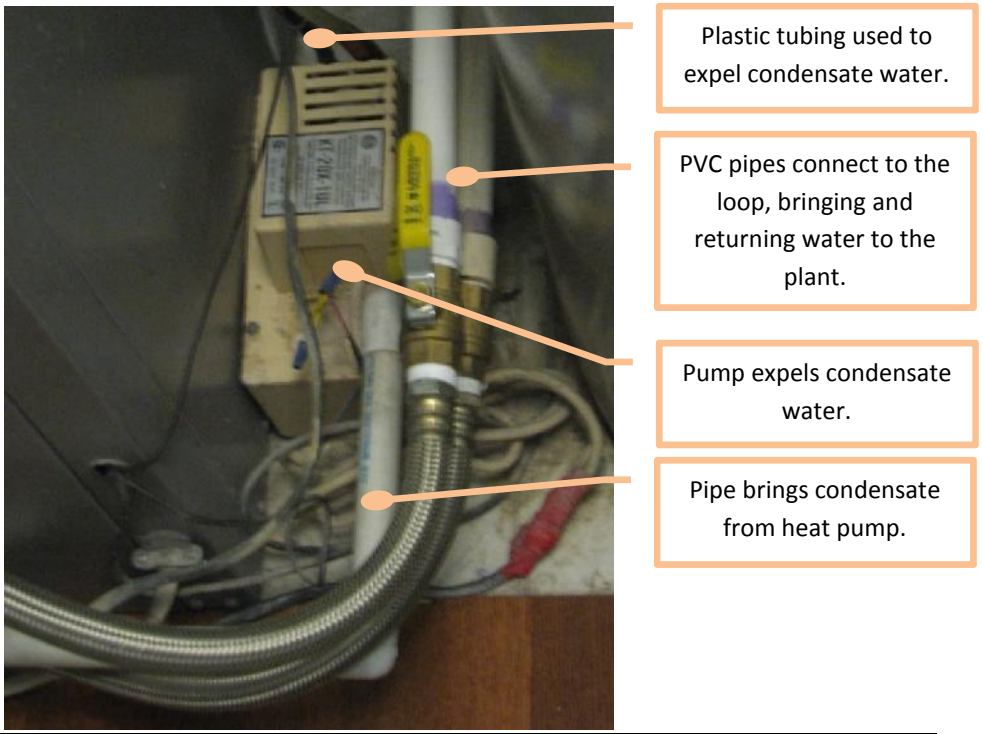
Condensation

The heat pump, during cooling season, condenses moisture that is in the air. This reduces the humidity in the apartment, but results in liquid water that must be disposed of. The heat pump enclosure includes a drain pan under the heat pump's coil to collect the condensed water. The water is carried by piping from the pan to a suitable termination point of disposal. Figure 3 shows elements of a condensate disposal system.

Without a regular program for servicing heat pumps, including cleaning the coil and changing filters, stoppage and water overflow can result. Overflow of the condensate will cause considerable damage to condominium units. In addition, where possible, periodic cleaning of condensate drainage pipes is conducted by Association maintenance staff.

The condensate drainage piping is routed as follows: For units A and B for buildings 1, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 26, 27, 28, 29, 30, and 31 (Phase I and II buildings), the condensate is pumped outside by a condensate pump located in the units. (See Figure 2.) For buildings 2, 3, 4, 5, 6, 7, 8, 23, 24, and 25 (Phase III buildings) the condensate drains into the washing machine's drain in the basement. A common vertical (riser) condensate drain line discharges the condensate from units A, C & E and B, D & F from each entryway.

Figure 3. Condensate Pump and Heat Pump Loop Pipes (Phase II Unit)



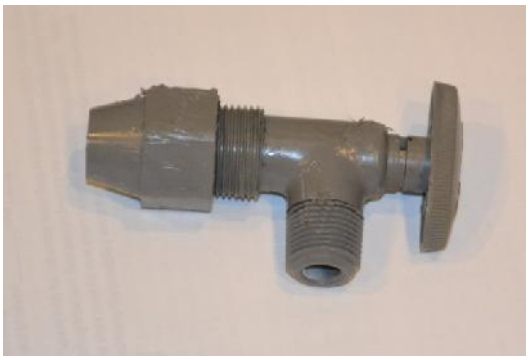
Recommended Maintenance (to Avoid Costly Repairs)

Proper maintenance will prevent most problems related to the heating and cooling system:

- Have your heat pump checked every six months by a certified and licensed contractor, and have the recommended maintenance performed. Many residents have maintenance contracts with their heat pump installers or other contractors for seasonal service. A properly-maintained heat pump works more efficiently, saving you money on energy bills, and prevents costly failures that could damage your and your neighbors' units.

- Replace aging or obsolete pipes and valves. The pictures in Figure 4 illustrate the types of valves that may fail due to age. (Contrast these with the valves in Figure 6, page 11.)

Figure 4. Plastic Valve(s)



- Replace heat pumps that are beyond their useful life.

- Replace the filter every three months (or sooner if dirty).

- If you have any questions about heat pump and related equipment problems and maintenance, call the management office at 202-966-9780.

Providing Heated and Cooled Water – The Plants

The Association provides cooled or heated water according to the season. Six plants located on the grounds heat or cool water that circulates through underground PVC pipes to each building, forming a loop. The plants and the buildings they serve are listed in Attachment A. Information on the equipment in the plants is in Attachment C.

In the heating season water in the loops is heated by boilers that burn natural gas. In the cooling season, cooling towers use electricity and water to dissipate heat – large fans move air over a large radiator and evaporate water. Electricity is also used to power pumps that circulate the water to the buildings.

The plants are designed to provide water at temperatures between 70° F and 75° F for heating and for cooling. The plants cannot handle returning loop water with temperature above 100° F. If the loop water temperature (resulting from unit heat pumps heating the loop water while cooling the units) exceeds 100° F, the plant must be shut down to avoid damage to the equipment. (When there are exceptionally hot days in the summer, air conditioning may result in water loop temperatures that exceed this limit and air conditioning may not be available. However, this has not happened.)

The heated or cooled water flows constantly from the plants to the buildings and back to the plants. This water flow is continuous and the water is not lost. (The water in the loops is used up only if there is a leak.) However, water used in the cooling towers is used up as it evaporates to provide cooling and must be replenished.

Providing cooled water to the unit heat pumps requires that the cooling towers be operational. The cooling towers require winterization at the end of the cooling season in order to avoid damage caused by freezing weather. The towers cannot be operated while winterized. Readying the cooling towers for the cooling season is normally accomplished by April 15, the average date after which freezing is not likely in the Washington area. By law, heated water must be provided until May 15. These constraints make it difficult to provide cooling on short notice before April 15. Only under unusual circumstances would cooling be available prior to April 15.

A control system that allows either heating or cooling in the periods of transition from one to the other was installed in 2012. For a month or so either cooling or heating can be operational during the spring and fall transition periods. Announcements of these periods will be made by management.

The Pipes

The underground PVC pipe system branches out to distribute the heated or cooled water into each building. The distribution system within each building consists of PVC pipes of progressively diminishing size, ending in the pipes that are visible at the heat pumps in each unit.

The flow of heating/cooling water into buildings can be individually controlled by cut-off valves at each entryway, with some exceptions. Building isolation valves for Buildings 1 through 8 and 23 through 25 are as follows:

Valve at 3863 Rodman isolates building # 1.
Valve at 3871 Rodman isolates building # 2.
Valve at 3821 39th isolates buildings # 5 through #8.
Valve at 3760 39th Street isolates building # 8.
Valve rear of 3821 39th Street isolates buildings # 4 through #8.
Valve between Plant F and 3871 Rodman isolates buildings # 1 through #3.
Valve across from Plant F (next to Fannie Mae's fence) isolates buildings # 6 through #8.
There are three isolation valves for buildings #23 through #25.

The valves for Buildings 1 through 8 and 23 through 25 are strategically located in the loops to provide flexibility in isolating a building or buildings from one another in case parts of the loops must be shut down. These isolation valves were installed during the 2012 underground pipe replacement projects.

The PVC pipes are rated for temperatures of up to 180° F. If exceeded, the pipe will soften and become deformed (for example, narrower, which impedes water flow) or burst or otherwise break, leading to major flooding. These breakages can take place long after the initial damage was inflicted. Figure 7 (page 11) shows the damage that can result.

Potential Problems and Failures

Failures in the heating and cooling system can be related to individual heat pumps, pipes, plant operations, and human errors.

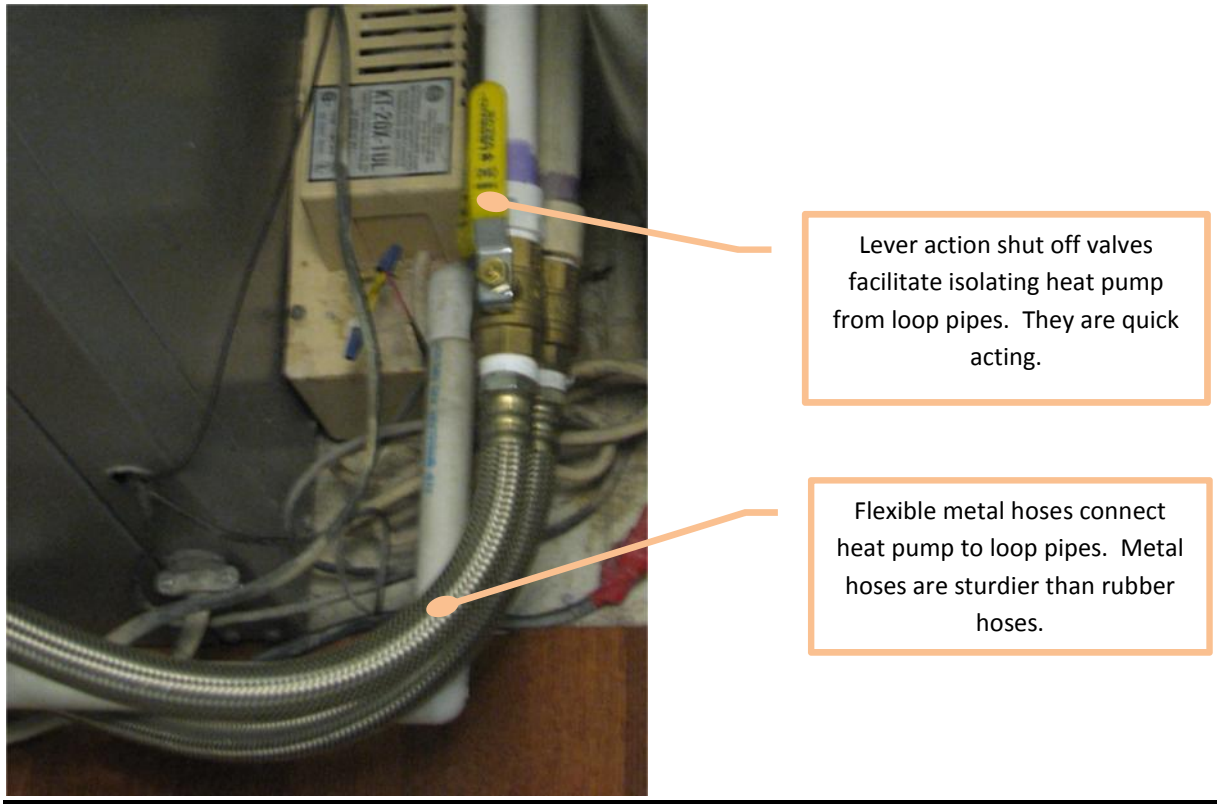
Heat Pump Failures

Each apartment has a heating and cooling system, enclosed in a metal box with various openings. The system consists of the heat pump itself, a fan, a filter, electrical controls, pipes and pipe connections. Each of these can affect how a unit is cooled or heated. Figures 1 (on

page 4) and 5 illustrate the main elements (those that are visible without disassembly) of the unit heating and cooling systems. Figure 6 shows updated replacement hoses and valves.

Figure 5: Typical Unit Valves and Pipes

Figure 6. Unit Heating and Cooling System with Updated Valves and Hoses



The whole cooling and heating system is designed and operated to provide heating or cooling only, not both simultaneously (but see page 8 for an explanation of the capability to switch from one mode to the other and back in the spring and fall):

- When heated water is provided by the plants, all heat pumps in all apartments must be set to heating or be shut off.

- If a heat pump is set to cooling when heated water is provided, the heat pump will further heat the water in the loop, which can lead to damaging the heat pump and to melting the PVC pipes. In addition, the plant may have to be shut down to avoid major damage. What can happen to pipes is shown in Figure 7. As a result of melting, the pipe constricted and cracked, and later burst, resulting in serious water damage to multiple units.

Figure 7. Melted HVAC PVC Pipe

- Melting PVC pipes will lead to floods, potentially affecting multiple units.

- When cooled water is provided by the plants, all heat pumps in all apartments must be set to cooling or be shut off.

- Management will inform residents of the status of the plants and when heated or cooled water will be provided. (See page 8 for an explanation of the capability to switch between heating and cooling modes during the spring and fall.)

Heat Pump Operation and Maintenance

Regular monitoring of heat pump operation is critical. Although modern water source heat pumps may be equipped with safety devices that control and monitor the compressor and protect the heat pump, these devices may not be absolutely reliable.

High-and low-pressure safety switches are designed to monitor high and low pressure in the heat pump system. Abnormal pressures may be caused by abnormal water temperatures in the loops, or by an unexpected plant shutdown. The safety switches can be expected to automatically shut off the heat pump when they sense abnormal pressures. This should protect the heat pump from potential damage, which could result in flooding the unit and those below.

In addition to built-in safety switches, another safety measure could be the installation of sensors that recognize the water temperature being supplied to the heat pump. If the water temperature exceeds your heat pump's pre-set high and low temperature, the sensor system should safely shut down the heat pump. When the water temperature is back to normal, the heat pump automatically restarts. These temperature sensors are available from heat pump contractors.

To ensure continued proper operation of the safety control mechanism, it is very important that your heat pump be checked and serviced (at least annually but preferably at each change from heating to cooling and vice versa) by a reputable heating and cooling company that specializes in water source heat pumps. If the pressure/high temperature safety control in your heat pump is not functioning properly, it will not recognize increased condenser pressure, or that the central plant has shut down, and will continue running. When this happens the PVC pipes in your system begin to swell and may rupture, resulting in a flood.

Condensate

The condensate drain can get clogged, resulting in a backup of condensate water, which will spill into the apartment and units below. See the section on Condensation (page 6) for further information.

The Fan

The fan moves the air from the apartment through the heat exchanger of the heat pump and forces it through the ducts to the various rooms. It is driven by an electric motor. The fan must operate to cool or heat the apartment.

The Filter

A filter is installed where the return air from the apartment enters the heating/cooling radiator of the heat pump, before the fan. The filter keeps dirt from obstructing the air flow across the radiator and helps to keep the heat exchange surfaces clean. The filter should be changed every three months or sooner if it has been accumulating dirt. Failure to change the filter will result in inefficient operation (using more electricity than necessary) and can lead to premature fan and/or heat pump failure and resulting need for replacement.

Electrical controls

Various electrical circuits provide high voltage current to operate the heat pump and low voltage current for controls such as the thermostat. These systems are generally quite sturdy and durable. Should there be an electrical or control problem they should be addressed by qualified and licensed repair people.

Pipes and Pipe Connections

Individual pipes that are attached to the unit can break. Equipment originally installed had rubber hoses connecting the heat pump to the PVC pipes that connect to the loop. Those hoses are beyond their useful life. If these hoses have not been replaced they can break and cause flooding (with concomitant repair liabilities) as well as stop the ability to cool or heat the unit.

Plant Operations Failures

An entire plant may be shut down, in which case the buildings serviced by the plant will not have cooling or heating, and must shut down their heat pumps. Plants may be shut down for many reasons, including:

- To repair an individual unit's heat pump. An entryway may be isolated from the loop by closing the isolation shut off valve, so repairs can be done on an individual unit without interrupting service to all units in other entryways and buildings in the loop. However, the isolation shut off valves may sometimes be found to be inoperable, requiring a plant shut down. The isolation valves may be inoperable due to damage caused by earthquakes, other soil movement, corrosion, age, and accidents. In these cases, repair of the isolation valves may also require an additional plant shutdown.

- To repair a plant component. Depending on the type of repair, the system could be down for hours or days. For example, the adhesive used to replace a broken PVC pipe requires 16 to 24 hours to cure.

- To perform regular preventive maintenance. Every effort is made to schedule this work during the spring and fall months when it is not necessary to use apartment heat pumps. However, the weather does not always cooperate.

- Plant shutdowns are sometimes caused by unforeseeable break downs such as a blown fuse (which could be caused by electrical surges), clogged filters (which could result from debris that enters the water loops), pump failures (which could be caused by wear and tear or power surges), and other mishaps.

- Power failures will shut plants down and cause damage, which may result in delays in restarting a plant.

Attachment A: Plants and the Buildings they Service

Plant A services Buildings 17-21; Plant B Buildings 14-16 & 22; Plant C Buildings 9-13; Plant D Buildings 23-29; Plant E Buildings 30-31; and Plant F Buildings 1-8. The related addresses are as follows (a cross reference organized by addresses is provided in Attachment D. Cross Reference of Addresses to Plants and Buildings):

Plant A services:

Porter Street numbers 3848, 3840, 3832, 3824, and 3816.
38th Street 3450, 3440, 3420, and 3410.
Newark Street 3801, 3811, 3821, 3831, 3841, 3851, 3861, 3871, and 3881.

Plant B services:

39th Street numbers 3511, 3521, 3531, 3541, 3551, 3641, 3631, 3621, 3611, and 3601.
Porter Street 3896, 3888, 3880, 3872, 3864, and 3856.
3891 Newark St

Plant C services:

39th Street numbers 3701, 3711, 3721, 3731, and 3741.
Rodman Street 3880, 3870, 3860, and 3850.
38th Street 3690, 3680, 3670, 3660, 3620, 3610, and 3600,
Porter Street 3851, 3861, 3871, 3881, and 3891.

Plant D services:

39th Street numbers 3540, 3530, 3520, 3510, 3500, 3650, 3640, 3630, 3620, 3610, and 3600.
Langley Court all addresses.

Plant E services:

39th Street numbers 3470, 3460, 3450, 3440, 3430, 3420, 3410, and 3400.

Plant F services: Buildings 1-8

Rodman Street numbers 3801, 3807, 3815, 3823, 3831, 3839, 3847, 3855, 3863, 3871, 3879, 3887, and 3895.
39th Street numbers 3801, 3811, 3821, 3850, 3840, 3830, 3820, 3810, 3800, 3770, 3760, 3750, 3740, 3730, 3720, 3710, and 3700.

Attachment B: What Contractors Should Know

If work needs to be performed on the heat pump in a unit, the contractor performing the work should be given the following information:

- The heating and air conditioning unit is a water source heat pump. Note that not all heating and air conditioning contractors work on water source heat pumps. If you need assistance in finding a qualified contractor, call the management office (202-966-9780).

- There is no specific drainage system for the water that is in the heat pump and associated pipes. During replacement of heat pumps or shut off valves, water in the system should be drained into the water heater's drain or poured with buckets into the bathtub or toilet.

- If the shut off valves for the loop water have to be replaced, or are not trusted (due to condition) to fully isolate the unit's pipes from the loop, the loop must be isolated for the whole entry way (and sometimes the building) in which the apartment unit is located and the water in the pipes must be drained. Draining the pipes may take a day or longer, depending on the location of the unit. Call the management office (202-966-9780) to arrange for shutting off the loop water. Failure to do so most likely will result in severe damage to the unit and those below it.

Attachment C: Pictures of the Plants and their Equipment

Figure 8. Inside a Plant. Lightest blue pipes are for cold water, darker blue pipes for hot water.

Figure 9. Cold water heat exchanger.

Figure 10. Boiler provides heated water.

Figure 11. Electric motors power the pumps that circulate the water in the loops.

Figure 12. Electronic controls and Internet connections provide for remote monitoring of plant operations.

Figure 13. Cooling tower fans.

Figure 14. Pipes bring heated water after use to cool units to cooling tower.

Figure 15. Electric motors power cooling fans.

Figure 16. Inside the cooling tower – grille removed for visibility.

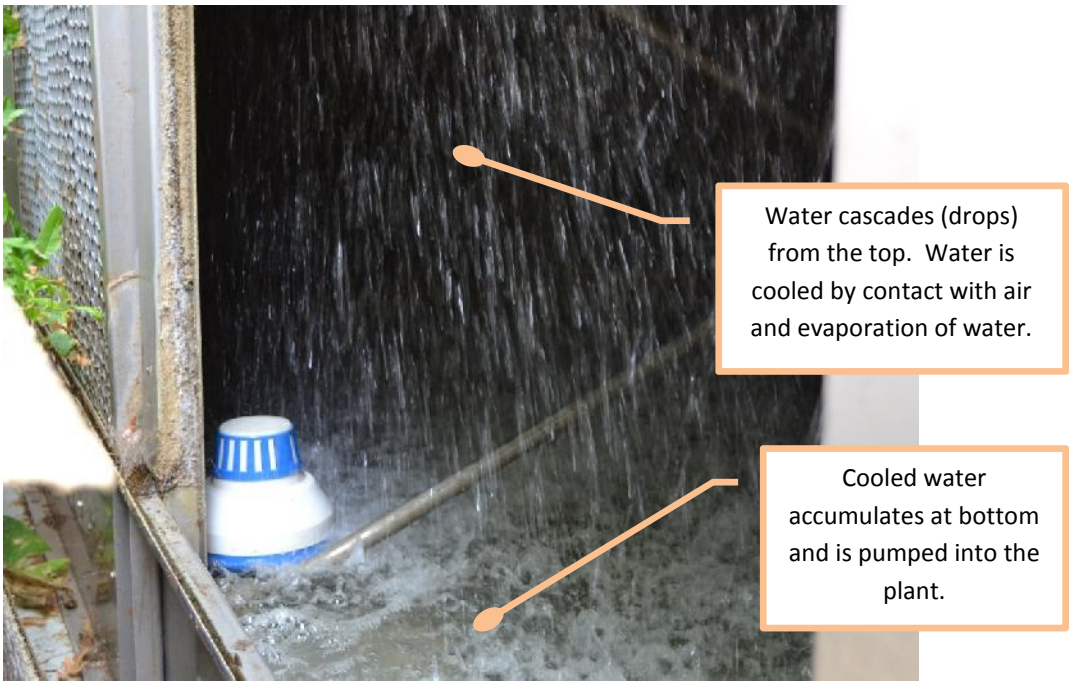
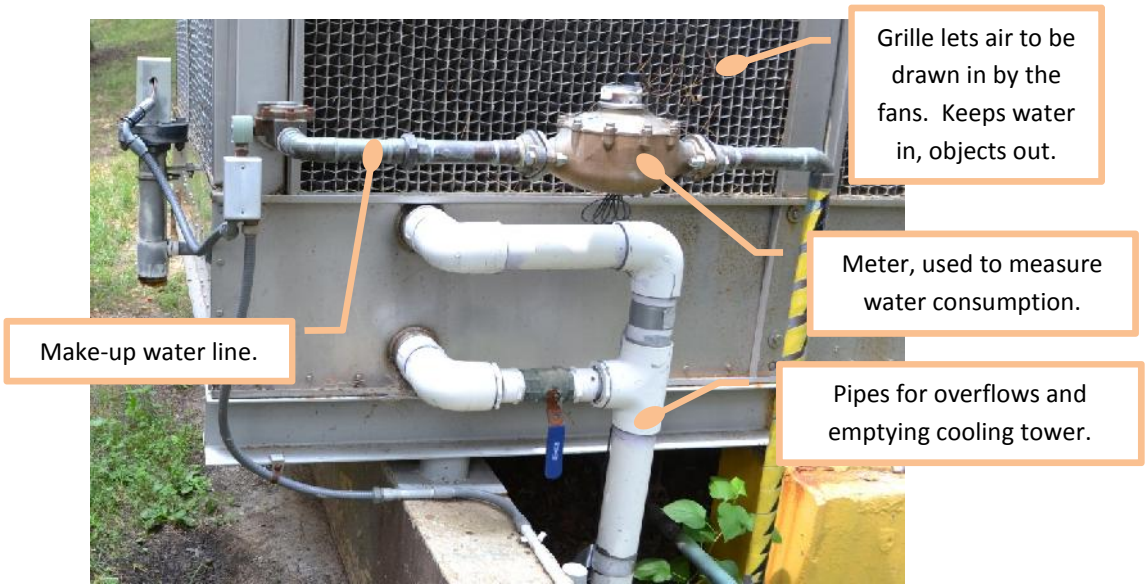


Figure 17. More cooling tower pipes and grille.



Attachment D. Cross Reference of Addresses to Plants and Buildings

A map of the buildings' location and address is at the end of this attachment.

Address		Bldg.	Units	Plant		Address		Bldg.	Units	Plant
No.	Street					No.	Street			
3410	38th St	19	A421-F426	Plant A		3901	Langley Ct	25	A553 -F558	Plant D
3420	38th St	19	A415 -F420	Plant A		3911	Langley Ct	25	A559 -F564	Plant D
3440	38th St	18	A409-F414	Plant A		3921	Langley Ct	25	A565 -F570	Plant D
3450	38th St	18	A403 -F408	Plant A		3930	Langley Ct	28	A637 -F642	Plant D
3600	38th St	12	A271-F276	Plant C		3931	Langley Ct	25	A571-F576	Plant D
3610	38th St	12	A265 -F270	Plant C		3940	Langley Ct	28	A631-F636	Plant D
3620	38th St	12	A259-F264	Plant C		3941	Langley Ct	25	A577 -F582	Plant D
3660	38th St	11	A253 -F258	Plant C		3950	Langley Ct	28	A625 -F630	Plant D
3670	38th St	11	A247 -F252	Plant C		3951	Langley Ct	26	A583 -F588	Plant D
3680	38th St	11	A241-F246	Plant C		3960	Langley Ct	27	A619 -F624	Plant D
3690	38th St	11	A235 -F240	Plant C		3961	Langley Ct	26	A589 -F594	Plant D
3400	39th St	31	A715 -F720	Plant E		3970	Langley Ct	27	A613 - F618	Plant D
3410	39th St	31	A709 -F714	Plant E		3971	Langley Ct	26	A595 -F600	Plant D
3420	39th St	31	A703 -F708	Plant E		3980	Langley Ct	27	A607 -F612	Plant D
3430	39th St	30	A697 -F702	Plant E		3990	Langley Ct	27	A601-F606	Plant D
3440	39th St	30	A691-F696	Plant E		3801	Newark St	19	A427 -F432	Plant A
3450	39th St	30	A685 -F690	Plant E		3811	Newark St	19	A433 -F438	Plant A
3460	39th St	30	A679 -F684	Plant E		3821	Newark St	20	A439-F444	Plant A
3470	39th St	30	A673 -F678	Plant E		3831	Newark St	20	A445 -F450	Plant A
3500	39th St	29	A667 -F672	Plant D		3841	Newark St	20	A451-F456	Plant A
3510	39th St	29	A661-F666	Plant D		3851	Newark St	20	A457 -F462	Plant A
3511	39th St	22	A487 -F492	Plant B		3861	Newark St	21	A463 -F468·	Plant A
3520	39th St	29	A655 -F660	Plant D		3871	Newark St	21	A469-F474	Plant A
3521	39th St	22	A493 -F498	Plant B		3881	Newark St	21	A475 -F480	Plant A
3530	39th St	29	A649-F654	Plant D		3891	Newark St	22	A481-F486	Plant B
3531	39th St	22	A499-F504	Plant B		3816	Porter St	18	A397 -F402	Plant A
3540	39th St	29	A643 -F648	Plant D		3824	Porter St	18	A391-F396	Plant A
3541	39th St	22	A505 -F510	Plant B		3832	Porter St	17	A385-F390	Plant A
3551	39th St	22	A511 - F516	Plant B		3840	Porter St	17	A379-F384	Plant A
3600	39th St	24	A547 -F552	Plant D		3848	Porter St	17	A373 -F378	Plant A
3601	39th St	14	A331-F336	Plant B		3851	Porter St	13	A277 -F282	Plant C
3610	39th St	24	A541-F546	Plant D		3856	Porter St	16	A367 -F372	Plant B
3611	39th St	14	A325 -F330	Plant B		3861	Porter St	13	A283 -F288	Plant C
3620	39th St	24	A535 -F540	Plant D		3864	Porter St	16	A361-F366	Plant B

Address		Bldg.	Units	Plant		Address		Bldg.	Units	Plant
No.	Street					No.	Street			
3621	39th St	14	A319-F324	Plant B		3871	Porter St	13	A289 -F294	Plant C
3630	39th St	23	A529 -F534	Plant D		3872	Porter St	16	A355 -F360	Plant B
3631	39th St	14	A313 -F318	Plant B		3880	Porter St	15	A349 -F354	Plant B
3640	39th St	23	A523 -F528	Plant D		3881	Porter St	13	A295 -F300	Plant C
3641	39th St	14	A307-F312	Plant B		3888	Porter St	15	A343 -F348	Plant B
3650	39th st	23	A517 -F522	Plant D		3891	Porter St	13	A301-F306	Plant C
3700	39th St	8	A175-F180	Plant F		3896	Porter St	15	A337 -F342	Plant B
3701	39th St	9	A181 - F186	Plant C		3801	Rodman St	1	AI-F6	Plant F
3710	39th St	8	A169 - F174	Plant F		3807	Rodman St	1	A7 -F12	Plant F
3711	39th St	9	A187 - F192	Plant C		3815	Rodman St	1	A13 - FI8	Plant F
3720	39th St	8	A163 - F168	Plant F		3823	Rodman St	1	AI9 -F24	Plant F
3721	39th St	9	A193 - F198	Plant C		3831	Rodman St	1	A25-F30	Plant F
3730	39th St	8	A157 - F162	Plant F		3839	Rodman St	2	A31-F36	Plant F
3731	39th St	9	A199 -F204	Plant C		3847	Rodman St	2	A37 -F42	Plant F
3740	39th St	7	A151 - F156	Plant F		3850	Rodman St	10	A229 -F234	Plant C
3741	39th St	9	A205 -F210	Plant C		3855	Rodman St	2	A43 -F48	Plant F
3750	39th St	7	AI45 - FI50	Plant F		3860	Rodman St	10	A223 -F228	Plant C
3760	39th St	7	A139 - FI44	Plant F		3863	Rodman St	2	A49-F54	Plant F
3770	39th St	7	AI33 -F138	Plant F		3870	Rodman St	10	A217 -F222	Plant C
3800	39th St	6	A127 -F132	Plant F		3871	Rodman St	3	A55 -F60	Plant F
3801	39th St	4	A79-F84	Plant F		3879	Rodman St	3	A61-F66	Plant F
3810	39th St	6	A121-F126	Plant F		3880	Rodman St	10	A211 - F216	Plant C
3811	39th St	4	A85 -F90	Plant F		3887	Rodman St	3	A67 -F72	Plant F
3820	39th St	6	AI15 -F120	Plant F		3895	Rodman St	3	A73 -F78	Plant F
3821	39th St	4	A91-F96	Plant F						
3830	39th St	5	AI09 -F114	Plant F						
3840	39th St	5	AI03 -FI08	Plant F						
3850	39th St	5	A97 -FI02	Plant F						

Figure 18. Map with Buildings Identified