



Vertical Stack Fan Coil Units Riser Guide

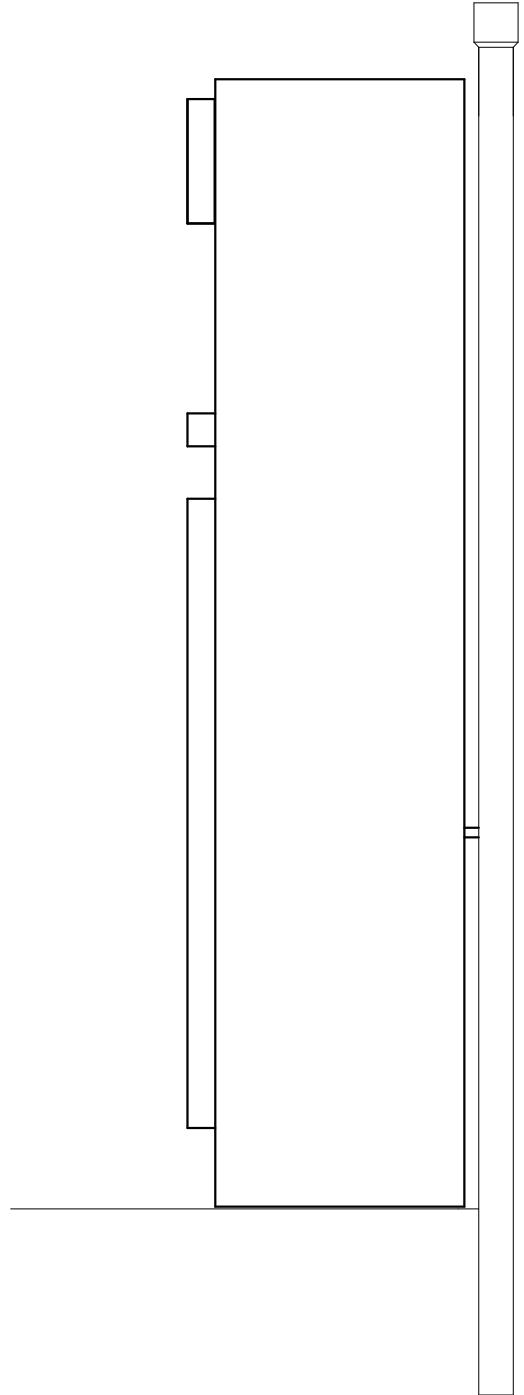




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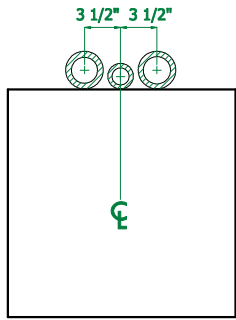


Introduction

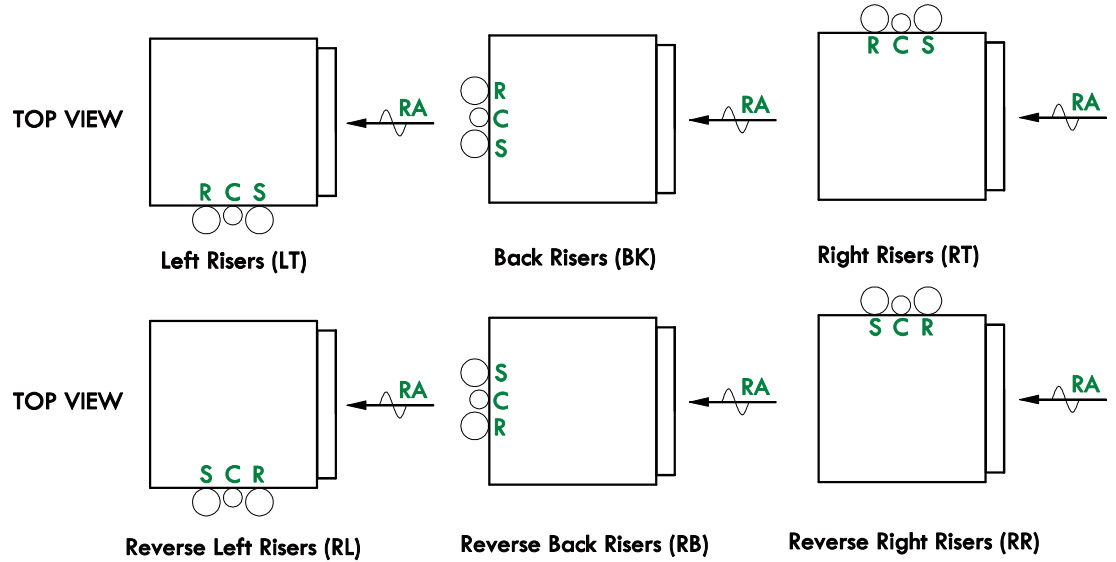
The purpose of this manual is to aid in the understanding of the selection of copper pipe risers for high rise vertical stack fan coil units. The proper selection of risers for length, diameter and other features are critical components to designing a cost effective job due to the fact that copper is a significant portion of a fan coils' material costs. If the riser diameter is too small, the water velocity through the riser may cause an excessive water pressure drop due to friction loss and/or erosion of the pipe. If the riser diameter is too large it can be difficult to maintain pressure in the system. It can also cause the cost of the fan coil unit and riser system to become unnecessarily high making the equipment bid package uncompetitive. If other features, such as expansion compensation and the amount of field piping required to connect the units, are also not considered then installation costs and maintenance costs in the legacy of the project can escalate. Therefore proper riser sizing and understanding of the system can minimize initial costs and avoiding the undesirable effects of high water velocities, noise, erosion, and installation and maintenance costs down the road.

THE DESIGN, SELECTION OF COMPONENTS, AND SPECIFICATIONS FOR A BUILDING'S RISER SYSTEM ARE TYPICALLY THE RESPONSIBILITY OF THE MECHANICAL ENGINEERING COMPANY RETAINED ON A GIVEN PROJECT. THIS GUIDE IS TO BE USED SOLELY AS A GUIDE DOCUMENT.

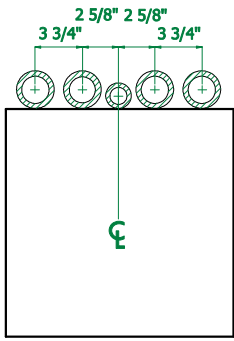
2 PIPE SYSTEMS



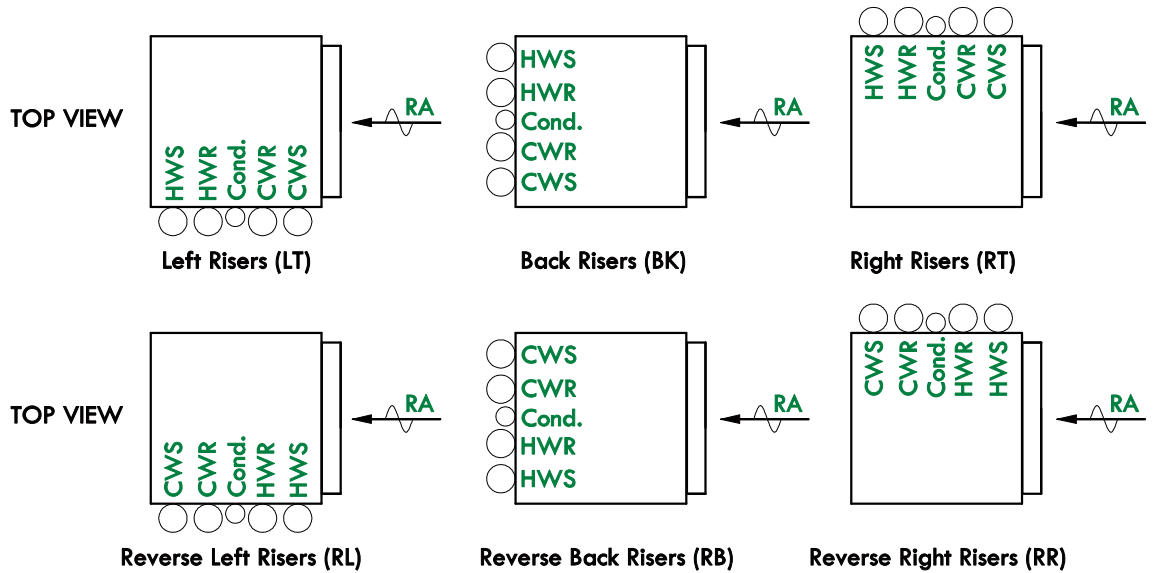
S = Supply Riser
R = Return Riser
C = Condensate Riser



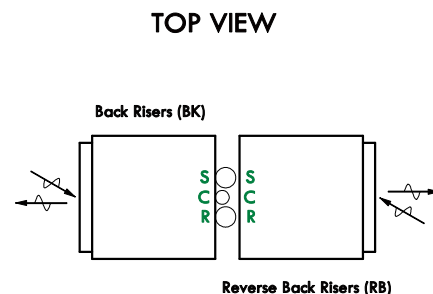
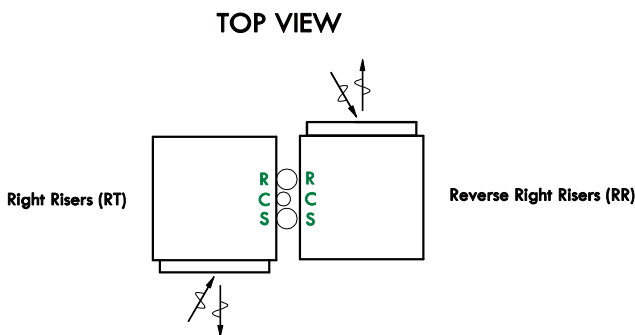
4 PIPE SYSTEMS



HWS = Hot Water Supply Riser
HWR = Hot Water Return Riser
CWS = Chilled Water Supply Riser
CWR = Chilled Water Return Riser
Cond. = Condensate Riser



Reverse Riser orientations are used to aid in eliminating cross over piping when units on a riser stack change position from floor to floor or when two units share a common riser (Master/Slave).



Riser Systems

The riser is a vertical pipe system, usually copper, that carries the supply, return (chilled and/or hot) and condensate water to and from a vertical stack fan coil unit. Materials other than copper can be used, but copper pipe is more desirable due to its relatively light weight, ease of installation, availability, and durability. Riser systems are installed in multi-story buildings where vertical stack hi-rise fan coil units are installed on top of each other, floor-by-floor. The risers interconnect the individual fan coil units as one moves from floor-to-floor forming a "stack" as the risers ascend vertically through the building. Installation of the vertical stack fan coil unit is quick with no lateral runs of copper piping off the main riser lines.

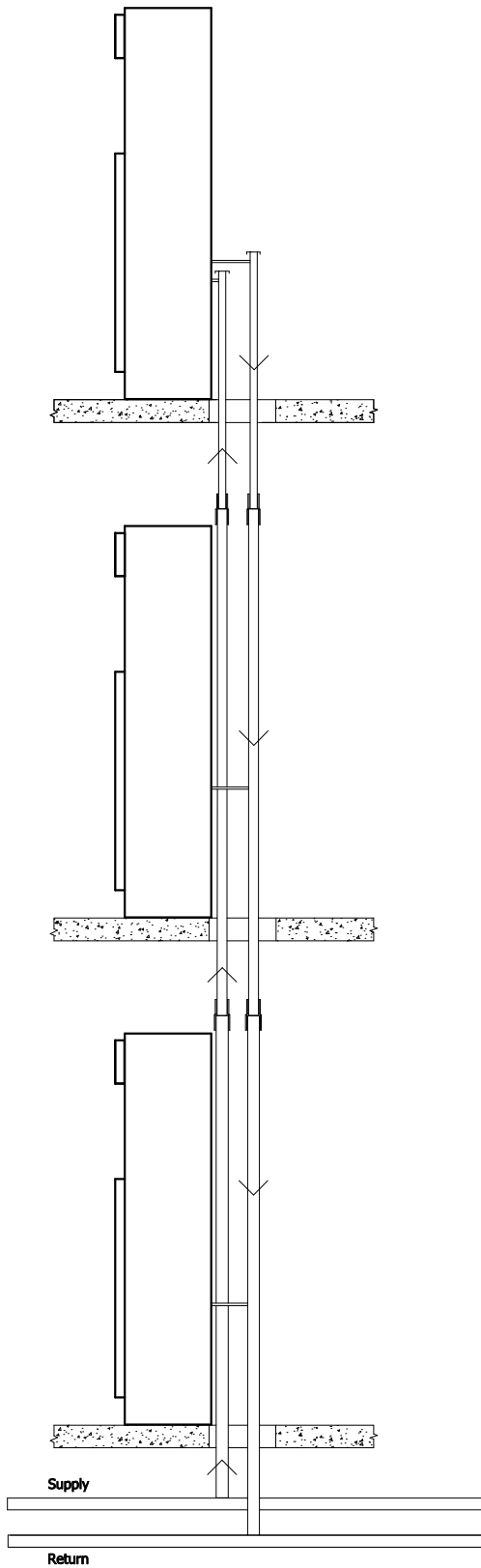
Vertical stack fan coil units are available in both two-pipe and four-pipe systems. Two-pipe systems can provide chilled water only or can be installed as a changeover system that switches seasonally from a chilled water system to a hot water system. Dedicated chilled water systems are common in warmer climates but can be augmented with a dedicated electric heater. More temperate climates will use the changeover system when their cooler months will only require heating and their warmer months will only require cooling. Four-pipe systems provide both dedicated chilled water cooling and hot water heating. Both systems types come equipped with an additional riser pipe to handle the condensate that is generated during cooling. A heating only two-pipe system can be selected without a condensate riser.

Risers can be installed on any of the three free sides of the fan coil unit cabinet. The front of the unit is always defined by the location of the return air/access panel. Left, right, and back are all determined as if you were standing in front of the unit looking at the return air/access panel. In addition to the three primary riser orientations, a "reverse" version of each is available to aid in the elimination of cross-over piping when the unit locations change on the floor plans as one moves up through the building.

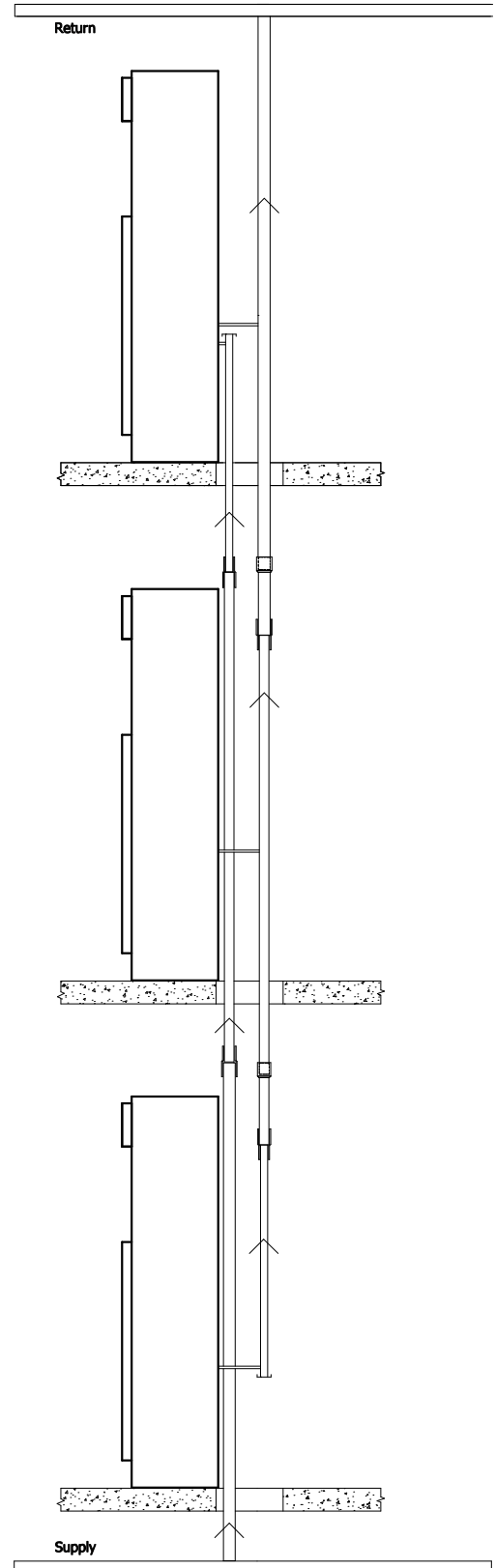
Chilled water, hot water, and condensate risers are factory insulated to avoid condensation and/or heat loss. Factory insulation and installation of risers on the fan coil unit is standard and is recommended to minimize installation costs and to assure quality control of the insulation application. Insulation is available in a variety of materials (glassfiber, closed cell polyolefin foam, and closed cell elastomeric) and thicknesses (3/8" thru 1") though not all material types are available in all sizes. It is interesting to note that in the Toronto area, condensate risers are not typically insulated and condensate riser insulation may not be necessary in dry western regions. Factory insulation is typically only fitted to the riser within the cabinet height as the ends of the riser should be accessible for connection to the units above/below. The exposed riser areas are then insulated in the field after installation and pressure testing.

It is important to consider the centerlines of the riser pipes when selecting insulation thickness. Some compression of riser insulation can occur, but in the case of a direct return system with two 3" diameter risers side by side with 1" of insulation a 5" spacing between center lines would be required, and not the 3 3/4" that they are designed for.

Direct Return



Reverse Return



Direct & Reverse Return

There are two typical methods for designing and installing a riser stack; direct return and reverse return. In the United States, the direct return is more common, whereas in Canada, the reverse return is more common. Both offer their own advantages and disadvantages.

Direct Return

Advantages

- Cost-effective and simple
- Straight forward installation
- Less confusion about properly sizing the risers

Disadvantages

- The pressure drop is not equal at each unit on the stack. The total pressure drop on the path that the water takes to the top floor is much greater than the path to the unit on the lower floor(s) near the main/pump. A means of balancing the water flows at each floor must be provided. If a means for balancing is not provided, it is possible that there will be no water flow through the upper units on the stack due to height and friction loss. Balancing is most often achieved by including a balancing valve on the return side of the coil piping package, either a manual balancing valve or an auto-flow balancing valve that is paired with a strainer on the coil supply side. Either option adds cost to the piping package in the unit.

Reverse Return

Advantages

- The system can be designed so that the total system pressure drop through each unit is equalized.
- The overall pressure drop is lower – offering the potential for energy savings.
- Fewer components in the piping package.
- Easier to accommodate larger riser pipe sizes and insulation thicknesses.
- Can eliminate the need for balancing valves and strainers.

Disadvantages

- At least one* additional “express” return main/riser is required to collect all of the return water from all the stacks back to the boiler/chiller.
- The design of the system is more complex/less intuitive.
 - Supply side risers start at the main with the largest size and decrease in size as they reach the end of the stack.
 - Return side risers start at the smallest size and increase in size as they reach the end of the stack.
 - This can make the reverse return riser difficult to understand, however if the stack is “balanced” with an equal number of pipes of each size on each side of the stack it begins to make sense.

*Some reverse return systems will employ an express return riser on each stack to take the return back to the mechanical room; however this is very rare.

Dimensional Data of Type M & L Copper

Riser Size	Type M			Type L		
	OD	ID	Wall Thickness	OD	ID	Wall Thickness
3/4"	0.875	0.811	0.032	0.875	0.785	0.045
1"	1.125	1.055	0.035	1.125	1.025	0.05
1 1/4"	1.375	1.291	0.042	1.375	1.265	0.055
1 1/2"	1.625	1.527	0.049	1.625	1.505	0.06
2"	2.125	2.009	0.058	2.125	1.985	0.07
2 1/2"	2.625	2.495	0.065	2.625	2.465	0.08
3"	3.125	2.981	0.072	3.125	2.945	0.09

Supply & Return Riser Pipe Sizing Guidelines (L & M Copper)

Pipe Size	GPM	Condensate Riser Pipe Sizing Guidelines (L & M* Copper)		
3/4"	< 4	Location in Riser Stack	Pipe Size	Max Size Used in _____
1"	< 9	Top 4 Floors	3/4"	1 to 4 Story
1 1/4"	< 14	The Next Lower 10 Floors	1"	5 to 14 Story
1 1/2"	< 25	The Next Lower 12 Floors	1 1/4"	15 to 26 Story
2"	< 50	The Next Lower 12 Floors	1 1/2"	27 to 38 Story
2 1/2"	< 75	*M copper is more typical for use in condensate risers.		
3"	< 120			

Typical 2-Pipe Direct Return Riser Schedule

Floor	CWS	CWR	COND.	GPM in Supply	GPM in Return
First	2"	2"	1"	32.5	32.5
Second	2"	2"	1"	30	30
Third	2"	2"	1"	27.5	27.5
Fourth	2"	2"	1"	25	25
Fifth	2" > 1 1/2"	2" > 1 1/2"	1"	22.5	22.5
Sixth	1 1/2"	1 1/2"	1"	20	20
Seventh	1 1/2"	1 1/2"	1"	17.5	17.5
Eighth	1 1/2"	1 1/2"	1"	15	15
Ninth	1 1/2" > 1 1/4"	1 1/2" > 1 1/4"	1" > 3/4"	12.5	12.5
Tenth	1 1/4" > 1"	1 1/4" > 1"	3/4"	10	10
Eleventh	1"	1"	3/4"	7.5	7.5
Twelfth	1" > 3/4"	1" > 3/4"	3/4"	5	5
Thirteenth	3/4" TC	3/4" TC	3/4"	2.5	2.5

Typical 2-Pipe Reverse Return Riser Schedule

Floor	CWS	CWR	COND.	GPM in Supply	GPM in Return
First	2"	3/4" < 1" BC	1"	32.5	5
Second	2"	1"	1"	30	7.5
Third	2"	1" < 1 1/4"	1"	27.5	10
Fourth	2"	1 1/4" < 1 1/2"	1"	25	12.5
Fifth	2" > 1 1/2"	1 1/2"	1"	22.5	15
Sixth	1 1/2"	1 1/2"	1"	20	17.5
Seventh	1 1/2"	1 1/2"	1"	17.5	20
Eighth	1 1/2"	1 1/2" < 2"	1"	15	22.5
Ninth	1 1/2" > 1 1/4"	2"	1" > 3/4"	12.5	25
Tenth	1 1/4" > 1"	2"	3/4"	10	27.5
Eleventh	1"	2"	3/4"	7.5	30
Twelfth	1" > 3/4"	2"	3/4"	5	32.5
Thirteenth	3/4" TC	2"	3/4"	2.5	35

TC = Top Capped Riser

BC = Bottom Capped Riser

Rev04

Riser Pipe Sizes

Copper pipe is used for risers. Job specifications will dictate the type of piping to be used. There are two types of copper available from Temspec, type L and type M; the difference between the two being the wall thickness of the copper pipe. For most applications either type is adequate. Condensate risers do not need to be type L and will be assumed type M unless advised otherwise.

Sizing the risers can be determined by totaling the sum of the flow required for all the units on the stack. By tracking the flow required in the stack as one ascends the building, the riser sizes should increase or decrease to accommodate the flow. The risers closest to the supply and return mains will be carrying the greatest amount of water and will be the largest, the risers furthest from the mains will carry the least amount of water and will be the smallest. Risers are available from 3/4" up to 3" in diameter.

The tables on the left are the general guidelines for the pipe sizes that Temspec typically supplies for a riser system. There can be some variation of where the size transition should occur, +/- a few GPM. This is based on design criteria for frictional loss of 2ft. per 100 ft. of pipe. Actual project velocity limits may be different than these based on the type of service, annual operating hours, or other guidelines as defined in the job specifications.

Direct Return

- Assuming the main is at the bottom of the stack, the largest risers will be located at the bottom of the stack. As the water diverts out of the supply riser and into the unit, it is subtracted from the supply side volume and the risers decrease in diameter as they get further from the main.
- Since the water is returning down after the water goes through the unit it flows back out into the return riser. The return riser then carries all the water of the units above it and so the riser also decreases in diameter as they get further from the main.

Reverse Return Risers

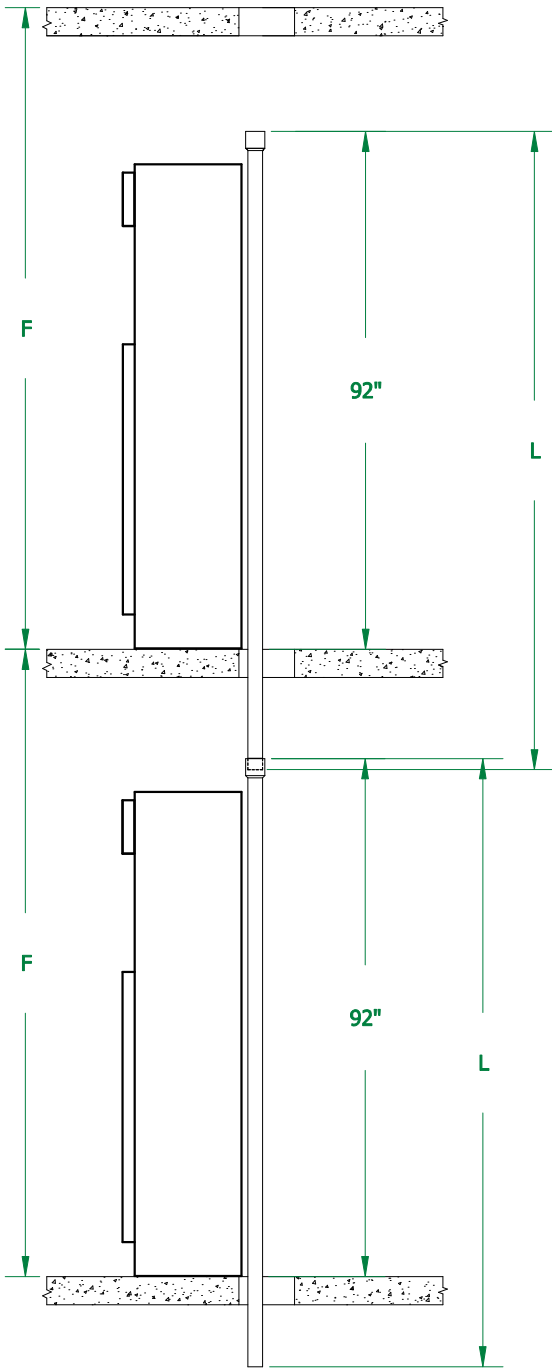
- Again assuming the main is at the bottom of the stack, the largest supply risers will be located at the bottom of the stack and as the water diverts out of the supply riser and into the unit, it is subtracted from the supply side and the risers decrease in diameter as they get further from the main.
- Unlike the direct return, the return is being drawn up the stack and therefore as the riser ascends the building it carries the water of all the units below and it increases in diameter as they get further from the main.
- A reverse return riser system is "balanced" when the total number of pipes of a given size is the same on both the supply and return sides.

In both direct and reverse return risers, the whole system can be flipped with the mains located at the top.

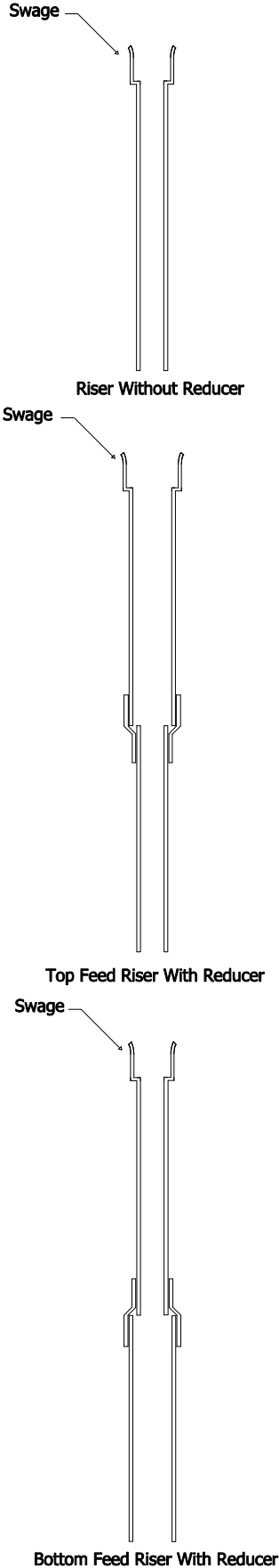
Risers are typically capped at the end of the riser stack. Either top capped (TC) at the top, or bottom capped (BC) at the bottom. Direct returns are typically top capped for both supply and return with the bottoms connected to the main. Reverse returns have their returns capped at the bottom, and supply capped at the top. Unless the mains are located at the opposite end of the building, then as above, flip your capping locations.

Riser drain valves, riser air vents, and riser balancing valves, if required, are typically supplied and installed by the contractor.

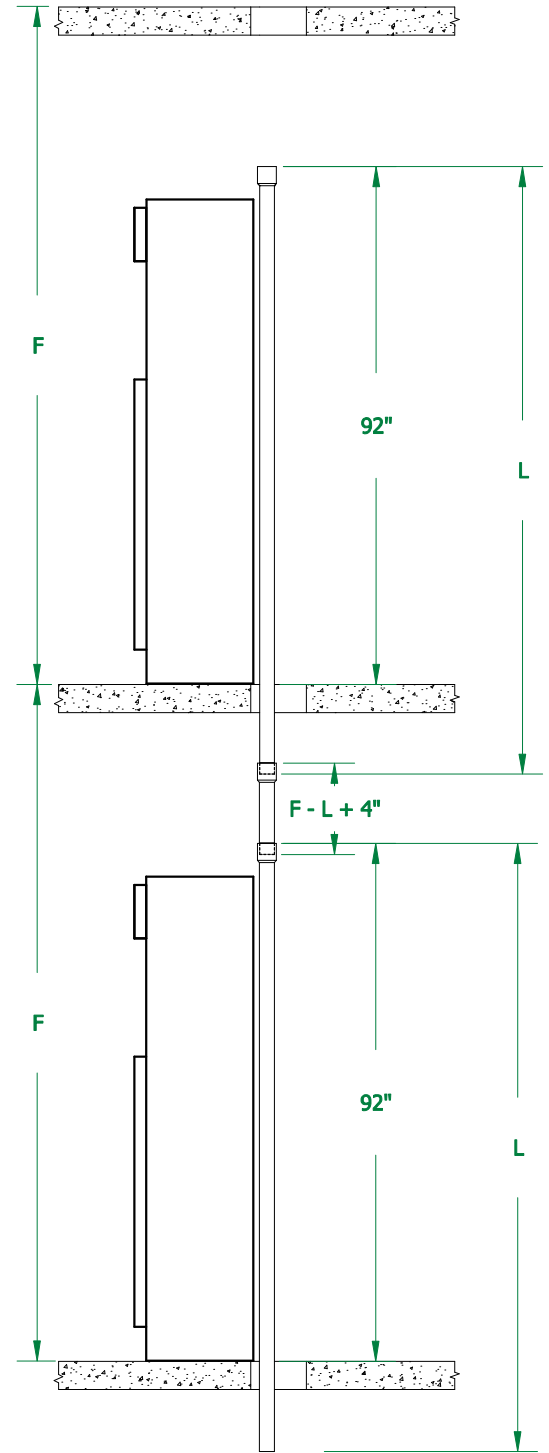
Standard Installation



$$L = F + 2"$$



Standard Installation Using Spool Pieces



$$\text{Spool Piece Length} = F - L + 4"$$

$$L = F - \text{Spool Length} + 4"$$

Riser Length

Risers are coupled together using a swaged connection. The swage is the expanded portion at the top of the riser that allows for the insertion of the riser from above of the same nominal pipe size. Once inserted into the swage, the risers are soldered together. Do not use brazing as this will cause the pipe to overheat and damage the pipe insulation. **It is critical to ensure that the horizontal run-out from each riser to the coil is centered in the slot in the cabinet and that the run-out from the riser is at 90° as it enters the cabinet prior to soldering the risers.** If the run-out is not centered in the opening it can be damaged when the risers expand/contract.

The length of the swage is approximately 3", this length allows for some tolerance in building floor-to-floor distances. Each riser joint must be aligned vertically, with a minimum of 1" penetration, though 2" is preferred. This condition will be met if the floor-to-floor dimensions are as specified and each branch run-out is properly centered. Wide variations in the floor-to-floor dimension may necessitate field modifications to factory risers.

An alternate to swaged connections are compression coupling systems like ProPress®. If these fittings are to be used, the risers are supplied plain ended from the factory with no swaging.

Temspec risers extend 6" above the 86" unit cabinet. From the top of the slab to the top of the riser is 92". This height is to be maintained for all units on all floors to ensure that the run-out from the riser to the unit is centered in the opening, as noted above. The remaining riser length extends below the unit cabinet and through the floor slab (typical floor slab is 8").

The required riser length is determined by knowing the floor-to-floor height (top of slab to top of slab) and adding the additional length of pipe for insertion into the swaged end (typically 2").

The equation $L = F + 2''$ is used to determine the length of the riser. Where F is your floor-to floor height and the 2" is added for insertion into the swaged end of the riser below.

EXAMPLE: If $F = 110''$

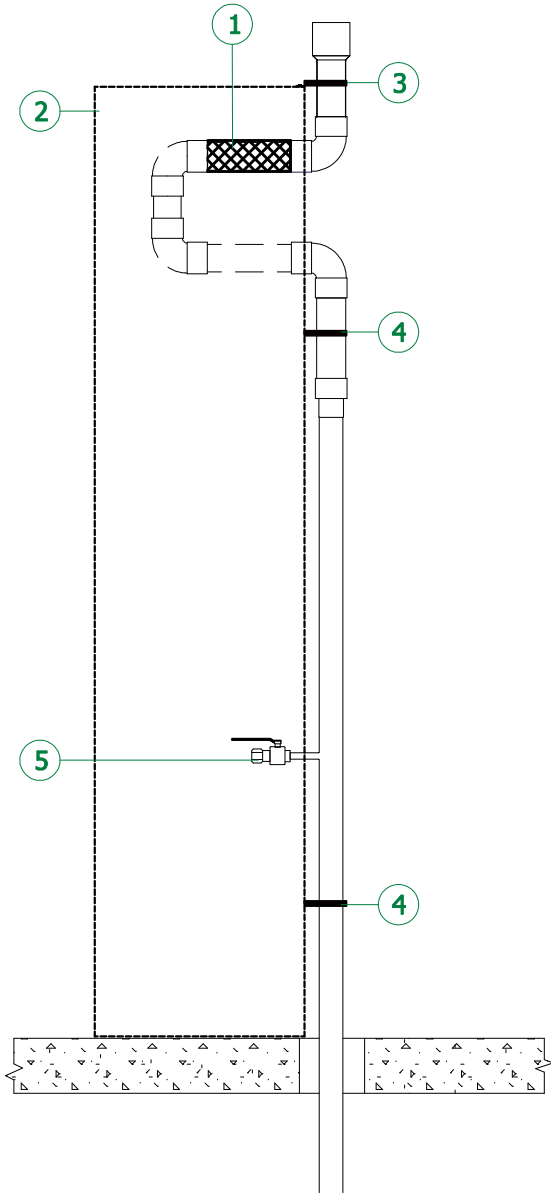
$$L = 110'' + 2'' = 112''$$

Temspec risers can be supplied up to 120" in length. Though a 120" riser will extend 28" below the unit cabinet and can be difficult to maneuver through a floor slab on site. When the floor-to-floor height exceeds 118" or if 28" below the unit is deemed too long, spool pieces can be provided to fill in the gap.

When spool pieces are used, the riser length provided on the units is typically 108" but can be any dimension up to 120". The spool piece length is determined by the equation $\text{Spool} = F - L + 4''$ where the F still equals your floor-to-floor height, L equals the riser length provided on the unit, and the 4" allows for the insertion above and below on the spool piece.

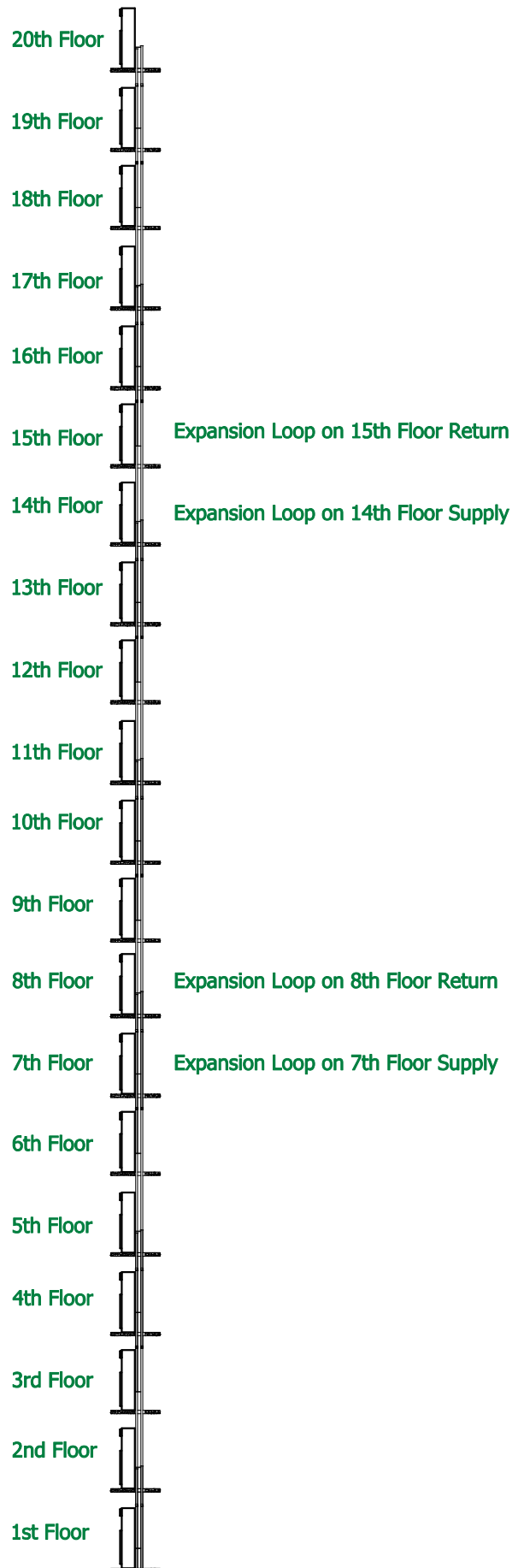
EXAMPLE: If $F = 144''$ and $L = 108''$

$$\text{Spool} = 144'' - 108'' + 4'' = 40''$$



- ① High pressure braided hose
- ② Fan coil cabinet
- ③ Location of loop support bracket
(Remove after riser has been anchored)
- ④ Riser Strap (Remove after riser installation)
- ⑤ Coil branch connection (Run-out)

Note: Riser insulation not shown



Riser Expansion

Risers are not rigidly secured to each fan coil unit. Once installed, they are left free to move up and down with normal vertical expansion and contraction movements in the copper. The internal piping package is designed to allow for $\pm 1 \frac{1}{4}$ " of movement, this is why it is critical for the riser run-out to be centered in the 5" opening of the unit at installation. This $1 \frac{1}{4}$ " of movement is adequate in smaller low rise buildings; however buildings that exceed 12 stories should be fitted with additional expansion compensators.

The general guideline for the application of riser expansion compensators or loops is as follows:

12 to 16 Floors: 1 Expansion Compensator per Riser

17 to 28 Floors: 2 Expansion Compensators per Riser

29 to 40* Floors: 3 Expansion Compensators per Riser

Compensators should be equally spaced along the height of the riser stack.

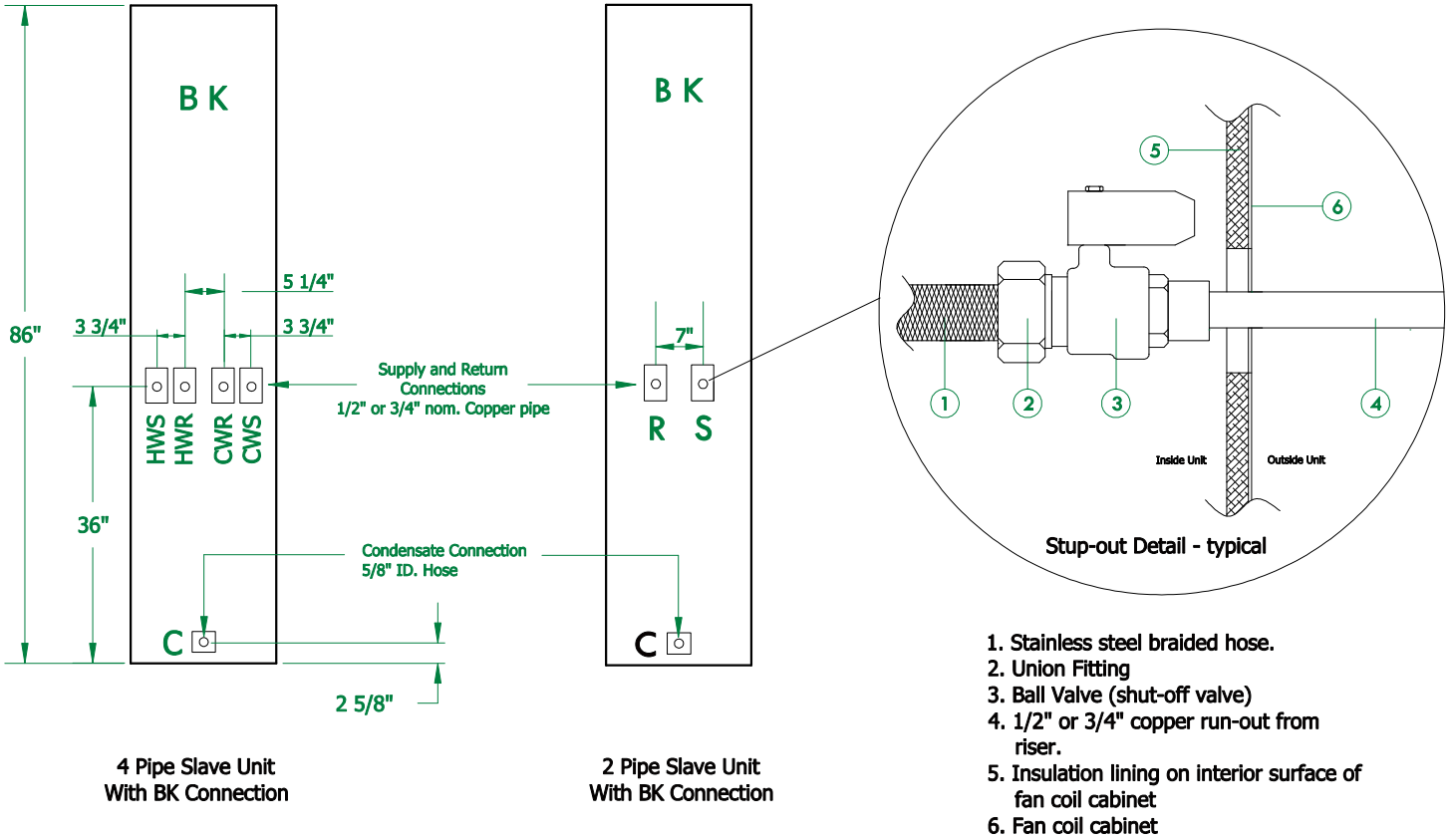
The expansion loops are primarily applied to hot water risers (2-pipe changeover and 4 pipe dedicated hot water) as they expand almost 3x that of chilled water risers. If chilled water expansion compensation is required they are typically installed at a quantity of 1 less than the hot water risers.

The expansion loop is provided on the supply riser on one floor, and then on the return riser on an adjacent floor. This is done because the loop is installed inside the supply air plenum of the fan coil cabinet and to install two loops in one unit would restrict the supply air delivery.

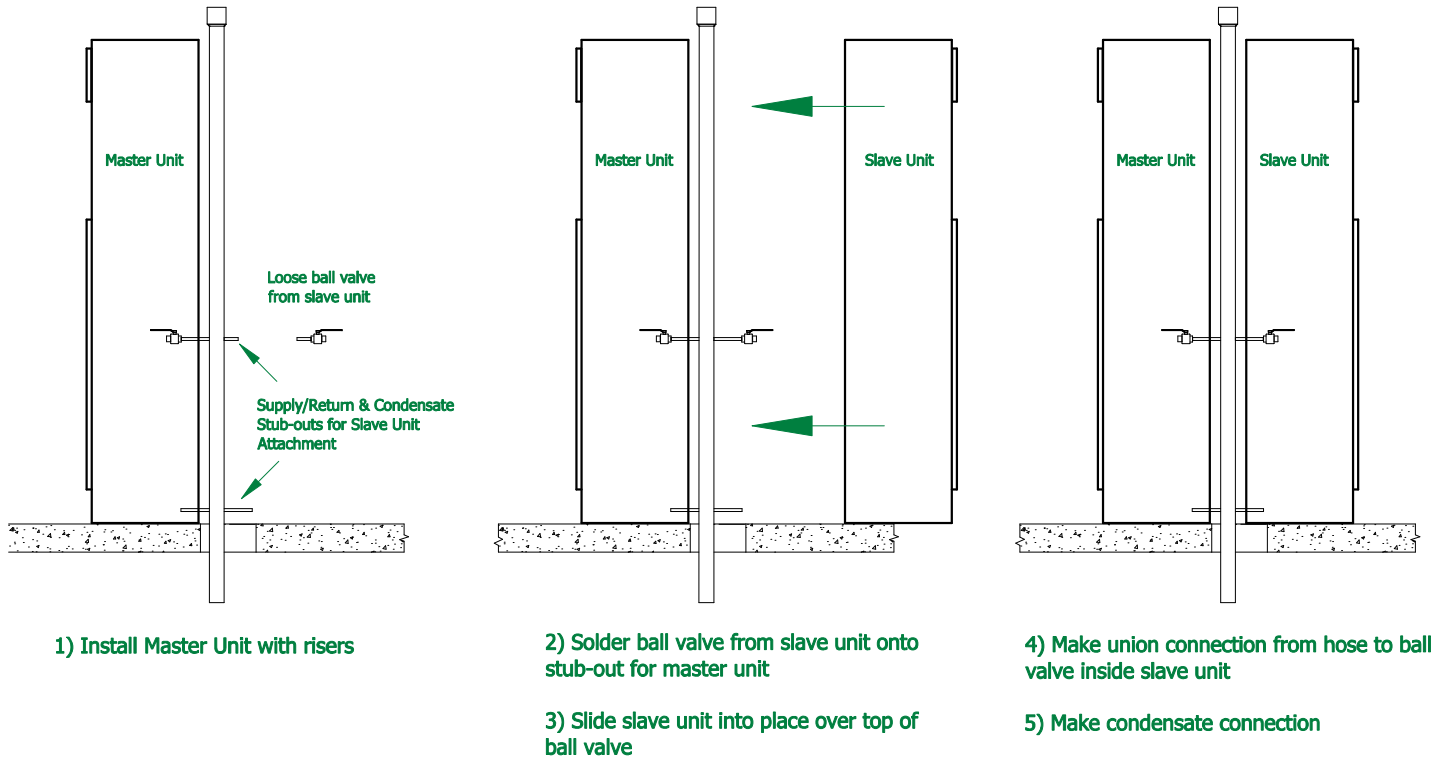
EXAMPLE ON PREVIOUS PAGE: *A twenty story building with a two-pipe changeover riser system. Hot water will run through these risers at least half of the year, chilled water for the other half. Two compensators are provided, spaced as evenly as possible across the total height of the stack.*

Risers themselves should be anchored to the floor slab at multiple points in the building by the installing contractor. Anchor points typically are spaced equally among end points of the stack and any expansion compensators. This should be done so that the risers do not move under gravity and to spread the expansion in opposite directions from the anchor points. **Temspec does not advise on the location or method of anchoring as this is the responsibility of the engineering company retained to design the riser system.** Once anchored to the slab and soldered together, the risers are in effect attached to the building structure, not to the fan coil units. At this point any of the plastic straps used to secure the risers during shipping may be removed or allowed to naturally break off. **The expansion loop support brackets must be removed at this time.**

*Often buildings exceeding 36 floors will break the riser stack in the middle and begin a new stack. This is done to reduce the expansion as well as pipe sizes that can exceed 3" to carry the water for over 40 floors worth of units.



Master/Slave Unit Installation Procedure



Fan Coil Units without Risers

When a fan coil unit is provided without risers it is called a slave or secondary unit. Slave units may be provided for a number of reasons, including:

- There are existing risers that this new unit will be connected to.
- The unit is part of a master/slave pair where a single riser is used to feed a pair of fan coil units. The master unit ships with the riser attached and the slave unit is connected to a run-out on the master unit by the contractor in the field (typical of hotel applications with mirrored room layouts).

The pipe connections are the same for a slave unit as a unit with the risers attached. Only the riser is missing. To install a slave unit to the field riser it requires a few simple steps.

1. Remove the shut-off valve supplied in the unit by releasing the union on the coil side.
2. Solder the run-out* end of the shut-off valve to the existing riser run-out.
*Some field piping may be required to bridge the distance between the riser and the slave unit.
3. Slide the slave unit into position so that the shut-off valve passes through the 2" x 5" opening in the unit. The shut-off valve should be inside the fan coil unit so that once the unit is furred-in the shut-off valve will be accessible and the handle fully operable through the return air access panel.
4. Re-attach the union side of the shut-off valve to the coil piping package inside the fan coil unit.
5. Connect the condensate run-out to the condensate riser.

As with risers attached to the fan coil unit, it is important to center the run-out from the riser to the unit in the opening on the cabinet to allow for the natural expansion and contraction in the riser system.

The insulation of the run-outs from the riser to the shut-off valve is the responsibility of the installing contractor.