Application Note 2013

CITY MULTI or P-Series Systems in Server Rooms

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CRITICAL SERVER ROOM VS NON-CRITICAL

Some companies have computer server rooms that must be in operation 24/7/365 and if the servers should go down for some reason the company could lose a lot of money. The potential loss makes it worth spending extra money to keep this from happening. One reason for a server room to go down is that the HVAC system fails and the room gets too hot, causing the servers to shut down from overheating. A reliable dedicated HVAC system is worth installing to owners of a critical server room for this reason.

A non-critical server room, by comparison, is one that can go offline without it being a problem for the company. Or at least not a big enough problem to justify the cost of a reliable dedicated HVAC system. Maybe the server room is actually just a closet and if the building HVAC system goes down they open the closet door and that keeps it from overheating. Or maybe the servers are located in the corner of a larger room and overheating is never an issue. It could be that the servers could go offline and the company would not lose money until it could be repaired in a couple of days. These are not the server rooms that this Application Note addresses.

COOLING IN A SERVER ROOM

Many projects that utilize Mitsubishi Electric Variable Refrigerant Flow (VRF) will have one or more server rooms which require cooling throughout the entire year. There are several design topics that must be considered to ensure the server rooms are adequately handled and are not at risk of being without cooling for significant periods of time.

Two of the main considerations are:
Redundancy – making sure that the failure of one component will not leave the critical server room without cooling, and
Low Ambient Temperatures - which can also result in the loss of cooling.

REDUNDANCY

If a City Multi system is used on a project and one outdoor unit has enough capacity to handle the server room load by itself, a failure of the outdoor unit will leave the server room without cooling. On a critical application this would be unacceptable.

There are ways to increase redundancy which will provide more reliable cooling, and the loss of an outdoor unit will not be as detrimental. The following is a list of recommended best practices to incorporate redundancy into a City Multi design:

- Critical server room applications, where precise temperature control is required or an alarm is activated, should always have a 100% backup system installed. It is up to the designer to determine which applications are critical. Depending on system size, P-Series units may be a good choice. *M-series product should never be used on critical server room applications. See the M-Series Units section for more details.*

When designing a 100% redundant P-Series air conditioning units, at least two sets of equipment should be designed to run simultaneous. The number of sets depends on the total load of the server room and the size of the P-Series systems, in what is called N+1 redundancy.

For example, if only one P-Series system can handle the entire load, then two systems should be installed. However, if it requires 4 systems to meet the load, then 5 systems should be installed. This allows for a system to go down and still have 100% capacity available while the unit is repaired. The chance that two or more systems will go down at the same time is very low.

The control temperature setting for each system will be the same. As the heat load of the room is nearing set-point all units will reduce capacity to meet the heat load demand of the space. For example, during normal operation in a server room with two systems, each system may operate at 50% capacity. If one of the systems fails the second system will automatically ramp up to full capacity to maintain required temperature and there is no need for a lead/lag control. Since the systems are more energy efficient at part load, this approach has the added benefit of providing a return on the customer's capital investment for the second system, in addition to the insurance value it provides.

For critical server spaces, if redundancy is designed with VRF equipment only, where systems are on backup power, the designer should plan on the VRF system being on backup power as well. The designer and owner should be aware that after power loss, restart of P-Series as well as City Multi systems can be delayed. A P-Series system can restart in as little as 15 minutes if set up to do so. With a UPS on the system this wouldn't be necessary, and the HVAC would not be lost as the server room switches to the backup power.

City Multi equipment must go through a pre-programmed initialization routine after power is restored before the system can resume full operation. Depending on loading present in space at the time this occurs, initialization can last up to 90 minutes. Even if redundant City Multi systems are installed, both could experience this delay in resuming full operation. This is just one of the reasons why a P-Series is preferred to City Multi for a critical server room application.

- If 100% redundancy is not required, consider using multiple systems that will total up to more than 100% of the load. For instance, using three systems that each are half the load, will still leave 100% capacity if one is lost. Or using two systems that each are 70% of the load will still leave a server room with *some* cooling in the event of an outdoor unit failure. The amount of diversity provided is a decision the owner must make, based on how critical the server room is and how much they are wanting to invest to keep it operating.

- The smallest City Multi Y-Series units are much larger capacity than most server room loads tend to be, so utilizing multiple City Multi systems is often not possible. Utilizing the P-Series is a good way to get redundancy for less cost. S-Series could offer the redundancy that a P-Series could - but S-Series doesn't have the low ambient capability that P-Series does.

LOW AMBIENT COOLING

Because server rooms generate a lot of heat, they often require cooling all year long. In most areas of the U.S. this means that server rooms will require cooling even during the traditional heating months.

The lowest ambient temperature that City Multi (without a low ambient kit) can provide guaranteed cooling is 23º F. However, when the system experiences very low outdoor ambient temperatures the system will attempt to prevent an indoor coil from freezing by shutting the indoor unit off. In this case, the zone served by that indoor unit will receive no cooling at all. This is known as freeze protection mode. If a server room project is in an area with a winter design day below 30º F, a low ambient kit is highly recommended.

Adding a low ambient kit extends the system's cooling operating range down to -10º F outdoor ambient temperature. While the low ambient kit will help to prevent the system from going into freeze protection mode (due to an ambient temperature below 23º F), there are still several other factors that could cause the system to go into freeze protection mode and lose cooling capacity, even above 23º F.

Here are some recommended best practices to limit the likelihood of the system going into freeze protection mode:

- The low ambient kit is required for City Multi applications that will see outdoor ambient temperatures below 23º F.
- All installation instructions for the low ambient kit and outdoor units should be followed closely including outdoor unit placement and mounting.
- If an R2 system is utilized with a server room as well as some comfort cooling zones, the system will likely go into freeze protection if the R2 unit operates in heating main. Zones that will typically call for heat can be put on an R2 system with a server room ONLY if:
    - The combined peak and instantaneous heating load from the zones calling for heat are always less than the peak and instantaneous cooling load in the server space at any given time.
        - This requires analysis of not only the peak design loads but also the actual load profile.
        - Failure to ensure this at all times may lead to frequent system wide mode shifting between cooling and heating dominant operation. Such mode switching will cause temporary delays in output capacity that may not be tolerable for the server space.
        - Even if this analysis prevents freeze protection, there are other risks to combining a critical server room on the same R2 or Y-Series system as other comfort cooling zones. See the section "Comfort Cooling Issues" for more details.
    - The outdoor unit has less than 100% connected capacity.

- When using a Y-Series, the server room zone should never be combined on the same system with comfort cooling zones in cases where there is a slight chance that the comfort cooling zones may require heat, because the units serving these areas will only go into standby, and will not provide heat.

- The best way to lay out a server room is to use fewer larger indoor units (a single unit when possible) as opposed to many small indoor units. If multiple indoor units are used, it's best to connect them to one controller and sense temperature from the wall controller. If no controller is located in the space, a remote sensor should be mounted to take the place of the return sensor. Airflow should be evenly distributed throughout the space for even loading of all indoor units. In most cases ducted style units are preferred because air distribution can be easily customized for the room.

- When using ducted models, whenever possible, system design should target a higher than nominal airflow as shown in the fan curves.

- The system should be sized to have a 50% minimum guaranteed capacity demand year round. If multiple server rooms are connected, the 50% minimum applies to each room. This means that indoor units should have a minimum 50% demand year round.

- The indoor unit should be run at maximum airflow at all times. If necessary lock the system on high speed. (see Table 1 for switch settings).

Table 1. Dip Switch Settings for Locking Indoor Unit into High Speed

Indoor Unit Model	Switch Setting
PEFY-PXXNMHU-E	SW7-1 ON
PFFY- PXXNE(R)MU	SW7-1 ON
PVFY-PXXE00B	SW7-1 ON
PEFY- PXXNMAU-E(2)	SW4-6 ON
PEFY- PXXNMSU-E(R2)	SWB in #3 position
PEFY- PXXNMHSU	SW4-6 ON

- On the PLFY and the PCFY indoor units, the high ceiling setting and the high efficiency filter setting can also be used to maximize airflow (see Table 2 for settings).

Table 2. Settings for High Ceiling and High Efficiency Filter Settings

Indoor Unit Model	Switch Setting
PLFY- PXXNBMU-E(R2)	* SWA #3 position / SWB #4 position
PCFY-PXXNKMU-E(R1)	SWA #3 position

* Settings are for 4-way airflow. For 2 or 3-way airflow refer to the technical service manual

- 68º F is the lowest temperature set-point that is allowed.
- Enable the self-recovery function in case of power failure by turning on DipSW1-9 of indoor units.
- Use remote thermal sensor if air inlet of indoor units is located near the exhaust heat from servers.
- Manage humidifying locally if humidity control is required.
- Upon being restarted or coming out of a thermal off mode; it may take several minutes, up to 90 minutes, for the City Multi system to begin cooling again.

M-SERIES UNITS

The M-Series systems are designed as a residential unit and as such they do not provide significant cooling capacity below 64°F and may not function as installed in Full Load environments. A true Low Ambient system generally modulates certain system components in order to maintain a specific liquid line temperature or pressure. This is sometimes damaging to the compressor when operating in such low temperatures. M-Series units do not try to maintain specific liquid line pressures as other low ambient units. Logic built into the M-Series adjusts the condenser fan speed based on compressor frequency. This function allows the M-Series to better protect and extend the longevity of its compressor lifespan. M-Series unit are capable of cooling down to 14°F, but with diminished capacity. In residential installations this works as engineered. However, when Indoor Load is at its max, for example in a computer room, the M-Series may be unable to maintain cooling load requirements. For this reason it is *Strongly Recommended* to avoid M-Series units for critical server rooms. The P-Series, however, is intended to handle such harsh environments and perform as engineered for these critical applications.

COMFORT COOLING ISSUES

When an R2 or a Y-Series is utilized to have a critical server room and some comfort cooling zones on the same system, there is potential for the comfort cooling zones to take out the server room HVAC.

Refrigerant loss

If something should happen in the comfort cooling zones which results in a refrigerant leak, slow or catastrophic, all the connected zones are effected. This would eliminate cooling in the server room.

Condensate Blockage

The condensate overflow sensors in the Indoor Units will shut down not only the Indoor Unit it detects the overflow on, but the entire system as well. The logic is that often the condensate drains are all feeding into a mutual drain line, and if a blockage occurs in that common drain pipe it will cause the next upstream Indoor Unit to overflow the drain pan. If the other units are allowed to continue to operate they will feed condensate into the common drain line which will force water to overflow the lower pan even though that unit had been turned off. There is not a way to override this setting, even if all Indoor Units have separate drain lines.

SUMMARY

While it is possible in some situations to utilize systems other than a P-Series for a critical server room, it is not the best practice to do so. As shown in this Application Note there are several reasons why City Multi systems should not be used, and a M-Series system should never be used.

P-Series systems, sized with enough capacity and number of systems to provide the required redundancy, which serve only the Server Room and no comfort cooling spaces, and are connected to any emergency power that the computer servers are connected to, is the recommended method for cooling a critical server room.