

WISCONSIN DRAIN AND VENT SYSTEM DESIGN



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by

WI. DEPARTMENT OF COMMERCE

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Introduction

The Wisconsin plumbing code is continually revised to keep pace with changing technology. Using these changes, people in the plumbing industry are designing and installing greater varieties of drain and vent systems. Drain and vent system design is as important to the beginning apprentice as it is to the seasoned engineer.

These systems are regulated by the Division of Safety and Buildings, to protect the health of Wisconsin residents. This training material is designed as a review for the plumbing industry. It is the hope of Safety and Buildings Division staff that this manual helps a student understand the options available in drain and vent design and helps a trained professional offer a safe, code compliant product to the consumer.

*145.02 Wis. Stats:
Powers of department.
(1) The construction,
installation and
maintenance of plumbing
in connection with all
buildings in this state,
including buildings owned
by the state or any political
subdivision thereof, shall
be safe, sanitary, and such
as to safeguard the public
health and the waters of
the state.*

Drains

Drainage Fixture Unit Values

To begin sizing a sanitary drainage system, start with the individual fixtures that contribute to the system. Various intermittent-flow plumbing fixtures that discharge to the plumbing system are assigned drainage fixture unit (dfu) values. These values are listed in Table 82.30-1 of the code (Figure 1). The minimum trap sizes are also included in this table.

If the fixture, appliance or device is not listed in the table a drainage fixture unit value can be assigned to the device by one of the following methods:

Sink Tailpiece Diameter

Table 82.30-1, footnote i, assigns a dfu equivalence to a given tailpiece diameter:

1 1/4" tailpiece = 1 dfu
 1 1/2" tailpiece = 2 dfu
 2" tailpiece = 3 dfu

Intermittent-flow Device

The intermittent flow device or fixture has a dfu value determined by dividing the gallon per minute discharge rate of the device by 1.0. This can be shown in a math equation as:

$$1 \text{ GPM (intermittent flow)} = 1 \text{ dfu}$$

Where: GPM = gallons per minute
 dfu = drainage fixture unit

A note in s. Comm 82.30 (3) (a) 2. states that equipment with a timed discharge cycle of 2 minutes or less may be considered as an intermittent flow device.

Comm 82.30(3)

LOAD ON DRAIN PIPING.

(a) Intermittent flow. 1. 'Fixture.' The load factor on drain piping shall be computed in terms of drainage fixture unit values specified in Table 82.30-1 for the corresponding listed fixture. 2. 'Devices.' Drainage fixture unit values for intermittent flow devices not listed in Table 82.30-1 shall be computed on the basis of one fixture unit equalling one gallon per minute of flow.

***Note:** Equipment with a timed discharge cycle(s) of 2 minutes or less may be considered as an intermittent flow device.*

Drainage fixture unit (dfu) means a measurement of the probable discharge into the drainage system by various types of plumbing fixtures.

(Similar to the International Plumbing Code)

TABLE 82.30-1
DRAINAGE FIXTURE UNIT VALUES BY FIXTURE TYPE

Type of Fixture	Drainage Fixture Unit Value (dfu)	Trap Size Minimum Diameter (inches)
Automatic Clothes Washers:		
Commercial, individual	4	2
Commercial, large capacity	a	a
Self Service Laundry	4	2
Residential	4	2
Autopsy Table	b	b
Bathroom Group, includes: water closet, lavatory, bathtub or shower	6	
Bathtubs, all types ^b	2	1½
Bedpan Washer	6	2
Beer Tap	½	1¼
Bidet	2	1½
Bottle Cooler	½	1¼
Campsite Receptor	6	4
Coffee Maker	½	1¼
Cuspidor, fountain or dental	1	1¼
Dipper Well	1	1½
Dishwasher, commercial type	c	c
Dishwasher, residential type	2	1½
Drinking Fountain	½	1¼
Exhaust Hood Washer	4	2
Floor Drain:		
2 inch	2	2
3 inch	3	3
4 inch	4	4
Larger than 4 inch	4	d
Glass Filler	½	1¼
Glass Washer	2	1½
Health Care Fixtures:		
Clinic sink	6	NA
Exam/treatment sink	1	1¼
Sitz bath	2	1½
Ice Chest	½	1½
Laundry Tray, 1 or 2 compartment	2	1½
Lavatory	1	1¼
Lavatory, combination per trap	1	1½
Manufactured Home	11	NA
Refrigerated Food Display Case	1	1
Shower Stall:		
Residential	2	2
Public, individual	2	2
Public, group	2 per shower head	2
Sinks: ⁱ		
Bar, residential	1	1¼
Breakroom (single compartment)	1	1½
Cup	½	1¼
Factory, wash, per set of faucets	1	1½

TABLE 82.30-1 (Continued)
DRAINAGE FIXTURE UNIT VALUES BY FIXTURE TYPE

Type of Fixture	Drainage Fixture Unit Value (dfu)	Trap Size Minimum Diameter (inches)
Fountain wash up	1	1½
Fountain or Bar, 4 compartments or less	3	1½
Food Waste Grinder, commercial 2 HP or less	2	f
Food Waste Grinder, commercial 3 HP or more	3	f
Laboratory	2	1½
Laboratory, school	2	1½
Classroom	1	1¼
Pack or plaster	3	2
Residential, with or without food waste grinder	2	1½
Restaurant, Scullery, pots and pans — 4 compartments or less	3	f
Food, rinsing, cleaning or thawing	3	2
Service Sink, Flushing Rim	6	3
Service Sink, 2 inch diameter, wall outlet	2	2
Service Sink, 3 inch diameter, wall outlet	3	3
Service Sink, 2 inch diameter, floor outlet	2	2
Service Sink, 3 inch diameter, floor outlet	3	3
Shampoo Sink, barber or beauty parlor	2	1½
Surgeons, wash up	3	1½
Wash Fountain, circular and semi-circular	2	1½
Receptors of Indirect Wastes, gravity flow discharge:		
1¼ inch receptor outlet diameter	1	1¼
1½ inch receptor outlet diameter	2	1½
2 inch receptor outlet diameter	3	2
3 inch receptor outlet diameter	4	3
4 inch receptor outlet diameter	6	4
Larger than 4 inch receptor outlet diameter	8	f
Soda Dispenser	½	1¼
Sterilizers:		
Bedpan	4	2
Garbage can washer	3	3
Instrument or water	1	
Urinal	2	g
Water Closet, nonpublic	4	g
Water Closet, public	6	g

NA = not applicable

^a Based on discharge rate of the fixture.

^b Includes foot, sitz and infant baths and regular bathtubs with or without showers or whirlpool circulation piping.

^c Based on discharge rates and number of outlets; a 4" diameter trap and drain pipe minimum recommended.

^d Trap size corresponds to the size of the floor drain.

^e Trap size corresponds to the size of the drain outlet.

^f Trap size specified in referenced standards of s. Comm 84.20.

^g Trap size corresponds to the size of the drain outlet. Use the dfu value of the receptor serving the autopsy table.

ⁱ Sinks not specified in this table shall be assigned 1 dfu for 1¼" tailpiece, 2 dfu for 1½" tailpiece and 3 dfu for 2" tailpiece.

Figure 1: Table 82.30-1. Drainage Fixture Unit Values

Continuous Flow Devices

The continuous device, such as a pump or a condensate waste discharge line, can be assigned a drainage fixture unit value in a similar way. The discharge rate is multiplied by two, because of the continuous flow:

$$2 \times \text{GPM} = \text{dfu}$$

Where:

GPM = gallons per minute

dfu = drainage fixture units

This means that if a building included a processor that discharges 30 gpm continuously, the drainage fixture unit value of the device could be calculated by multiplying the discharge rate of 30 by two. The drainage fixture unit value for this processor is 60 dfu (Figure 2).

For assistance in assigning the drainage fixture unit value for an unknown device, contact division staff.

The drainage fixture unit values for all fixtures and receptors discharging to a drain line are combined to assess the dfu load of that drain. After calculating the total fixture unit load, the drain line is sized using Tables 82.30-2 and 82.30-3.

S. Comm 82.30(4)(a)2. permits the dfu value for domestic water heater T&P relief valve receptor to be disregarded when sizing the building drain and building sewer.

*Comm 82.30(3)(b):
(b) Continuous flow devices. Drainage fixture unit values for continuous flow devices such as pumps, ejectors, air conditioning equipment or similar devices that discharge continuously shall be computed on the basis of 2 fixture units for each 1 gallon per minute of flow.*

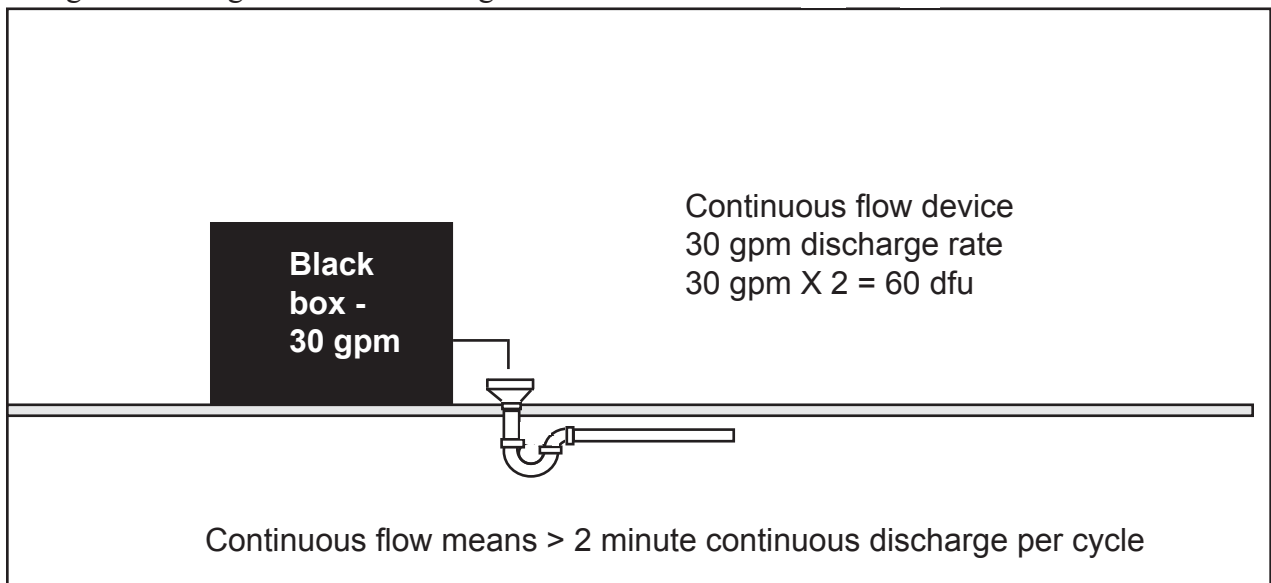


Figure 2: Calculating Fixture Discharge Rates

Minimum Requirements

*Comm 82.30(4)(c)1:
Minimum size of building sewers. Gravity flow sewers. The minimum size of a gravity flow sanitary building sewer shall be 4 inches in diameter. A municipality of sanitary district by ordinance may require that portion of the building sewer between the lot line and the public sewer to be larger than 4 inches in diameter.*

*Comm 82.30(4)(c)2a & b:
Sewers pressurized through the use of sewage ejectors, sewage pumps or sewage grinder pumps shall be sized to maintain a minimum flow velocity of 2 feet per second and shall be in accordance with the ejector or pump manufacturer's recommendations.*

Pressurized building sewers shall be sized not less than 2 inches in diameter for sewage ejectors and sewage pumps, and 1 1/4 inches in diameter for all sewage grinder pumps.

Comm 81.01 (122) "Horizontal pipe" means any pipe or fitting which makes an angle of less than 45° from horizontal.

Before using Tables 82.30-2 and 82.30-3, there are some absolute minimums that should be remembered:

- * The minimum diameter for the entire length of a gravity flow sanitary building sewer is four inches.
- * Building sewers pressurized by the use of sewage ejectors or sewage pumps must be at least two inches in diameter, except that where a sewage grinder pump is installed the minimum diameter is 1-1/4 inches.

Drains & Stacks

The next step in reviewing drain and vent sizing is studying Table 82.30-2 (Figure 3).

This table lists the maximum number of drainage fixture units allowed to drain through drain piping (including stacks).

There are five columns in Table 82.30-2. The first column lists pipe sizes. There is one column for drain piping other than stacks which does not include building drains, building subdrains, building sewers, forced discharge piping or private interceptor main sewers (see footnote b). There is another column for total discharge from side connections into one branch interval, one for stacks of three branch intervals or less and one column for stacks of more than three branch intervals.

Note the capacity ranges of a 4 - inch diameter pipe:

4 - inch horizontal pipe	-	160 dfu
4 - inch vertical pipe	-	240 dfu
(3 branch intervals or less)		
4 -inch vertical pipe	-	500 dfu
(More than 3 branch int.)		
4 - inch limitation into one branch interval	-	90 dfu

The same diameter pipe (in this example, 4" has a capacity to carry from 90 dfu to 500 dfu. The cause of this variance is based on the dynamics of the piping system.

Table 82.30-2 STACKS AND DRAIN PIPING				
Pipe Diameter (Inches)	Maximum Number of Drainage Fixture Units That May Drain Through Any Portion of Drain Piping ^a			
	Drain Piping Other Than Stacks ^b	Stacks ^c		
		Total Discharge from Side Connections into One Branch Interval ^{d,e}	Stacks of 3 Branch Intervals or Less	Stacks of More Than 3 Branch Intervals
1 1/4	1	1	2	2
1 1/2	3	2	4	8
2	6	6	10	24
3	20	20	48	72
4	160	90	240	500
5	360	200	540	1,100
6	620	350	960	1,900
8	1,400	600	2,200	3,600
10	2,500	1,000	3,800	5,600
12	3,900	1,500	6,000	8,400
15	7,000	f	f	f

^a Through any portion of a stack includes all of the flow at the design point.

^b Does not include building drains and subdrains, building sewers, private interceptor main sewers and forced discharge piping.

^c Drain stacks may be reduced in size as the drainage load decreases to a minimum diameter of one half of the diameter required at the base of the stack, but not smaller than that required for a stack vent under s. Comm 82.31 (14) (a)

^d Into one branch interval includes the discharge from the top fitting of the branch interval and does not include the discharge from the bottom most fitting creating the branch interval.

^e Reduction in diameter may occur within a branch interval.

^f Sizing based on design criteria.

Figure 3. Table 82.30-2 Horizontal and Vertical Drain Piping

A horizontal drain (not a building drain or sewer) is anticipated to discharge to the stack. When a horizontal drain discharges to a stack the flow within the horizontal drain has an impact on the flow through the stack. Because of this impact, the horizontal drain is limited to a lower load than the building drain or sewer. A horizontal drain discharging to a stack may have a vertical portion. See figure 4.

Vertical and horizontal drain piping are sized with column two of Table 82.30-2

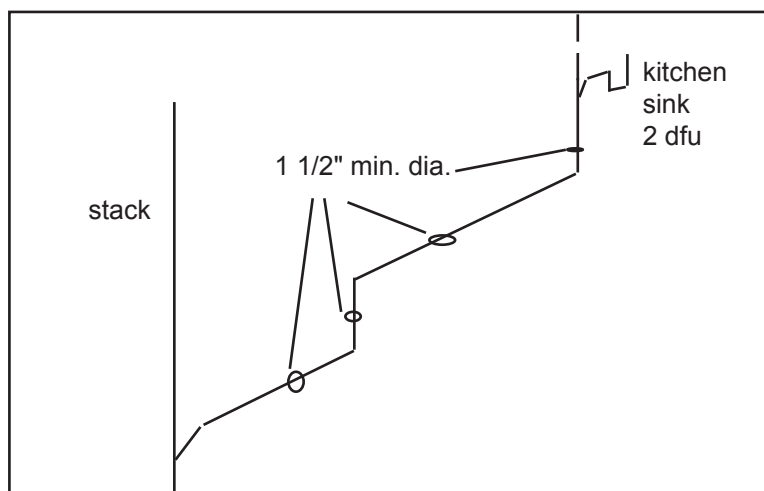


Figure 4. Sizing drains other than stacks.-Column 2 Table 82.30-2

Comm 82.30(5) PITCH OF HORIZONTAL DRAIN PIPING.

All horizontal drain piping 4" or larger in diameter shall be installed at a pitch which produces a computed velocity of at least 2 feet per second when flowing half full.

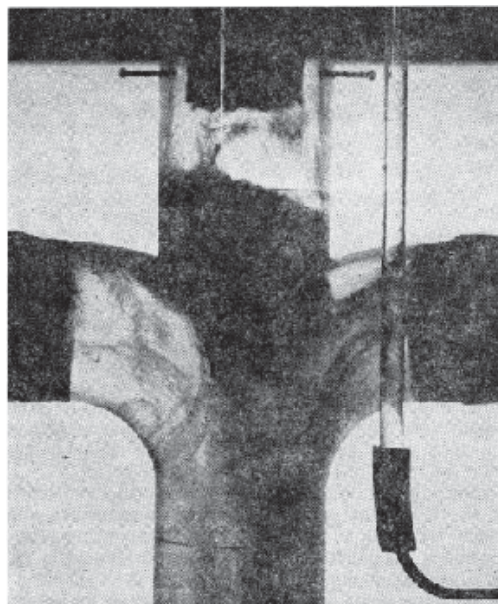
Comm 82.30 (5) (a)

Horizontal branch drains.

1. The minimum pitch of horizontal branch drains 2" or less in diameter shall be 1/4" per foot.

2. The minimum pitch or horizontal branch drains larger than 2" in diameter shall be 1/8" per foot.

Comm 81.01 (122) "Horizontal pipe" means any pipe or fitting which make an angle of less than 45° from the horizontal.



Comm 81.01 (34)

"Branch" means a part of a piping system other than a riser, main or stack.

Figure 5. Flow into a 3-inch diameter stack from two horizontal branches at the same elevation, illustrating exceeding the capacity of the stack. NBS Monograph 31. July 3, 1961.

s. Comm 81.01 (233)

"Stack" means a drain or vent pipe that extends vertically one full story or more.

When the horizontal flow from a drain branch enters a stack there is deflection of any upstream flow carried in the stack. With increased flow within the horizontal branch disruption of the flow in the stack occurs (see Figure 5). The deflection of the annular flow in the stack can cause a back-pressure that can occur in the horizontal drain. If the flow from the horizontal branch drain or the stack becomes excessive at the junction point, the stack hydraulic control is compromised and efficient drainage fails. These two phenomena are addressed by the horizontal branch drain and stack sizing criteria found in Table 82.30-2.

s. Comm 81.01 (271)

"Vertical pipe" means any pipe or fitting which makes an angle of 45° or less with the vertical.

When studying stack hydraulics, remember:

- * Wastewater clings to the side of the stack causing annular flow.
- * The junction of the stack and horizontal branch drains has the potential to cause a disruption of flow and air movement within the stack.
- * The junction of the stack and horizontal branch drain has the potential to cause backpressure within the horizontal branch drain.

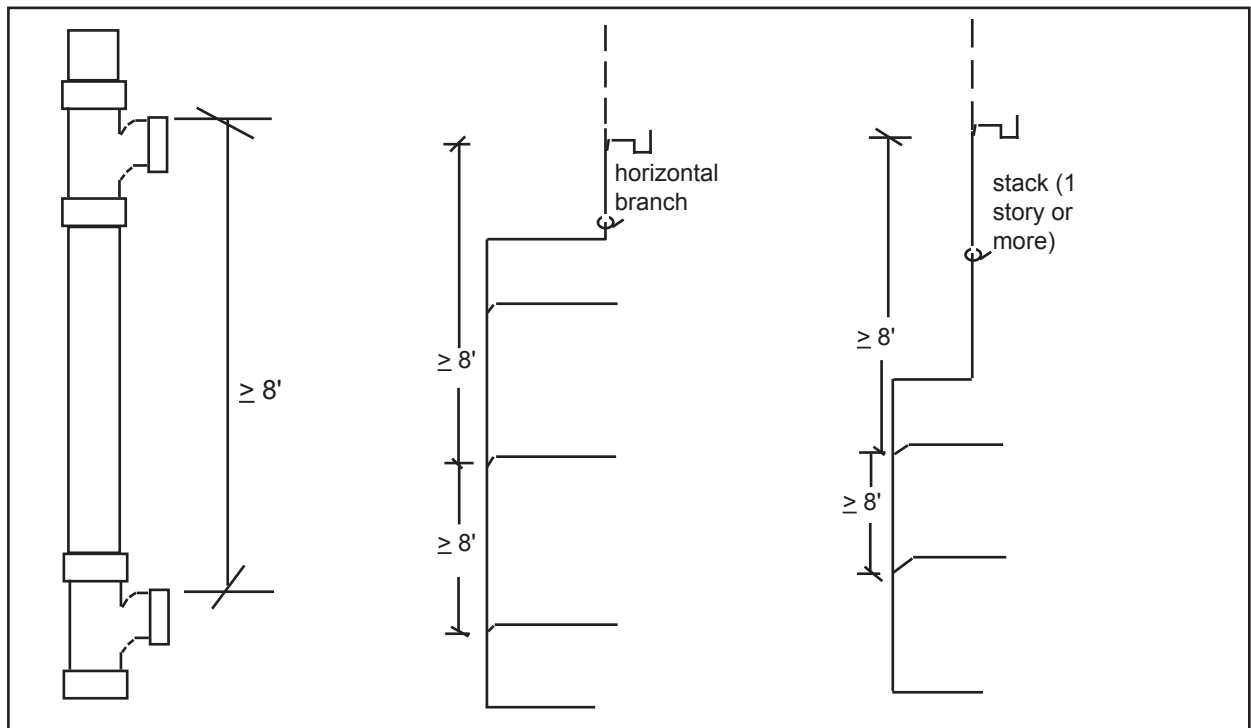


Figure 6. Branch Interval

Branch Intervals

Before using the three right-hand columns in Table 82.30-2, the designer must understand the definition of "branch interval".

A branch interval is defined as: "a vertical measurement of distance, 8 feet or more in length, between the connections of horizontal branches to a drainage stack."

Measure branch intervals from the highest to the lowest connection (Figure 6). Each vertical section of the stack at least eight feet long represents a branch interval.

Note: The code allow an offset of 45° or less from the vertical to be sized as vertical piping.

Remember, branch intervals are not always the same length. What they have in common is that they will always be at least eight feet long.

*s. Comm 81.01
(35) "Branch interval" means a vertical measurement of distance, 8 feet or more in length, between the connections of horizontal branches to a drainage stack.*

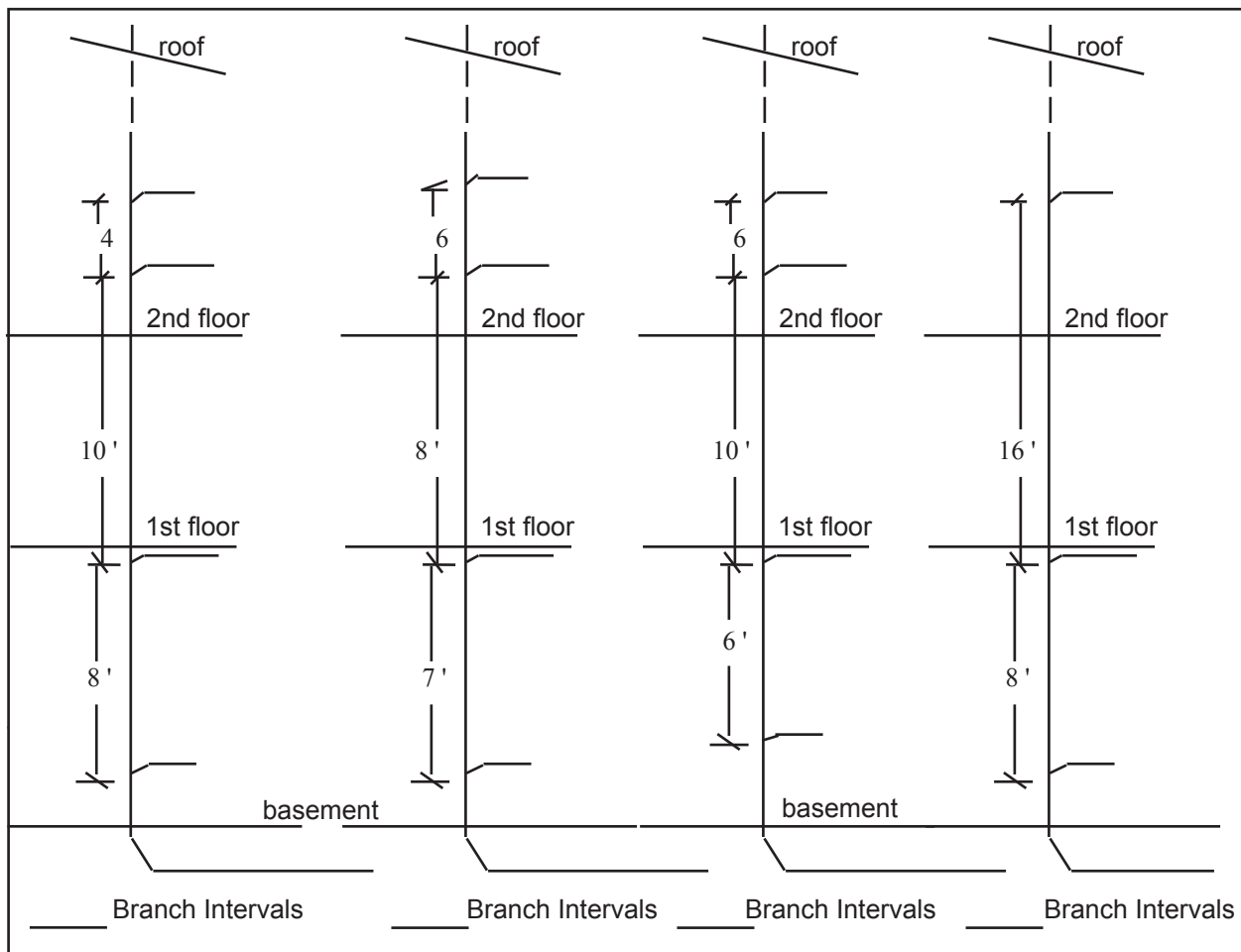


Figure 7. Measuring Branch Intervals

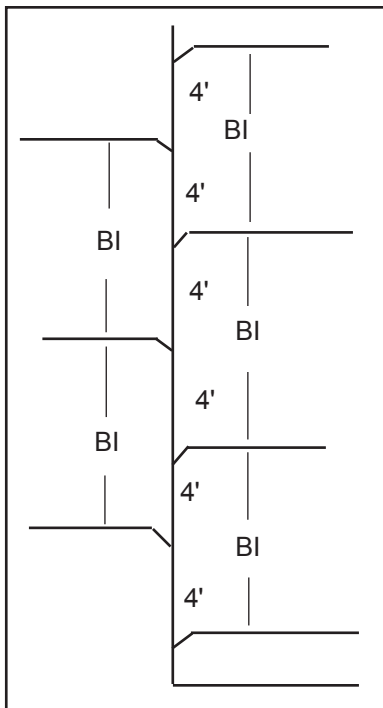


Figure 8.
Overlapping branch intervals.

In figure 7, fill in the total number of branch intervals on the line provided and identify each branch interval on each stack.

Note: The answers are located in the appendix, page 76.

The remainder of Table 82.30-2 relates to the sizing of vertical drain piping (basically stacks, as horizontal branches may contain vertical portions). Notice that the dfu discharging into any one branch interval is located in the third column of the table. This limitation restricts the flow from side connections so as to avoid possible interference within the stack. The limitation of flow within one branch interval is within any space of 8 feet within the stack.

A stack with several horizontal branch drain connections within 8 feet of one another could be considered to have many overlapping branch intervals (See Figure 8), so caution should be exercised when situations occur similar to Figure 8.

Table 1
Terminal velocities and water film thickness
For various stack diameters

Flow rate	3" dia.			4" dia.			6" dia.		
	t	Vt	Lt	t	Vt	Lt	t	Vt	Lt
1.0	.09	7.5	2.8	.06	6.7	2.2	.05	5.7	1.6
2.0	.11	10.1	4.9	.09	9.0	3.9	.07	7.6	2.8
3.0	.13	11.9	6.8	.12	10.6	5.4	.09	9.0	3.9
4.0	.16	13.4	8.7	.14	11.9	6.9	.11	10.1	4.9
4.8	.18	14.4	10.0	.15	12.8	8.0	.12	10.9	5.7
10.6				.25	17.7	15.2	.19	15.0	10.9
31.2							.37	23.1	26.0

Table 1 adapted from The Engineered Design of Building Drainage Systems
J. A. Swaffield & LS Galowin

Where: Flow rate is expressed in GPM
t = Thickness of the water film, in inches
Vt = Terminal velocity along the core, in feet per second
Lt = Terminal distance, in feet

As Table 1 shows, at a certain length, each pipe diameter reaches its own terminal velocity. It has been shown that shorter, smaller stacks do not reach terminal velocity, so the code allows larger flows through the longer stacks of 3 or more branch intervals.

Table 1 is based on a smooth stack, 25% limit for the annular thickness of the water flowing through the stack and the equations found in Dr. Swaffield's section 4.3¹ of The Engineered Design of Building Drainage Systems.

The increase in the capacity related to the increase in the number of branch intervals is based on the peak flow through vertical pipe. As the distance increases, the speed of the water and air travelling through the pipe also increases. See Figure 9.

Note: Annular thickness means the depth of water clinging to the inside of the pipe.

Note: Terminal velocity means the condition when the water within the stack is moving at a constant speed due to gravity and the restraining forces exerted by the air and stack interior surface.

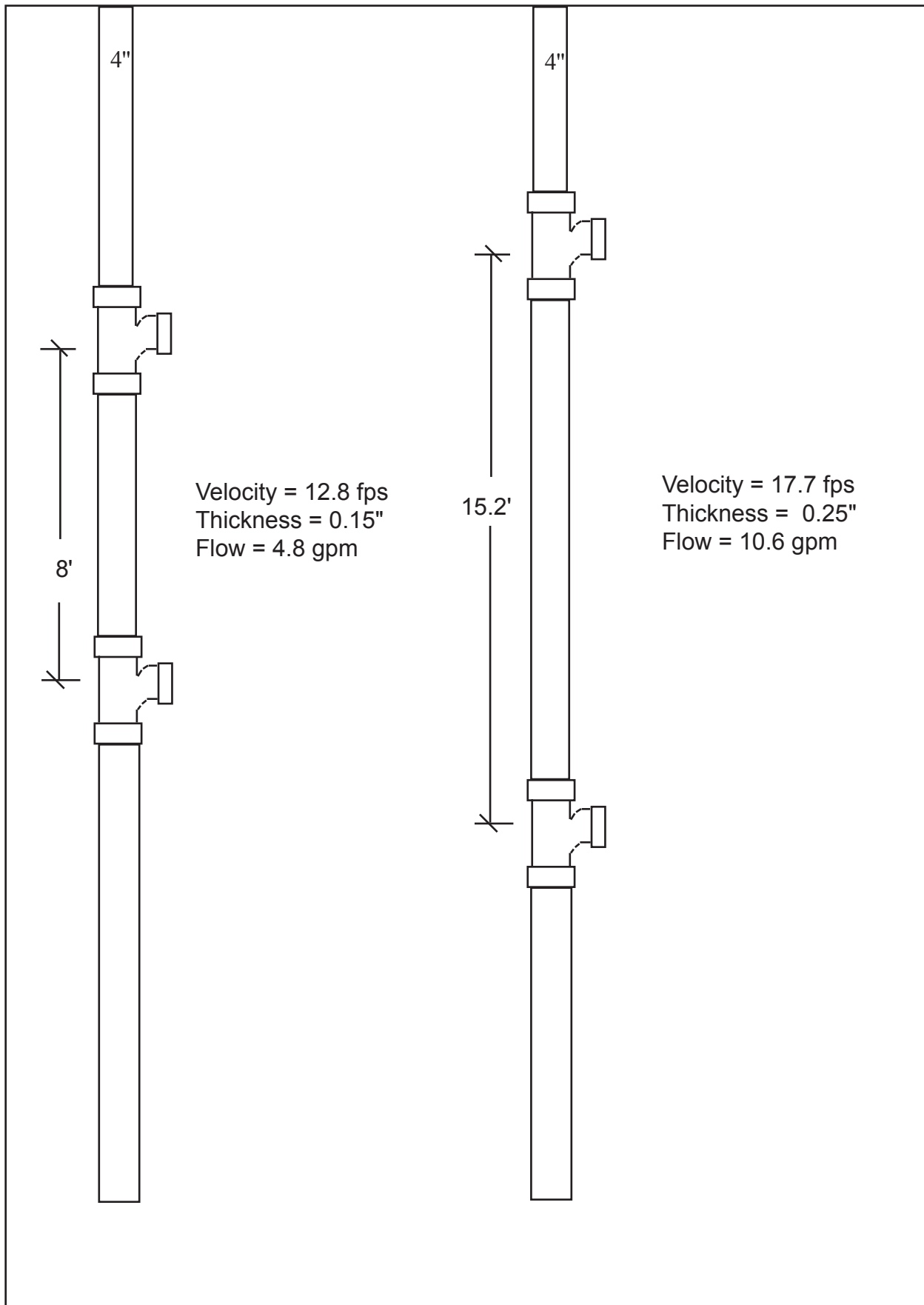


Figure 9 GPM load on stacks

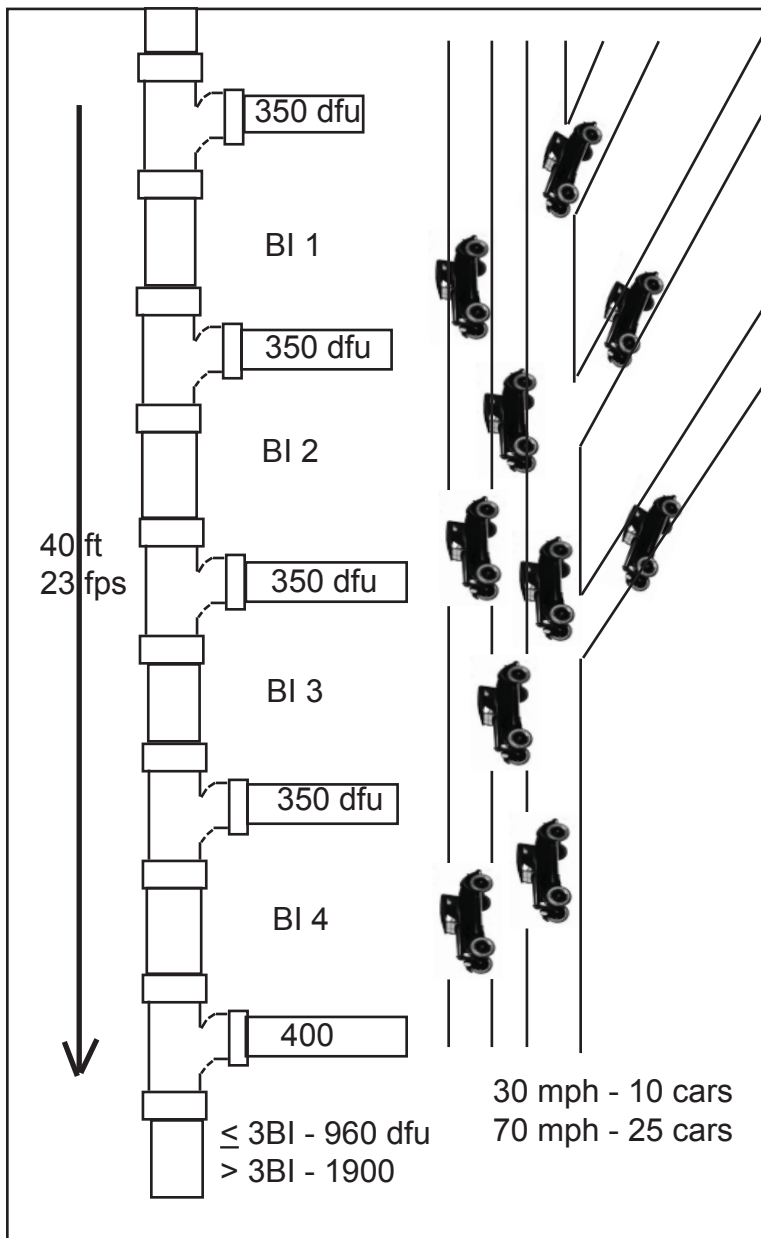


Figure 10 Capacity of stacks

The flow characteristics in a tall drain stack are such that when excessive drainage enters a stack in one area, the stack does not function efficiently. A tall drain stack will handle a great number of fixture units (because of terminal velocity), as long as the connected load is spread out sufficiently.

Figure 10 illustrates the comparison of traffic on a highway to water within the stack. As the speed of the cars on the highway increases so does the number of cars that can be carried on that highway. Similarly, as the speed of the water within the stack increases (velocity) the water-carrying capacity (or number of dfu) of the stack is also increased. Like the stack horizontal branch drain limitations, the flow of cars onto the freeway is controlled through signaled entrance ramps.

Comm 82.30 (4) SIZE OF DRAIN PIPING. 1. The total drainage load in any portion of drain piping shall not exceed the limits specified in Tables 82.30-2 and 82.30-3.

Table 82.30-2, footnote "b". Drain stacks may be reduced in size as the drainage load decreases to a minimum diameter of one half of the diameter required at the base of the stack, but not smaller than that required for a stack vent under s. Comm 82.31 (14) (a).



Much like this person is pouring water "into" the glass, wastewater that's discharging "into" the branch interval is from above and within that branch interval.

What's Discharging "Into" a Branch Interval?

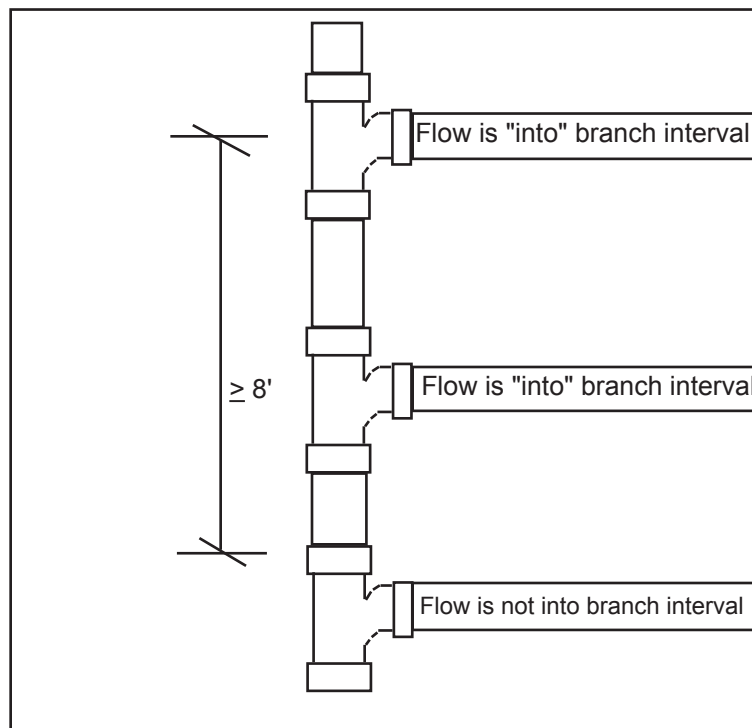


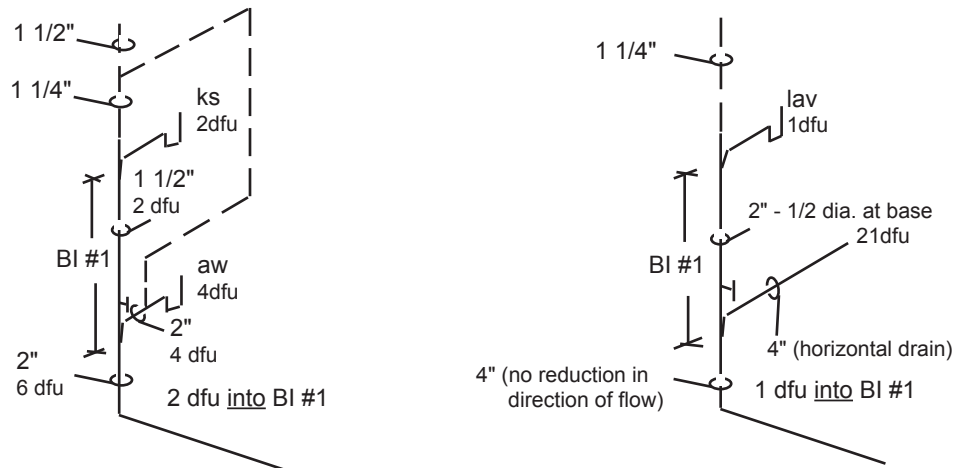
Figure 11. Into and Through the Branch Interval

Table 82.30-2 contains three columns that apply to the minimum stack diameter requirements at specific points of the stack. The third column in the table limits the number of dfu that may be connected via horizontal branch drains into a branch interval based on the stack diameter at that point within that branch interval. See figure 11.

Major things to be aware of when sizing a drain stack are:

1. How many branch intervals does the stack contain?
2. How many dfu are entering any one branch interval?
3. What is the total dfu load discharging into the stack?
4. The drain stack may be reduced, but not to less than half of the diameter of the drain at the base of the stack. (See footnote "b" to Table 82.30-2, Figure 3.)

Less Than 3 Branch Interval Stack Sizing Examples



Stack Sizing Using Table 82.30-2

1. Number of branch intervals
2. Discharge from horizontal drain branches into the branch interval.
3. Dfu through the stack at any point.
4. Diameter required at the stack base.

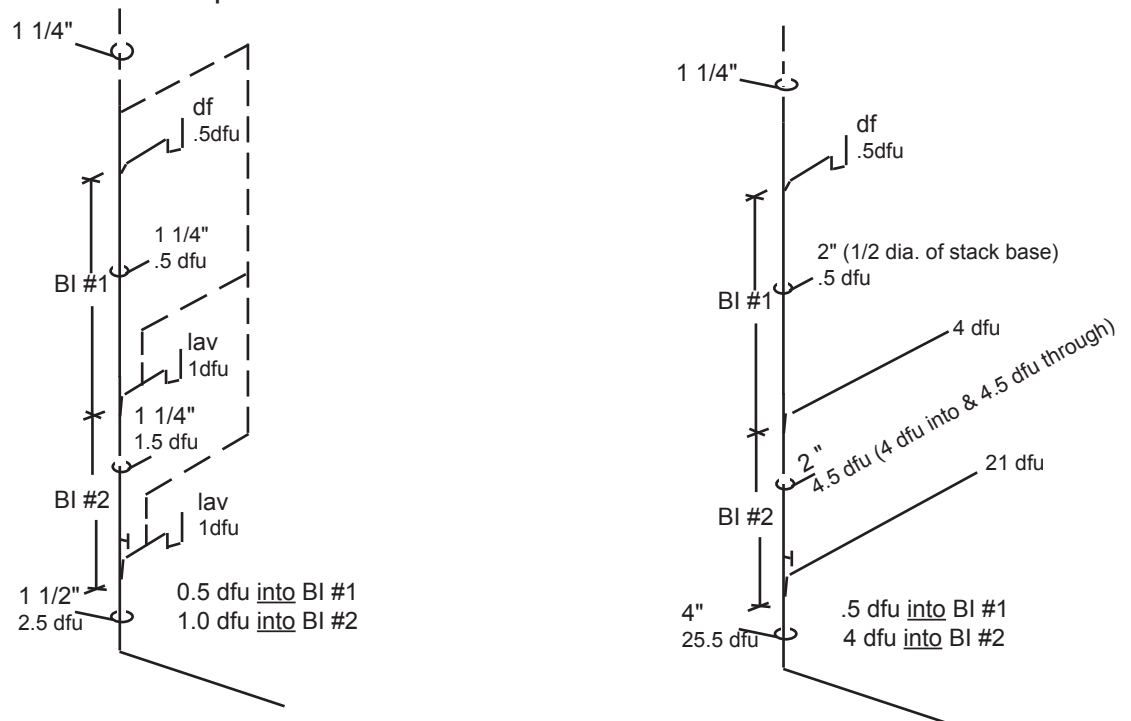


Figure 12. Sizing Stacks

Horizontal Branch Drain Requirement Affecting Minimum Stack Diameter

Note: No stack vent required on less than 5 BI. Vent size determined as branch vent.

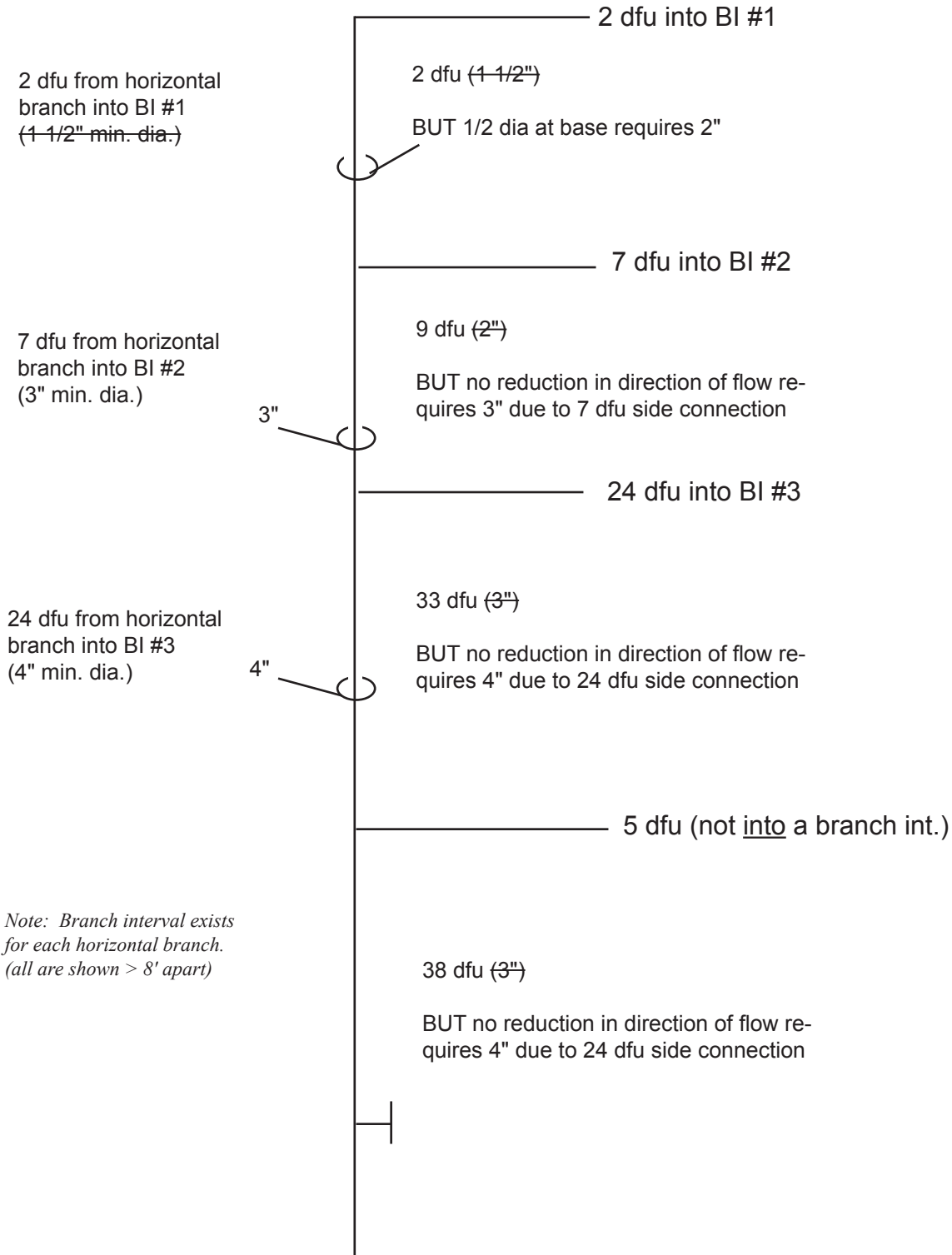


Figure 13. How horizontal branch drains affect minimum stack diameter

Determining Minimum Stack Diameter

Note: No stack vent required on less than 5 BI. Vent size determined as branch vent.

Note: Based on the footnote to Table 82.30-2, the stack size is reduced within branch interval #1.

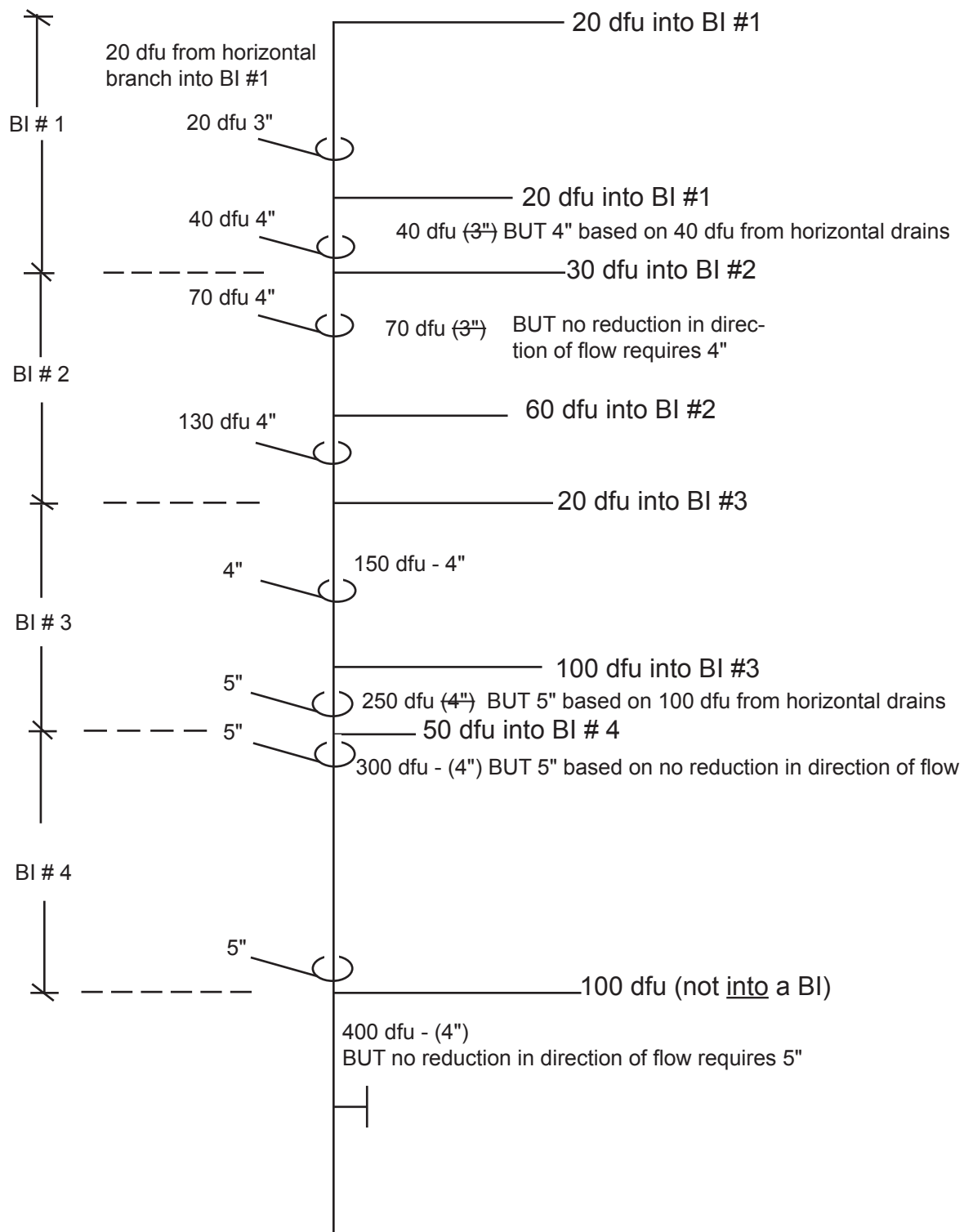
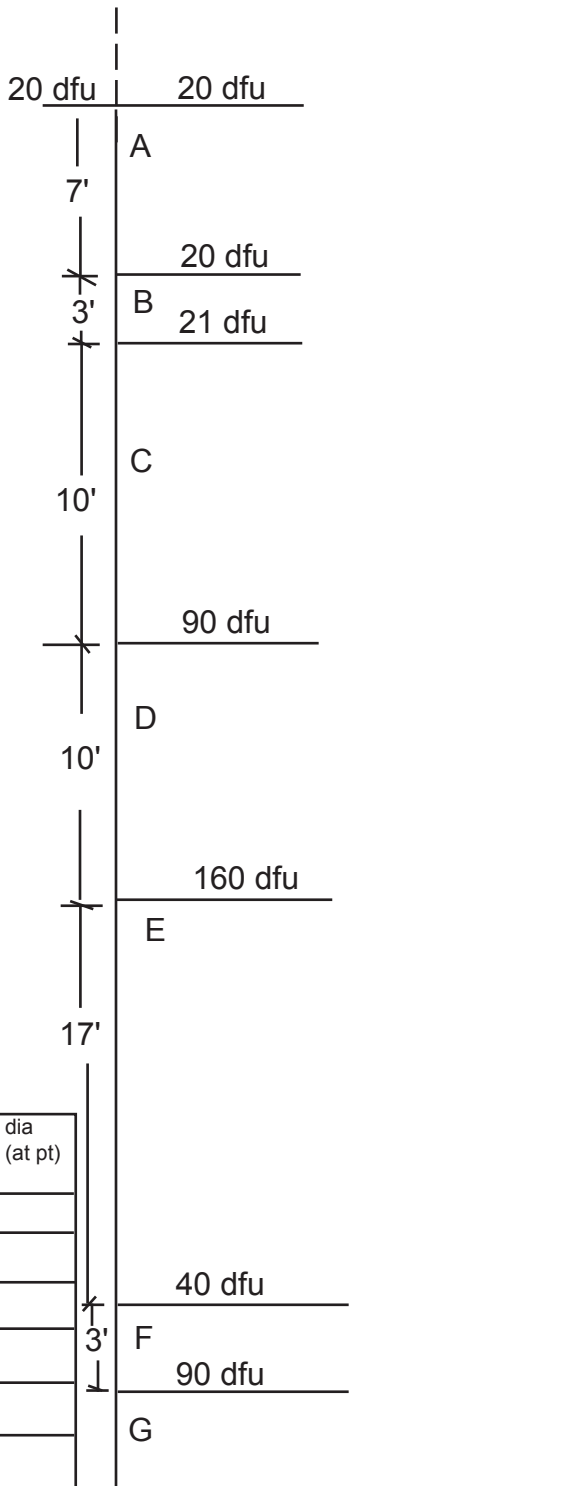
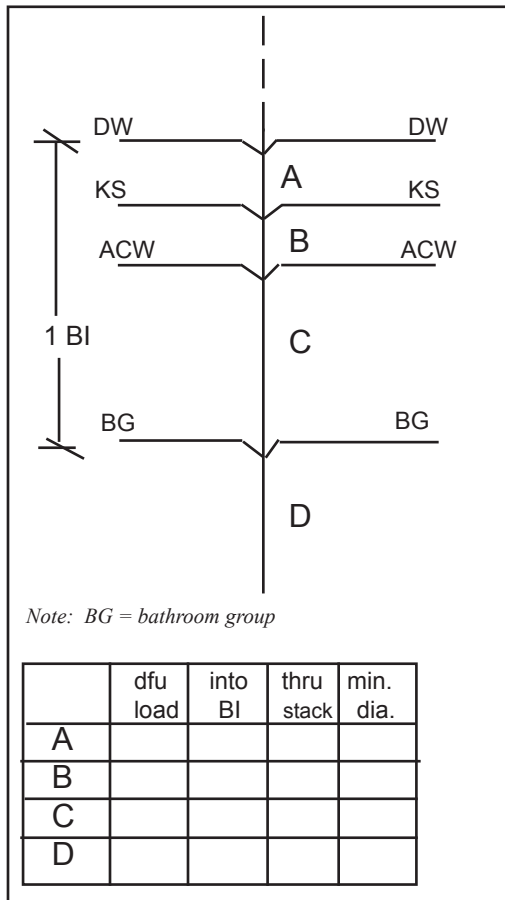


Figure 14. How horizontal branch drains affect minimum stack diameter

Stack Sizing Problems

Students may complete the following problems on stack sizing. Answers are located on page 77 of the appendix. Fill in the table with the appropriate dfu load, dfu into the branch interval, through the pipe at that point and minimum pipe size for every example.



* This column refers to any horizontal branch drain above the point designated.

Stack Offsets

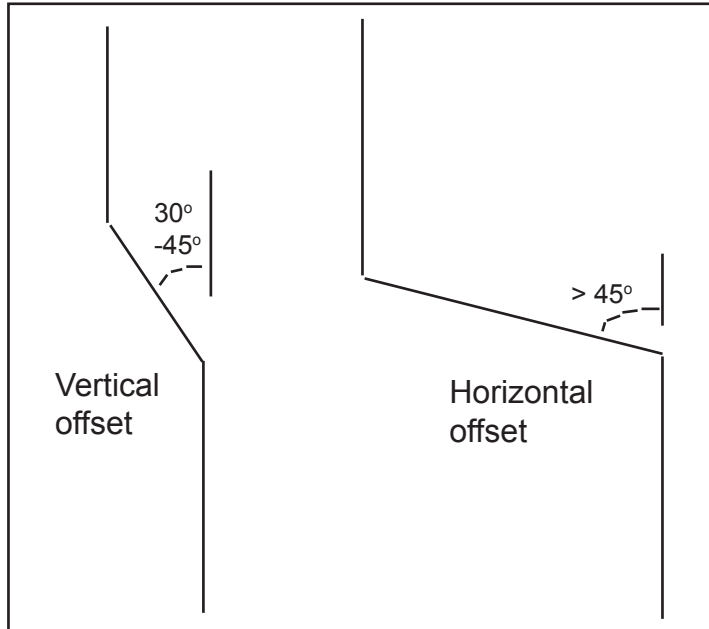


Figure 15. Types of stack offsets.

Not all stacks are perfectly vertical. The code has options and limitations for offsets within a stack. The two types of stack offsets are the "vertical offset" which has an offset that's 45 degrees or less from vertical and the "horizontal offset" which has an offset that is more than 45 degrees from vertical. See figure 15.

Determining the diameter of a vertical offset is fairly simple. The diameter remains the same as the stack.

Determining the diameter of a horizontal offset is more complicated and follows these steps:

1. Size the portion above the highest offset as vertical piping/stack in accordance with Table 82.30-2.
2. Size the offset and the offset fittings as building drain in accordance with Table 82.30-3. The limitation for horizontal branch connections within the offset allows the sizing as building drain.
3. Size the stack below the offset as a stack, but not less than the size of the diameter of the offset (see Figure 16).

There is an exception to the venting requirement where offsets are located below the lowest branch drain. Comm 82.30 (6) (c) has this exemption.

Comm 81.01 (166) "Offset" means a combination of fittings or bends that makes two changes in direction bringing one section of the pipe out of line but into a line parallel with another section.

Comm 82.30 (6) (a) Offsets of 45° or less. 1. An offset in a vertical drain, with a change in direction of 45° or less from the vertical, shall be sized as vertical drain piping in accordance with sub. (4).

2. Except as provided in (c), where a horizontal branch connects to a drain stack within 2 feet above or below an offset with a change of direction of 30 to 45° from the vertical and the offset is located 5 or more branch intervals below the top of the stack, the offset shall be vented in accordance with s. Comm 82.31 (5) (a).

Comm 82.30 (6) (b) Offsets of more than 45°. Except as provided in par. (c), a drain stack with an offset of more than 45° from the vertical shall be installed in accordance with subds. 1. to 5.
1. That portion of the drain stack above the highest offset shall be sized as for vertical drain piping in accordance with sub. (4).
2. That portion of the offset between and including the offset fittings shall be sized as building drain piping in accordance with sub. (4).

3. That portion of stack below the offset shall be not less than the size of the offset.
4. Where an offset of more than 45° is located more than four branch intervals below the top of the drain stack, a horizontal branch may not connect within the offset or within 2 feet above or below such offset.
5. a. Except as exempted in subd. 5. b. or par. (c), where an offset in a drain stack with a change of more than 45° from vertical is located below 5 or more branch intervals, the offset shall be vented in accordance with s. Comm 82.31 (5) (b).
- b. The vent required in subd. 5. a. shall not be required where the drain stack, including the offset, is sized one pipe size larger than required for a building drain designed to serve as per sub. (4) and the entire stack and offset are not less in cross sectional area than that required for a stack plus the area of a vent as required in s. Comm 82.31 (5) (b).

(6)(c) Exception. Where an offset is located more than two feet below the lowest branch drain connection to the stack, the venting specified in this subsection and 82.31 (5) and (6) are not required.

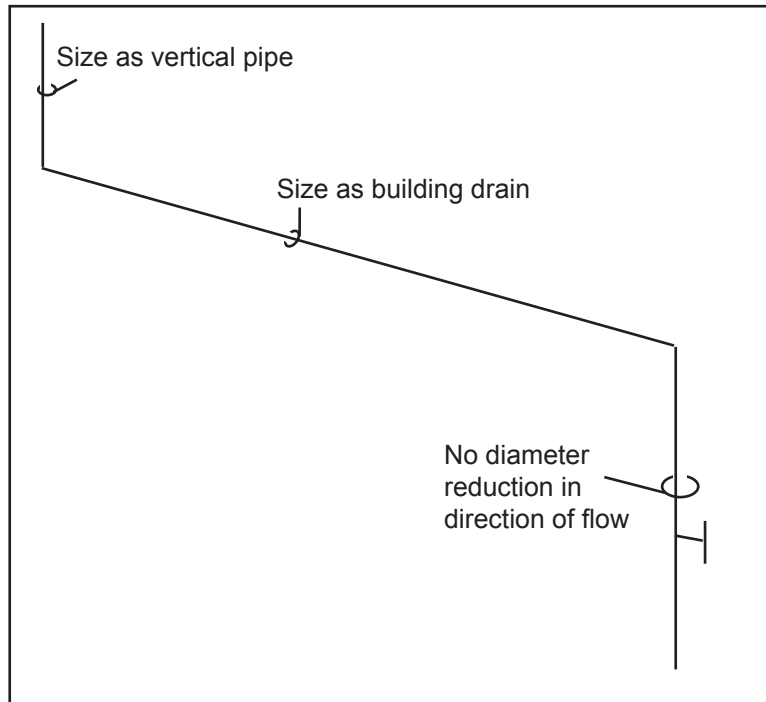


Figure 16. Minimum diameter for horizontal stack offsets.

**Horizontal branch drain connection -
within 2' above to 2' below a vertical offset when
located below 5 branch intervals.**

Below 5 or more branch intervals, where a horizontal branch connects to the stack within 2 feet above or below an offset, venting must be provided for the offset. (See venting, page 31)

**Horizontal branch drain connection -
within 2' above to 2' below a horizontal offset**

Horizontal branch drain connection requirements for installations within a stack offset of more than 45 degrees is actually the same as connecting a horizontal branch drain to the base of a stack.

In theory the turbulence created at the base of a stack creates an environment that is unsuitable for the installation of horizontal branches. Currently there are no requirements in the code for the horizontal branch drain connections to horizontal offsets below less than 5 branch intervals. Whether the horizontal branch drain connection is located at the base of a stack or associated with a stack offset, the department will interpret and enforce the same requirements in both situations.

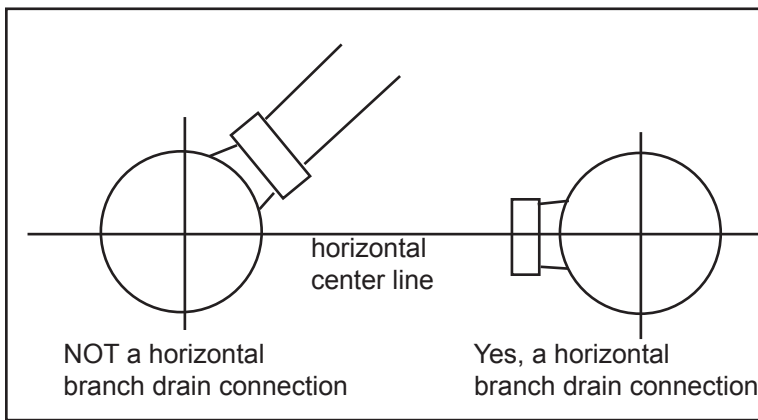


Figure 17. Connections above the horizontal centerline.

**Connections to horizontal offsets -
Below 5 or more branch intervals**

No horizontal branch drain connections are permitted to be installed from 2 feet above the horizontal offset to 2 feet below the offset when the offset is located below 5 or more branch intervals (Figure 18).

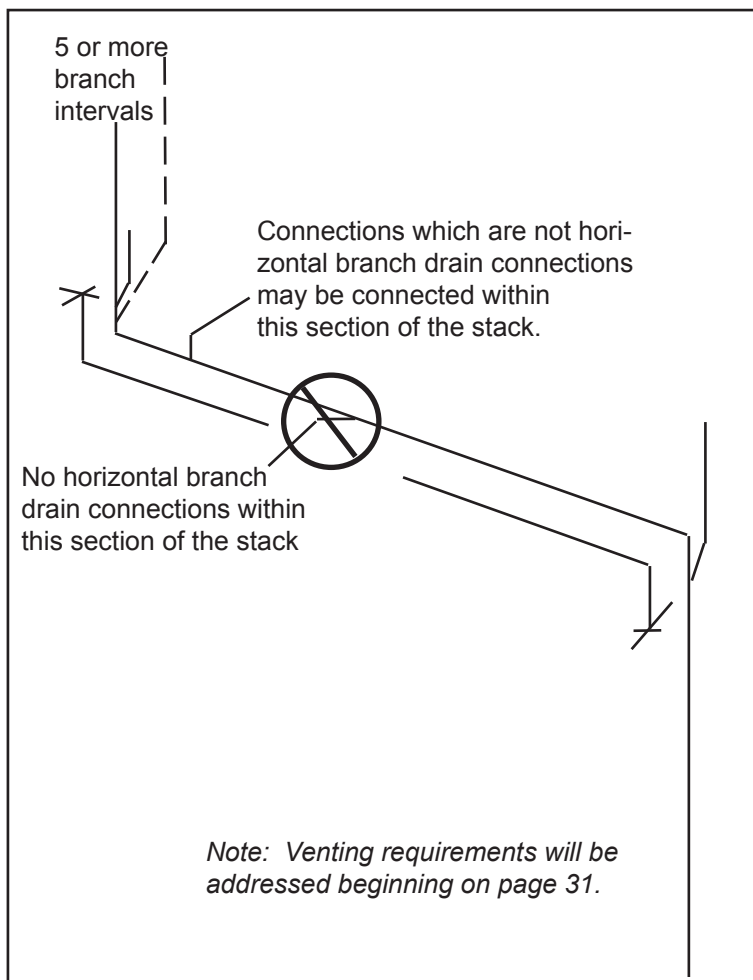


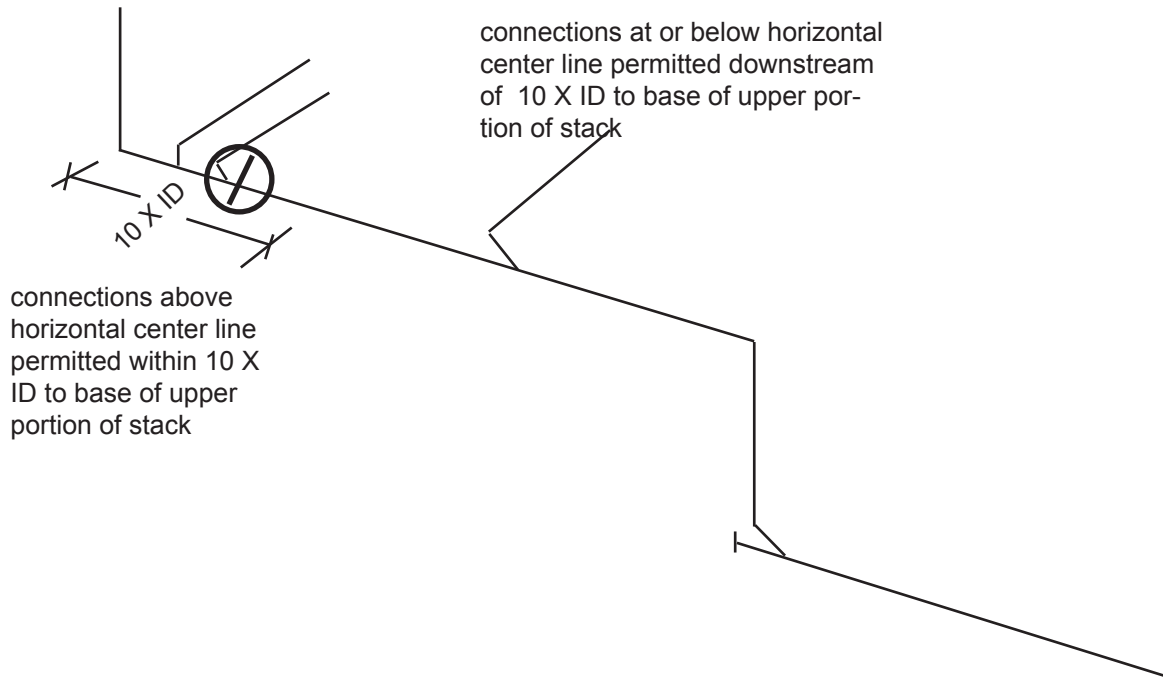
Figure 18. Connections to offsets below 5 or more branch intervals.

Comm 82.30 (6) (b) 4.
Where an offset or more than 45° is located more than four branch intervals below the top of the drain stack, a horizontal branch may not connect within the offset or within 2 feet above or below such offset.

Comm 82.30 (7) (a)
HORIZONTAL BRANCH DRAIN CONNECTION AT BASE OF A STACK.
(a) A horizontal branch drain may not connect downstream from the base fitting of a drain stack 2" or larger in diameter within the distance equal to 10 pipe diameters of the drain to which the horizontal branch drain connects.

***Connections to horizontal offsets -
Below 4 or less branch intervals***

≥ 2" diameter and
4 or less branch
intervals above



Connections at the base of a 2" or larger diameter stack

2" or larger vertical drain pipe extending one story or more (stack)

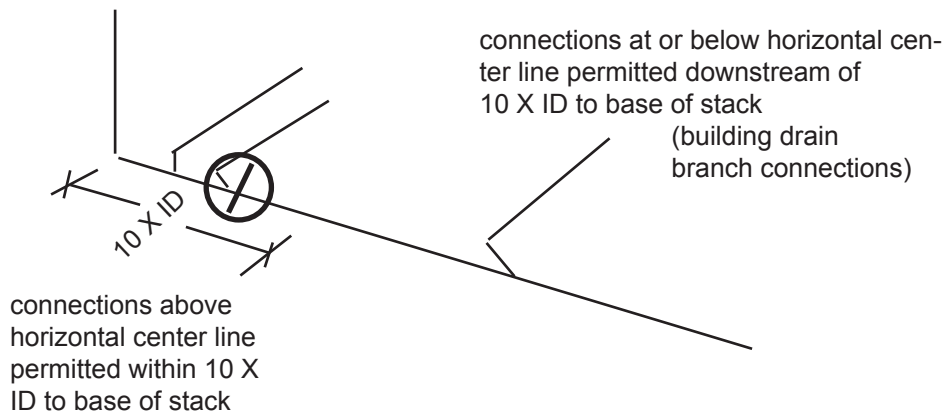


Figure 19. Connections at the base of a stack and connections at a stack offset

BUILDING DRAINS, BUILDING SUBDRAINS, BUILDING SEWERS AND PRIVATE INTERCEPTOR MAIN SEWERS ^a				
Pipe Diameter (inches)	Maximum Number of Drainage Fixture Units Which May Drain Through Any Portion of a Building Drain, Building Subdrain, Building Sewer or Private Interceptor Main Sewer			
	Pitch (inch per foot)			
	1/16	1/8	1/4	1/2
1 ¼	NP ^b	NP	1	1
1 ½	NP	NP	3	3
2	NP	NP	6	9
3	NP	36	42	50
4	NP	180	216	250
5	NP	390	480	575
6	NP	700	840	1,000
8	1,400	1,600	1,920	2,300
10	2,500	2,900	3,500	4,200
12	3,900	4,600	5,600	6,700
15	7,000	8,300	10,000	12,000

^a Private interceptor main sewers 6 inches or less in diameter, see s. NR 130.13 for private interceptor main sewers 8 inches or larger in diameter.

^b NP means Not Permitted.

Note: For further explanatory material see Appendix A-82.30 (4).

Building Drains, Sewers, and Subdrains

The table for sizing building drains, building subdrains, building sewers, and private interceptor main sewers is Table 82.30-3 (Figure 20)

Notice that the pitch of the drainage piping affects the number of drainage fixture units that a given diameter pipe may carry (Figure 21). Table 82.30-3 is also used when sizing the combination drain and vent system using the building drain. Understanding this table is a necessity for efficient combination drain and vent system design.

Materials

Tables 84.30-1 and 84.30-2 list the acceptable materials for drain and vent pipe and tubing. Table 84.30-3 contains the requirements for sanitary building sewer materials.

Comm 82.30(4)(a):
Maximum loading. 1. The total drainage load in any portion of drain piping shall not exceed the limits specified in Tables 82.30-2 and 82.30-3.

Comm 81.01 (39) “Building drain” means horizontal piping within or under a building, installed below the lowest fixture or the lowest floor level from which fixtures can drain by gravity to the building sewer.

(40) “Building drain branch” means a fixture drain which is individually connected to a building drain and is vented by means of a combination drain and vent system.

(41) “Building drain, sanitary” means a building drain which conveys wastewater consisting in part of domestic wastewater.

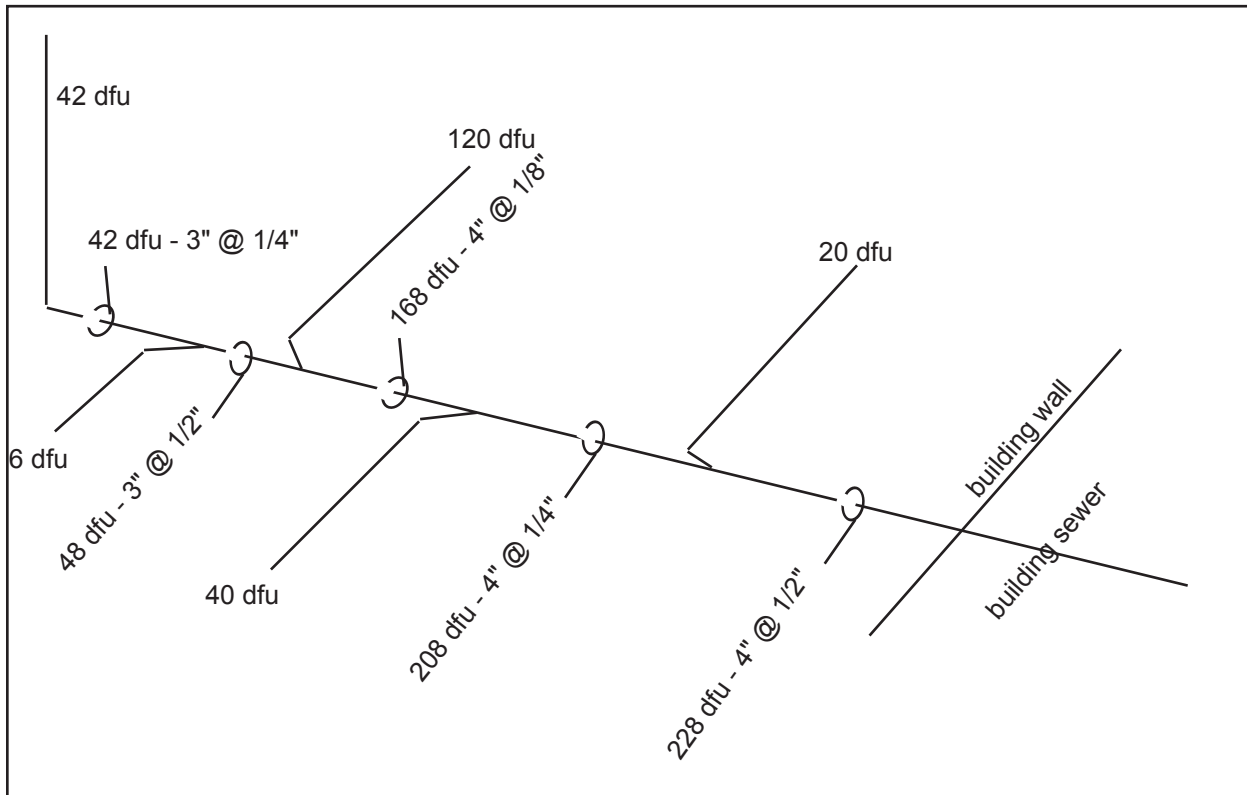


Figure 21. Building Drain Sizing

Comm 82.30 (11) (b) Building drains. 1. 'Elevation.' a. All building drains shall be installed below the lowest floor levels on which fixtures may be installed if the public sewer, POWTs or private interceptor main sewer elevation permits.

b. Where any portion of an above ground building drain discharges to a vertical pipe, the building drain shall connect to the building sewer at an elevation at least 30 above the basement floor.

Building drains are required to be installed below the lowest floor level where possible, which in Wisconsin is quite often the basement. The installation of the building drain is not required to be installed below the lowest floor level when the only alternative for discharge to the sewer is via a pump.

Figure 22 illustrates the determination of definitions for horizontal and vertical pipe serving a building. The importance of the definition is the drain diameter and venting options contained in the code.

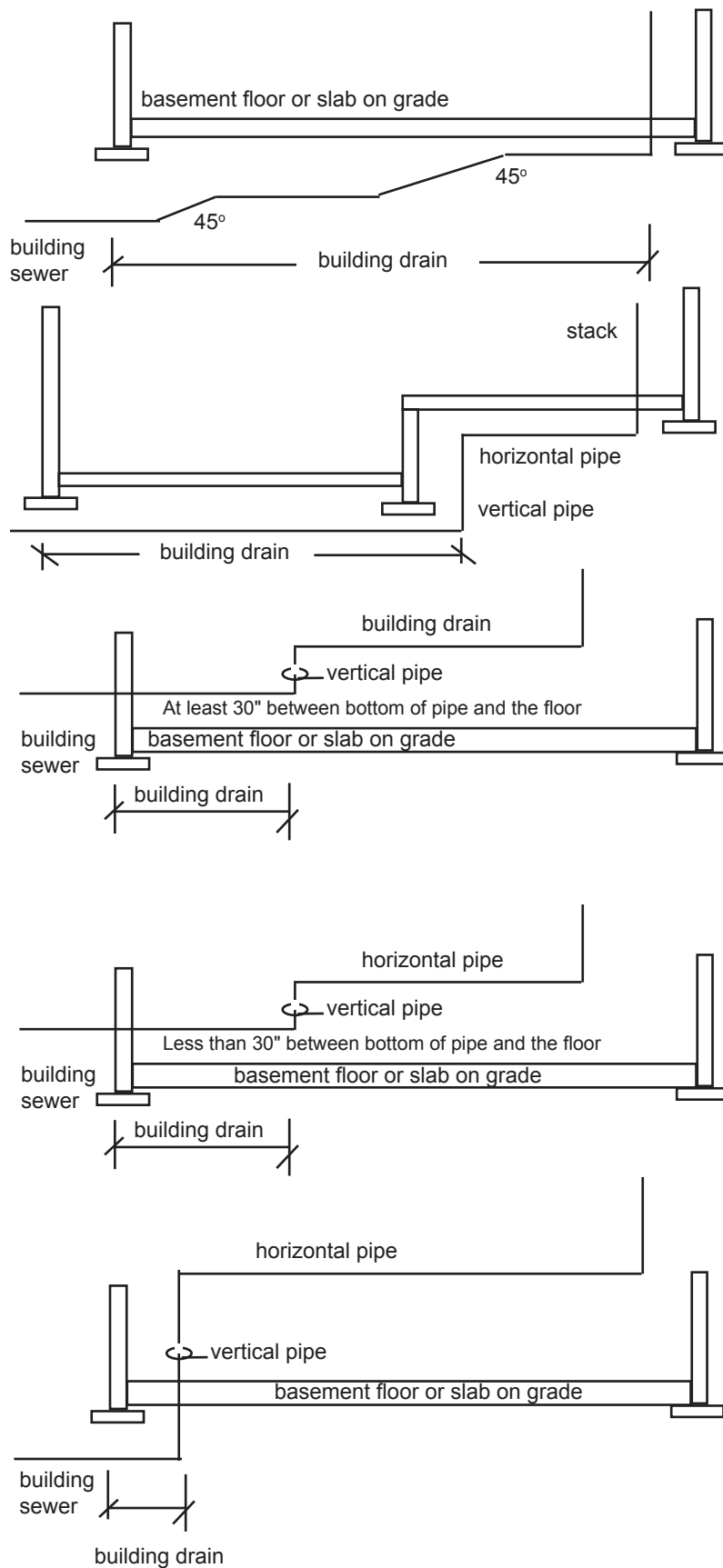


Figure 22. Designation of building drain piping.

Comm 81.01 (39) "Building drain" means horizontal piping within or under a building, installed below the lowest fixture or the lowest floor level from which fixtures can drain by gravity to the building sewer.

(Interpretation: The building drain extends to the exterior face of the building wall. The building sewer begins at the exterior face of the building wall.)

Comm 81.01 (41) "Building drain, sanitary" means a building drain which conveys wastewater consisting in part of domestic wastewater.

Comm 81.01 (44) "Building sewer" means that part of the drain system not within or under a building which conveys its discharge to a public sewer; private interceptor main sewer; private onsite wastewater treatment system or other point of discharge or dispersal.

Fixture Drain Connections

Comm 82.32 (3)

GENERAL. Each plumbing fixture, each compartment of a plumbing fixture and each floor drain shall be separately trapped by a water seal trap, except as provided in par. (a) or as otherwise permitted by this chapter. A fixture shall not be double trapped.

(a) Trap exceptions. The plumbing fixtures listed in subds. 1. to 3. shall not be required to be separately trapped:

1. Fixtures having integral traps;

2. Compartments of a combination plumbing fixture installed on one trap, provided:

a. No compartment is more than 6 deeper than any other;

b. The distance between the compartments' waste outlets farthest apart does not exceed 30; and

c. No compartment waste outlet is equipped with a food waste grinder.

3. Storm drains as provided in s. Comm 82.36 (12) (a).

Fixture drain connections are addressed in sections 82.32 and 82.33 of the code. Indirect fixture drain connections are addressed in other publications available from Safety and Buildings.

Every fixture connecting to the sanitary sewer is protected by a trap of some type. Exceptions for individual traps are:

- A fixture with an integral trap, like a water closet, is not required to also be discharged through an exterior trap.

- Multi-compartment fixtures are not required to be separately trapped if the installation complies with the following limitations (See figure 23):

- * No compartment is more than 6" deeper than the other compartments.

- * The distance between waste outlets is not more than 30".

- * A garbage disposal (food waste grinder) may not be included in the installation.

- Storm drains, as provided in s. Comm 82.36 (12) (a) are not required to be individually trapped.

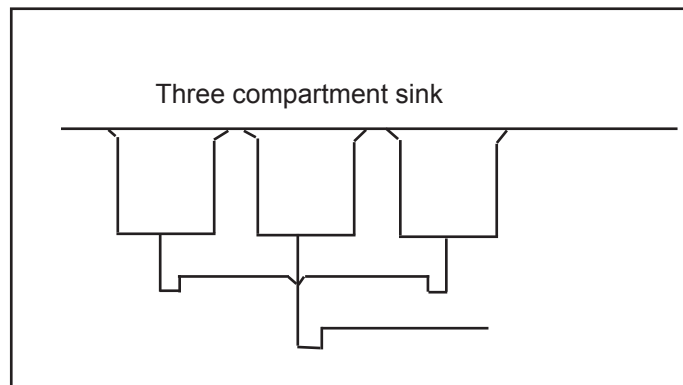


Figure 23. Exception for individual traps.

When a trap is provided for a fixture there are requirements for the maximum lengths of pipe between the fixture and trap. Figure 24 illustrates the following vertical limitations:

- The maximum vertical distance from the top of a strainer to the vertical centerline of the trap outlet must not exceed 15".

- The maximum vertical distance from the top of a stand-pipe, floor drain inlet or the waterline in a water closet to the centerline of the trap outlet must not exceed 36".

- The maximum vertical distance from the fixture drain outlet of a pedestal fixture or cuspidor must not be more than 60".

- The vertical restrictions may be exceeded for campsite receptors, dump stations and exterior storm drain inlets.

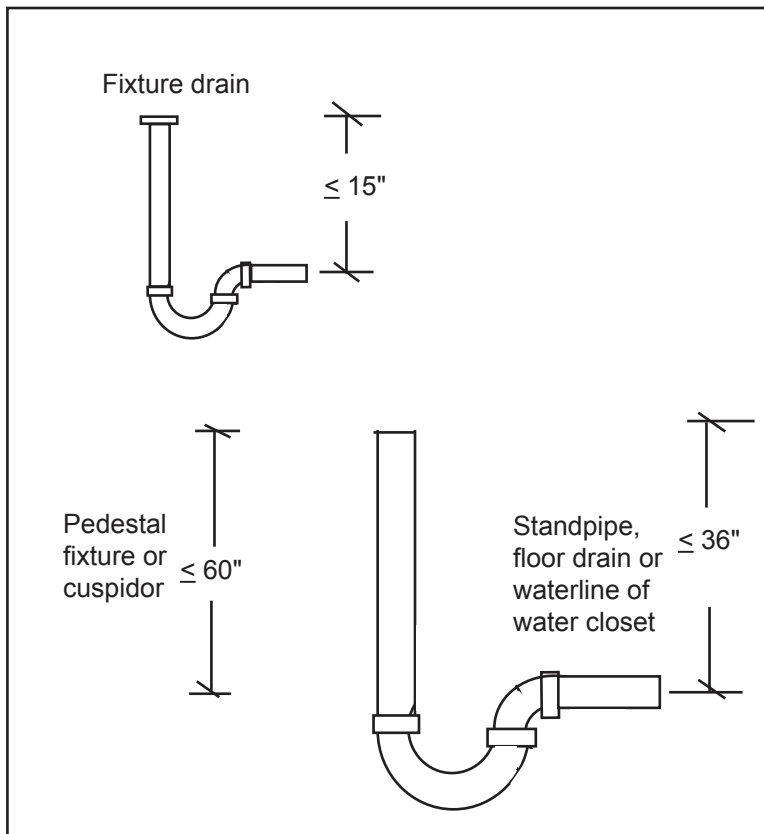


Figure 24. Vertical distance restrictions.

Horizontal distances from fixture outlets to trap inlets are also limited in the code:

- The distance between the vertical centerline of a fixture drain and the vertical centerline of a trap inlet must not exceed 15". The only exception is for a pedestal drinking fountain - 24".

- The distance between the vertical centerline of an exterior sanitary area drain or residential garage floor drain discharging through an interior trap is 25 feet. See figure 25.

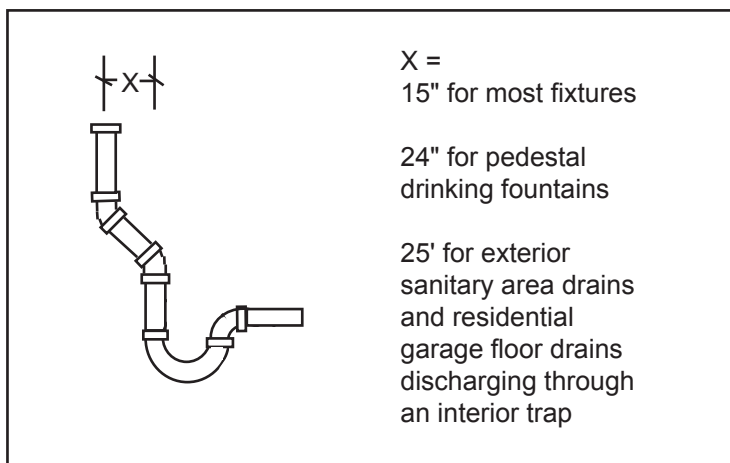


Figure 25. Horizontal distance restrictions.

Comm 82.32 (4) (b) Distance from fixture drain outlets. 1. 'Vertical distance.' Except as provided in subd. 1. a. to c., the vertical distance between the top of the fixture drain outlet and the horizontal center line of the trap outlet shall not exceed 15".

a. The vertical distance between the top of the strainer of a floor drain or the opening of a standpipe receptor and the horizontal center line of the trap outlet shall not exceed 36".

b. The vertical distance between the top of the fixture drain outlet of a pedestal fixture or a cuspidor and the horizontal center line of the trap outlet shall not exceed 60".

c. The vertical distance between the water level in the bowl of a floor outlet water closet and the center line of the horizontal portion of the fixture drain shall not exceed 36".

d. The vertical distance from the inlet to the horizontal centerline of the fixture drain for a camp-site receptor, exterior storm drain inlet, or a receptor for a sanitary dump station may exceed 3 feet so as to permit the trap to be installed below the predicted depth of frost.

2. 'Horizontal distance.'

2. a. and b., the horizontal distance between the vertical centerline of a fixture drain outlet and the vertical centerline of the trap inlet shall not exceed 15".

a. The horizontal distance for a pedestal drinking fountain shall not exceed 24".

b. The horizontal distance for an exterior sanitary area drain or a residential garage floor drain discharging through an interior trap shall not exceed 25 feet.

Back-to-back water closet installation

When two back-to-back water closet fixture drains connect to a stack, the code requires that the fittings installed must be either a 3-inch double wye or a 4-inch tee cross. Figure 26.

*Comm 82.32 (4) (b)
2. c. The minimum horizontal distance between the vertical centerline of the outlet from a floor-mounted water closet and a 3-inch double tee shall be 30 inches.*

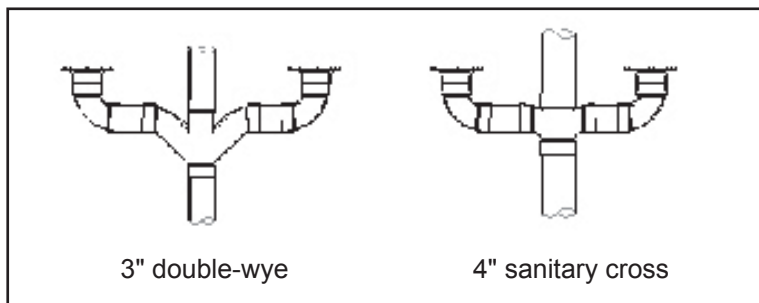


Figure 26. Back-to-back fixture drain connections.

When the installation is not a "fixture drain connection", there is a different requirement for the installation of two water closets into a single stack fitting. Where a 3-inch sanitary tee cross is used in this situation, there is a 30-inch minimum horizontal distance from the vertical center line of the fixture drain to the face of the cross fitting.

*Comm 82.32 (5) (c)
4. Two water closets discharging to a vertical drain from opposite sides by means of the same fitting shall be installed in accordance with subd. 4. a. and b.*

a. Where the vertical drain is 3 in diameter, the fitting for floor outlet water closets shall be a 3 inch double wye pattern fitting.

b. Where the water closets are wall outlet types the fitting shall be a double wye pattern fitting or a carrier-type fitting.

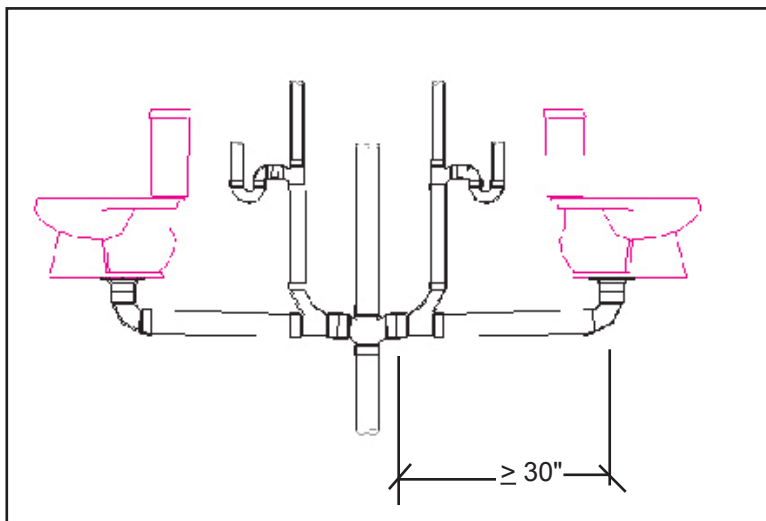


Figure 27. Branch drain connections with water closets

Vents

The proper placement and sizing of vents in a plumbing system protects the occupants of a building from possible harmful and, sometimes, fatal effects of noxious sewer gases.

The Wisconsin Uniform Plumbing Code, Comm 82.31(3)(b), states that: “Each gravity flow sanitary building sewer shall be served by at least one stack which extends from a building drain to a vent terminal or vent header.” This stack must be a minimum of 3 inches in diameter and is installed to serve as a vent for the building sewer.

Vent Stacks/Stack Vents

Where a drain stack has five or more branch intervals, a vent stack and stack vent must be installed to serve the drain stack. (Figure 28). The main purpose for vent stacks is to relieve positive pressures that may develop at the base of drain stacks. The connection of a vent stack to a drain stack must be made at or below the lowest branch drain connection to the drain stack by using a wye pattern fitting. The vent stack and stack vent must extend to a vent terminal, connect to another vent stack or stack vent at least six inches above the flood level rim of the highest fixture discharging into the drain stack, or connect to a common vent header and then extend to a vent terminal. Vent stacks are also sized by using Table 82.31-2. The vent stack is measured from the vent stack base connection to the vent terminal.

*Comm 82.31(3)(a):
Vents. Every trap and trapped plumbing fixture shall be provided with an individual vent, except as otherwise permitted in this chapter. Vents and venting systems shall be designed and installed so that the water seal of a trap shall be subject to a maximum pneumatic pressure differential equal to one inch of water column.*

*Comm 82.31(3)(b):
MAIN STACK. Each gravity-flow sanitary building sewer shall be served by at least one stack which extends from a building drain to a vent terminal or vent header. The stack shall be not less than 3 inches in diameter from the building drain to the vent terminal or vent header.*

*Comm 82.31(4)(a):
Where required. A vent stack and a stack vent shall be installed to serve any drain stacks of 5 or more branch intervals.*

Comm 82.31(4)(b):

(b) Installation. 1. The connection of the vent stack to a drain stack shall be at or below the lowest branch drain connection to the drain stack. The connection to the drain stack shall be by means of a wye pattern fitting installed in a vertical portion of the stack.

2. A vent stack and a stack vent shall:

- a. Extend to a vent terminal in accordance with sub. (16);
- b. Connect to a vent stack which extends to a vent terminal;
- or
- c. Connect to a stack vent at least 6 above the flood level rim of the highest fixture discharging into a drain stack.

3. Vent stacks and stack vents may connect into a common vent header and then shall extend to a vent terminal.

4. The connection of a vent stack with another vent may not be less than 38 above the next higher floor level where the plumbing fixtures are vented, but in no case lower than 2 above the elevation of the highest flood level rim of any fixture served by the vent.

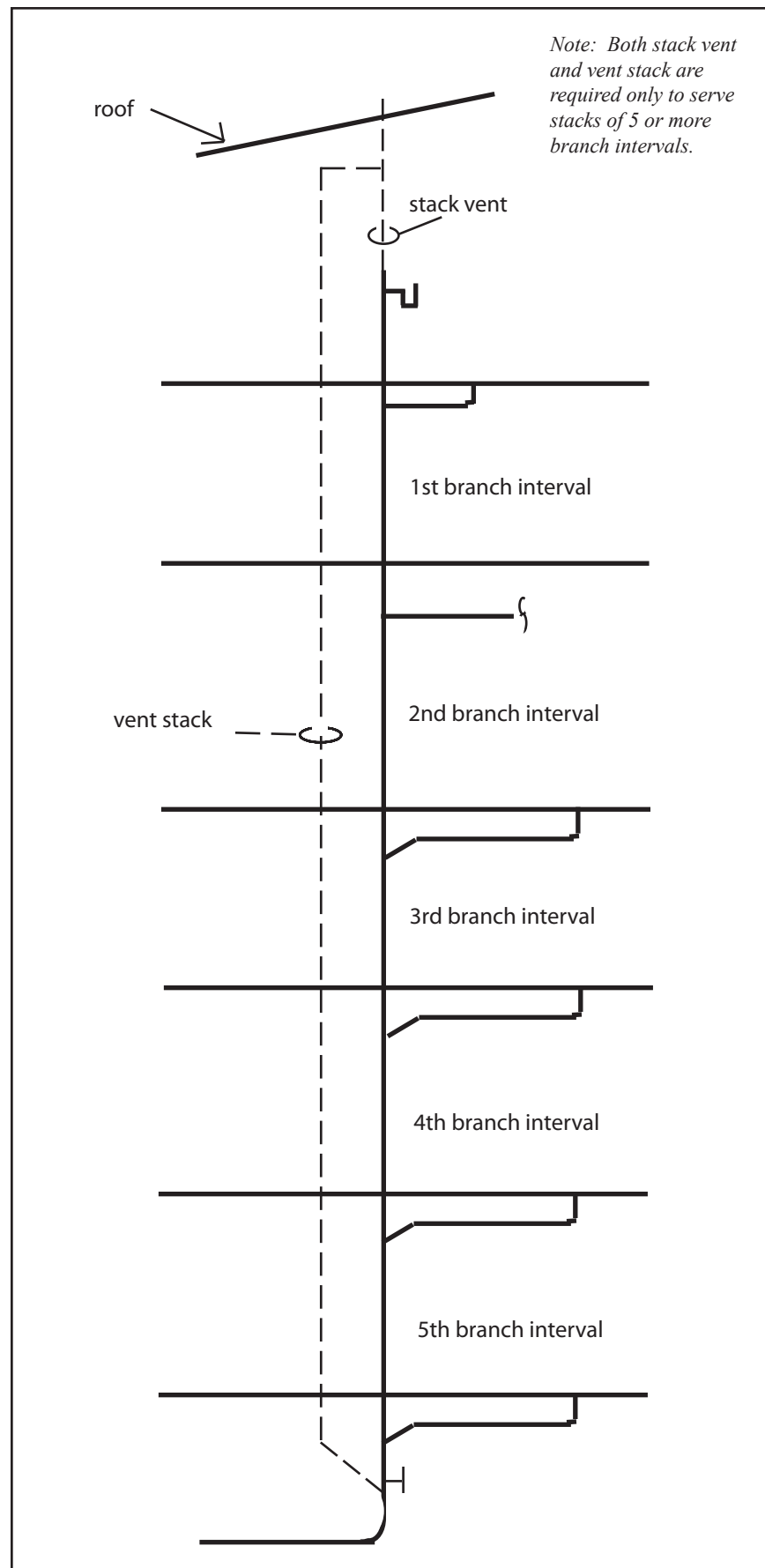


Figure 28. Vent Stack and Stack Vent

Table 82.31-2
SIZE AND LENGTH OF VENT STACKS AND STACK VENTS

Diameter of Drain Stack at Base (inches)	Maximum Developed Length of Vent (feet)									
	Diameter of Vent (inches)									
	1 ¹ / ₄	1 ¹ / ₂ ^a	2	3	4	5	6	8	10	12
1 ¹ / ₂	50	150	NL ^b							
2	NP ^c	50	150	NL						
3		NP	50	400	NL					
4		NP	20	180	700	NL				
5			NP	50	200	700	NL			
6			NP	20	70	200	700	NL		
8				NP	25	60	250	800	NL	
10					NP	25	60	250	800	NL
12						NP	25	100	300	900

^a Not more than 2 water closets or similar flush action type fixtures of 4 or more drainage fixture units.

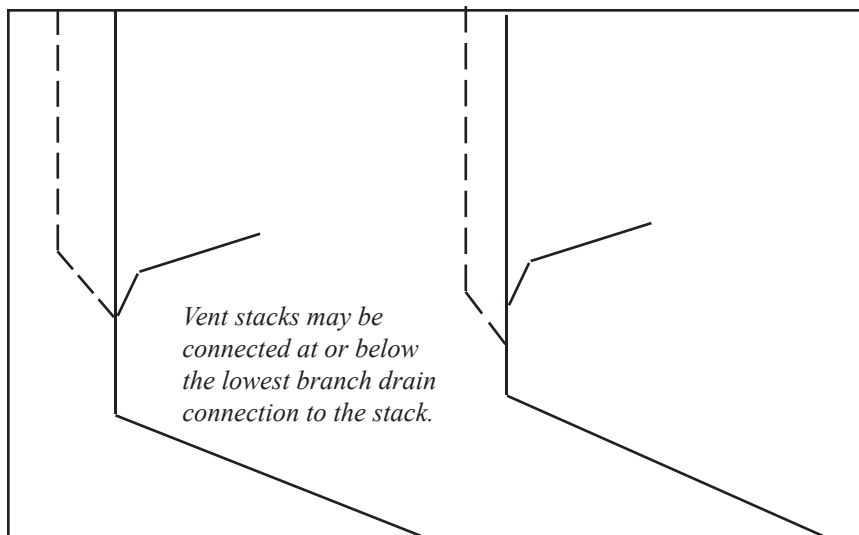
^b NL means No Limit.

^c NP means Not Permitted.

Figure 29. Table 82.31-2
Vent Stack - Stack Vent - Relief Vent - Yoke Vent Sizing

The stack vent is a vent which extends from the top of a drain stack. A stack vent is required for all drain stacks of two or more branch intervals. Stack vents shall be sized according to Table 82.31-2 (Figure 29). Note that sizing depends on the diameter of the drain stack at its base. If the stack is oversized at the base, the vent stack must also be oversized to reflect that stack base.

Comm 81.01 (234)
"Stack vent" means a vent extending from the highest horizontal drain connected to a stack.



Comm 81.01 (269) "Vent stack" means a vertical vent pipe that provides air for a drain stack of 5 or more branch intervals.

Figure 30. Connection of vent stack to drain stack

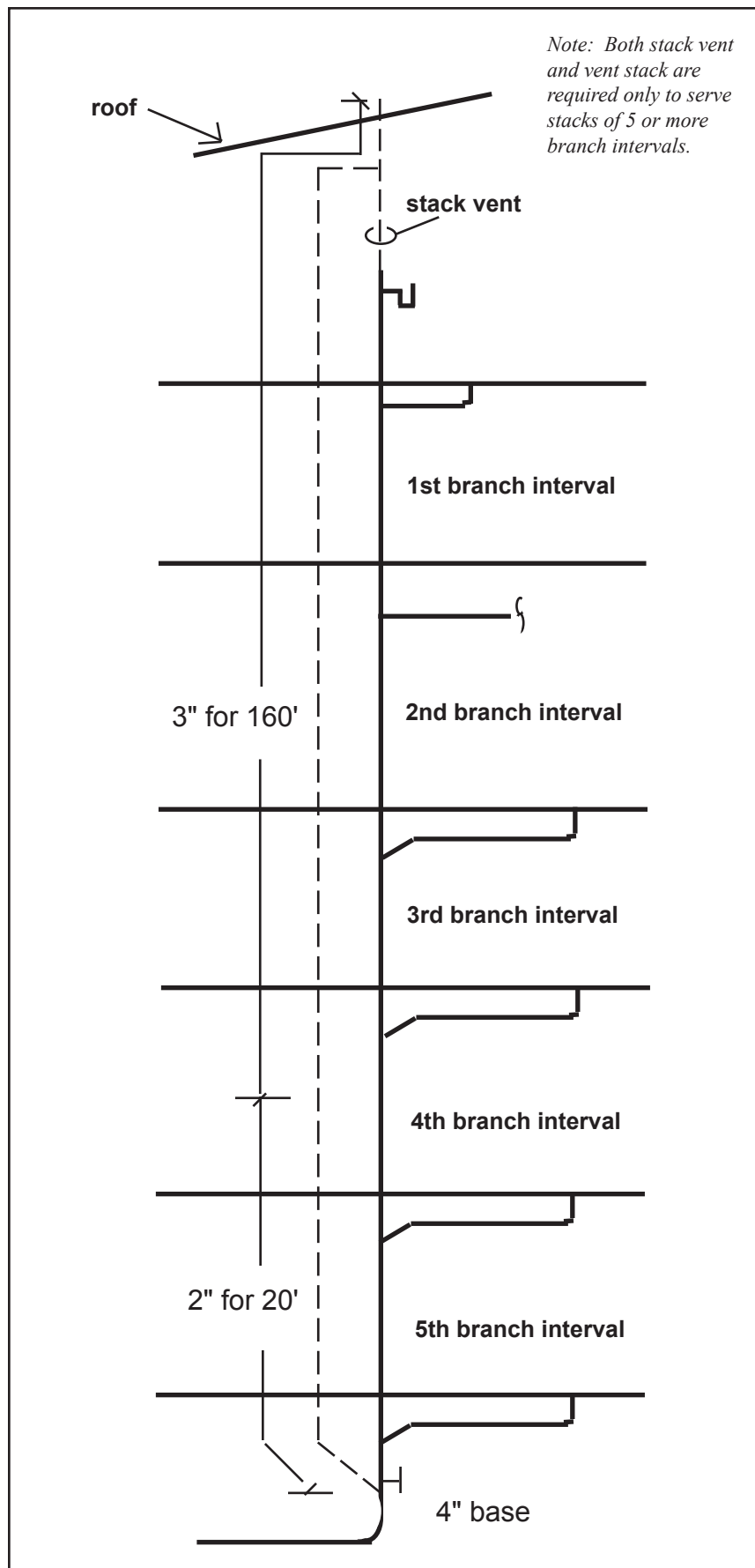


Figure 31. Vent Stack Sizing

Stack vents and vent stacks are sized using Table 82.31-2. To size the stack shown in figure 31, follow these steps:

1. What is the diameter of the drain stack at the base?
In this example the diameter at the base is 4".
2. Read across the row for 4" stacks in Table 82.31-2.
The smallest diameter vent stack or stack vent that may be installed is 2". That 2" vent stack or stack vent is limited to 20 feet. The next larger permissible diameter is 3" and limited to 180 feet.
3. Begin with the smallest permissible diameter at the lowest connection to the stack. In figure 31, the 2" vent stack is installed for the maximum distance of 20 feet.
4. Proceed up the stack with the minimum diameter vent stack to the terminus of the stack vent (or vent stack as there are no requirement for reconnection to the stack). In the example in figure 31, the 3" diameter vent may extend 180 feet, which is within the constructed stack length of 180 feet. This is a design option. In this example the designer chose to run 2" to the maximum length and then 3" within the stack.

(5) RELIEF AND YOKE VENTS FOR STACK OFFSETS. (a) Vents serving offsets of 30° to 45° in drain stacks. 1. Except as permitted in subd. 2., where a horizontal branch connects to a drain stack within 2 feet above or below an offset with a change of direction of 30° to 45° from the vertical and the offset is located below 5 or more branch intervals, the offset shall be vented in accordance with par. (b) 1. to 3. 2. Where the drain stack and offset are sized as building drain as per Table 82.30-3, the vents serving the offset of 30° to 45° in a drain stack are not required.

Vents for Stack Offsets

Vent requirements for stack offsets are necessary due to fluctuating pressures within the drain stack.

Vertical Offsets

First, for vertical offsets (offsets of 45° or less from vertical) located below 4 branch intervals or less there are no vents required to serve the offset. See figure 32.

There are no restrictions for the connection of horizontal branch drains into the area above or below the offset and within the offset.

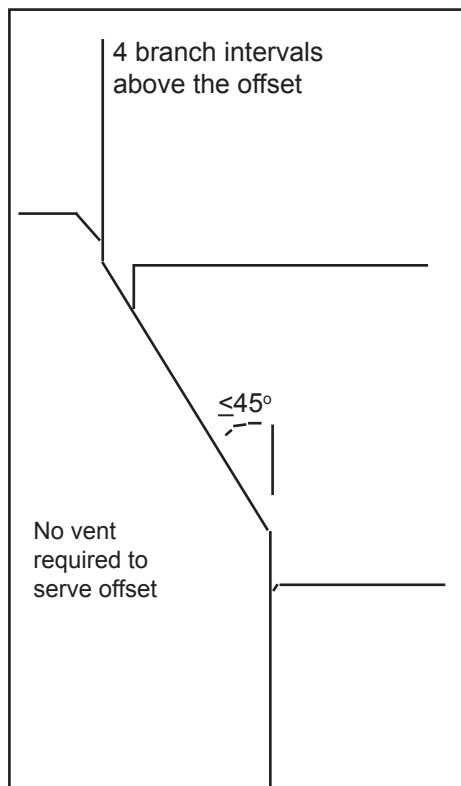


Figure 32. Vertical Offset < 5 BI

Note: Vertical offset means an offset of 45° or less from vertical.

Comm 82.31 (5) (b) 1.

1. 'Upper section.' The upper section of the stack shall be vented as a separate stack with a vent stack connection installed

in accordance with sub. (4). The offset shall be considered the base of the stack.

2. 'Vent connection above offset.' The vent stack shall connect with a wye pattern fitting above the stack offset and at or below the lowest drain branch above the offset.

3. 'Lower section.' The lower section of the stack shall be vented by a yoke vent connecting below the offset above or at the next lower horizontal branch.

a. Except as provided in subd. 3. b., the connection of the yoke vent to the drain stack shall be by means of a wye pattern fitting.

b. The yoke vent connection may be a vertical extension of the stack.

c. The connection of the yoke vent to another vent shall not be less than 38 inches above the next higher floor level where plumbing fixtures are installed that discharge into the drain stack.

Comm 82.31 (14) (h) Yoke vents. A yoke vent serving a drain stack shall be sized as a vent stack in accordance with par. (a).

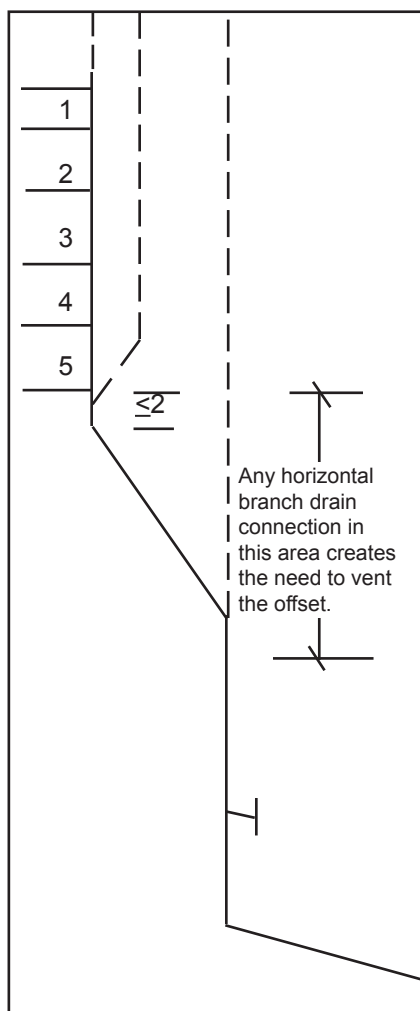


Figure 33. Venting a 45° offset

The stack shown in figure 33 has a vertical offset of 45° below 5 branch intervals. **When a horizontal branch drain connection is made within the distance of 2 feet above the offset to 2 feet below, the offset must be vented.**

The venting requirements are:

Upper Section. The upper section above the offset is vented by using a vent stack. The offset is considered the base of the stack. The offset vent is installed and sized as a vent stack serving that upper portion.

Lower Section. The lower section is vented by a yoke vent (serving as a relief vent). The vent is installed at or above the next lower horizontal branch and below the offset. Figure 32 shows the vent connecting as an extension of the offset. The connection may also be with a wye pattern fitting. The yoke vent is sized as a vent stack.

When the entire stack is sized as building drain (at any pitch), the vent serving the offset is not required. See Figure 34.

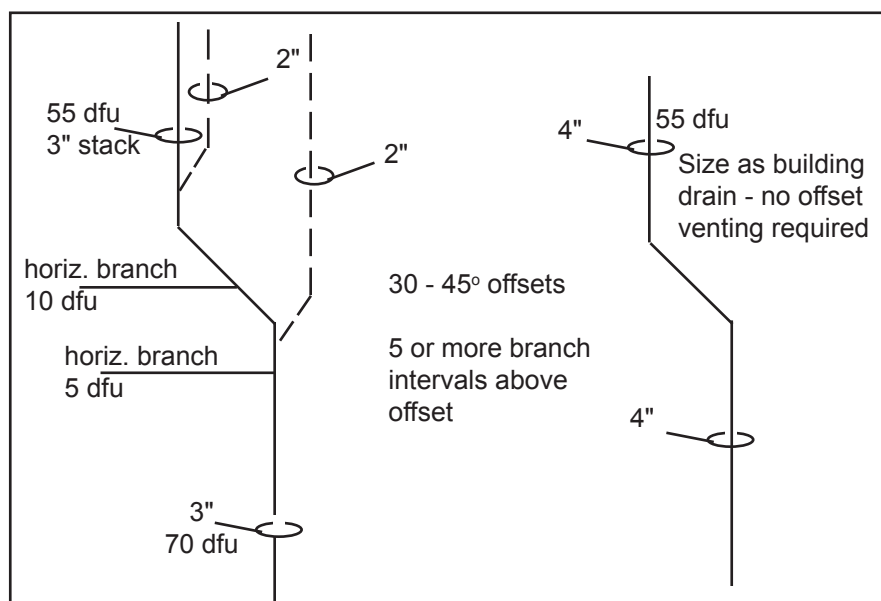


Figure 34. Two methods for venting a stack offset below 5 branch intervals

Horizontal Offsets (> 45° from vertical)

Due to the increased turbulence caused by an offset of more than 45° from vertical, there are more restrictive venting requirements for those offsets. The following rules apply to horizontal offsets:

1. Where a horizontal offset occurs within a stack (regardless of the number of branch intervals) the offset piping must be sized as building drain. The size of the stack below the offset will also be affected as there can be no reduction in size in the direction of flow. (Figure 35)
2. When 5 branch intervals exist above the horizontal offset, no horizontal connections to the stack may be made from 2 feet above the offset to 2 feet below the offset. (Figure 36)
3. When 5 branch intervals exist above the horizontal offset, the offset must be vented by a vent stack and yoke vent or by oversizing the offset so the stack acts as a drain and vent system. (Figure 37)

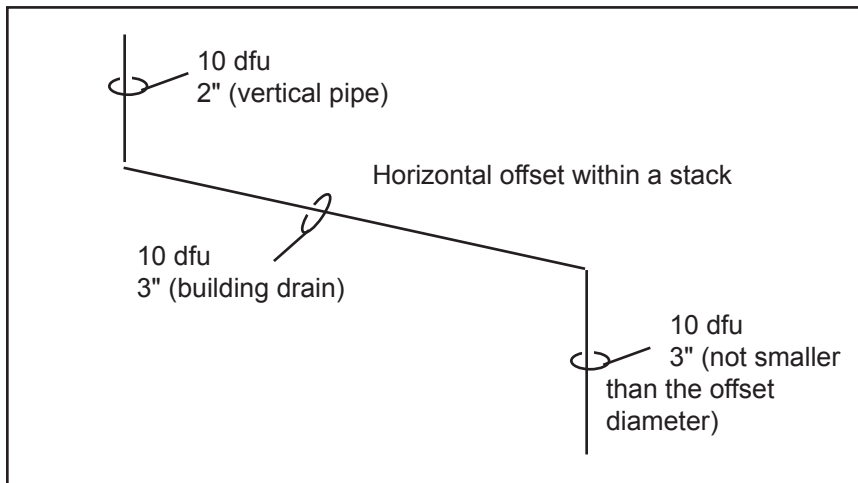


Figure 35. Horizontal offset - minimum diameters

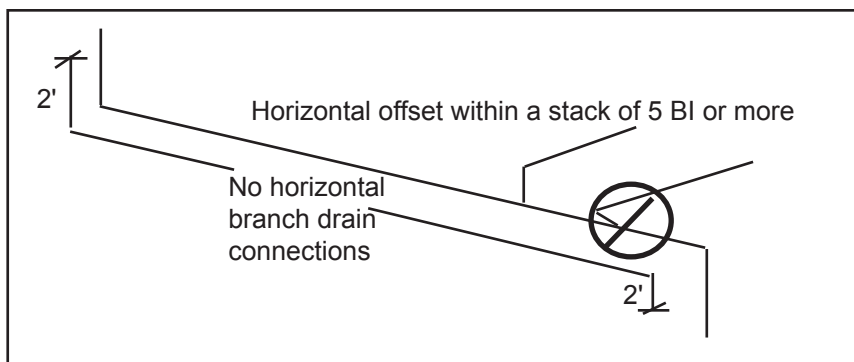


Figure 36. Connections to horizontal offset below 5 or more branch intervals.

Comm 82.31 (6) (b) Offsets of more than 45°. A drain stack with an offset of more than 45° from the vertical shall be installed in accordance with subds. 1. to 5.

1. That portion of the drain stack above the highest offset shall be sized as for vertical drain piping in accordance with sub. (4).

2. That portion of the offset between and including the offset fittings shall be sized as building drain piping in accordance with sub. (4).

3. That portion of stack below the offset shall be not less than the size of the offset.

4. Where an offset of more than 45° is located more than four branch intervals below the top of the drain stack, a horizontal branch may not connect within the offset or within 2 feet above or below such offset.

5. a. Except as exempted in subd. 5. b., where an offset in a drain stack with a change of more than 45° from vertical is located below 5 or more branch intervals, the offset shall be vented in accordance with s. Comm 82.31 (5) (b).

b. The vent required in subd. 5. a. shall not be required where the drain stack, including the offset, is sized one pipe size larger than required for a building drain designed to serve as per sub. (4) and the entire stack and offset are not less in cross sectional area than that required for a stack plus the area of a vent as required in s. Comm 82.31 (5) (b).

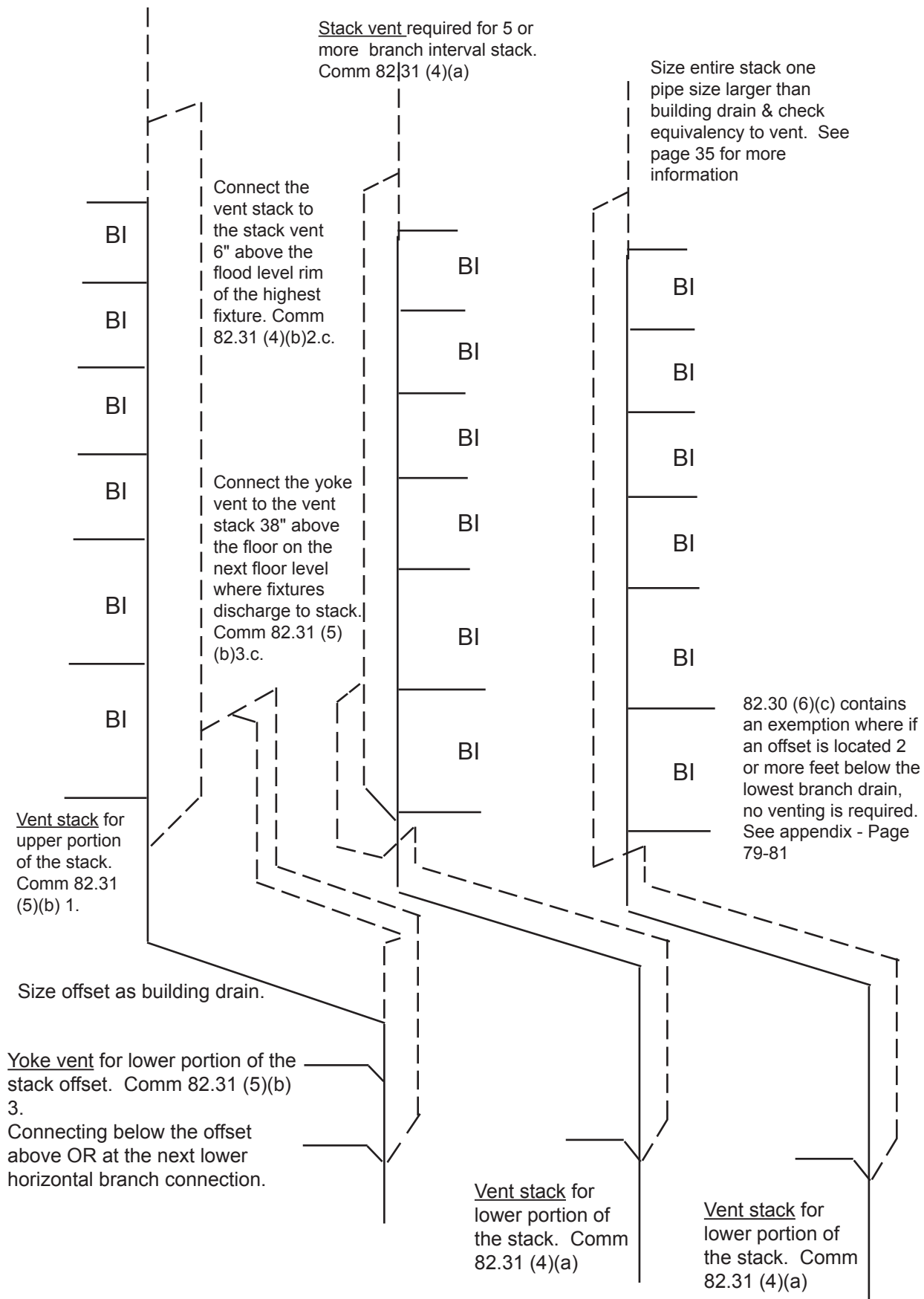


Figure 37. Three options: required vents for a horizontal offset below 5 branch intervals.

Using the exemption found in s. Comm 82.30 (6)(b) 5. b. to the requirement for a yoke vent on a horizontal offset requires two steps:

1. Determine the minimum diameter of the stack based on dfu load using Table 82.30-2.
Calculate the area of the ID of that drain stack.
2. Determine the building drain diameter required for the same dfu load using Table 82.30-3.
3. Choose the diameter that is one pipe size larger than the minimum building drain diameter.
4. Determine the minimum diameter for vent stack based on the diameter of the stack base and the length of the vent stack. Calculate the area of the largest diameter ID of that vent stack.
5. Calculate the area of the ID of the oversized stack (one pipe size larger than building drain).
6. Compare the combined area of the vent and stack with the area of the oversized stack. If the oversized stack area is larger, the stack diameter is adequate.

See the stack sizing example below:

EXAMPLE: 5 BI above a horizontal offset. 200 dfu load, length of stack above offset = 50 feet. Total dfu discharging to stack is 250 dfu and a total length of the stack = 75 feet. No side connections to stack exceed the limits in Table 82.30-2.

- | | |
|--|------------------------|
| 1. Minimum diameter of stack based on dfu load
(Based on maximum 500 dfu and Table 82.30-2) | <u>4"</u> |
| Area of the required diameter stack
($A = \pi r^2$, $A = 3.14 \times 2 \times 2$, $A =$ | <u>12.56 sq in</u> |
| 2. Minimum diameter of building drain w/stack load | <u>4"</u> |
| 3. One pipe size larger than #2 diameter | <u>5"</u> |
| 4. Minimum diameter for vent stack | <u>3"</u> |
| Area of the required dia. vent stack
($A = \pi r^2$, $A = 3.14 \times 1.5 \times 1.5$), $A =$ | <u>7.06 sq in</u> |
| 5. Area of oversized stack
Area of the required diameter stack
($A = \pi r^2$, $A = 3.14 \times 2.5 \times 2.5$), $A =$ | <u>19.62 sq in</u> |
| 6. Diameter of over sized stack = 19.62 sq in
Diameter of vent stack + stack = 19.62 sq in = | <u>code compliance</u> |

Relief Vents for Stacks > 10 Branch Intervals

A stack consisting of more than 10 branch intervals must be served by a relief vent at each 10th branch interval. The relief vent extends from below the horizontal branch serving that floor within the 10th branch interval to the vent stack with a tee pattern fitting. Figure 38 illustrates the installation of a relief vent for stacks of > 10 branch intervals.

Comm 82.31(6) RELIEF VENTS FOR STACKS OF MORE THAN 10 BRANCH INTERVALS.

(a) Drain stacks of more than 10 branch intervals shall be provided with a relief vent at each tenth interval installed.

(b) The lower end of the relief vent required in par. (a) shall connect to the stack by use of a wye pattern fitting below the horizontal branch serving that floor.

(c) The upper end of the relief vent required in par. (a) shall connect to the vent stack not less than 38 inches above the next higher floor level where plumbing fixtures are installed that discharge into the drain stack.

Comm 82.31 (14) (g) Relief vents. Relief vents shall be sized in accordance with the provisions of subds. 1. to 4. The developed length of a relief vent shall be measured along the vent from the connection with the branch drain served by the vent to the point where it connects to a vent pipe of a larger diameter or to a vent terminal.

Comm 82.31 (14) (g) 2. 'Drain stacks.' A vent serving an offset in a drain stack shall be sized as a stack vent in accordance with par. (a).

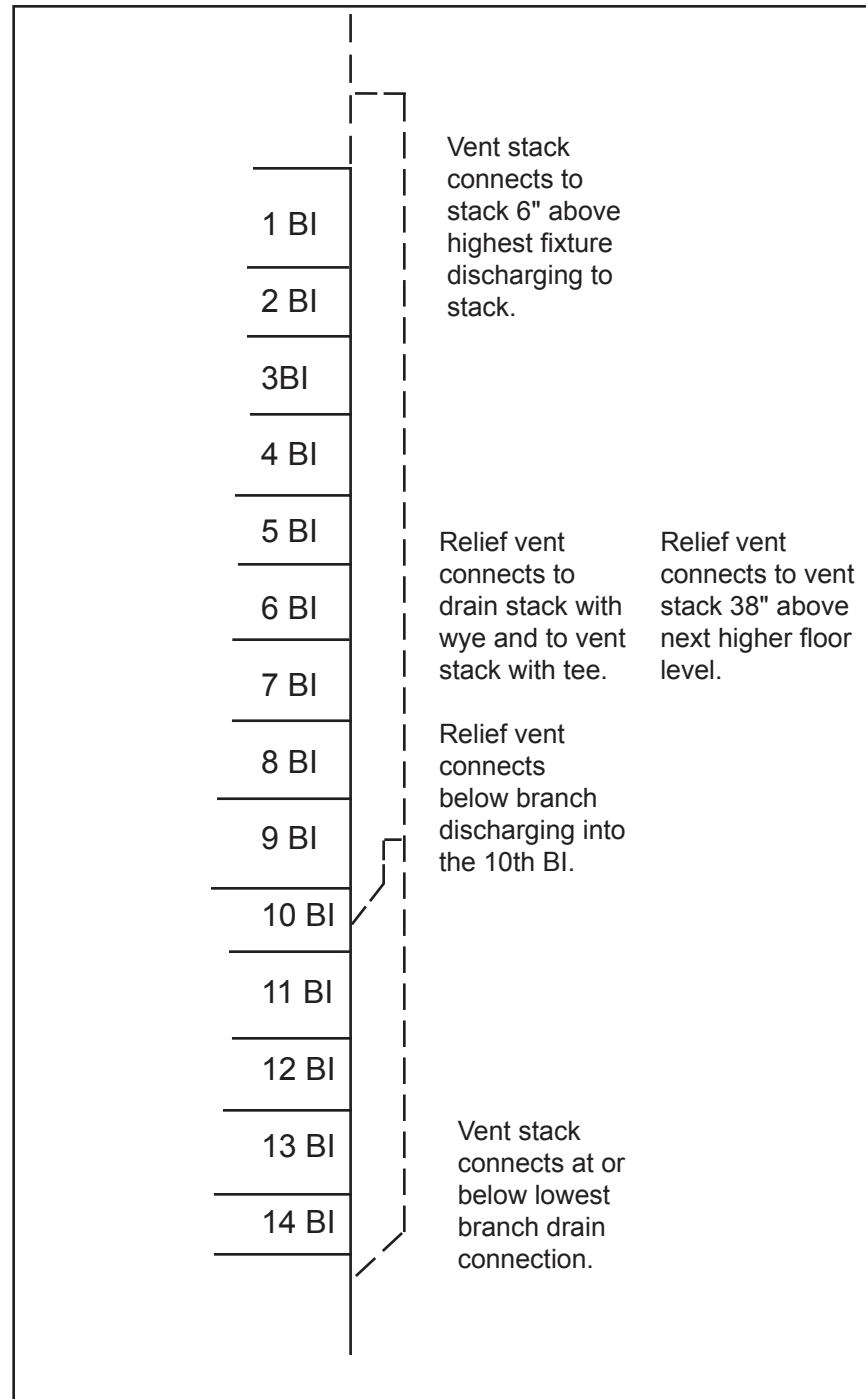


Figure 38. Relief vents for stacks of more than 10 branch intervals

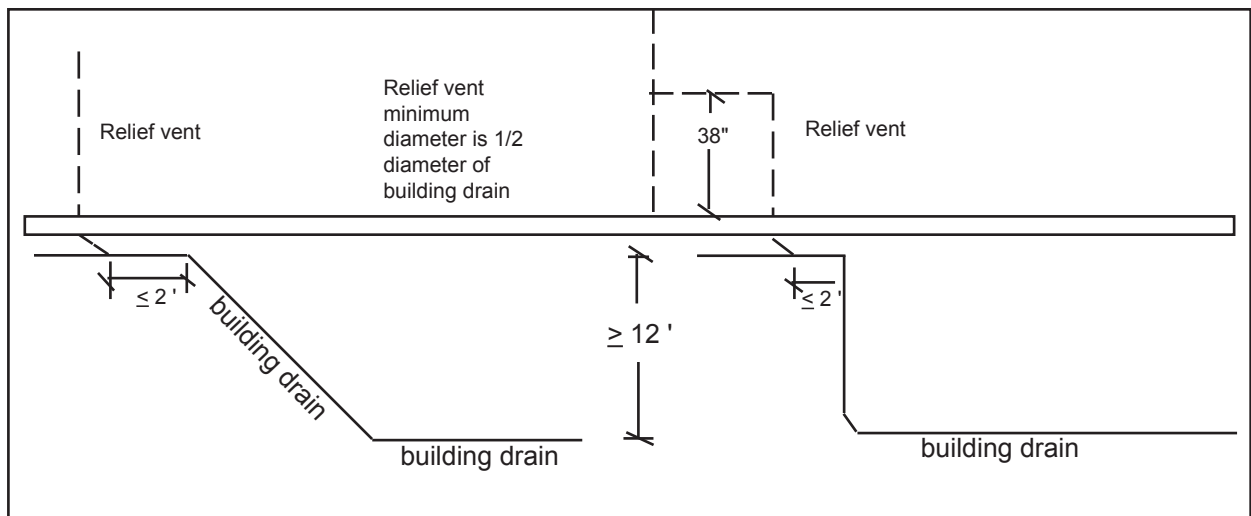


Figure 39. Relief vents for building drains

Relief Vents for Building Drains

Relief vents for building drains are installed to alleviate pressure within the building drain. The relief vents are required where there is a change of elevation of twelve feet or more within the building drain. The relief vent is installed within 2 feet upstream of the top of the change in elevation. The connection of the relief vent to another vent must be at least 38" above the next higher floor level where fixtures are installed. See figure 39.

Comm 82.31(7) RELIEF VENTS FOR BUILDING DRAINS. A building drain with a change in elevation of 12 feet or more and at an angle of 45° or more from the horizontal shall be provided with a relief vent.

(a) The connection of the relief vent to the building drain shall be by means of a wye pattern fitting installed within 2 feet upstream of the top of the change in elevation.

(b) The connection of the relief vent to another vent shall be not less than 38 above the next higher floor level where plumbing fixtures are installed that discharge through the building drain.

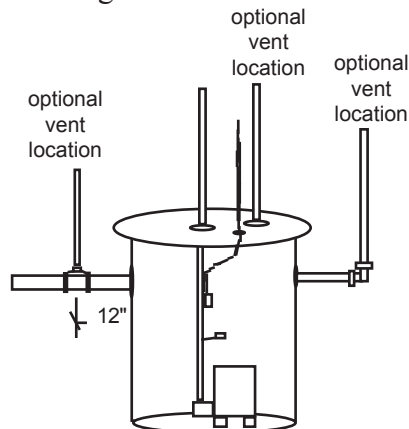


Figure 40. Vent placement options for sumps

Sump Venting

The vent for a sanitary sump (or a clearwater or storm sump with an air-tight cover) may connect to the sump cover above the drain inlet or to the drain inlet itself, within 12 inches of the sump (Figure 40).

Vents for sumps must be sized using Table 82.31-4 (Figure 41). In this table the vent size is based on the discharge rate of the pump installed in the sump.

A clearwater sump could be served by a 1 1/4" vent that terminates at least 1" above the floor.

(Note: sump vents may be sized for one pump unless duplex pumping is included in the design.)

Comm. 82.31(8) VENTS FOR SANITARY SUMPS.

(a) Interior sanitary sumps.

Sanitary sumps shall be provided with a vent connecting either to the sump above the drain inlet or to the drain inlet within 12 of the sump.

(b) Exterior sanitary sumps. Sanitary sumps shall be provided with a vent that terminates in accordance with sub. (16) (h).

Comm 82.31 (14) (i) Vents for sumps. 1. a. Except as provided in subd. 1. b., the size of a vent for a sanitary pump with other than a pneumatic ejector, shall be determined in accordance with Table 82.31-4.

b. The size of a vent for a sanitary sump located outside with other than a pneumatic ejector shall be determined in accordance with Table 82.31-4, but shall not be less than 2" in diameter.

2. The air pressure relief pipe from a pneumatic ejector shall not be connected to vent or vent system serving a sanitary drain system, storm drain system or chemical waste system.

a. The relief pipe shall be of a size to relieve the air pressure inside the ejector to atmospheric pressure, but shall not be less than 2" in diameter where the ejector is located outside and 1 1/4" in diameter for all other ejector locations.

b. The vent shall terminate in accordance with the provisions of sub. (16).

Table 82.31-4 SIZE AND LENGTH OF VENTS FOR SANITARY SUMPS					
Discharge Capacity of Ejector (gpm)	Maximum Developed Length of Vent ^a (feet)				
	Diameter of Vent (inches)				
	1 1/4 ^d	1 1/2 ^d	2	3	4
10	NL ^b				
20	270	NL			
40	72	160	NL		
60	31	75	270	NL	
80	16	41	150	NL	
100	10	25	97	NL	
150	NP ^c	10	44	370	NL
200		NP	20	210	NL
250		NP	10	132	NL
300		NP	10	88	380
400			NP	44	210
500			NP	24	130

^a The developed length of the vent is measured along the pipe from the connection to the sump, to the point where it connects to a vent pipe of a larger diameter.
^b NL means No Limit.
^c NP means Not Permitted.
^d Diameter not permitted for exterior sumps.

Figure 41. Table 82.31-4

When the vent serving a sump connects to vents serving fixtures, the gpm value of the pump is converted to dfu and the combined dfu value determines the diameter of the vent. s. 82.31(8)(a) allows the vent to connect to the sump or to the drain within 12" of the sump

Fixture Vents

There are a variety of ways that fixture traps can be vented. Regardless of the method, the maximum developed length from trap weir to vent is illustrated in Table 82.31-1 (Figure 42).

Notice that the distances given in Table 82.31-1 are affected by the size of the drain pipe, the pitch of the drain pipe, and the type of vent connection.

The trap to vent measurement used in individual venting is illustrated in Figure 43. Other methods of venting use different "point of vent" locations. However, the vent to trap measurement is always measured from the trap weir to this point of vent.

Table 82.31-1
MAXIMUM DEVELOPED LENGTH BETWEEN VENT AND TRAP (in feet)

Diameter of Fixture Drain ^a (inches)	Vent Connecting to Horizontal Drain Piping			Vent Connecting to Vertical Drain Piping					
				by means of a Sanitary Tee Fitting			by means of a Wye Pattern Fitting ^b		
	Pitch of Fixture Drain (inch per foot)			Pitch of Fixture Drain (inch per foot)			Pitch of Fixture Drain (inch per foot)		
	1/8	1/4	1/2	1/8	1/4	1/2	1/8	1/4	1/2
1 1/4	NP ^c	5.0	2.5	NP	3.5	2.0	NP	1.5	1.0
1 1/2	NP	6.0	3.0	NP	5.0	3.0	NP	4.0	2.0
2	NP	8.0	4.0	NP	6.0	4.0	NP	4.5	4.0
3	24	12.0	6.0	10.0	8.0	6.0	8.0	6.0	6.0
4 ^d	32	16.0	8.0	12.0	10.0	8.0	10.0	8.0	8.0

^a Diameters to be selected on the basis of the smallest drain pipe installed downstream from the trap serving a particular fixture.

^b The wye pattern fitting refers to a tee-wye fitting, a combination wye and eighth bend fitting or a wye and eighth bend combination of fittings with no more than one inch between the wye fitting and eighth bend fitting.

^c NP means Not Permitted.

^d The maximum developed length for fixture drains larger than 4 inches in diameter shall be approved by the department.

Figure 42. Vent to Trap Measurement

Important aspects of Table 82.31-1

Table 82.31-1 (Figure 42) contains the limitations for distance from trap to vent and there are tips for using this table:

- Where a vent connects to horizontal drain piping, the allowable length between vent and trap will usually be greater than where a vent connects to vertical drain piping, all else being equal.
- In smaller pipe sizes, where the vent is installed as a continuation of a vertical drain, the installation of a wye pattern fitting will result in a shorter allowable length between the vent and trap than if a sanitary tee fitting was installed.
- Where the pitch of the drain is increased, the allowable length between vent and trap is shortened.

Comm 82.31(9)(a)2:
Each fixture trap which is an integral part of the fixture shall be protected with a vent so located that the developed length of the fixture drain piping from fixture outlet to the vent connection is within the limits set forth in Table 82.31-1. For a floor outlet water closet or similar fixture, the point where the fixture drain piping turns horizontal shall be considered as the fixture outlet.

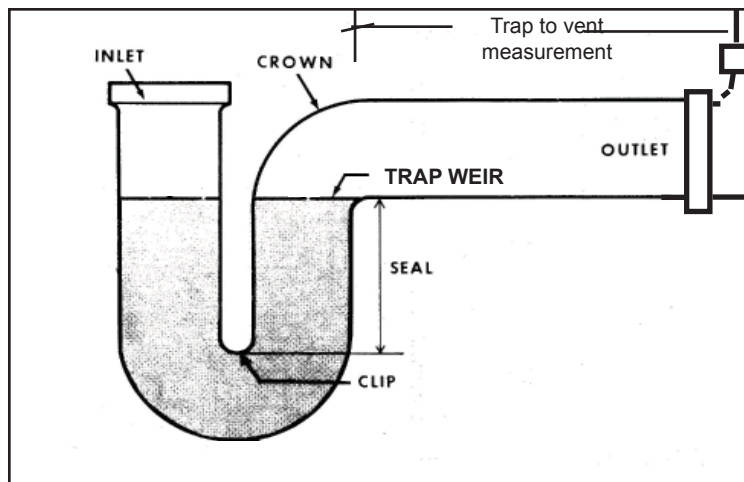


Figure 43. Vent to Trap Measurement

- Where the fixture trap is not an integral part of the fixture, the measurement between trap and vent is made from the trap weir to the vent pipe opening.

- Where the fixture trap is an integral part of the fixture, the measurement between trap and vent is made from the fixture outlet to the vent pipe opening. Figure 45 illustrates this point. For a floor outlet water closet or similar fixture, the measurement is made between the point where the fixture drain turns horizontal and the opening of the vent connection.

Comm 82.31(9)(a)2.
Each fixture trap which is an integral part of the fixture shall be protected with a vent so located that the developed length of the fixture drain piping from fixture outlet to the vent connection is within the limits set forth in Table 82.31-1. For a floor outlet water closet or similar fixture, the point where the fixture drain piping turns horizontal shall be considered as the fixture outlet.

Comm 82.31 (9)(b).
Minimum distance. A vent shall not connect to a fixture drain within the distance equal to 2 diameters of the drain piping from the weir of the trap.

Comm 82.31(9)(b).
Minimum distance. A vent shall not connect to a fixture drain within the distance equal to 2 diameters of the drain piping from the weir of a trap.

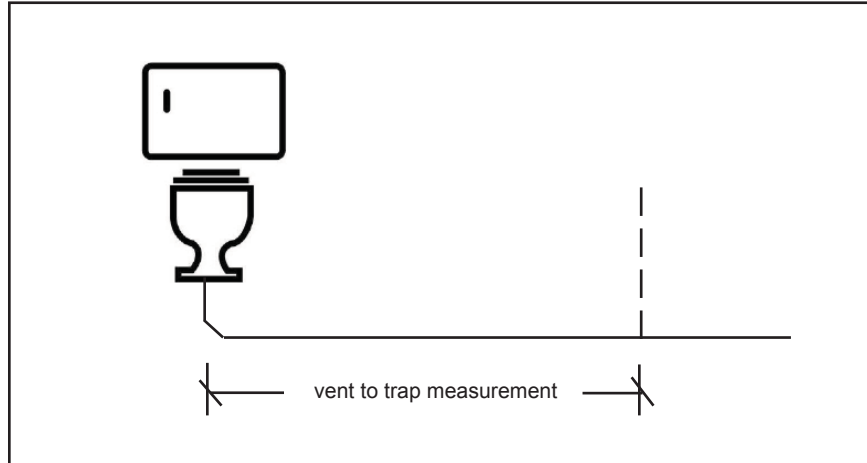


Figure 44. Trap to Vent Measurement with Internal Trap

Venting Rules for All Types of Vents

There are several rules that apply to all types of venting scenarios. Following are illustrations of those rules.

- **Minimum trap to vent distance.** Comm82.31 (9)(b) requires a minimum distance to be maintained between the trap weir and vent to more than two times the diameter of the drain piping. Where the vent is installed closer than this, the vent opening could be closed off completely under conditions of peak flow. This may cause fouling and/or clogged vent connections (Figure 45).

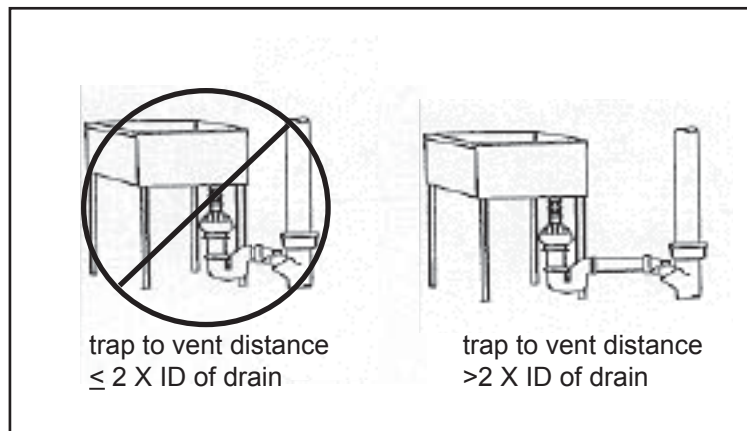


Figure 45. Minimum trap to vent distance

- Offsets in vent piping. Vent piping serving wall outlet fixtures is not permitted to offset horizontally below 36" except in two situations (combination drain and vent systems and return vents).

See figure 46.

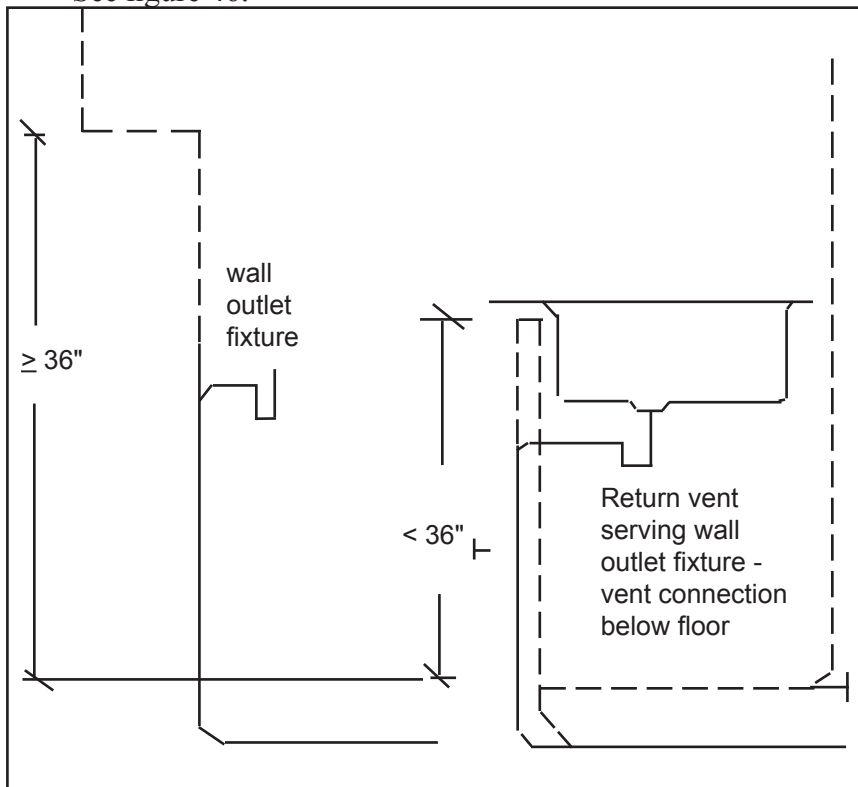


Figure 46. Vent offset height requirement.

Comm 82.31(15)(b)2:
Except as provided in subs. (12) and (17), vent piping serving a wall-outlet fixture may not offset horizontally less than 36 inches above the floor, but in no case lower than the elevation of the highest flood level rim of any fixture served by the vent.

- Drains within venting systems. The code permits vents to be graded so as to drain. The installation of these drains must still comply with the offset height requirement in s. Comm 82.31 (15) (b) 2. See figure 47.

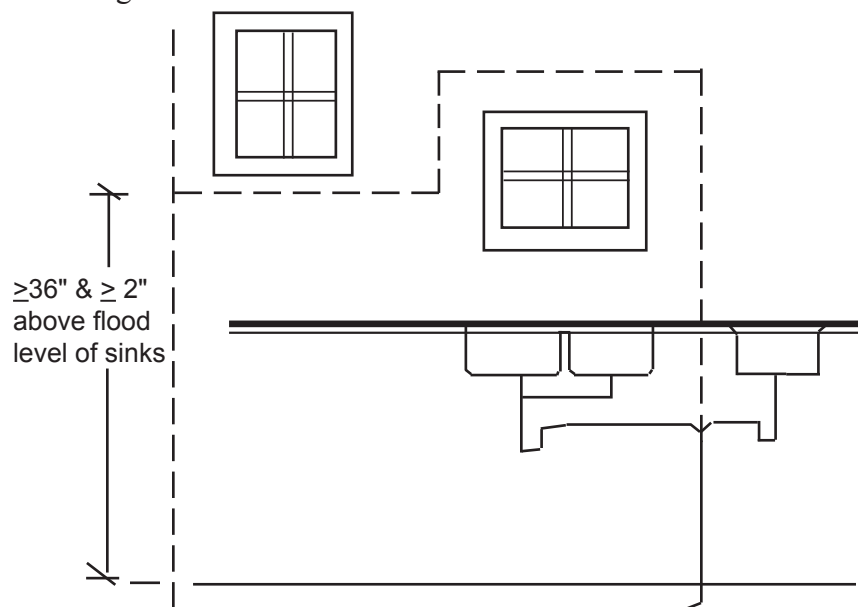


Figure 47. Vent drain, offset & connection requirements

Comm 82.31(15)(a)
Vent grade. All vent and branch vent pipes shall be graded and connected so as to drain back to a drain by means of gravity.

Limitations for dry vent connections. - The vent connection to horizontal drains must be at a point above the horizontal center line of the drain pipe, EXCEPT when the vent is a wet vent (Figure 49).

Comm 82.31 (15) (b)
1. Except for wet vent piping, the connection of a vent to horizontal drain piping shall be at a point above the horizontal center line of the drain piping.

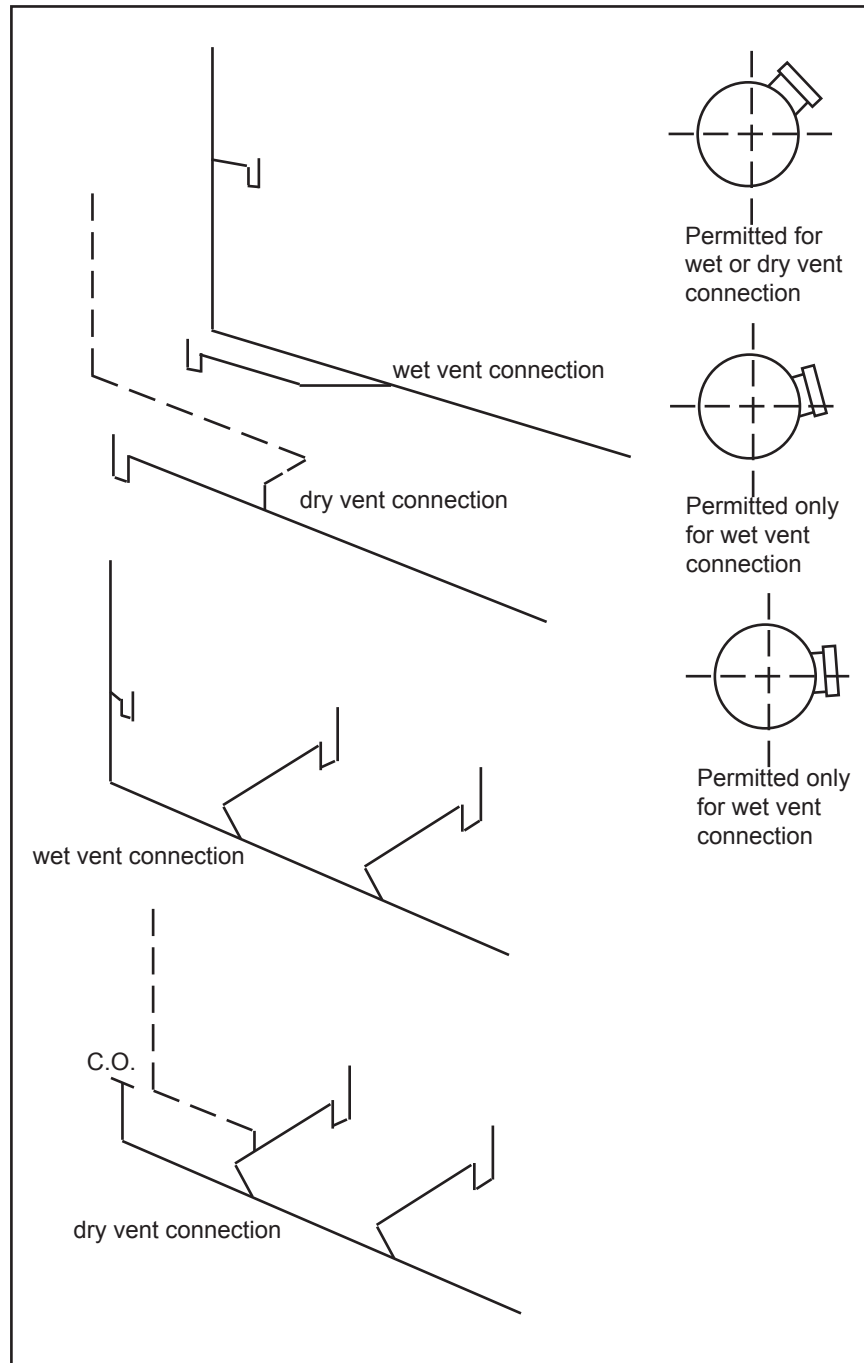


Figure 48. Wet and dry vent connections

Table 82.31-3
MINIMUM DIAMETERS AND MAXIMUM LENGTH OF INDIVIDUAL, COMMON,
BRANCH AND CIRCUIT VENTS AND VENT HEADERS

Drainage Fixture Units (dfu)	Maximum Developed Length of Vent (feet)								
	Diameter of Vent (inches)								
	1 1/4 ^a	1 1/2 ^b	2	3	4	5	6	8	10
2	50	NL ^c							
4	40	200	NL						
8	NP ^d	150	250	NL					
10	NP	100	200	NL					
24	NP	50	150	NL					
42	NP	30	100	500	NL				
72		NP	50	400	NL				
240		NP	40	250	NL				
500		NP	20	180	700	NL			
1100			NP	50	200	700	NL		
1900			NP	20	70	200	700	NL	
3600				NP	25	60	250	800	NL
5600					NP	25	60	250	800

^a No water closets permitted.

^b Not more than 2 water closets or similar flush action type fixtures of 4 or more drainage fixture units.

^c NL means No Limit.

^d NP means Not Permitted.

Figure 49. Table 82.31 - 3

Size Determination for Individual, Common, Branch, Circuit Vents and Vent Headers

Individual vents, common vents, branch vents, circuit vents and vent headers are all sized according to Table 82.31-3 (Figure 49). The developed length is measured along the vent pipe from the drain served to the point where the vent connects to a vent pipe of larger diameter or to a vent terminal. See figure 50.

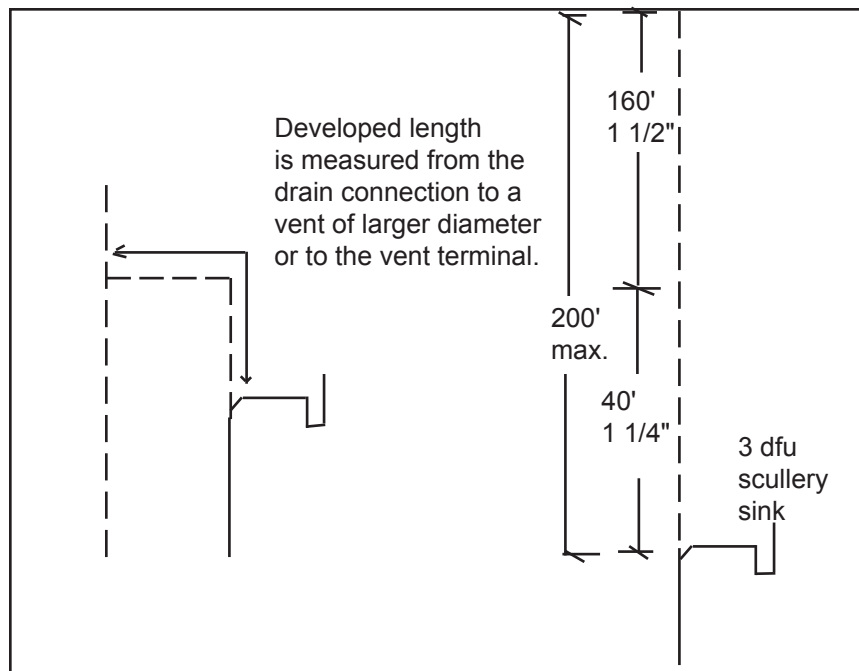


Figure 50. Determining vent diameter

Comm 82.31 (14) (b)
Vent headers. 1. Vent header pipe sizes shall be determined in accordance with Table 82.31-3 with the number of drainage fixture units being the sum of the fixture unit loads of the stacks vented through that portion of the header. The diameter of a vent header shall not be less than any vent connecting to it.
2. The developed length of the vent header shall be measured along the pipe from the most distant vent stack or stack vent base connection to the vent terminal.
(c) Branch vents. Branch vent pipe sizes shall be determined in accordance with Table 82.31-3. The developed length of the branch vent shall be measured along the pipe from the furthest fixture drain served by the branch vent to the point where it connects to a vent pipe of a larger diameter or to a vent terminal.

Vent Terminals

All vents must terminate in open air. These terminals have regulations concerning their placement and installation so as to eliminate the possibility of illness due to inhalation of poisonous gases and also to provide adequate air for proper functioning of plumbing fixtures.

Comm 82.31 (16) (d)

Location of vent terminals. 1.

A vent shall not terminate under the overhang of a building.

2. All vent terminals shall be located:

a. At least 10 feet from an air intake;

b. At least 5 feet from a power exhaust vent;

c. At least 10 feet horizontally from or 2 feet above roof scuttles, doors and openable windows; and

d. At least 5 feet from or 2 inches above parapet walls.

All vents extending through a roof must extend at least eight inches above the roof. If the roof is used for any purpose, such as a tanning deck or porch, the extension must be at least seven feet above the roof. If it is covered with earth extending from surrounding grade, it must terminate with an approved vent cap. There may be only one joint in this vent as it leaves the structure.

Every penetration point for a plumbing vent must be made watertight by the use of an approved flashing.

It is not permissible to use a vent terminal as a flag pole, clothes line pole, antenna support, or for any other purpose other than a vent terminal.

Vent terminals have location limitations:

1. A vent may not terminate under the overhang of a building.
2. A vent terminal must be . . .
 - at least ten feet from an air intake.
 - at least five feet from a power exhaust fan.
 - at least 10 feet horizontally from or two feet above roof scuttles, doors, or **openable** windows.
 - at least five feet from or two inches above parapet walls.

In new buildings, no drain or vent piping may be located on the outside of an exterior wall.

Vent terminals shall be a minimum of two inches inside diameter and, if an increase in the vent is necessary to ensure the vent is two inches i.d., it must be increased at least six inches under the roof.

Knowing the basic requirements and applying them to all venting situations ensures a code compliant sanitary drain and vent installation.

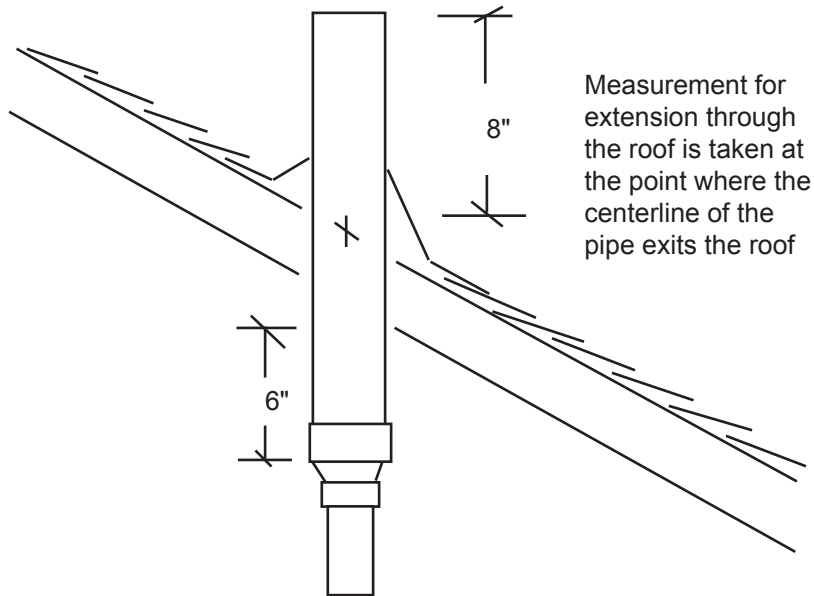


Figure 51. Vent terminal installation through roof

As shown in figure 51, the measurement for the required extension through the roof is taken at the center of the vent at the point where the center is even with the roof. The measurement for the required 6 inches of at least 2-inch pipe below the roof is taken from the lowest roof in contact with the vent.

A vent may terminate through an exterior wall when installed in accordance with s. 82.31 (16) (d) and figure 52.

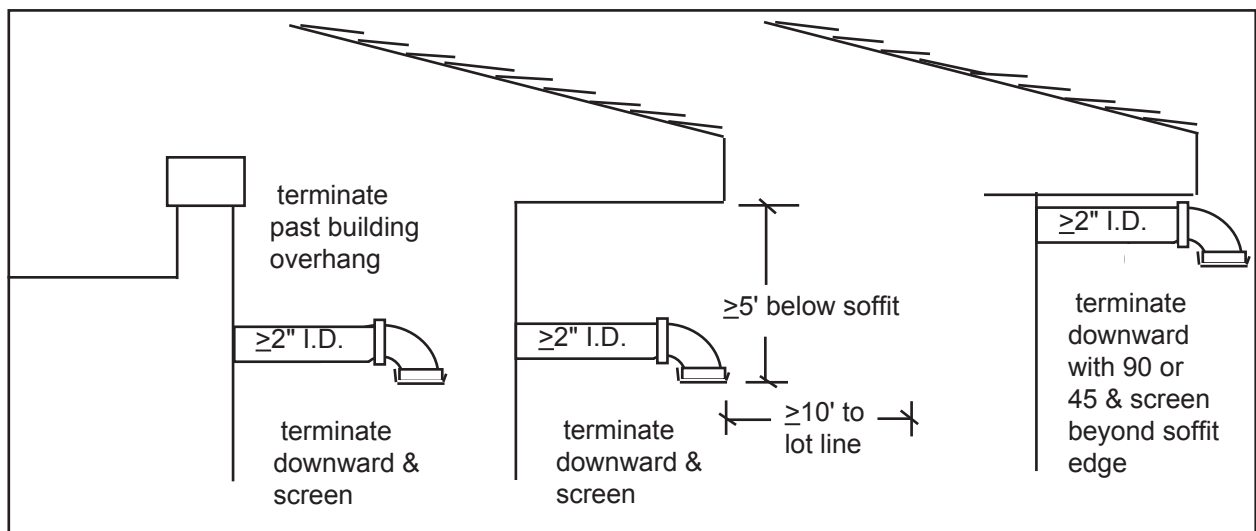


Figure 52. Vent terminal installation through exterior wall

Comm 82.31 (16) (d)

Location of vent terminals.

1. A vent shall not terminate under the overhang of a building.
2. All vent terminals shall be located:
 - a. At least 10 feet from an air intake;
 - b. At least 5 feet from a power exhaust vent;
 - c. At least 10 feet horizontally from or 2 feet above roof scuttles, doors and openable windows; and
 - d. At least 5 feet from or 2 inches above parapet walls.

Comm 82.31 (16) (e)

Extension through wall.

Where approved by the department, a vent may terminate through an exterior wall. Such a vent shall terminate at least 10 feet horizontally from any lot line and shall terminate downward. The vent shall be screened and shall comply with par. (d).

Individual Vents

The individual vent refers to one vent serving one fixture. Fixtures in public or private buildings may be individually vented. This vent must meet the requirements of Table 82.31-1. Individual vent sizing is illustrated in Figure 53.

Comm 82.31 (14)
(d) Individual vents.
 Individual vent pipe sizes shall be determined in accordance with Table 82.31-3. The developed length of an individual vent shall be measured along the vent pipe from the fixture drain served by the vent to the point where it connects to a vent pipe of a larger diameter or to a vent terminal.

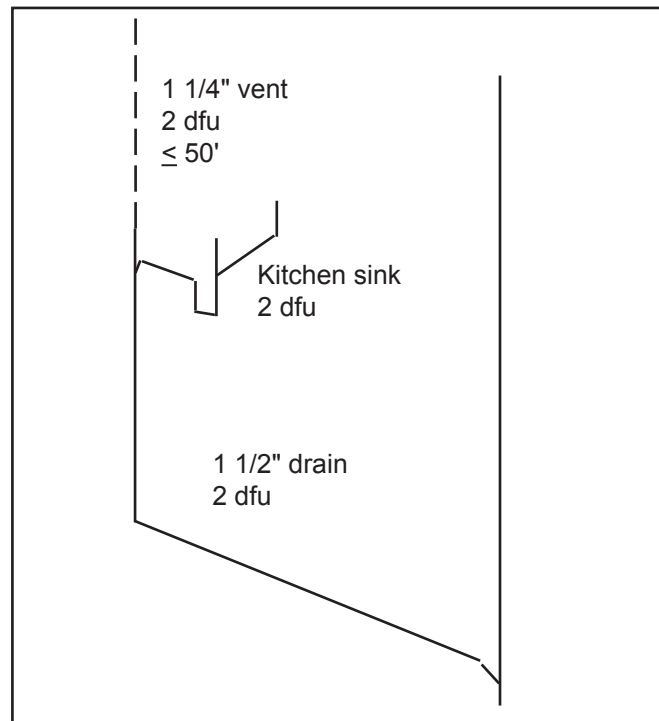


Figure 53. Individual vent design

Circuit Vents

Figure 54 illustrates a circuit vented drain. There are many conditions that apply to the design and installation of a circuit vent.

Comm 82.31 (14)(f)
Circuit vents. Circuit vent pipe sizes shall be determined in accordance with Table 82.31-3. The developed length of the circuit vent shall be measured along the vent from the connection with the branch drain served by the vent to the point where it connects to a vent pipe of a larger diameter or to a vent terminal.

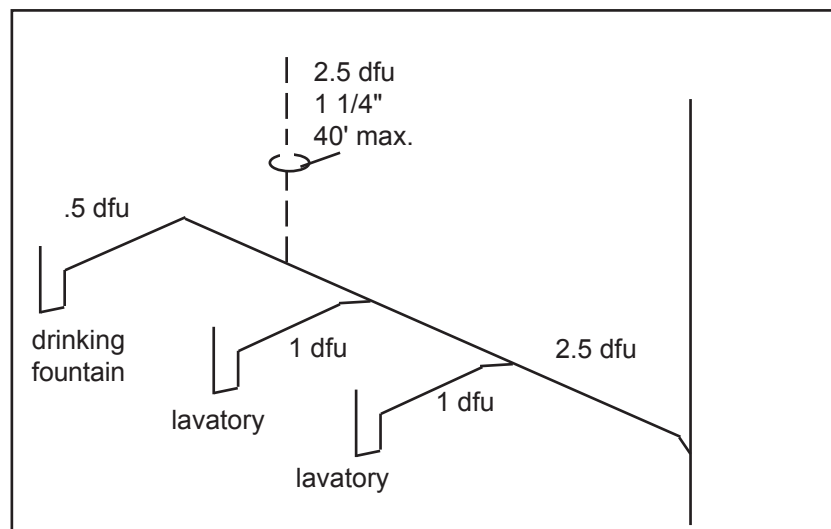


Figure 54. Circuit vent design

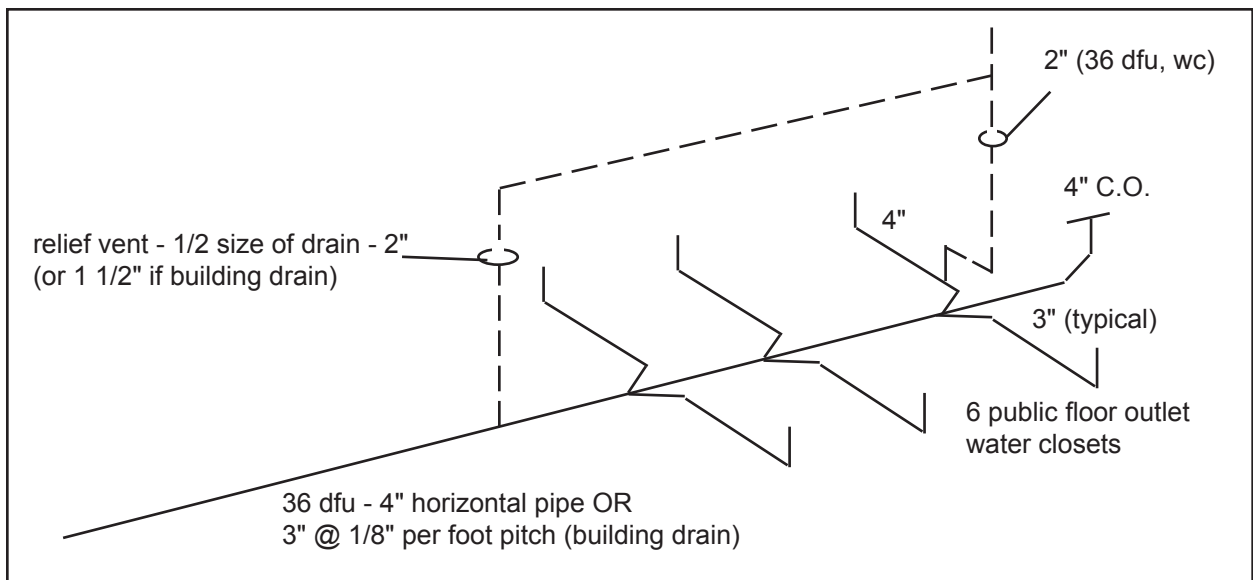


Figure 55. Circuit vent

Rules for circuit vent design and installation.

1. Public or private use fixtures may be circuit vented. Any building may contain circuit vented fixtures.
2. Only eight fixtures may be served by a circuit vent.
3. No blowout type fixtures are permitted on a circuit vented line.
4. Connect the circuit vent between the two most up stream fixtures.
5. A horizontal drain served by a circuit vent shall not diminish in size from the drain stack to the circuit vent connection.
6. Where a relief vent is installed, the horizontal drain served by the circuit vent shall not diminish in size from the relief vent connection to the circuit vent connection.
7. A relief vent must connect to the drain line when four or more fixtures are being circuit vented. This relief vent is connected to the horizontal drain downstream of the most downstream fixture drain that is vented by the circuit vent and upstream of all other drain connections.(Figure 55).
8. If two circuit vented branches each containing four fixtures discharge to the same point, one relief vent may connect downstream of the point where the two meet.
9. Only wall outlet fixtures with a drainage fixture unit value of one or less and which are served by individual or common vents may discharge into the horizontal drain served by the circuit vent (Figure 57).

Comm 82.31 (10) CIRCUIT VENTING. In lieu of providing individual vents, a horizontal drain to which at least 2 but not more than 8 wall outlet fixtures or at least 2 but not more than 8 floor outlet fixtures, other than blowout type fixtures and wall outlet carrier type water closets, are connected to the same horizontal branch drain, may be vented by a circuit vent in accordance with pars. (a) to (e).

(a) The circuit vent shall connect to the horizontal drain at a point between the 2 most upstream fixtures.

(b) 1. A circuit vented horizontal drain into which 4 or more fixtures discharge shall be provided with a relief vent. The relief vent shall connect to the circuit vented horizontal drain downstream of the most downstream fixture drain which is vented by the circuit vent and upstream of any other drain connections.

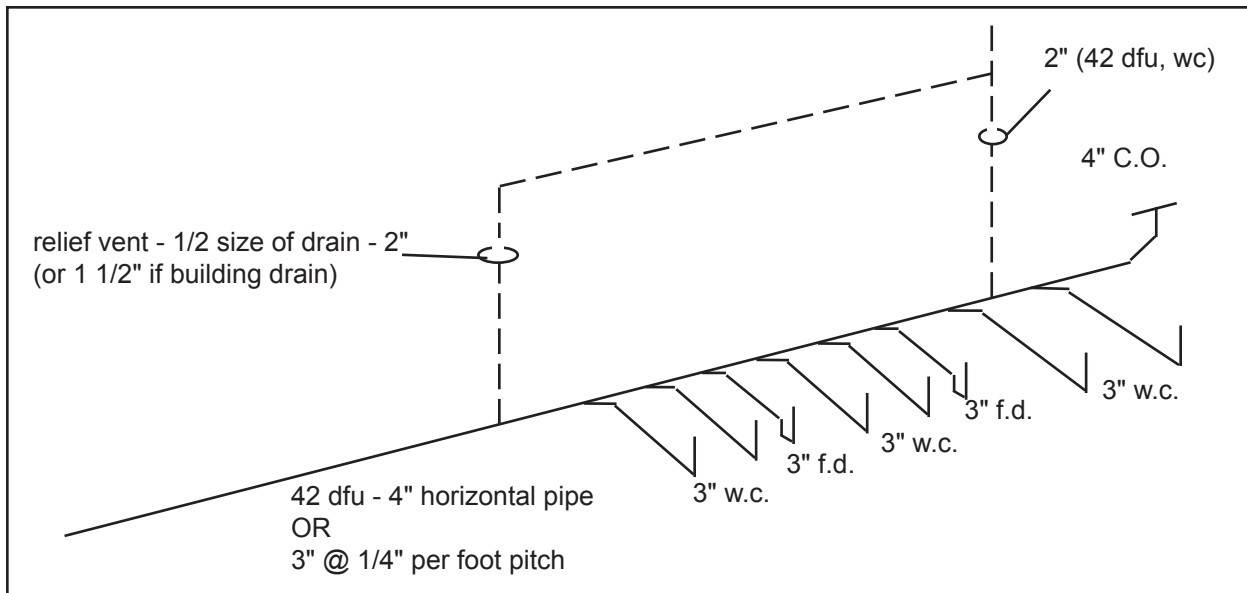


Figure 56. Circuit vent

Comm 82.31 (10) (cont.)

2. Two circuit vented horizontal drains serving a total of 8 fixtures, 4 on each branch, shall be provided with at least one relief vent, unless the horizontal drains connect to a drain stack with no other drain connections located above the circuit vented horizontal drains. One relief vent may serve both horizontal drains, if installed downstream of the point where the 2 horizontal drains are joined.

(c) A horizontal drain served by a circuit vent may not diminish in size from the most downstream fixture drain connection vented by the circuit vented drain to the circuit vent connection. Where a relief vent is installed, the horizontal drain served by the circuit vent shall not diminish in size from the relief vent connection to the circuit vent connection.

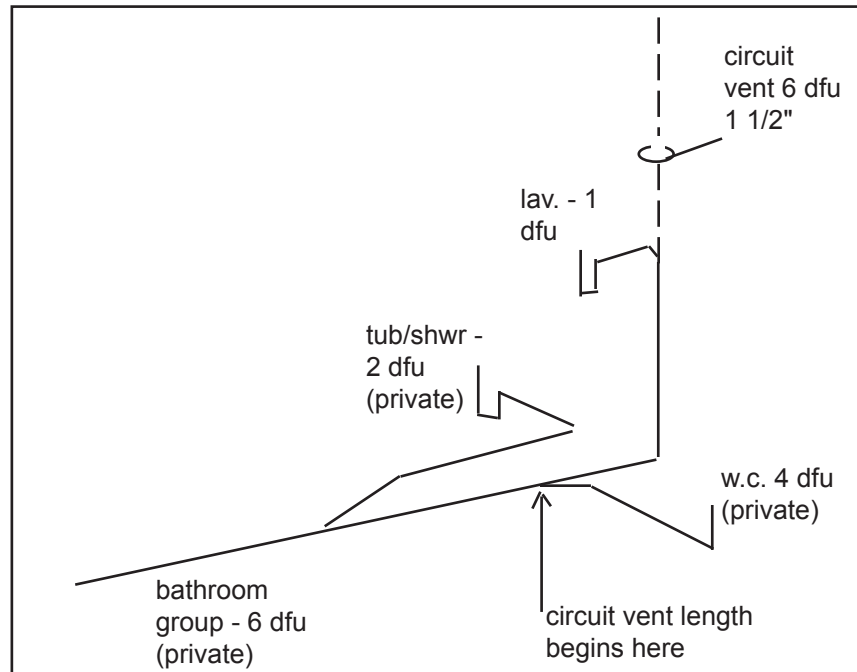


Figure 57. Circuit vented bathroom group

A circuit vent is sized using Table 82.31-3 (Figure 49). The sizing would be similar to that of individual vents.

The minimum diameter of a relief vent for a circuit vented line is half the diameter of the drain line served by the relief vent.

The maximum length is determined by Table 82.31-3 in the same manner as individual vents.

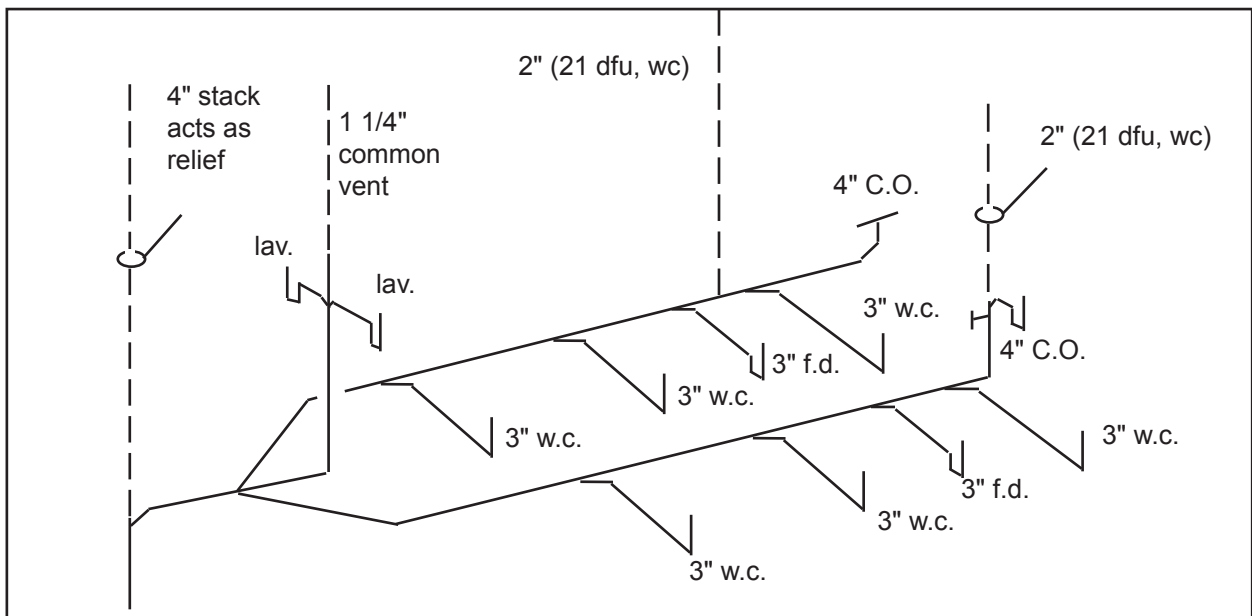


Figure 59. Circuit vent

The example of a circuit vent shown in figure 57 illustrates the use of a circuit vent with a private bathroom group. The horizontal wet vent is another option for venting bathroom groups, however with the configuration shown in figure 57, the circuit vent is an appropriate choice.

The example of the circuit vent in figure 58 illustrates the use of the stack as the relief vent for two circuit-vented horizontal branch drains. If no fixtures discharge above the connections for the circuit vented branch drains, this design configuration is possible. Note the two common-vented lavatories discharging into the circuit vented branch drain.

Comm 82.31 (10) (cont.)

(d) Fixture drains served by a circuit vent shall conform to the provisions of sub. (9). The connection of the fixture drain to the branch drain served by the circuit vent shall be considered as the vent connection.

(e) Additional wall outlet fixtures with a drainage fixture unit value of one or less which are served by individual vents or common vents may discharge into a horizontal drain served by a circuit vent.

Comm 82.31(10)(a):

The circuit vent shall connect to the horizontal drain at a point between the 2 most upstream fixtures.

Comm 82.31(10)(b):

1. A circuit vented horizontal drain into which 4 or more fixtures discharge shall be provided with a relief vent. The relief vent shall connect to the circuit vented horizontal drain downstream of the most downstream fixture drain which is vented by the circuit vent and upstream of any other drain connections.

Comm 82.31(11)(a): Vertical drains.

A common vent may serve 2 fixtures where both fixture drains connect to a vertical drain at the same elevation. Where this connection is by means of a sanitary tee fitting with a side inlet, the centerline of the side inlet opening may not be below the centerline of the larger opening. The drain connection of a blowout type fixture or a kitchen sink served by a common vent may not be by means of a double sanitary tee fitting.

Comm 82.31(14)(e):

Common vents. Common vent pipe sizes shall be determined in accordance with Table 82.31-3. The developed length of a common vent shall be measured along the vent pipe from the drain served by the vent to the point where it connects to a vent pipe of larger diameter or to the vent terminal.

Common Vents

There are two types of common vent installations. The first serves two fixture **traps** connecting to a vertical drain at the same elevation. They may be floor or wall outlet fixtures. (Figure 59). Both fixtures must discharge into a double tee, double tee wye, or side inlet tee. Where a side inlet tee is installed for a common vent connection, the center line of the smaller side inlet must not be below the centerline of the larger drain inlet (Figure 60).

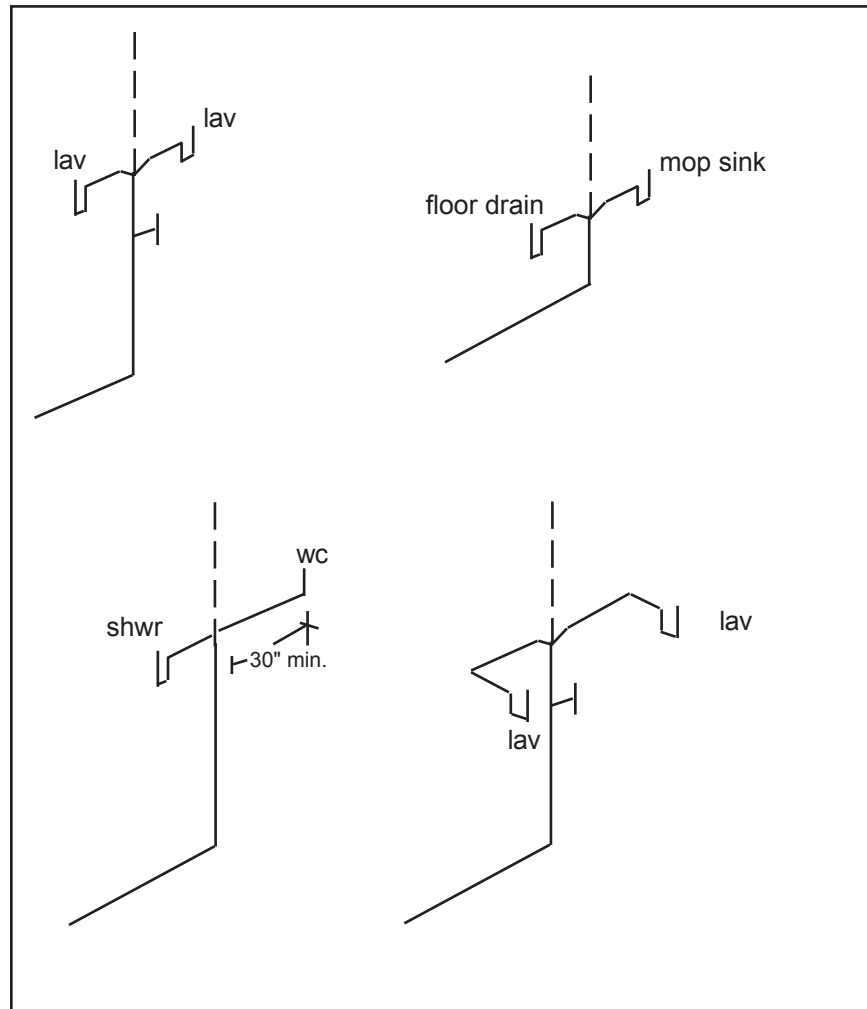
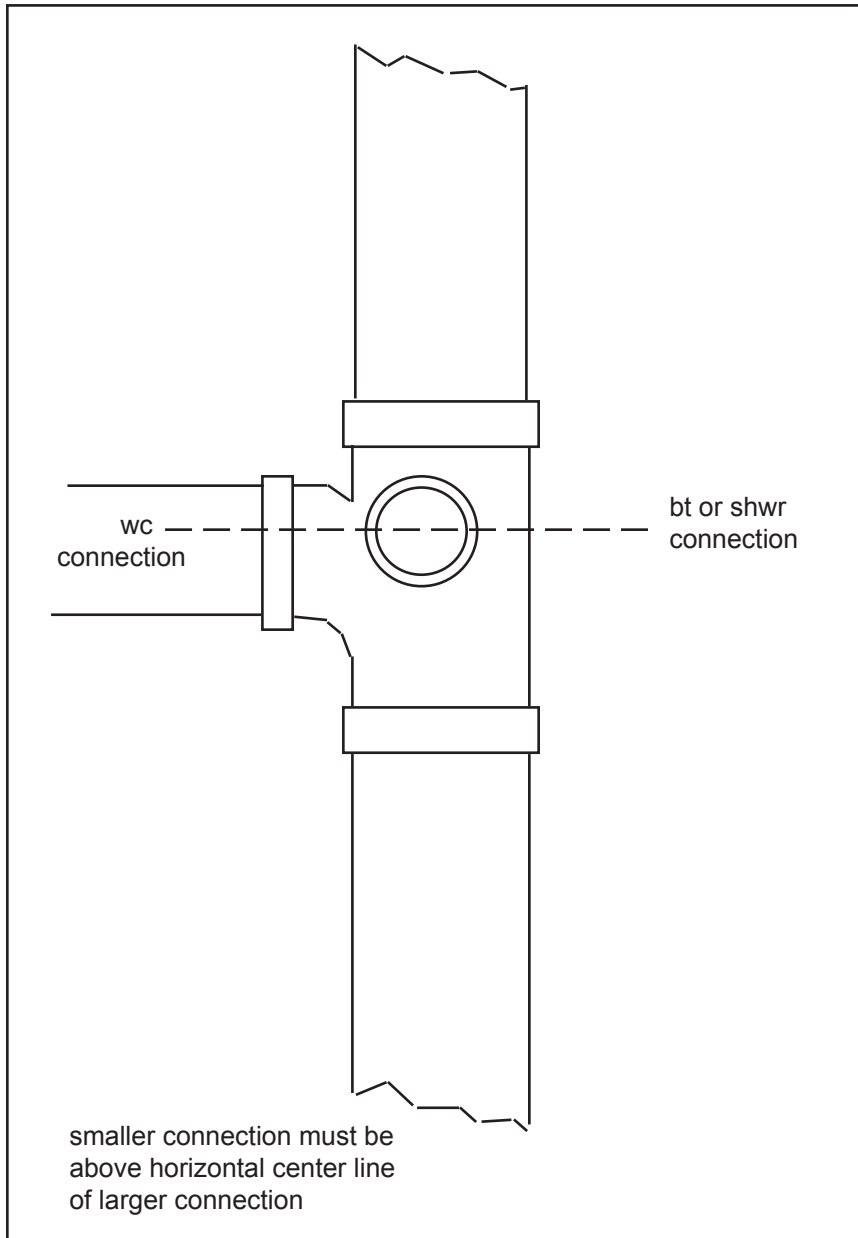


Figure 59. Common vent



*Comm 82.31 (11)(a)
(partial)*

Where this connection is by means of a sanitary tee fitting with a side inlet, the centerline of the side inlet opening may not be below the centerline of the larger opening.

Figure 60. Vertical common vent with side inlet tee

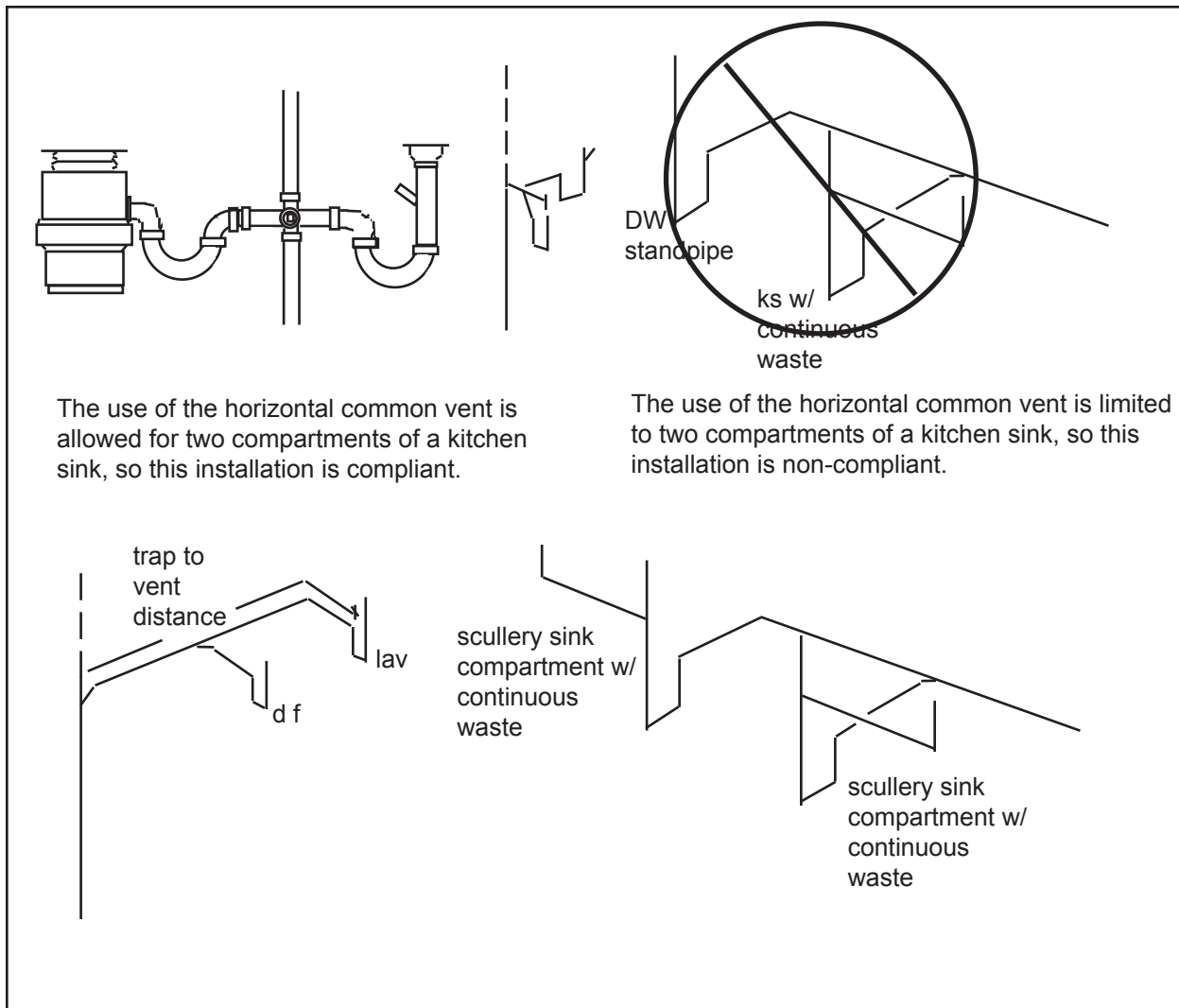


Figure 61. Horizontal common vent examples

*Comm 82.31 (11) (b)
Horizontal branches.
The fixture drains from 2 wall-outlet fixtures, each with a drainage fixture unit value of one or less, or the fixture drains from 2 traps serving a kitchen sink with or without a dishwasher may connect to a horizontal branch without individual vents provided a common vent connects to the branch drain downstream of both fixture drains. Both fixture drains shall be of the same diameter. The developed length of the drain from the vent to the farthest trap shall conform to sub. (9).*

The second type of common vent connects to a horizontal branch. This venting may only serve two wall outlet fixtures which have a dfu value of one or less, or the drains for two traps serving a residential or commercial kitchen sink with or without a dishwasher attached (Figure 61).

Both fixture drains must be the same diameter. The trap to vent measurement begins at the farthest trap weir from the vent connection as illustrated in Figure 61, lower left.

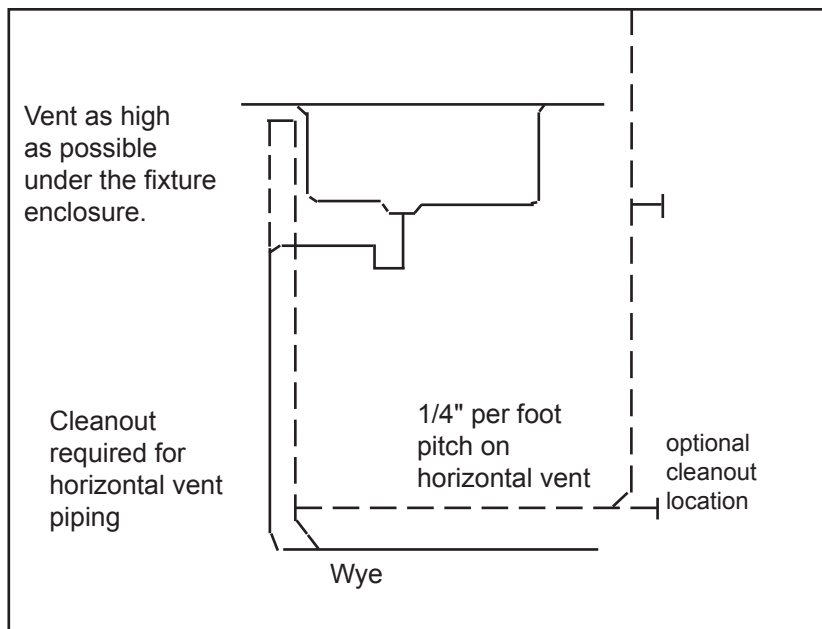


Figure 62. Return Vent

Return Vents

Figure 62 illustrates return venting, which may serve any wall outlet fixture. It may be an individual or a common vent. The vent pipe must be installed so as to run from the fixture drain outlet to a point as high as possible under the fixture enclosure, and then extend vertically downward to connect to the horizontal fixture drain. A fitting must be installed in this vertical vent pipe under the floor to continue the vent horizontally to a point where it can again rise and connect to a branch vent at 38 inches or more above the floor. This installation enables the low section of the vent to drain into the fixture drain and eliminates the “trapped” vent.

Other requirements for return venting include that drainage pattern fittings must be used on all sections of the vent below the floor, the vent must have a minimum slope of .25-inch per foot to the drainage point, and at least one cleanout must be installed to serve the horizontal vent pipe below the floor.

Comm 82.31(12) RETURN VENTS. Plumbing fixtures may be vented in accordance with pars. (a) to (d).

(a) Wall outlet fixtures may be vented by extending an individual vent, vertical wet vent or a common vent as high as possible under the fixture enclosure and returning the vent vertically downward and connecting the vent to the fixture drain or branch drain by means of a wye pattern fitting.

(b) Horizontal vent piping shall connect to the vertical section of the fixture vent and extend to a point where it can extend vertically to a vent terminal in accordance with sub. (16) or connect to another vent in accordance with sub. (15).

(c) Drainage fittings shall be used on all sections of the vent pipe below the floor level and a minimum slope of 1/4" per foot to the drainage point shall be provided.

(d) Cleanouts shall be provided on the vent piping in accordance with s. Comm 82.35.

Comm 82.31 (13) (a)
Vertical wet vents. 1.
Where 2 wall outlet
fixtures are located on the
same floor level with their
fixture drains connecting
to the same vertical
drain pipe at different
elevations, the lower
fixture drain may be wet
vented in accordance with
subd. 1. a. to e.
a. No other fixtures may
discharge into the vertical
drain pipe
above or between the
2 wall outlet fixtures.
Additional fixtures
may discharge into the
vertical drain pipe below
the 2 wall outlet
fixtures.
b. A branch vent shall
connect to the vertical
drain pipe immediately
above the higher fixture
drain connection.
c. The drain between the
2 fixtures shall be at least
one pipe size larger than
the upper fixture drain, but
not smaller than 2 in
diameter.
d. Both fixture drains shall
conform to sub. (9). The
connection
of the lower fixture drain
to the vertical drain shall
be considered
as the vent connection.
e. The higher fixture drain
may not serve a water
closet.

Wet Vents

The code has provisions for three different methods of wet venting: 1. vertical wet vents; 2. horizontal wet vents; and 3. wet vents formed by draining one or two wall outlet fixtures through a vent which serves floor outlet fixtures.

Vertical Wet Vents

A vertical wet vent serves two wall outlet fixtures which are located on the same floor level. The two wall outlet fixtures may be private- or public-use fixtures. Both fixtures must connect to the same vertical drain pipe with their drains connecting at different elevations. One branch vent must connect to the top of the vertical drain. The entire vertical drain must be at least one pipe size larger than the upper fixture drain, but may not be smaller than two inches. Any two fixtures may be combined in this type of installation, but the higher fixture drain may not serve a water closet. Figure 63 illustrates vertical wet vent installation.

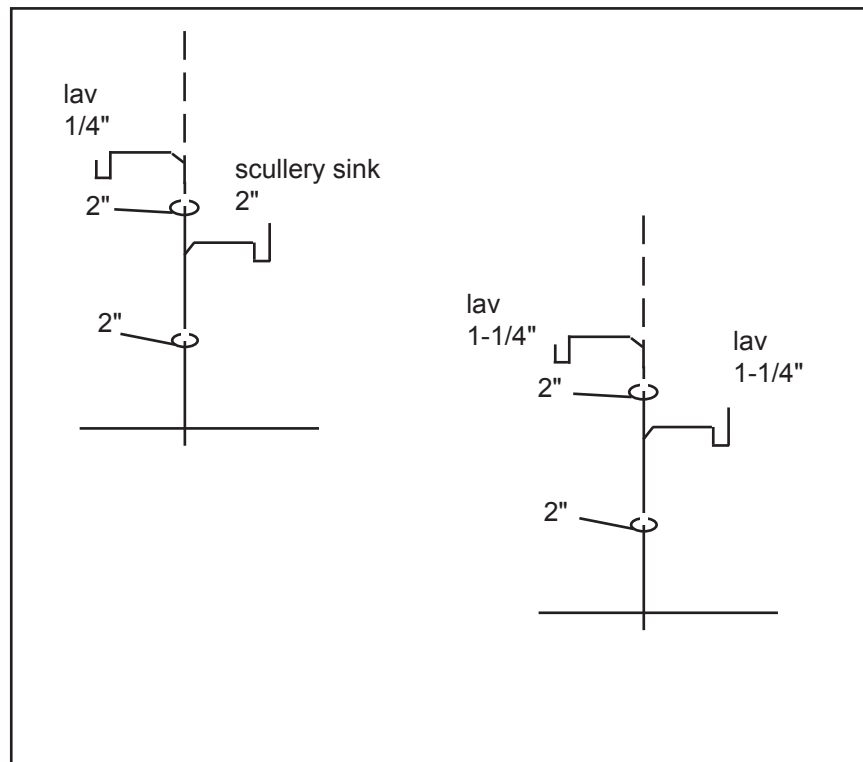


Figure 63. Vertical wet vent

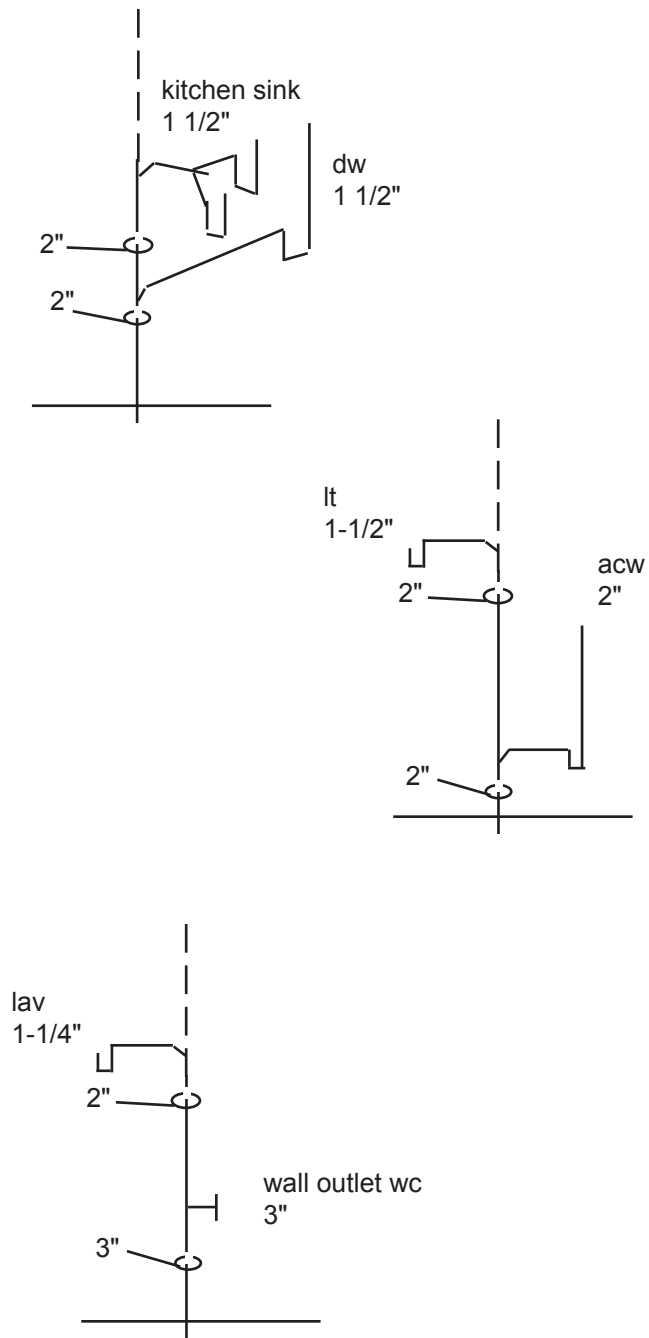


Figure 64. Vertical wet vent installation examples

Comm 82.31 (13) (b)
Horizontal wet vents. A drain from a lavatory or lavatories which are either provided with individual vents or a common vent may serve as the wet vent for not more than 2 bathtubs or showers and not more than 2 water closets in accordance with subds. 1. to 7. No other fixtures may discharge into or be served by the wet vent.

1. All of the fixtures shall be located in nonpublic bathroom groups.

2. The lavatories and bathtubs or showers shall have a common horizontal drain with the drain for the lavatories serving as a wet vent for the bathtubs or showers.

3. Where 2 bathtubs or showers are served by the same wet vent, their fixture drains shall connect independently to the common horizontal drain downstream of the vertical drain serving the lavatory or lavatories.

Horizontal Wet Vents

A horizontal wet vent may only serve the fixtures of one or two non-public bathroom groups. The lavatory, as illustrated in Figure 65, serves as a wet vent for the shower or bathtub and water closet.

Where two bathtubs or showers and two water closets are served by one horizontal wet vent, a relief vent must be installed downstream of the fixture drains for the water closets. The relief vent is not needed if the wet vent connects to a drain stack with no other drains discharging above the horizontal wet vent (Figure 65).

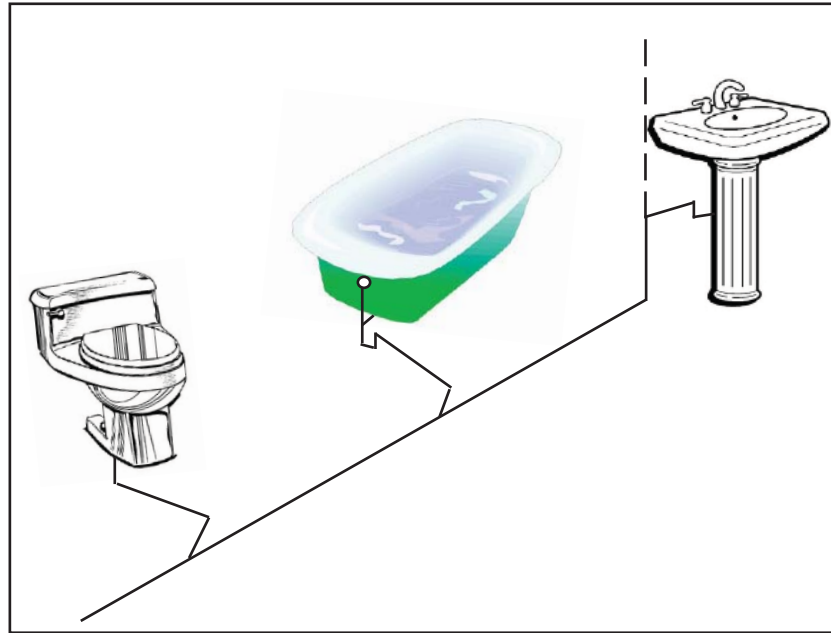


Figure 65. Horizontal wet vent

The lavatory and bathtub or shower must have a common horizontal drain. This common drain serves as a wet vent for the water closet. This causes the order of installation to consistently be lavatory - bathtub or shower - water closet.

The water in this system flows from the lavatory to the point where the shower or bathtub connect and then to the last type of fixture which may drain to the common horizontal pipe, which is the water closet (Figure 66).

The horizontal wet vent is similar to the circuit vent. However, if a bathroom group were circuit vented instead of vented by means of the horizontal wet vent, the 3-inch drain line would be required to the last circuit vented fixture in the circuit vented line. The horizontal wet vent code requirements permit reduction in the drain size upstream of the water closet.

When two water closets are served by a horizontal wet vent, they must connect to the horizontal drain at the same point, yet independently. The bathtub or shower drains need not connect at the same point. Also, a bathtub and shower are interchangeable. One bathtub and one shower may be included on one horizontal wet vent system. The wet vent portion of the lavatory drains must be a minimum 2-inch inside diameter. A relief vent serving a horizontal wet vent must have a minimum diameter of 1.5 inches.

Other Types of Wet Vents

The drains from one or two wall outlet fixtures with a drainage fixture unit value of one or less may serve as a wet vent for other fixtures. The minimum size of the wet vent portion of this installation is two inches inside diameter. The following types of

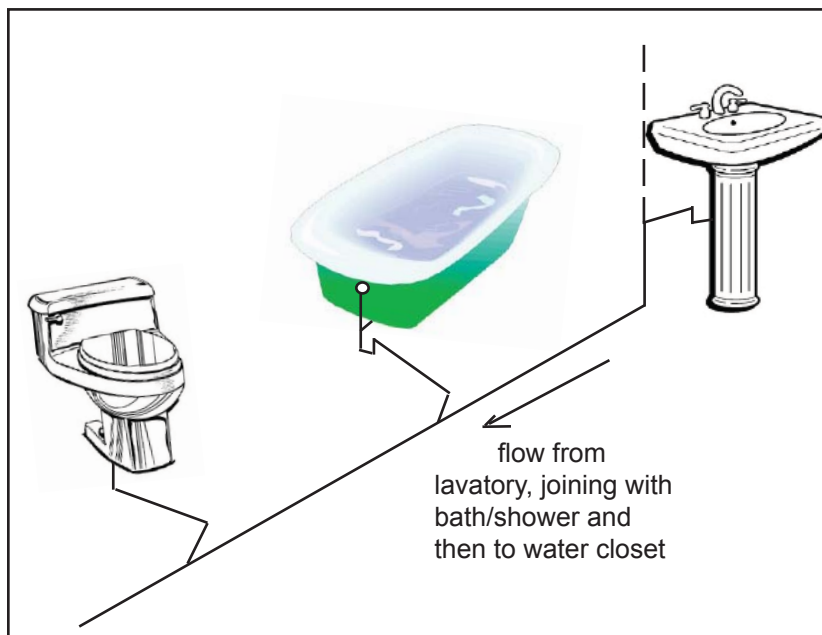


Figure 66. Flow through the horizontal wet vent

Comm 82.31 (13) (b) (cont.) 4. Where 2 bathtubs or showers and 2 water closets are served by the same wet vent a relief vent shall be provided, unless the wet vented horizontal drain connects to a drain stack with no other drain connections located above the wet vented horizontal drain.

The relief vent shall connect to the horizontal drain at a point downstream of the fixture drains for the water closets and upstream of any other fixture drain connections.

5. One or 2 water closets may connect to the common horizontal drain with the drain from the lavatories and bathtubs or showers also serving as a wet vent for the water closets. Where 2 water closets are served by the same wet vent, their fixture drains shall connect independently to the common horizontal drain at the same point.

6. The wet vent shall be at least 2 in diameter. No more than 4 drainage fixture units may discharge into a 2 diameter wet vent.

7. A branch vent shall connect immediately above the highest fixture drain connection and shall be sized in accordance with sub. (14).

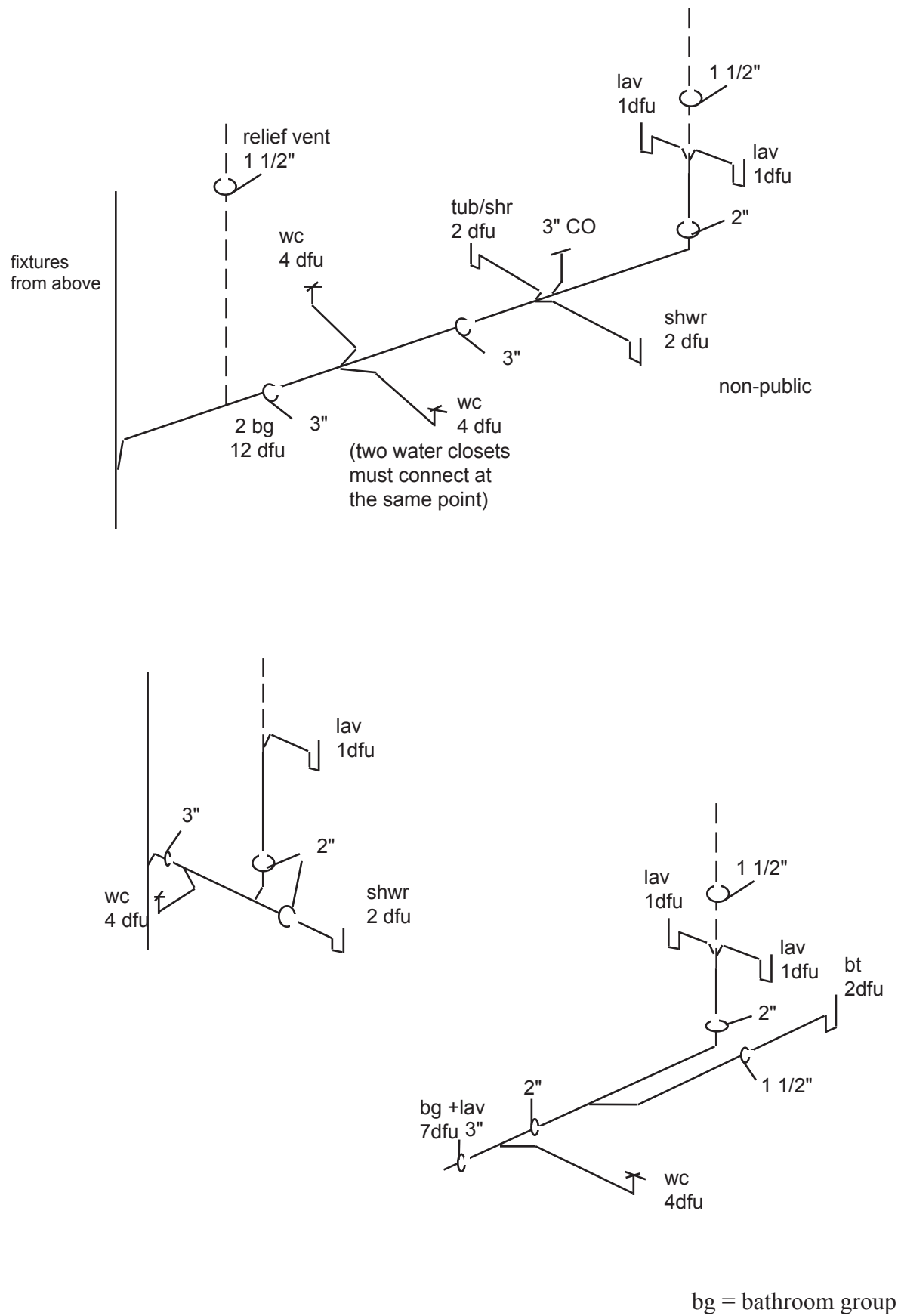


Figure 67. Examples of horizontal wet vent installations

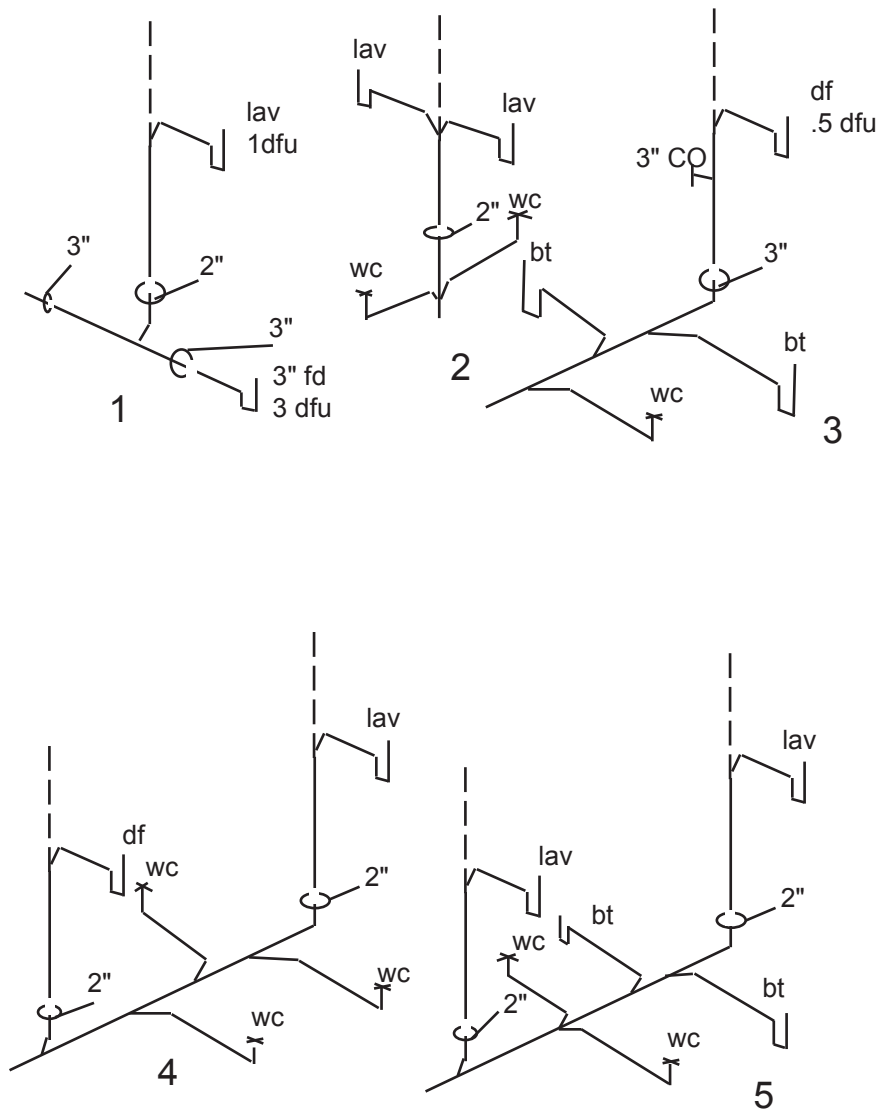


Figure 68. Wet vents

vents may serve as a wet vent draining one or two wall outlet fixtures, as illustrated above:

1. An individual vent serving another fixture;
2. A common vent serving other fixtures;
3. A circuit vent;
4. A relief vent serving a circuit vented drain, and;
5. A relief vent serving a horizontal wet vent.

Combination Drain And Vent Systems

The Wisconsin Uniform Plumbing Code provides four methods for using the drainage system for providing air to protect the trap seals of fixtures. These combination drain and vent systems may be installed anywhere the criteria for their use is met.

*Comm 82.31(13)(c):
Other types of wet vents.
An individual vent serving a floor outlet fixture, a common vent serving floor outlet fixtures, a circuit vent, a relief vent serving a circuit vented drain or a relief vent serving a wet vented horizontal drain may serve as a wet vent in accordance with subds. 1. to 4.*

1. No more than 2 wall outlet fixtures, each fixture with a drainage fixture unit value of one or less, may have their fixture drains connected into the individual vent, common vent, circuit vent or relief vent.

2. The wet vent shall be at least 2 inches in diameter.

3. The branch vent to which the wet vent connects shall be sized in accordance with sub. (14). The branch vent may serve the wall outlet fixtures in lieu of individual vents or a common vent.

4. The fixtures discharging into the wet vent shall be located on the same floor level as the fixtures served by the wet vent.

Comm 82.31(17)(a)1: A drain stack may serve as a combination drain and vent system for fixtures in accordance with subpars. a. to e.

a. The drain stack shall not serve more than 3 fixtures. Each fixture shall be located on a separate floor level.

b. The drain stack shall be limited to serving fixtures with a drainage fixture unit value of no greater than 2. A urinal may not discharge into the combination drain and vent portion of the stack. The largest drainage fixture unit value served by the stack shall determine the stack size as specified on Table 82.31-5.

c. The drain stack shall not be offset horizontally above the lowest fixture drain connection.

d. The developed length of any fixture drain from the trap weir to the drain stack shall not exceed the limits specified in Table 82.31-1.

e. The drain stack and its attendant vent shall be sized in accordance with Table 82.31-5.

Stacks

The first of the two types of combination drain and vent stacks allows the connection of up to three fixtures to the stack. This stack may serve fixtures with a dfu value no greater than 2.0. Each fixture must be located on a separate floor level and the drain stack may not be offset horizontally (Figure 69).

The entire stack and the stack vent is sized using Table 82.31-5 (Figure 70).

The second type of combination drain and vent stack serves a kitchen sink and another 2 dfu maximum wall outlet fixture within a dwelling unit. In Figures 71 and 72 the two methods of this style of venting are shown. The drain stack may not have a

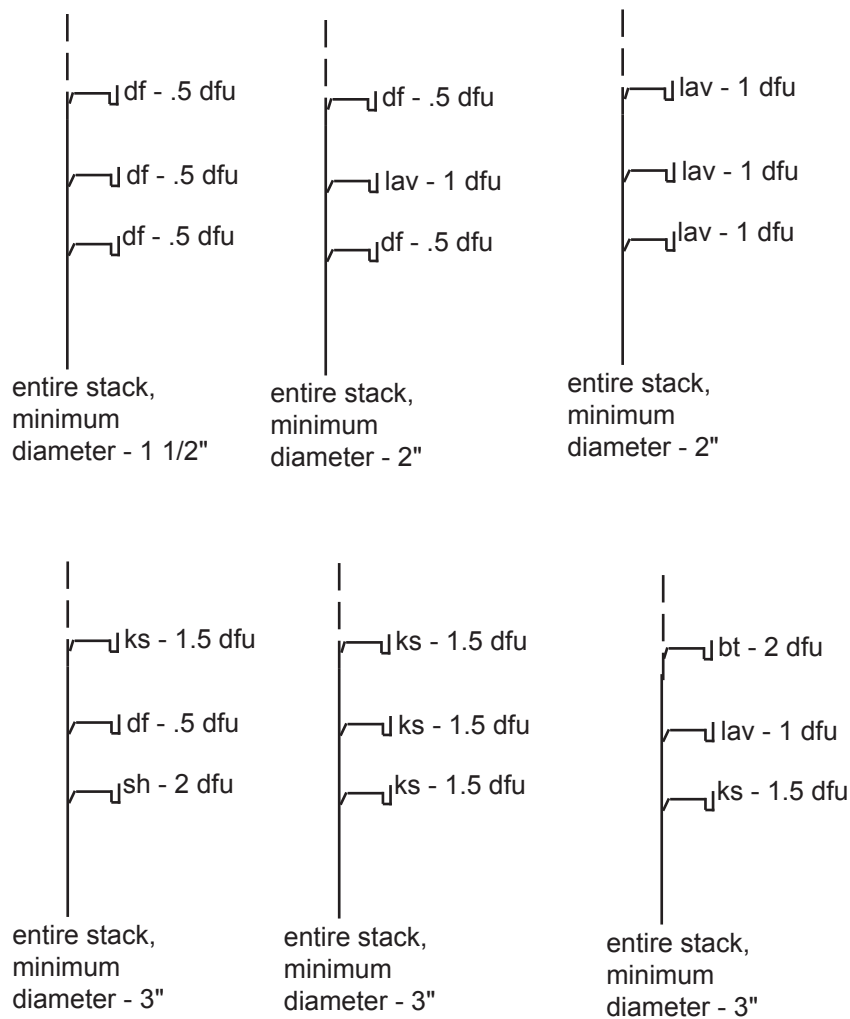


Figure 69. Stack-type combination drain and vent system

Table 82.31-5 STACK SIZING BY DFU VALUE	
Drainage Fixture Unit (dfu) Value	Size of Stack (inches)
0.5	1½
1.0	2
2.0	3

Figure 70. Table 82.31-5

horizontal offset above the lower fixture connection. Remember, a 45-degree offset is still considered vertical piping.

For both figures, the vent above the kitchen is considered a branch vent and must be sized as such. Note that the stack may diminish in size for this method of venting. The vent is sized by dfu value.

Building Drains and Building Subdrains

A combination drain and vent system using the building drain or building subdrain is actually a system within a system. This type of venting may **only** be installed in conjunction with a building drain or building subdrain. It cannot be installed on horizontal piping. A building drain that is to form a combination

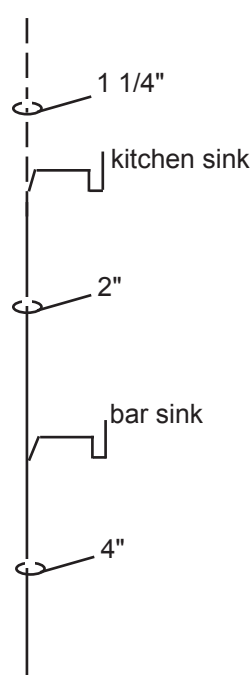


Figure 71. KS/bar sink stack

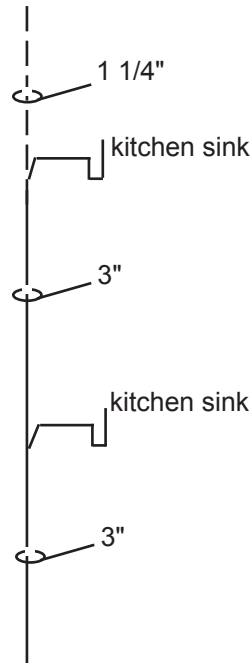


Figure 72. KS/KS stack

Comm 82.31 (17) (a)2. A drain stack may serve as a combination drain and vent system for a kitchen sink and a wall outlet fixture in accordance with subd. 2. a. to d.

a. One kitchen sink within a dwelling unit, with or without a food waste grinder or dishwasher connection shall connect to the drain stack above a wall outlet fixture with a drainage fixture unit value of 2 or less. No other fixtures may connect to the drain stack.

b. The drain stack shall be at least 2 inches in diameter below the kitchen sink connection and it shall be at least 4 in diameter below the connection to the lower fixture.

c. In lieu of the minimum sizes as required in subd. 2. b., the entire stack below the kitchen sink connection may be 3 in diameter.

d. The drain stack shall not offset horizontally above the fixture drain connection for the lower fixture.

Comm 82.31 (17) (b)

Building drains. A building drain or a building subdrain may serve as a combination drain and vent system for floor drains and floor outlet fixtures in accordance with subds. 1. to 6.

1. A vent or drain at least 2 inches in diameter shall be connected upstream of any building drain branch or building subdrain branch.

2. No more than 2 water closets may connect to the building drain or building subdrain by means of building drain branches or building subdrain branches.

3. a. That portion of the building drain or building subdrain between the connection of the building drain branch or building subdrain branch and the vent or drain required in subd. 1. shall be at least one pipe size larger than the minimum size permitted in Table 82.30-3 based on the total drainage fixture unit load, but not less than 3 inches.

b. The vent or drain required in subd. 1. shall be at least one-half the diameter of that portion of the building drain or building subdrain which is vented by the vent or drain, but may not be less than 2 inches in diameter.

drain and vent system must have a minimum 2-inch diameter vent or drain connected at the upstream end of the combination drain and vent system. See Figure 73.

The fixture drain serving a floor outlet fixture may connect individually to a building drain or building subdrain, and may be vented by the combination drain and vent system. This type of fixture drain is illustrated in Figure 74 and is called a "building drain branch" or, in the case of the building subdrain, a "building subdrain branch." The building drain or building subdrain branch must be at least three inches in diameter. The trap of any fixture or

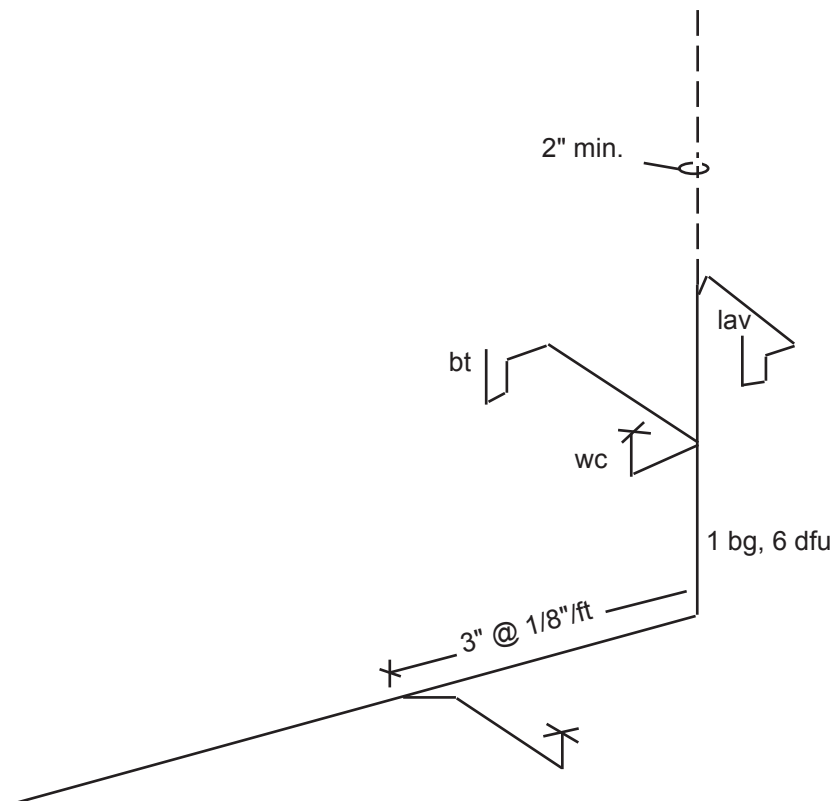


Figure 73. Combination drain and vent system

floor drain of a building drain or building subdrain branch must be a minimum of 3-inch inside diameter, with the exception of that for a water closet. A maximum of two water closets may be served by the combination drain and vent system. However, there is no limit to the number of other types of floor outlet fixtures which can be vented by this system. There is no limit to the number of combination drain and vent systems that may be installed in a building, or how many combination drain and vent systems may connect to a building drain.

The portion of the building drain or building subdrain between a building drain branch and the upstream stack serving the system must be at least one pipe size larger than the minimum size

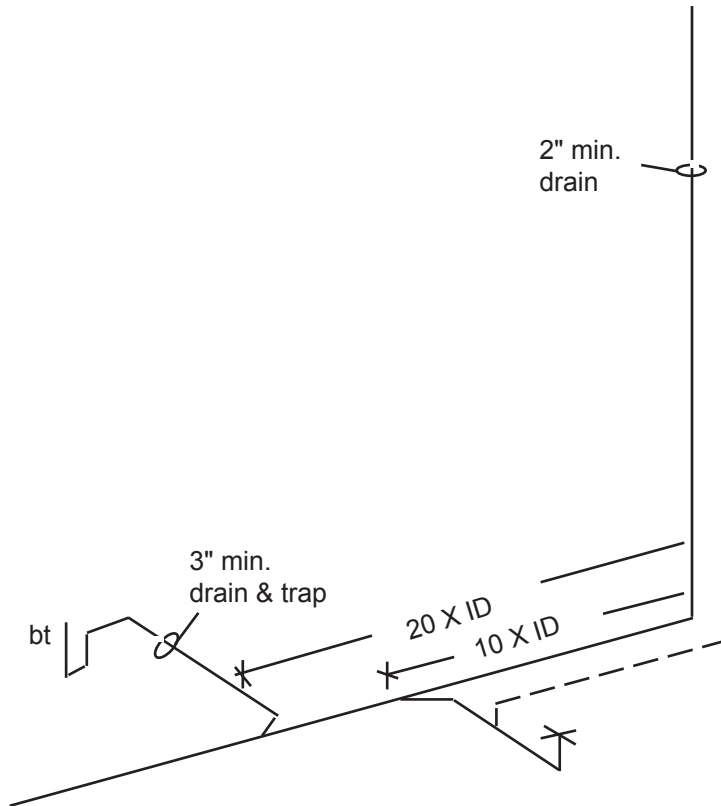


Figure 74. Combination drain and vent system and the building drain branch and horizontal branch drain.

Comm 82.31 (17) (cont.)
 (b) 3. c. A vent serving a drain required in subd. 1, shall be at least one half the diameter of that portion of the building drain or building subdrain which is vented by the system, but may not be less than 2 inches in diameter.

4. The trap of a floor drain or a floor outlet fixture, except a water closet, connected to a building drain branch or building subdrain branch shall be at least 3 in diameter.

5. A building drain branch or building subdrain branch may not connect to a building drain or building subdrain downstream from the base fitting of a drain stack 2 or larger in diameter within the distance equal to 20 pipe diameters of the building drain or building subdrain.

6. The pitch and the developed length of the building drain branch or building subdrain branch may not exceed the limits specified in Table 82.31-1.

permitted in Table 82.30-3 (Figure 20), but never less than 3". The sizing of the combination drain and vent system is totally dependent on the number of drainage fixture units which discharge through it (Figure 75).

A building drain or building subdrain branch may not connect to the building drain or building subdrain immediately downstream of the drain stack. The code requires the connection be downstream of the stack at least 20 times the inside diameter of the building drain or building subdrain (Figure 77).

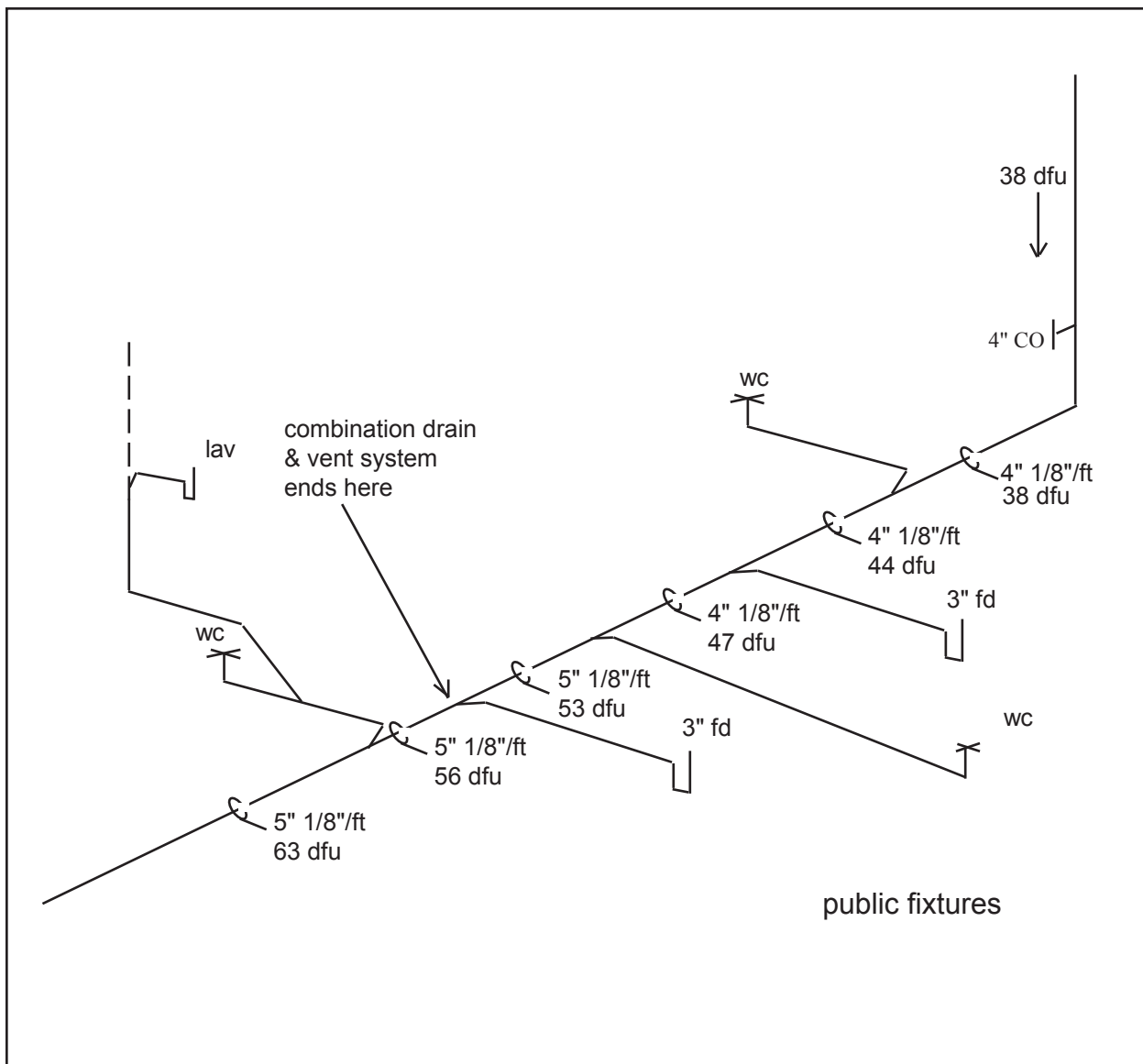


Figure 75. Combination drain and vent system

Another option for this same configuration is using a dry vent instead of the 38 dfu stack. In this option, the water closet fixture drain connection is located downstream of the dry vent. So, in this design there could be no additional water closets served by the combination drain vent system (2 wc max).

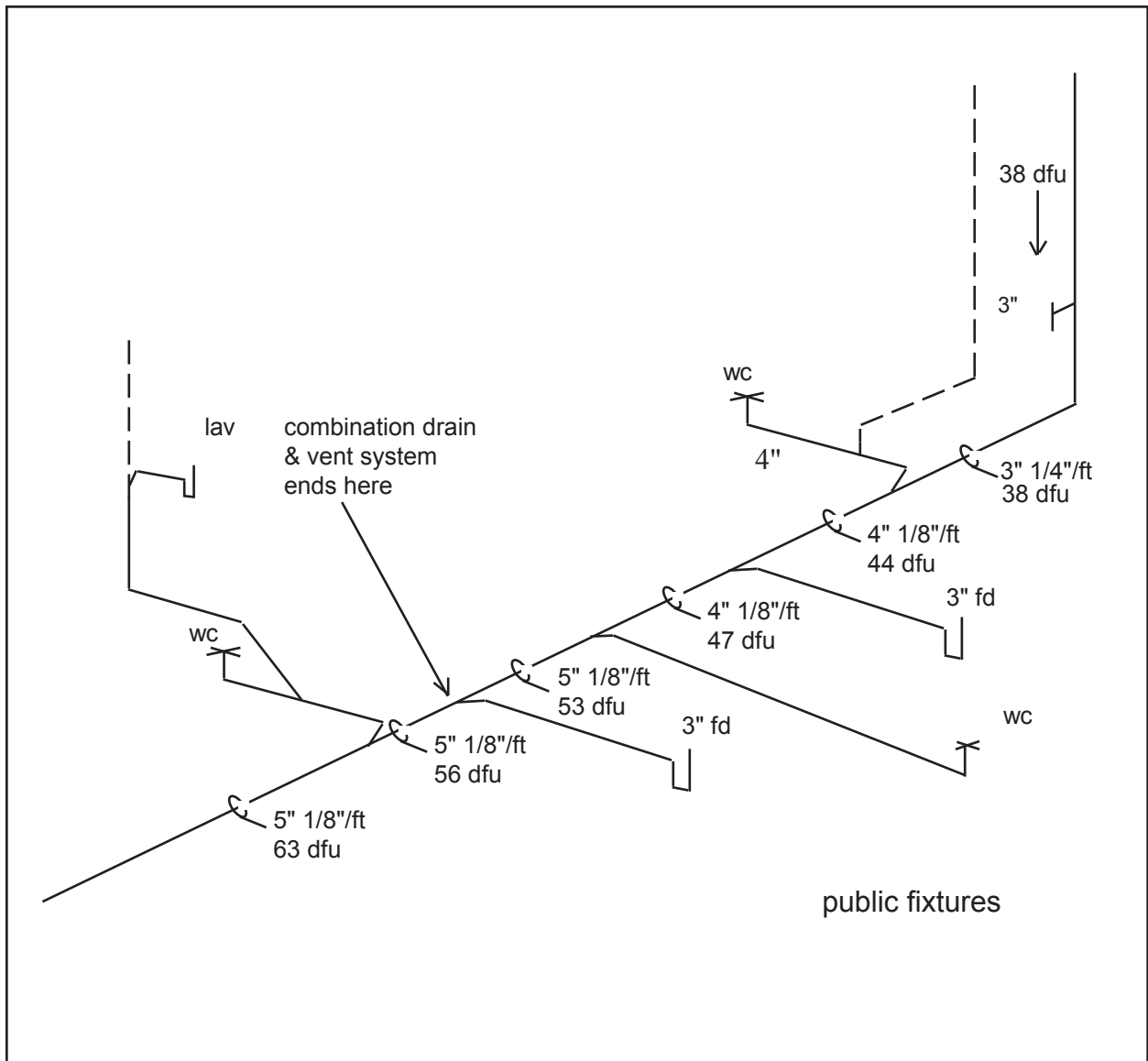


Figure 76. Combination drain and vent system

Any **building drain**, whether it is located above or below grade, can form a combination drain and vent system. As shown in Figure 78, under no circumstances will the building drain from the connection at the base of the stack to the first building drain branch ever be less than 3-inch inside diameter. Also note that the combination drain and vent system may increase in size in the direction of flow. It is not required to maintain the same diameter and pitch

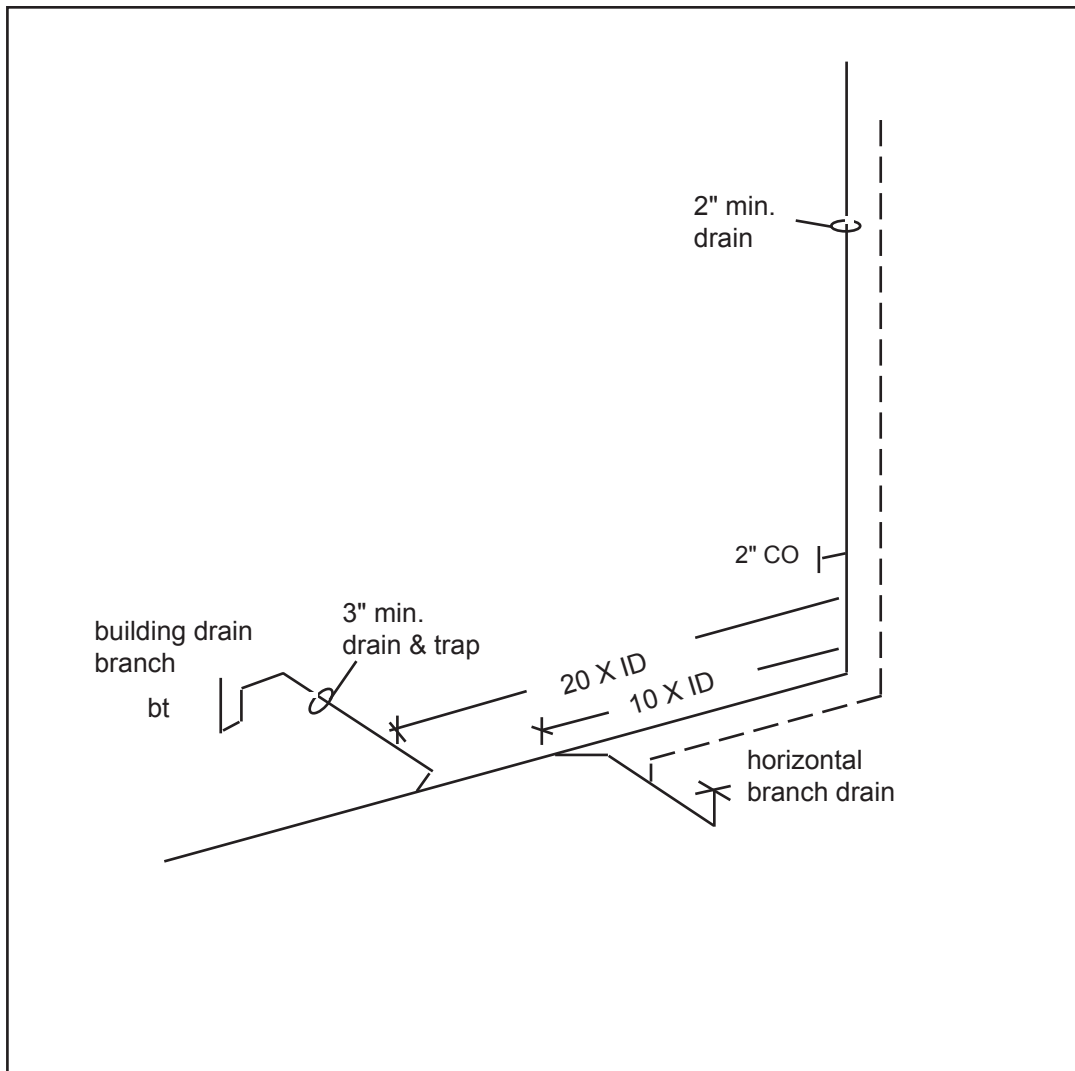


Figure 74. Combination drain and vent system utilizing the building drain

of the drain line from the base of the stack which serves the combination drain and vent system to the most downstream building drain branch. There is no limit to the number of combination drain and vent systems within a building, as long as the basic criteria are met.

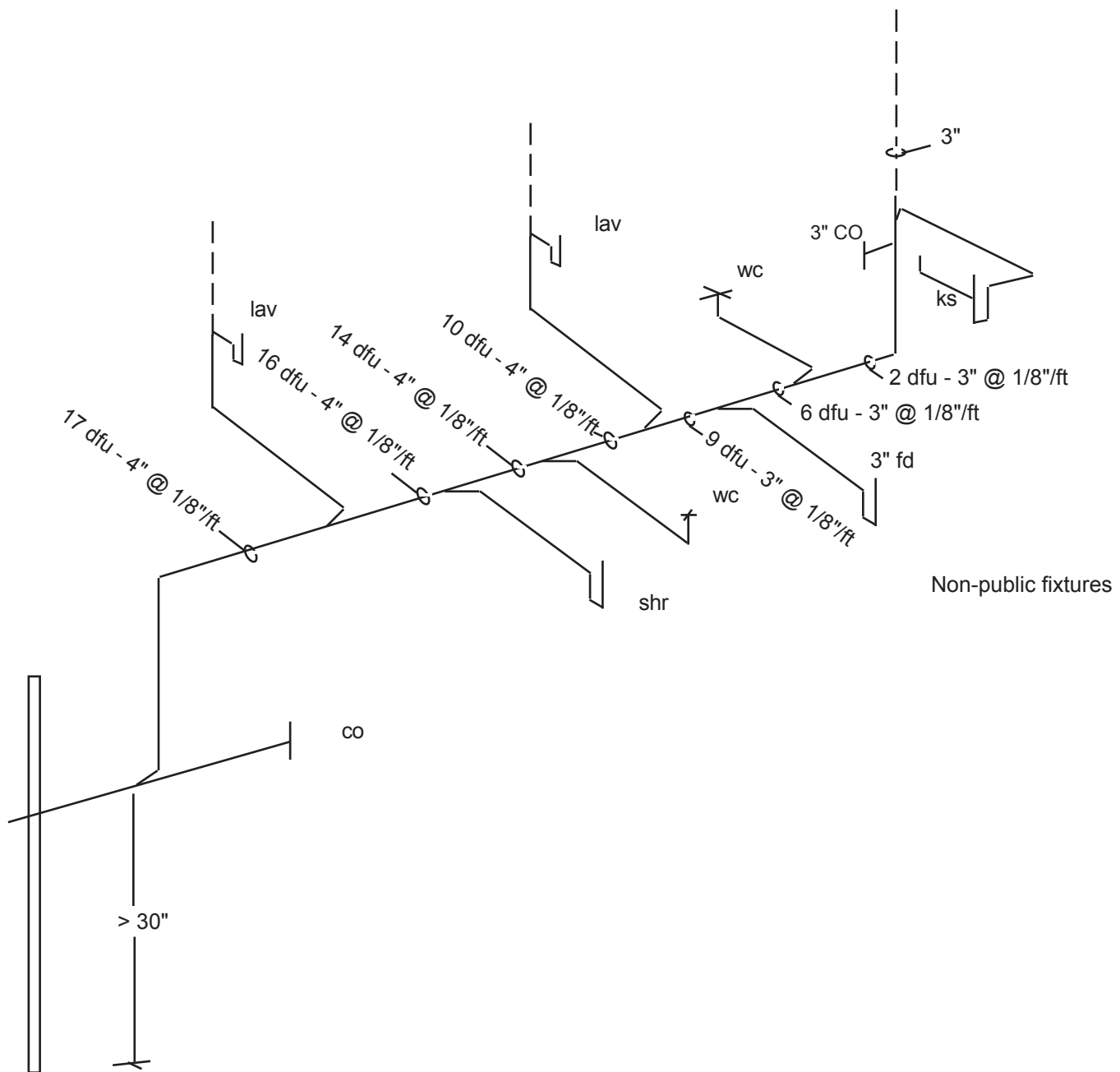


Figure 78. Combination drain and vent system design

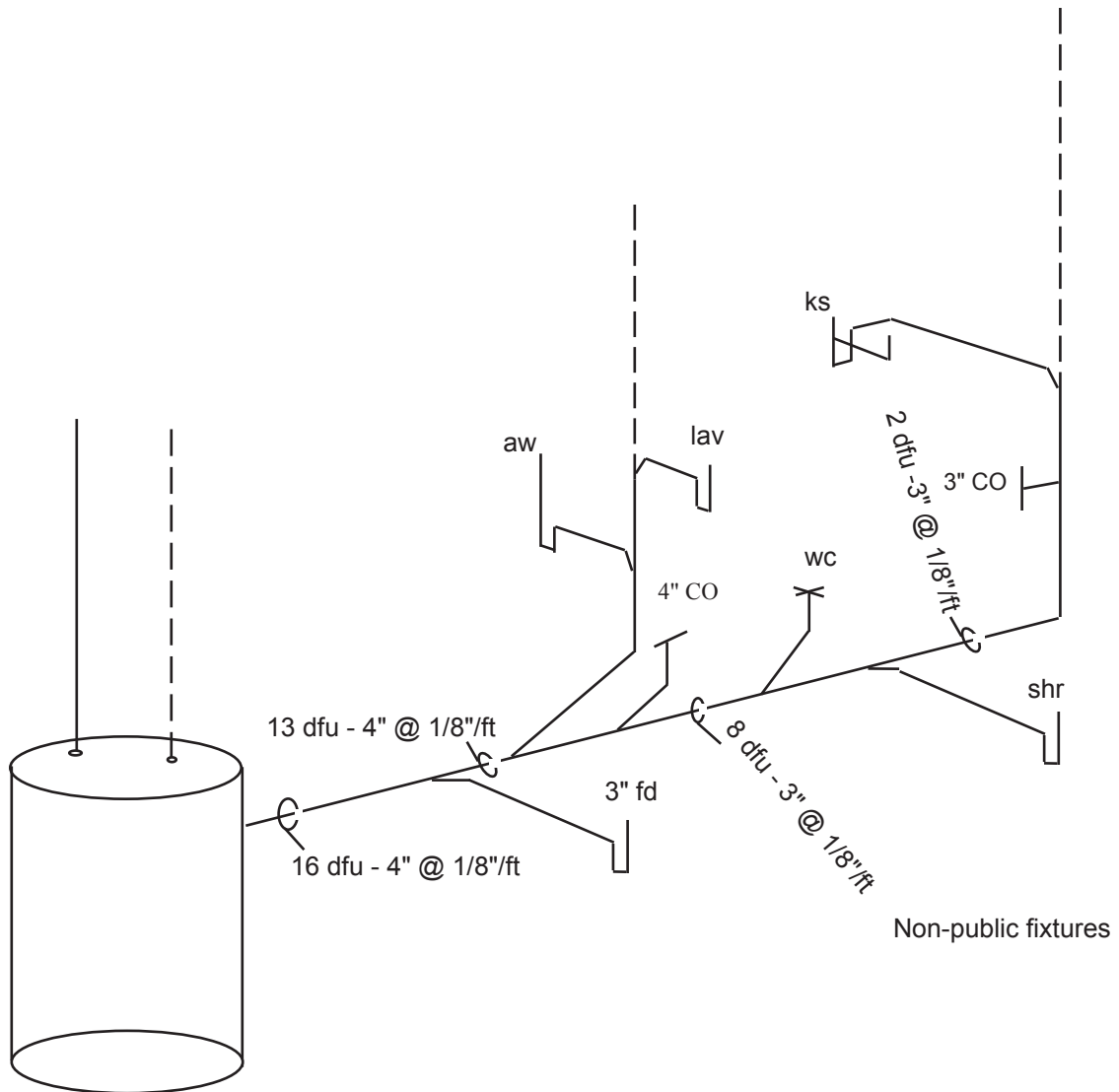


Figure 79. Combination drain and vent system design utilizing building subdrains

Review

Review the criteria for the installation of the combination drain and vent system using the building drain or building subdrain:

1. The combination drain and vent system may be installed in public or private buildings.
2. Installation is only permitted on a building drain or a building subdrain, not on horizontal drains.
3. The stack serving the combination drain and vent system must have a minimum diameter of two inches, and it may not be less than half the diameter of that portion of the building drain or building subdrain that is vented by the stack.
4. A building drain branch or building subdrain branch has a minimum inside diameter of three inches.
5. A building drain branch or building subdrain branch must connect a minimum of 20 times the inside diameter of the building drain or building subdrain downstream of a two-inch or larger diameter drain stack.
6. A maximum of two water closets may be served by each combination drain and vent system. The number of other floor outlet fixtures served by the combination drain and vent system is limited only by Table 82.30-3.
7. The portion of the building drain or building subdrain between the connection of the building drain branch or building subdrain branch to the vent or drain stack must be at least one pipe size larger than the minimum size permitted in Table 2.30-3, based on the total drainage fixture unit load, but not less than 3".
8. There may be an unlimited number of combination drain and vent systems within a building.
9. The minimum diameter of the horizontal drain between the drain or vent stack and the first building drain branch or building subdrain branch downstream of the stack is always three inches.

The sizing of a combination drain and vent system using a building drain or building subdrain requires study. Below is an isometric diagram of a combination drain and vent system that has yet to be sized. You may complete the design of this system by inserting the correct size and pitch of pipe required to vent the building drain branches installed on the combination drain and vent system. Answers are in the appendix of this manual.

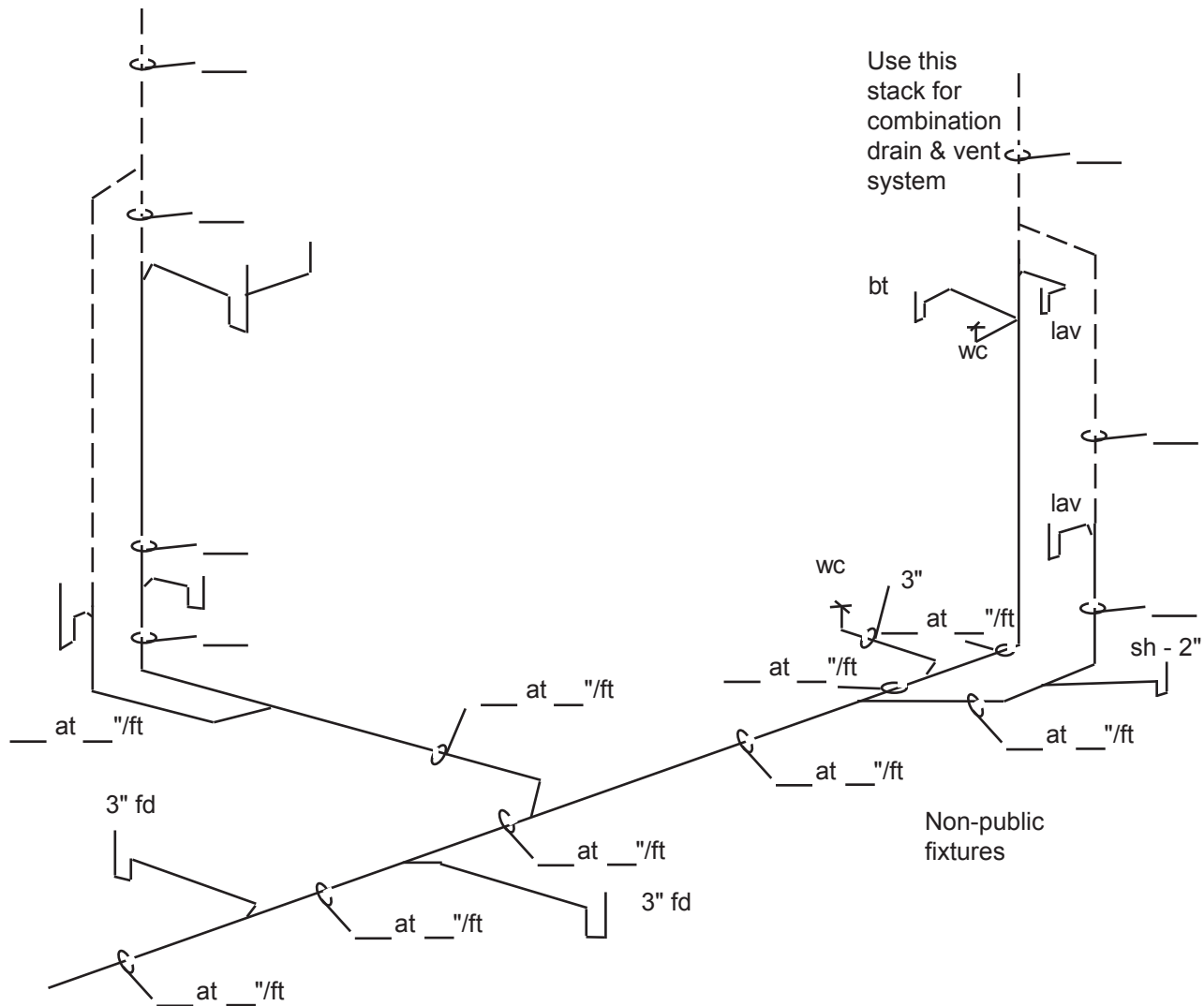


Figure 80. Combination drain and vent system design

Laboratory Sinks

The fourth type of combination drain and vent system applies to only lab sinks. The requirements for lab sink venting closely parallels those for building drain combination drain and vent systems.

For lab sinks there must be: (1) A vent or drain stack at least two inches in diameter upstream of any fixture drain vented by the combination drain and vent system; (2) The portion of the horizontal drain upstream from the fixture drain to its connection to the stack shall be one pipe size larger than the minimum that would be permitted in Table 82.30-2 (Figure 3); (3) The vent or drain stack must be at least one-half the diameter of that part of the horizontal drain that is vented by the stack, but not less than two inches inside diameter; (4) All fixture drains vented by the horizontal drain must be at least three inches in diameter. The fixture may discharge to, and the vent may tie back into, the horizontal drain which forms the drain and vent system (point A,

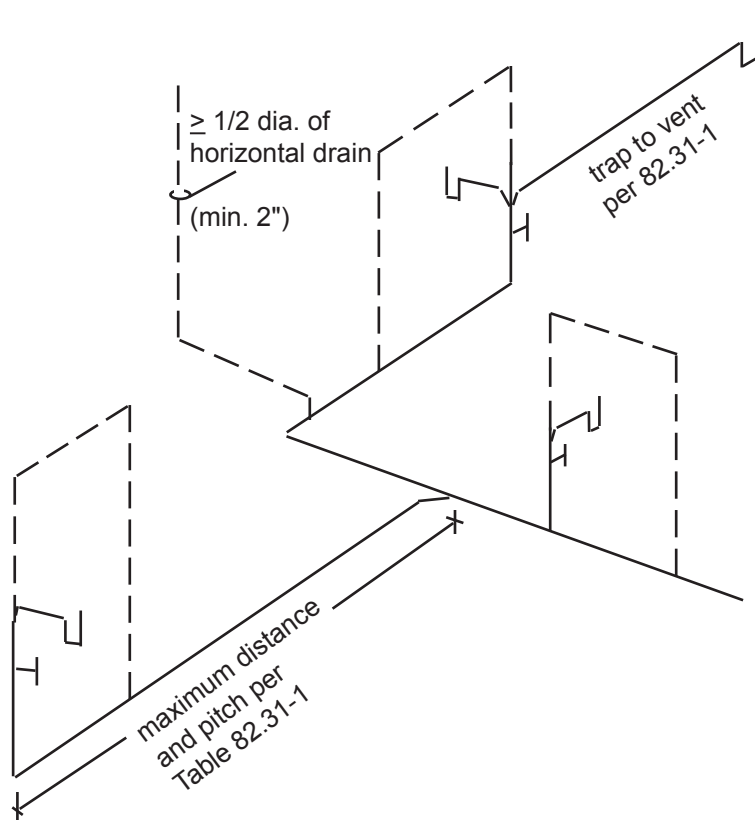


Figure 81. Combination drain and vent system

Comm 82.31 (17) (c)
Laboratory sink venting. A horizontal drain may serve as a combination drain and vent system for island laboratory sinks in accordance with subds. 1. to 7.

1. A vent stack or a drain stack at least 2 in diameter shall be connected upstream of any fixture drain vented by the combination drain and vent system.

2. a. That portion of the horizontal drain between the connection of fixture drain and the vent stack or drain stack required in subd. 1. shall be at least one pipe size larger than the minimum size permitted in Table 82.30-2 based on total drainage fixture unit load.

b. The vent stack or drain stack required in subd. 1. shall be at least one-half the diameter of that portion of the horizontal drain which is vented by the stack, but may not be less than 2" in diameter.

c. A stack vent serving a drain stack required in subd. 1. shall be at least one half the diameter of that portion of the horizontal drain which is vented by the stack, but may not be less than 2 in diameter.

3. All fixture drains vented by the horizontal drain shall be at least 3" in diameter.

4. Fixture drains to be vented by the horizontal drain shall connect individually to the horizontal drain.

5. An individual vent or common vent shall be extended as high as possible under the sink enclosure and then returned vertically downward and connected to the horizontal drain. A cleanout shall be provided on the vent piping.

6. In lieu of connecting the vent to the horizontal drain which forms the combination drain and vent system, the vent may connect to a horizontal fixture drain vented by the combination drain and vent system. The pitch and developed length of the horizontal fixture drain shall not exceed the limits specified in Table 82.31-1.

7. Fixture drains to be vented by the horizontal drain shall not connect to a horizontal drain downstream from the base fitting of a drain stack 2 or larger in diameter within the distance equal to 20 pipe diameters of the horizontal drain serving the stack.

Figure 82), or the fixture may discharge to and the vent tie back into a horizontal fixture drain vented by the combination drain and vent system (point B, figure 82); (5) The pitch and developed length of the horizontal drain must not exceed the limits in Table 82.31-1 (Figure 43); (6) As in island venting, the individual or common vent must extend as high as possible under the sink enclosure and return vertically to connect to the horizontal drain; (7) Fixture drains vented by the horizontal drain shall not connect downstream of a two-inch or larger stack within twenty times the pipe diameter of the horizontal drain serving the stack.

Don't confuse this style of venting with island sink venting. The vent running horizontally under the floor is not required with this type of venting because the oversized drain permits the free movement of air.

Remember: This type of venting is for laboratory sinks only.

Prohibited Vent Installations

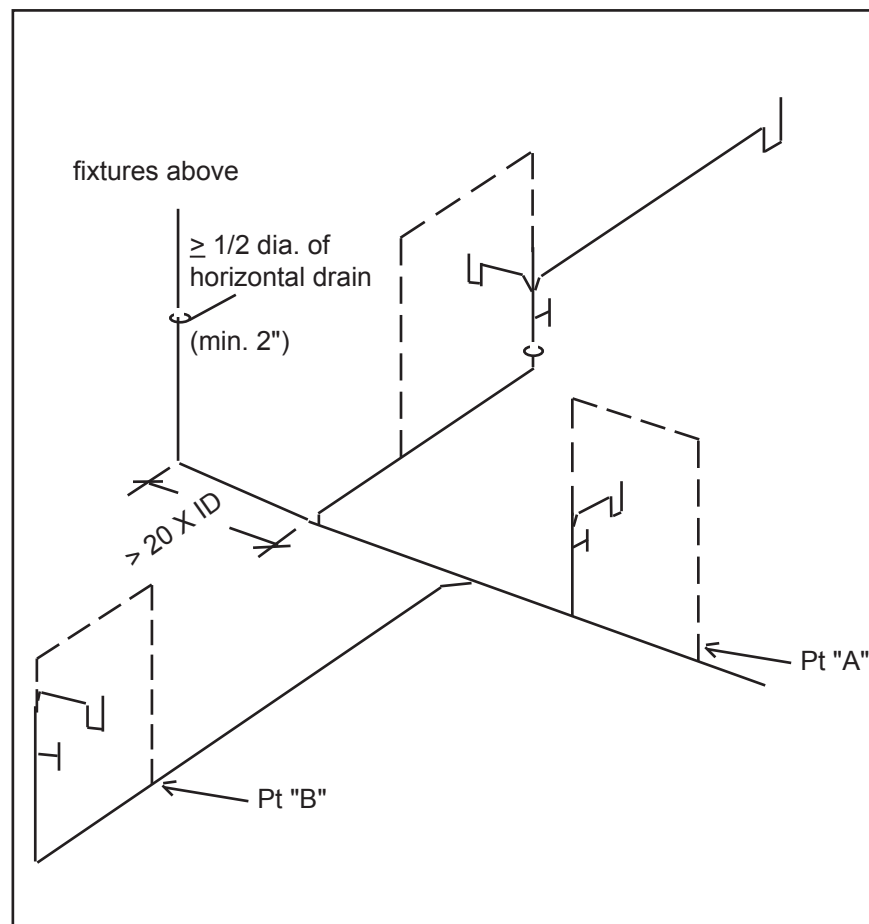


Figure 82. Laboratory sink combination drain and vent sizing

Vent piping for boiler blowoff basins may not connect to the sanitary, storm, or chemical venting system.

Vent piping for a chemical waste system may not connect to the sanitary or storm vent system.

Vents serving steam operated sterilizers, cleansing, or degreasing equipment which normally discharge steam into a vent shall not connect to a sanitary, storm, or chemical venting system.

FOOTNOTES

1 - The Engineered Design of Building Drainage Systems. J A Swaffield & L S Galowin. 1992. Ashgate Publishing Limited.

Comm 82.31 (18)

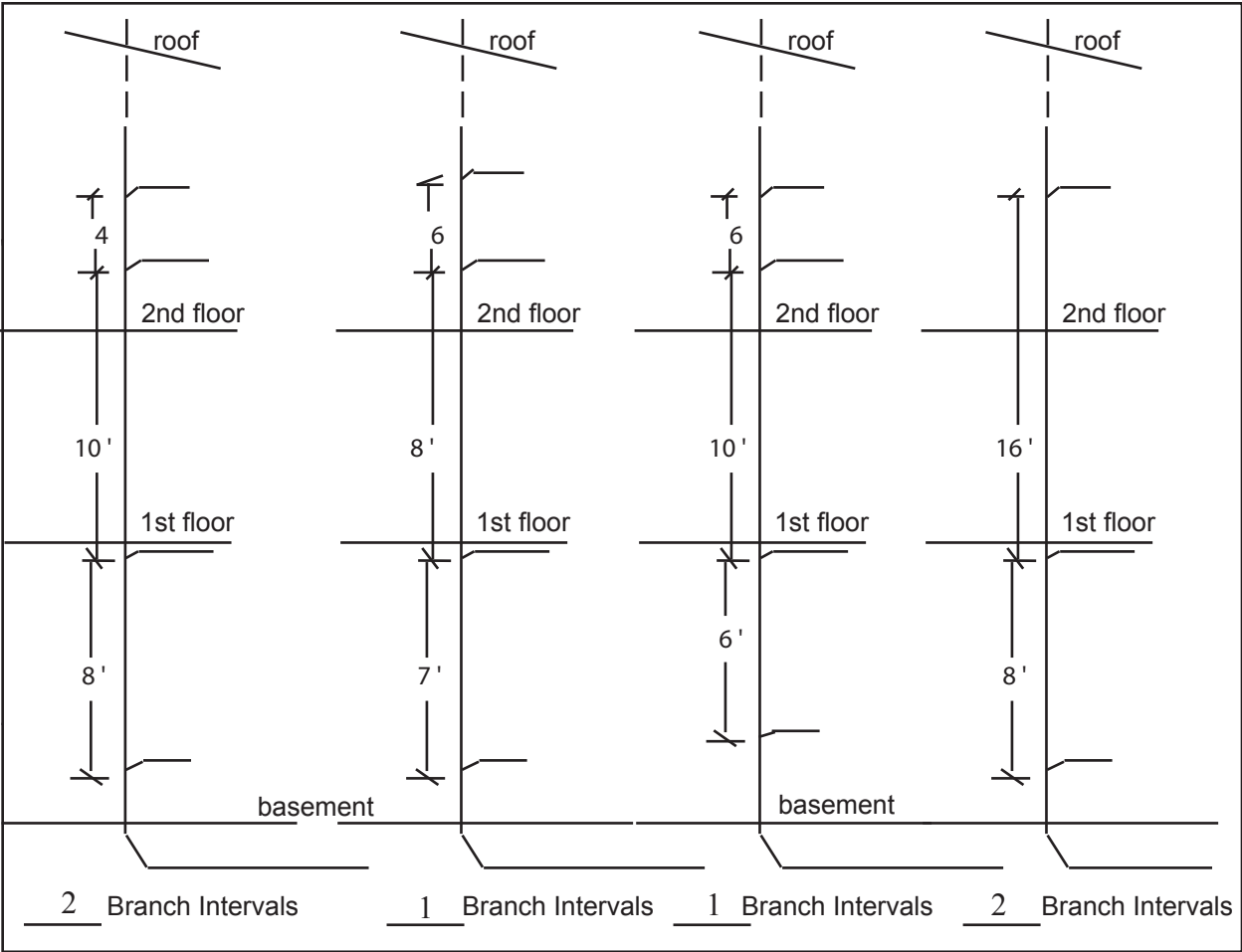
PROHIBITED USES. A vent or vent system shall not be used for purposes other than the venting of the plumbing system.

(a) Boiler blowoff basin vents. Vent piping from boiler blowoff basins shall not be connected to a vent or vent system serving a sanitary drain system, storm drain system or chemical waste system.

(b) Chemical waste vents. Vent piping for chemical waste systems shall not be connected to a vent system serving a sanitary drain system or storm drain system.

(c) Steam vents. Vents serving steam operated sterilizers, cleansing or degreasing equipment, pressing machines or any other apparatus which normally discharges steam into the vent shall not be connected to a vent or a vent system serving a sanitary drain system, storm drain system or chemical waste system.

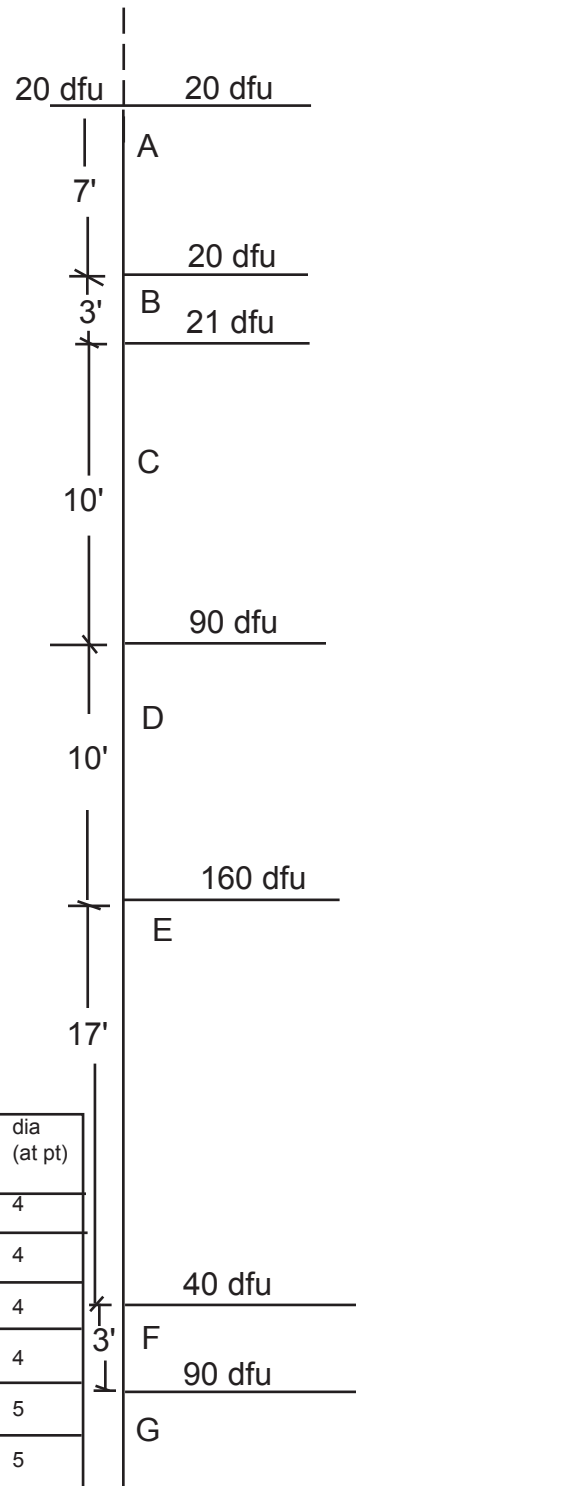
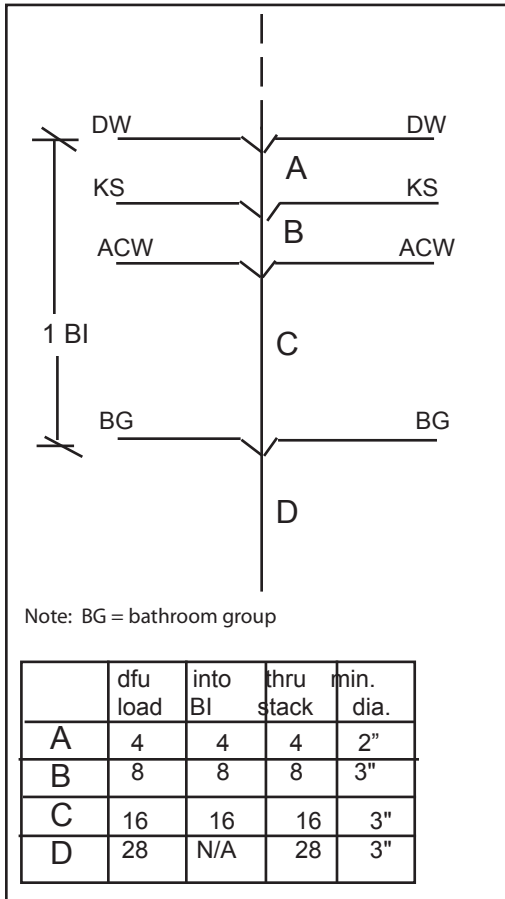
APPENDIX



Answers to figure 7 worksheet. Measuring Branch Intervals.

Stack Sizing Problems

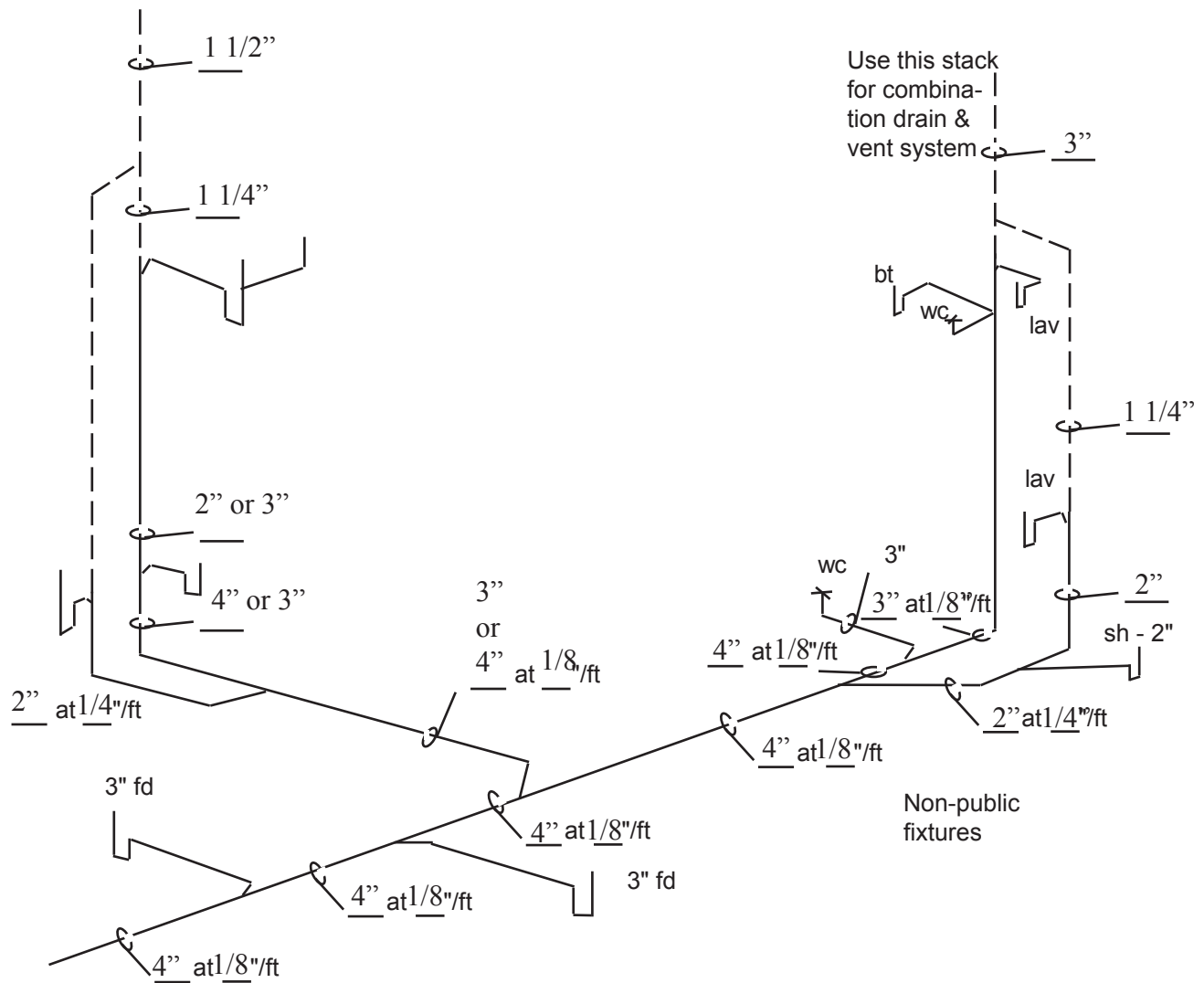
Answers to page 16



Point	min. branch dia.*	dfu into BI	dia due to dfu into	dfu thru stack	dia due to stack dfu	dia due to 1/2 base	dia (at pt)
A	3	40	4	40	4	3	4
B	3	60	3	60	4	3	4
C	4	21	4	81	4	3	4
D	4	90	4	171	4	3	4
E	4	160	5	331	4	3	5
F	4	N/A	4	371	4	3	5
G	4	N/A	4	421	4	3	5

* This column refers to any horizontal branch drain above the point designated.

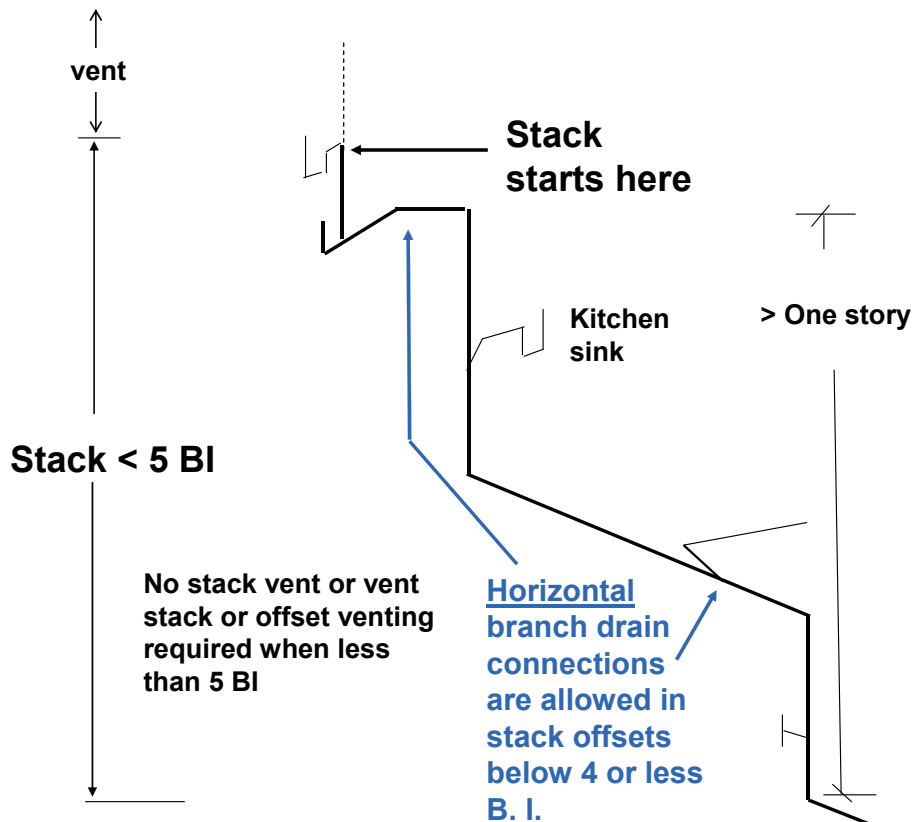
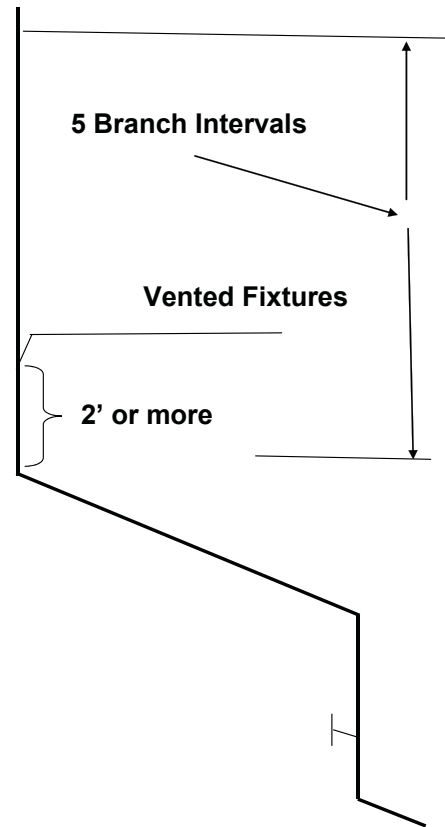
Answers to Figure 80, page 70.



New code change

Comm 82.30 (6) (c)

Exemption. Where an offset is located two or more feet below the lowest branch drain connection to the stack, the venting specified in this subsection and 82.31 (5)(b) is **not required**.



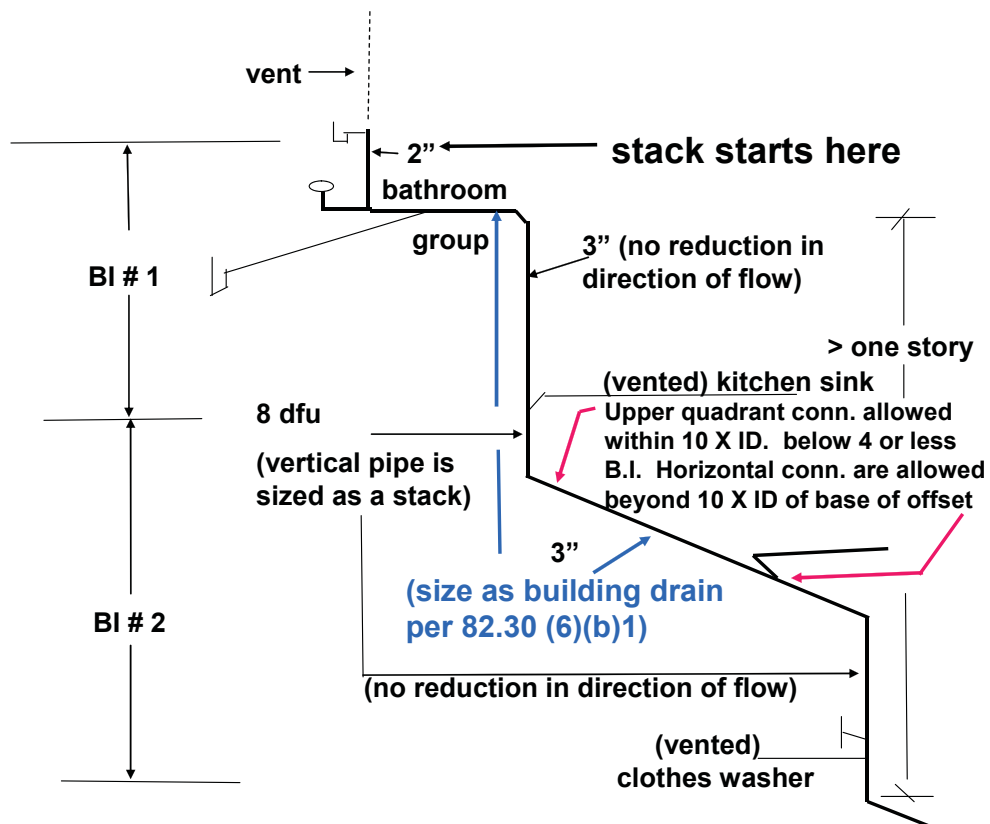
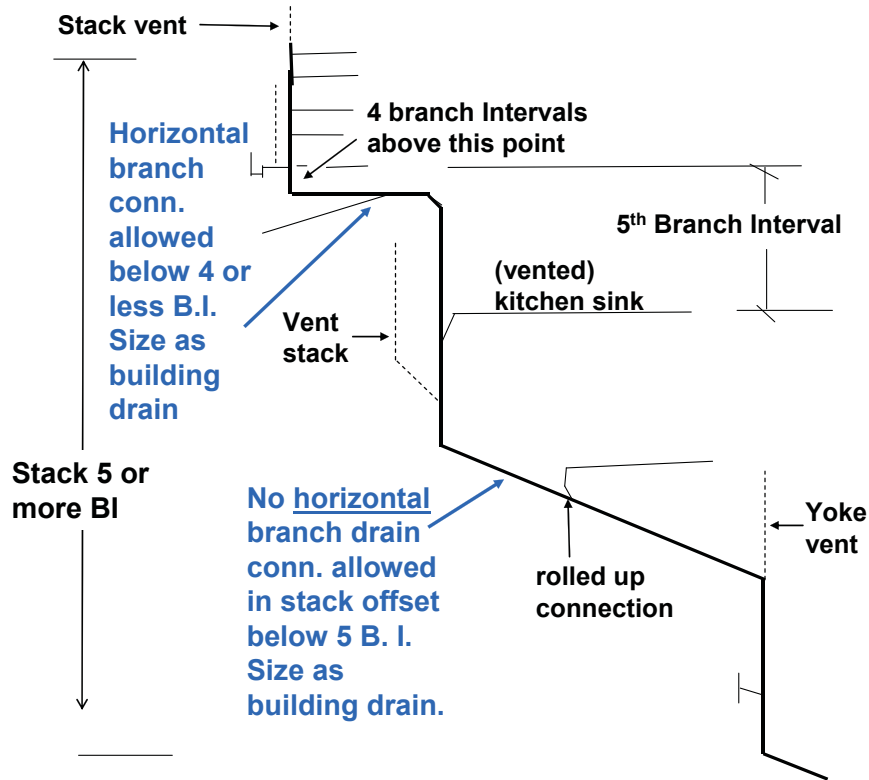
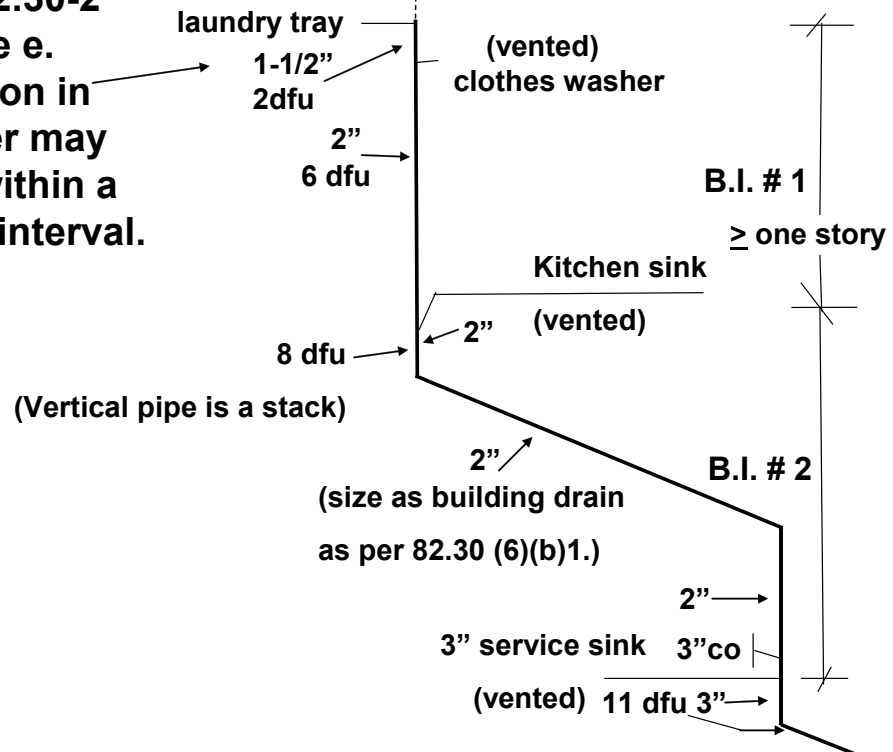


**Table 82.30-2
footnote e.**

**Reduction in
diameter may
occur within a
branch interval.**



**e. Reduction in diameter may
occur within a branch interval.**

