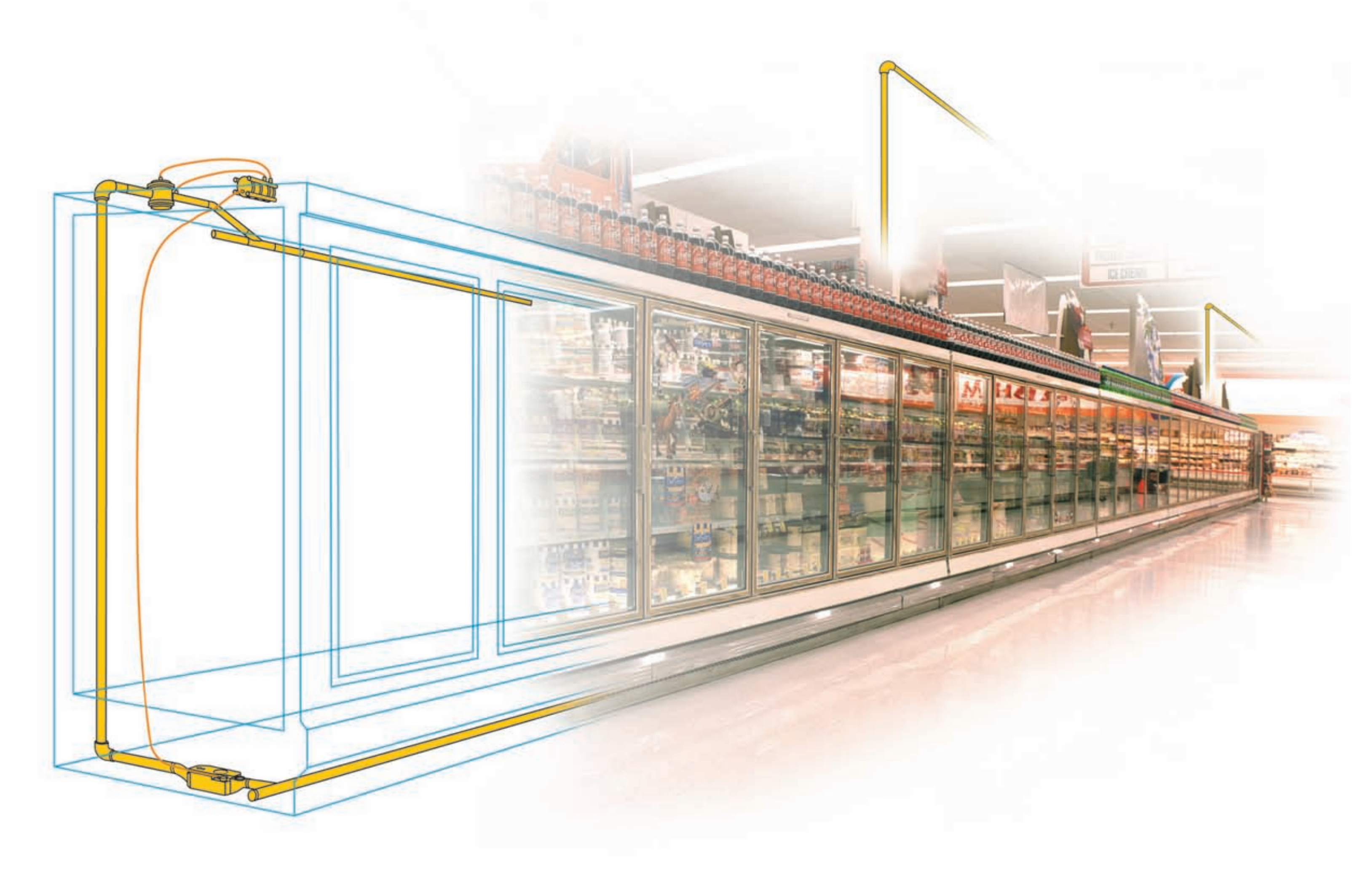
Design Manual for Supermarkets



AcornVac® Inc.

VACUUM PLUMBING SYSTEM

Rev. Aug 8, 2007

Subsidiary of Acorn Engineering Company

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Introduction

The AcornVac Vacuum Condensate and Grey Water Collection System provides drainage of condensate and grey water through overhead vacuum piping in lieu of under floor gravity piping. By eliminating or reducing the need for floor drains and under floor piping, a store has complete planning flexibility in new construction as well as flexibility to add or relocate cases and fixtures with less disruption to daily store operation, and less loss of revenue during remodeling.

The system uses differential air pressure to transport waste and consists of four primary components:

- *Vacuum Center*
  The Vacuum Center creates and maintains vacuum pressure within the system and discharges waste to sewer mains.
- *Vacuum Piping Network*
  The vacuum piping network transports the waste from cases or fixtures to the Vacuum Center.
- *Extraction Valve and Controller*
  The Extraction Valve is designed to maintain integrity between the negative pressures in the vacuum piping network and the surrounding atmosphere. The Controller activates the Extraction Valve in response to increased water level in the Accumulator.
- *Accumulator*
  The Accumulator provides a point of collection for condensate from cases and grey water from sinks.

Operation

Waste is transported through the system for discharge into sewer mains as follows:

- Vacuum is created and maintained by the vacuum pumps at the Vac Center. The vacuum pressure is held within the system by the normally closed Extraction Valve.
- Condensate from cases and grey water from sinks flow by gravity into an Accumulator.
- As the Accumulator fills, the Controller senses the rising water level and activates the Extraction Valve allowing the waste to be moved from the Accumulator to the Vacuum Center collection tanks through the vacuum piping network.
- When a Vacuum Center collection tank is sufficiently full, the Vacuum Center control system automatically discharges the collected waste to the sewer main.

This guide is intended to provide a set of general guidelines for the design and installation of the AcornVac Vacuum Plumbing equipment.
All installation should be made in compliance with local plumbing codes.
AcornVac assumes no responsibility for void or superceded data.

Details regarding design and installation of AcornVac vacuum plumbing systems can be found in the following sections:

- **Section 2 - Vacuum Center**

The Vacuum Center includes pumps, collection tanks, electrical control panel, valves and fittings necessary to provide a fully integrated automatic system. Dual tanks and multiple pumps ensure redundancy.

The Vacuum Center is typically located in the back of the store in a mechanical room, stock room, or on a mezzanine.

Vacuum Piping Network
Condensate and grey water are transported from the Accumulator to the Vacuum Center for discharge into sewer lines through the vacuum piping network. The vacuum piping network includes Lifts and horizontal overhead piping.

- **Section 3 - Lifts**

Lifts connect Accumulators to the overhead piping network. They are typically located near existing support columns or within false columns.

The Extraction Valve and Controller are integral components of the Lift. The Extraction Valve is located in a suitable position within the Lift and the Controller is typically located on top of the case or other accessible location.

- **Section 4 - Horizontal Overhead Piping**

The overhead horizontal piping network is typically located above a dropped ceiling or near roof joists, and runs to the Vacuum Center.

The vacuum piping network is typically provided and installed by a plumbing contractor in accordance with guidelines as specified in this manual *(and in compliance with local building codes.)*

- **Section 5 - Accumulators**

Accumulators are a temporary storage vessel for condensate or grey water. They are typically installed in a concealed area close to the case or fixture so that waste flows into the Accumulator by means of gravity.

The Accumulator includes an integral water level sensor which is monitored by the Controller. When the level in the Accumulator reaches a pre-set height, the Controller activates the Extraction Valve allowing the waste to move into the vacuum piping network.

- **Section 6 - System Bracing Guidelines**

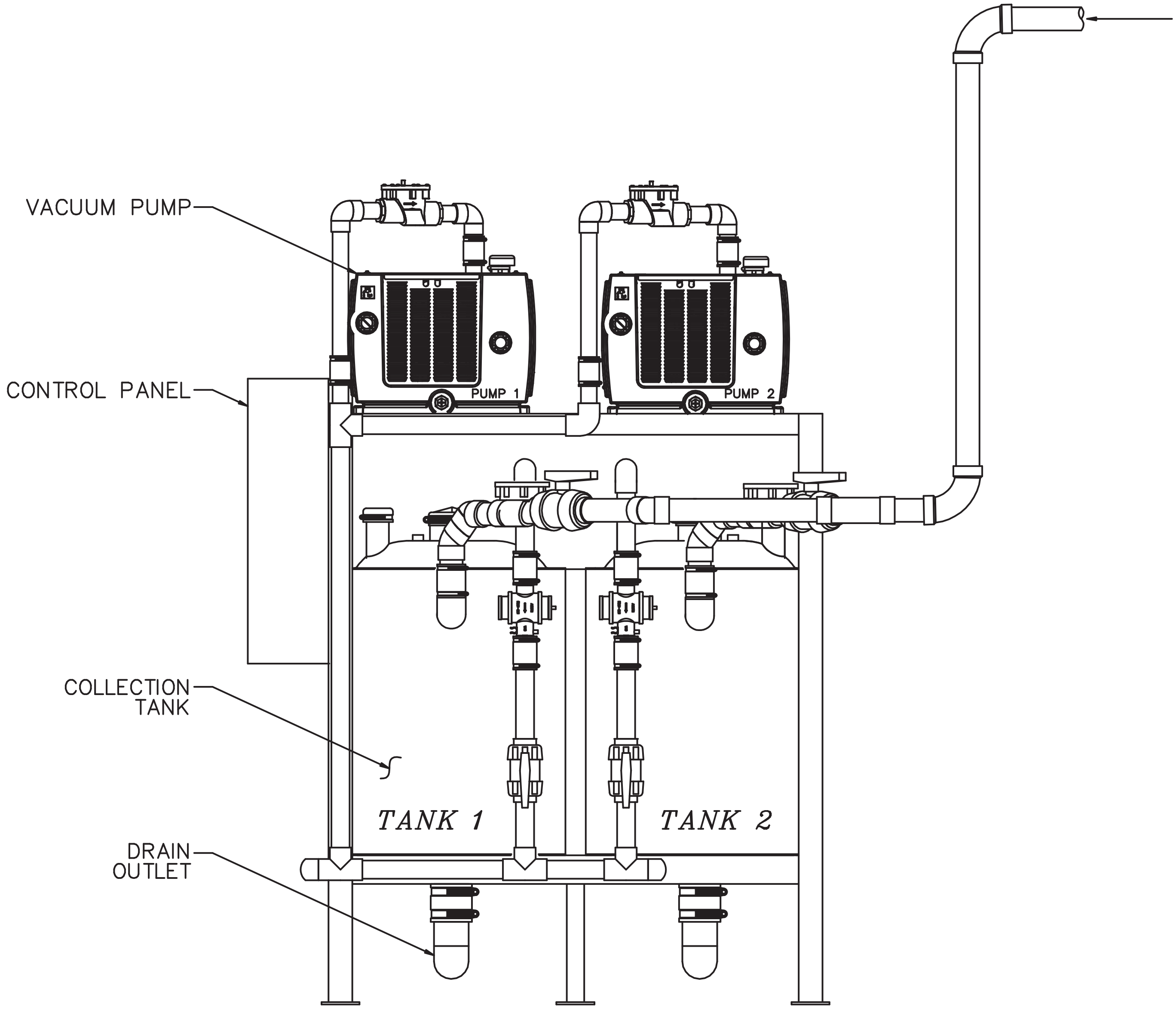


FIG. 1

TYPICAL VACUUM CENTER

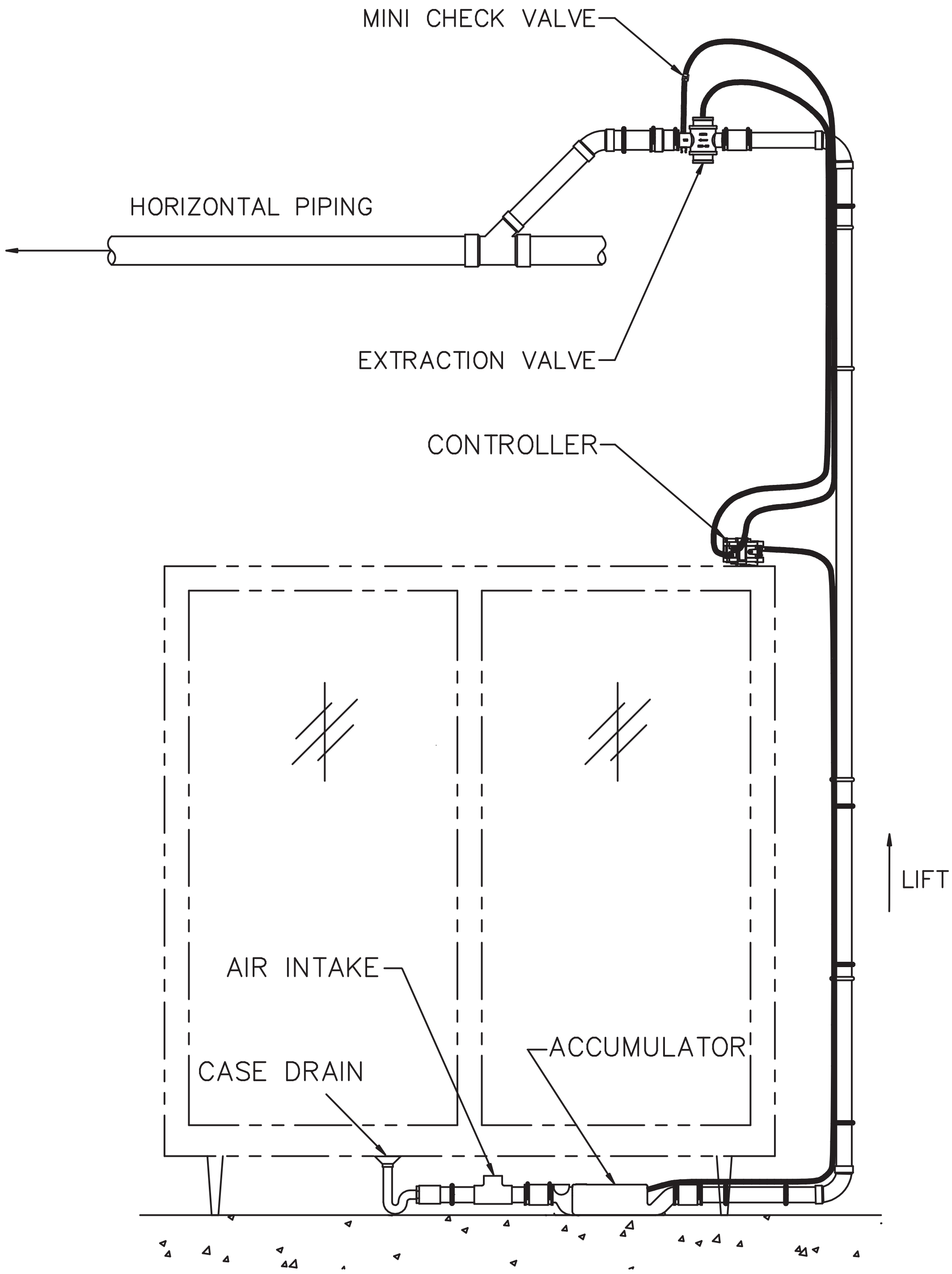


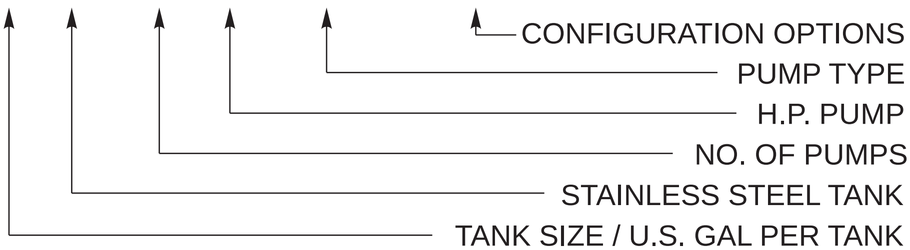
FIG. 2

TYPICAL CASE AND COMPONENT ARRANGEMENT

The AcornVac Vacuum Center is a pre-packaged and factory tested system designed to serve the vacuum plumbing network. The Vacuum Center requires connections to the vacuum piping network, gravity drain, and electrical power source to make the system operational. All processes of the system such as vacuum regulation, tank drainage, pump sequencing, pump alternation, alarm processing, and historical data collection are fully automated.

VACUUM CENTER MODEL NUMBERS & DESCRIPTIONS

AV - 30 S - 2 . 2 - LR - XXX



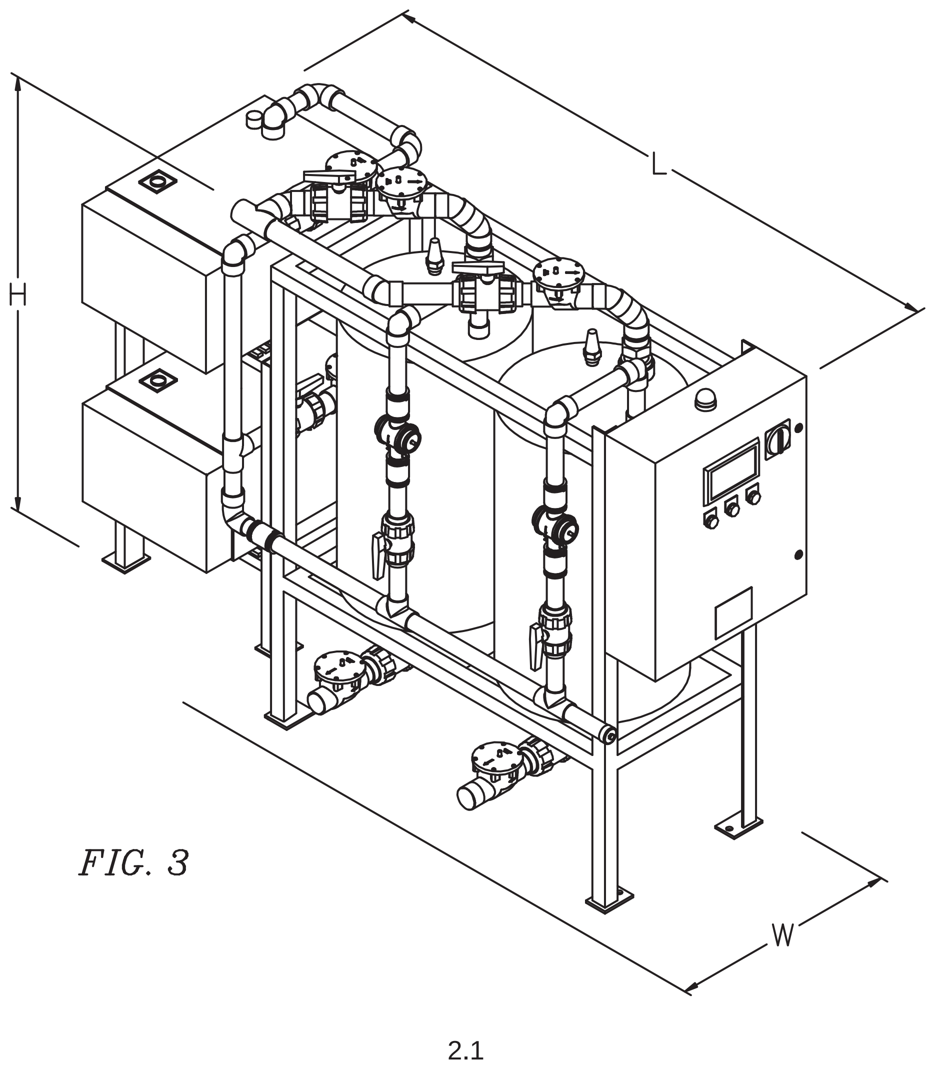


FIG. 3

VACUUM CENTER WEIGHTS, MEASURES, AND SERVICE AMP REQUIREMENTS

	Pumps		Full Load Amperes[1&2]		Weights		Overall Dimensions		
Simplex Systems	Qty	HP[3]	200-275V	345-480V	Dry	Wet	H	W	L
AV-20S-1.2-LR(BV)	1	1.5	8.3	4.7	200 lbs (91 kg)	375 lbs (170 kg)	59 in (1499 mm)	20 in (508 mm)	23 in (584 mm)
AV-30S-1.2-LR-STK	1	2	8.3	4.7	400 lbs (182 kg)	750 lbs (340 kg)	83 in (2108 mm)	33 in (838 mm)	37 in (940 mm)
AV-30S-1.2-LR-STK-MOB	1	2	8.3	4.7	400 lbs (182 kg)	750 lbs (340 kg)	71 in (1803 mm)	31 in (788 mm)	43 in (1092 mm)
AV-30S-1.3-LR-STK	1	3	10.7	6.1	437 lbs (199 kg)	871 lbs (170 kg)	85 in (2159 mm)	24 in (610 mm)	39 in (991 mm)
Duplex and Triplex Systems									
AV-30S-2.2-LR	2	2	15.4	8.8	640 lbs (291 kg)	1300 lbs (590 kg)	95 in (2413 mm)	34 in (864 mm)	64 in (1626 mm)
AV-30S-2.2-LR-STK	2	2	15.4	8.8	700 lbs (317 kg)	1365 lbs (635 kg)	84 in (2134 mm)	34 in (864 mm)	60 in (1524 mm)
AV-30S-2.3-LR	2	3	20.2	11.6	750 lbs (341 kg)	1450 lbs (658 kg)	95 in (2413 mm)	34 in (864 mm)	64 in (1626 mm)
AV-30S-2.3-LR-STK	2	3	20.2	11.6	800 lbs (363 kg)	1667 lbs (756 kg)	85 in (2159 mm)	34 in (864 mm)	60 in (1524 mm)
AV-60S-2.3-LR	2	3	20.2	11.6	978 lbs (444 kg)	2000 lbs (908 kg)	80 in (2032 mm)	37 in (940 mm)	102 in (2591 mm)
AV-60S-2.3-LR-STK	2	3	20.2	11.6	854 lbs (388 kg)	2221 lbs (1006 kg)	90 in (2286 mm)	35 in (889 mm)	60 in (1524 mm)
AV-60S-2.5-LR	2	5	34.4	19.8	1178 lbs (535 kg)	2206 lbs (1000 kg)	80 in (2032 mm)	37 in (940 mm)	102 in (2591 mm)
AV-60S-2.5-LR-STK	2	5	34.4	19.8	950 lbs (431 kg)	2317 lbs (1051 kg)	90 in (2286 mm)	36 in (914 mm)	60 in (1524 mm)
AV-60S-3.3-LR-STK	3	3	29.7	17.1	1125 lbs (511 kg)	2675 lbs (1214 kg)	90 in (2286 mm)	35 in (889 mm)	91 in (2311 mm)
AV-60S-3.5-LR-STK	3	5	51.0	29.4	1250 lbs (567 kg)	2800 lbs (1270 kg)	90 in (2286 mm)	35 in (889 mm)	91 in (2311 mm)
AV-60S-2.10-LR	2	10	56.2[4]	33.2[4]	1525 lbs (692 kg)	3440 lbs (1561 kg)	79 in (2006 mm)	44 in (1118 mm)	111 in (2819 mm)
AV-100S-2.5-LR	2	5	34.4	19.8	1350 lbs (613 kg)	3320 lbs (1506 kg)	98 in (2489 mm)	39 in (991 mm)	102 in (2591 mm)
AV-100S-3.5-LR	3	5	51.0	29.4	1620 lbs (735 kg)	3720 lbs (1688 kg)	108 in (2743 mm)	39 in (991 mm)	102 in (2591 mm)
AV-100S-2.10-LR	2	10	56.2[4]	33.2[4]	1870 lbs (849 kg)	4460 lbs (2023 kg)	98 in (2489 mm)	44 in (1118 mm)	111 in (2819 mm)

Note 1: *The Full Load Ampere data represents values that the Vac Center system will draw under normal operating conditions. The electrical service provided for the Vac Center must be sized in accordance with the latest edition of all National and Local Code requirements.*
Note 2: *50Hz Voltages are 200-240 and 345-415 respectively.*
Note 3: *Horsepower ratings are nominal.*
Note 4: *10HP 60Hz System voltages are 220-275 and 380-480 respectively.*
Note 5: *Ambient temperature at Vac Center must not exceed 104° F (40° C).*
Note 6: *Contact factory for applications above 3300 Ft. (1000 M) elevation.*
Note 7: *This information is provided for reference only and is subject to change without notice.*

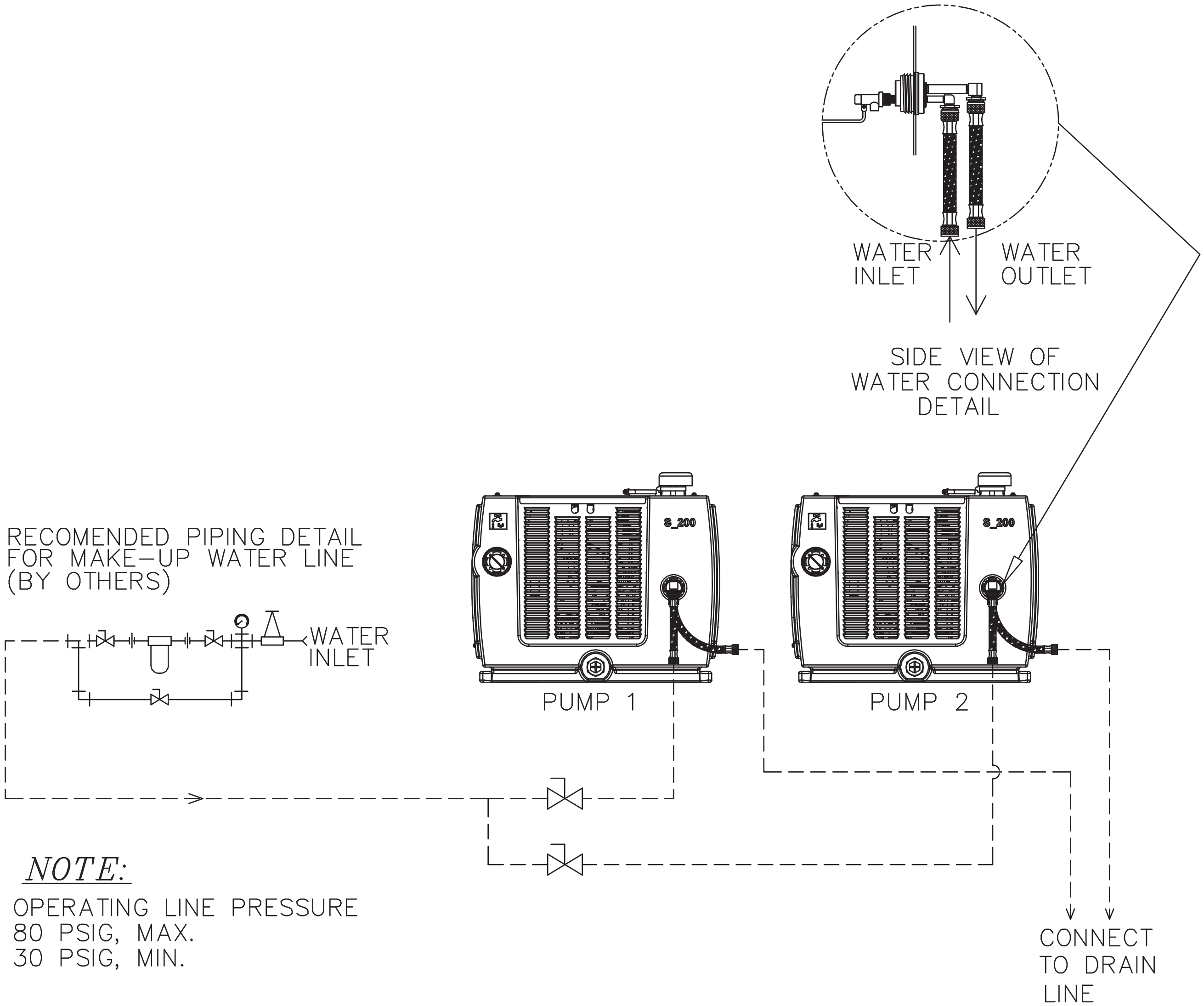


FIG. 4

RECOMMENDED PIPING DETAIL
FOR MAKE-UP WATERLINE (BY OTHERS)

VACUUM CENTER SIZING GUIDELINES

Lift points, water flow, and type of equipment determine the size of your AcornVac Vacuum Center. These guidelines are provided as general information for estimating Vacuum Center size based on typical drainage requirements. Please contact AcornVac or your local representative for additional information if the equipment or facility drainage requirements are not covered in these guidelines.

Sizing Factors
Calculate the total load requirement by adding the total point value for all equipment requiring vacuum drainage. Some types of equipment have higher volume drainage requirements and add a greater number of points. See the following table:

Item	Total Qty	Load Factor		Total Load Point Value *
1. Refrigerated cases and refrigeration coils	______	Divide by 2.5	=	______
2. Hand sinks	______	Multiply by 1.0	=	______
3. Misting systems	______	Multiply by 1.0	=	______
4. Floor drains, including trench drains	______	Multiply by 5	=	______
5. Prep sinks	______	Multiply by 10	=	______
		Total Lift Point Value =		______

**Note: Always round up to the next whole point when calculating total load point values*

Calculating Size
Add the total value for each type of equipment to find the appropriate Vacuum Center size in the Selection Table below.

Example:
Store requires vacuum drainage for the following equipment:

• 57 refrigerated and frozen food cases	(57)	Divided by 2.5	=	22.8 = 23
• 2 misting systems	(2)	Multiply by 1.0	=	2
• 1 prep sink	(1)	Multiply by 10	=	10
• 2 floor drains	(2)	Multiply by 5	=	10
		Total Lift Point Value =		45

In this example, the total load point value is 45, which would recommend the use of an
Acorn Vac Model AV-60S-2.3-LR-STK Vac Center

VAC CENTER SELECTION TABLE

Maximum Load Point Capacity	Vac Center Model	Maximum Multi-Bay Sinks
5	AV-20S-1.2-LR(BV) [1]	0
15	AV-30S-1.2-LR-STK [1 & 2]	0
20	AV-30S-1.3-LR-STK [1]	0
35	AV-30S-2.2-LR-STK	0
55	AV-30S-2.3-LR-STK	1
55	AV-60S-2.3-LR-STK	3
65	AV-60S-3.3-LR-STK	4
75	AV-60S-2.5-LR-STK or AV-100S-2.5-LR [4]	5
100	AV-60S-3.5-LR-STK or AV 100S-3.5-LR [4]	7
135	AV-60S-2.10-LR-STK or AV-100S-2.10-LR [4]	7

NOTES:

[1] State and Local code may require duplex pumps and tanks. If so, use AV-30S-2.2-LR-STK.

[2] Same Load Point capacity applies to AV-30S-1.2-LR-STK-MOB

[3] Contact Factory for Sizing approval on installations at or above 3,300 Ft. (1000 m)

[4] Use 100 Gallon Tank Size Systems for applications that cannot drain by gravity in 40 seconds or less.

Lifts connect Accumulators to overhead mains and branches leading to the Vacuum Center.

TYPICAL LIFT INSTALLATION

Under standard conditions, maximum allowable height is 25' (7.6 m). If higher Lifts are required, please consult the factory.

Lifts require PVC Schedule 40 pressure rated 1-1/2" (40 mm) pipe or other vacuum rated piping. Where PVC is not acceptable, 1-1/2" copper, Type M or higher piping is also acceptable.

Lifts should be located near walls or columns for support and must be braced per AcornVac requirements, (refer to Section 6 for details) using pipe clamps every 6' (1.8 m) minimum and at any change in direction.

Lifts must be connected to the Accumulator with one 1-1/2" DWV long sweep fitting or two PVC Schedule 80 45-degree elbows.

The change in direction toward horizontal at the top of the lift must be made with one 1-1/2" DWV long sweep fitting or two PVC Schedule 80 45-degree elbows.

The connection from a Lift to the horizontal main or branch **must always** be from above the centerline of the main or branch. This connection should be made via a wye fitting directed toward the Vacuum Center. The wye fitting may be rotated up to 45-degrees from vertical.

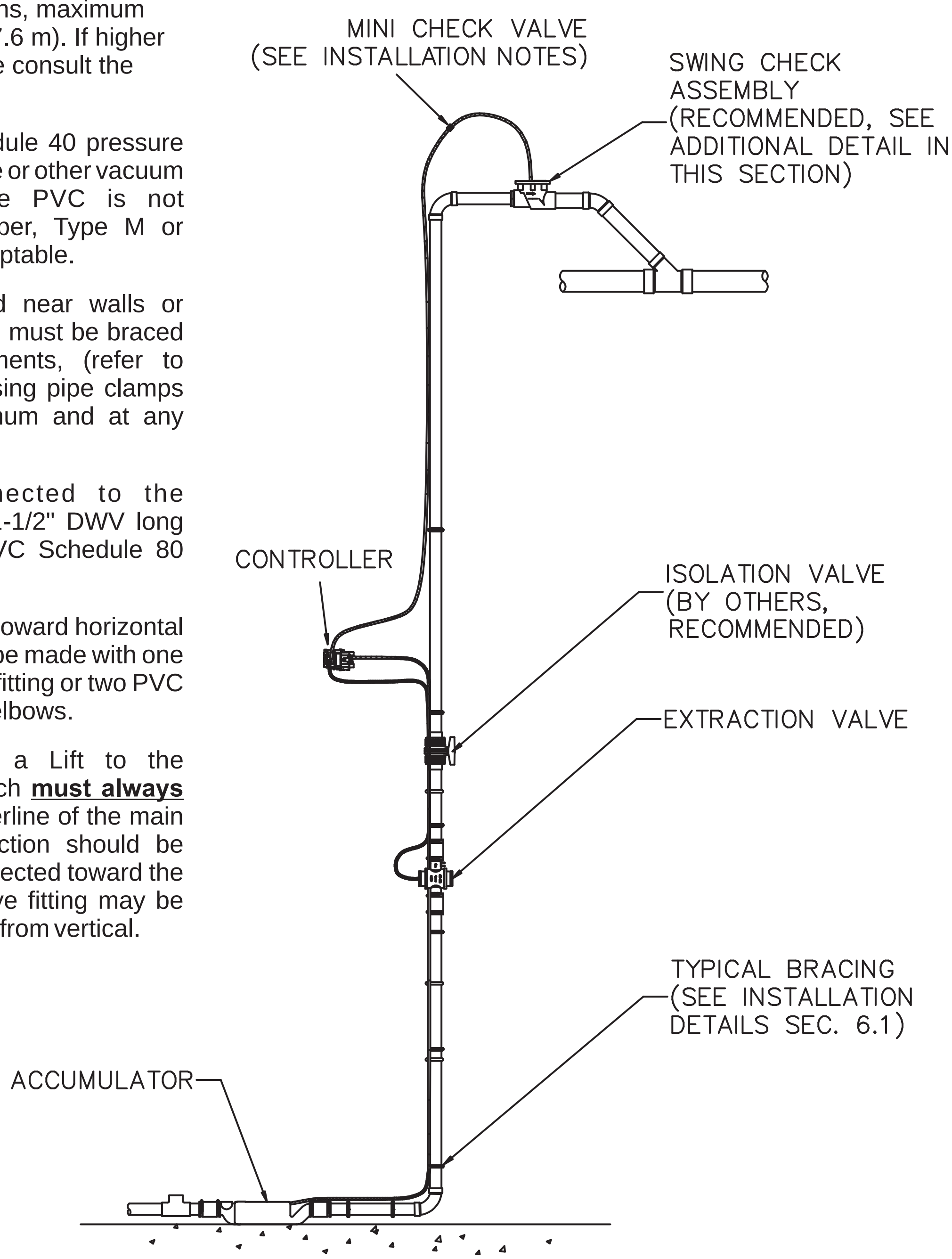


FIG. 5

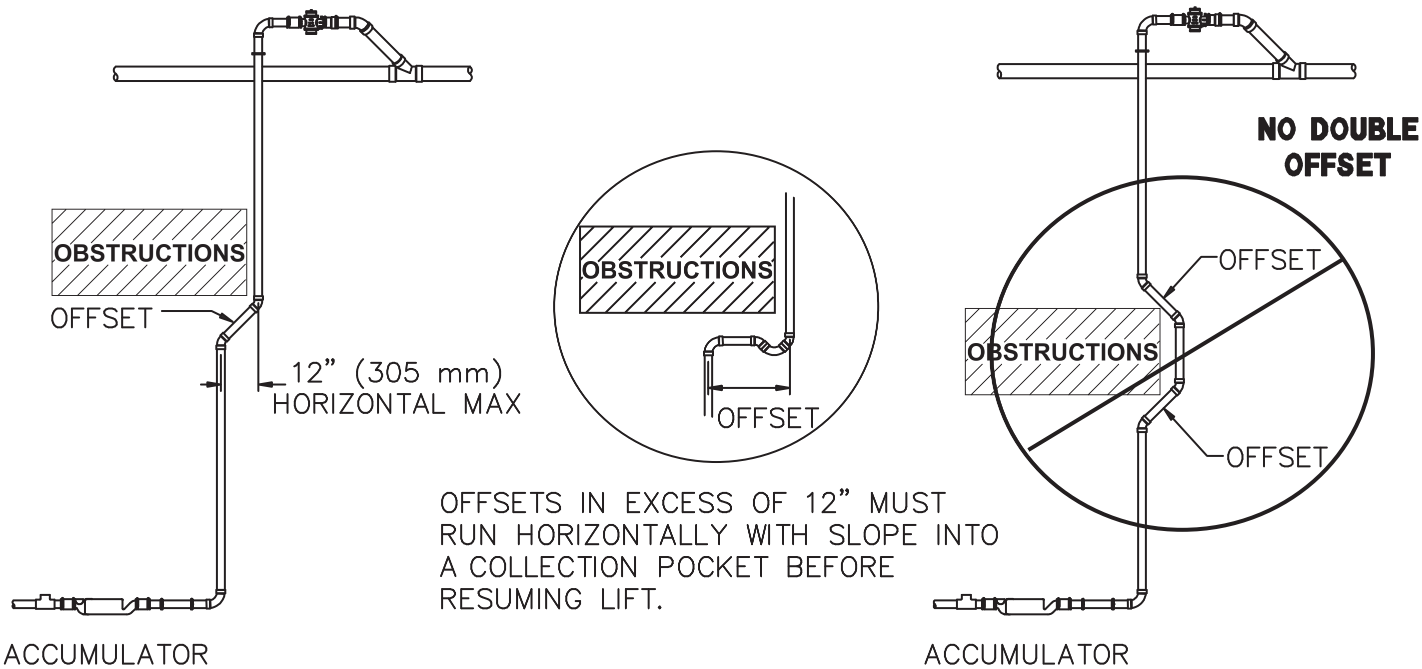


FIG. 6

OBSTRUCTIONS

Where obstructions in the path of a Lift occur, a single offset can be installed; however, it should not exceed 12" (305 mm) horizontally and the change in direction should be made with two PVC Schedule 80 45-degree elbow fittings or two DWV 1/8" bend fittings. Lifts may not include more than one offset and the Lift must be braced with appropriate hangers within 12" (305 mm) of each change of direction. Refer to bracing details, Section 6.

Note:
Where store layout and design will not allow for a Lift from an island style refrigerated case directly to the overhead piping network, gravity waste piping from the case may be installed in the same service trench containing electrical and refrigeration piping to a point where a Lift is acceptable. The gravity plumbing should terminate into an Accumulator.

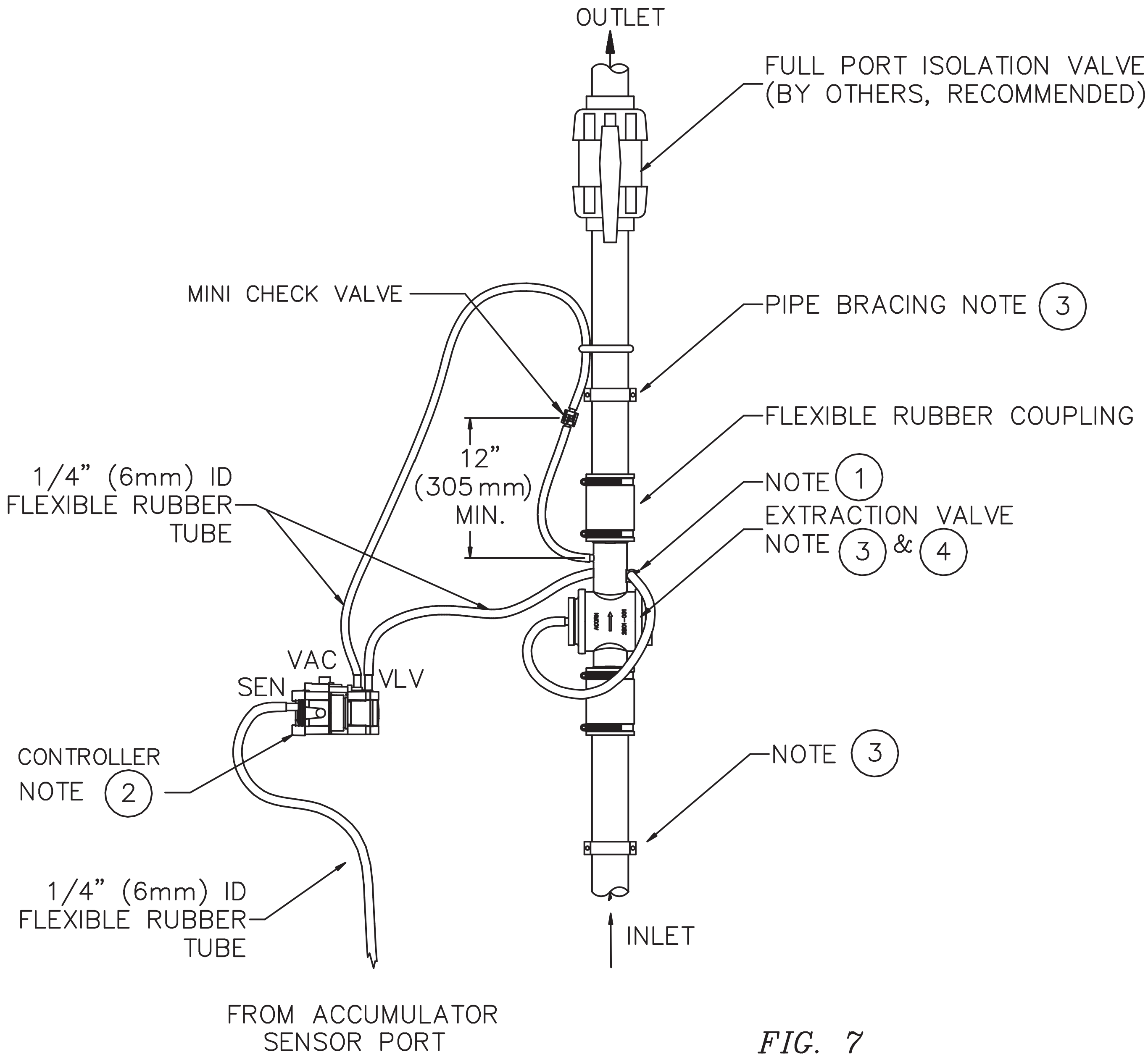


FIG. 7

CONTROLLER AND EXTRACTION VALVE INSTALLATION DETAIL

NOTE:

① Flexible rubber tube must be attached to Extraction Valve Clip.
② Controller must be installed in an accessible location.
③ Appropriate pipe bracing must be 12" (305 mm) away from Extraction Valve on both sides to allow coupling to slide freely. See Section 6.1.
④ Extraction Valve must be installed to allow for unobstructed movement.

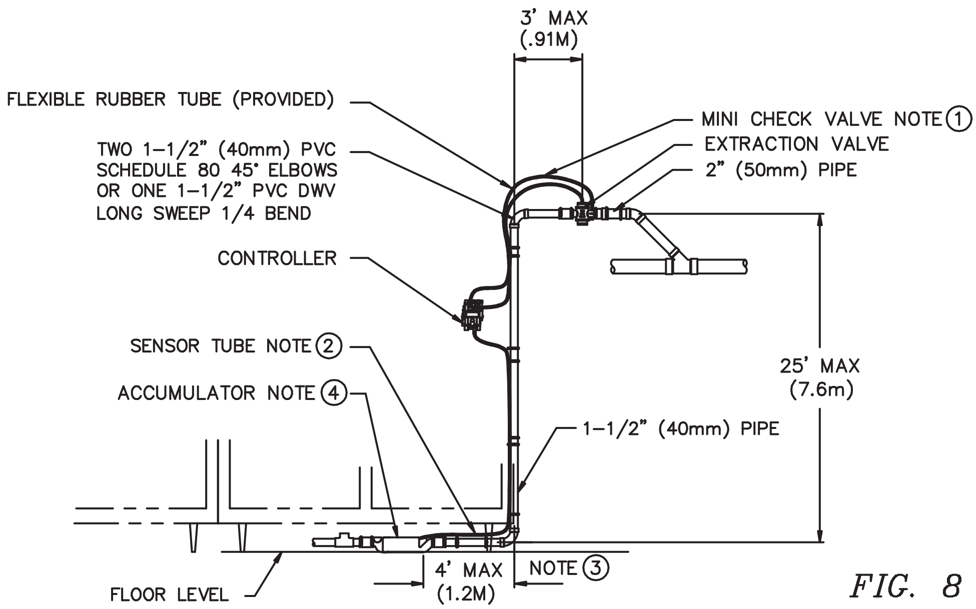


FIG. 8

LIFT WITH EXTRACTION VALVE IN THE HORIZONTAL

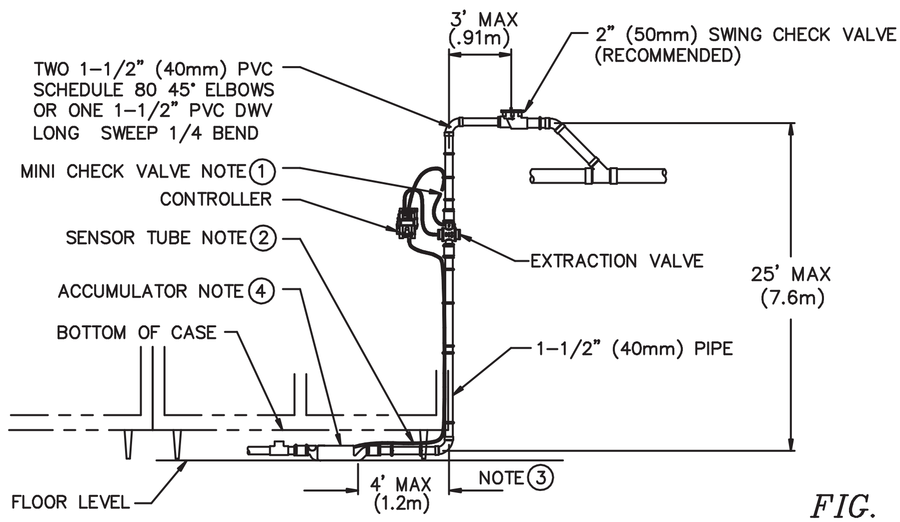


FIG. 9

LIFT WITH EXTRACTION VALVE IN THE VERTICAL

NOTE:

(1) MINI CHECK VALVE MUST BE 6" ABOVE VACUUM SOURCE PORT WHEN X-VALVE IS MOUNTED HORIZONTALLY, OR 12" ABOVE VACUUM SOURCE WHEN X-VALVE IS MOUNTED VERTICALLY. WHEN SWING CHECK VALVE IS USED FOR VACUUM SOURCE, MINI CHECK VALVE MUST BE 4" ABOVE VACUUM SOURCE PORT.

(2) THE CONNECTION FROM THE ACCUMULATOR SENSOR PORT TO THE CONTROLLER MUST NOT DIP BELOW TOP OF ACCUMULATOR OR CONTAIN ANY TRAPS.

(3) 48" MAXIMUM DEVELOPED LENGTH FROM DISCHARGE OF ACCUMULATOR TO VERTICAL LIFT. HORIZONTAL PIPING BETWEEN ACCUMULATOR AND LIFT CANNOT HAVE MORE THAN 2 OFFSETS AND 2 CHANGES OF DIRECTION.

(4) INSTALL ACCUMULATOR IN AN ACCESSIBLE LOCATION FOR SERVICE.

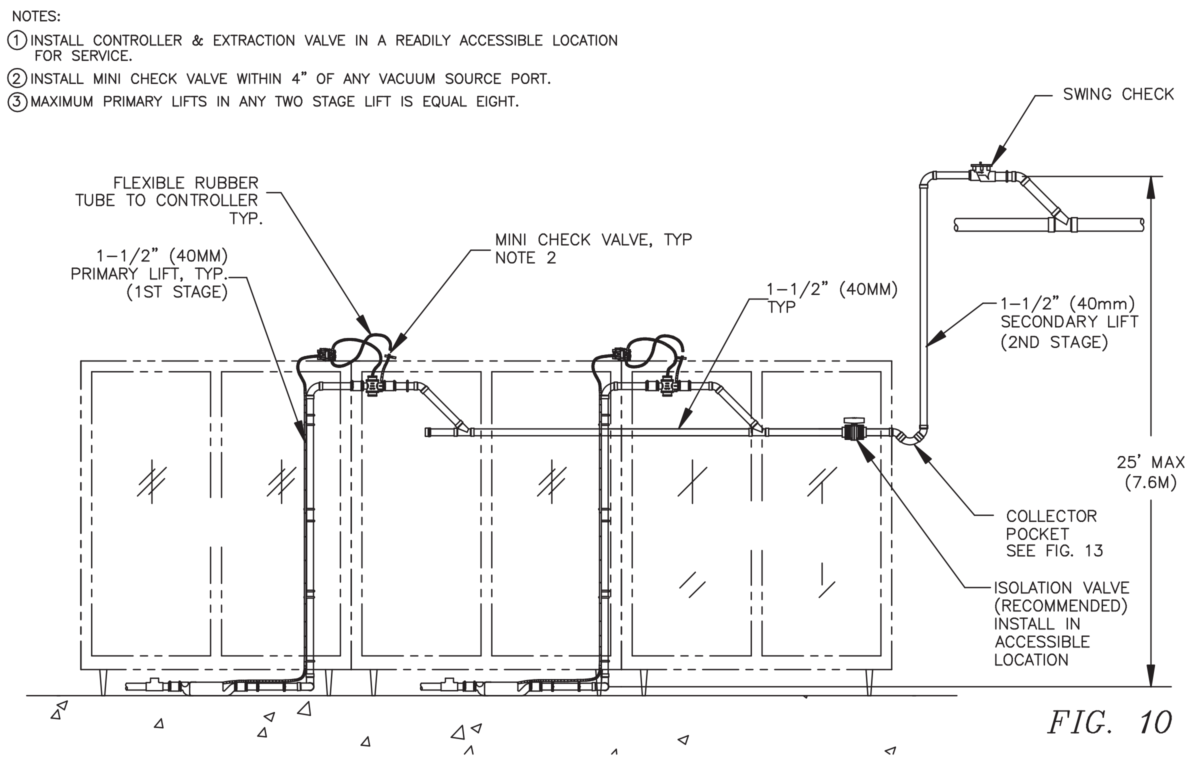


FIG. 10

TWO STAGE LIFT DETAIL

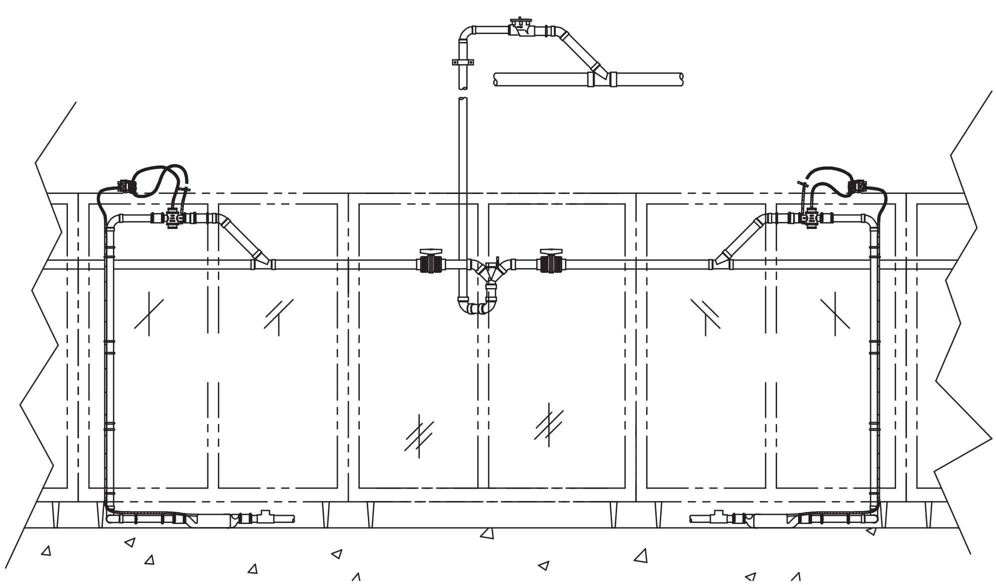


FIG. 11

ALTERNATIVE TWO STAGE LIFT ARRANGEMENT

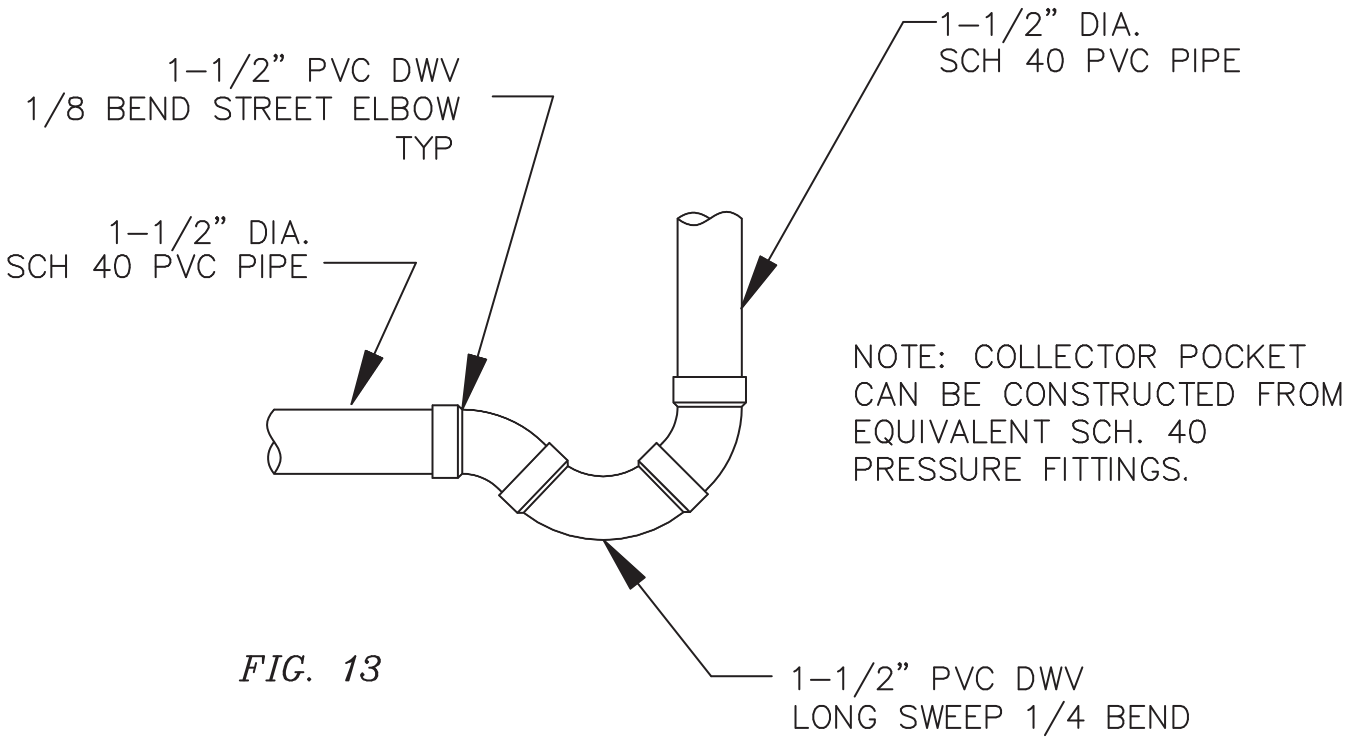


FIG. 13

COLLECTOR POCKET FOR TWO STAGE LIFT

The Horizontal Piping receives waste water from the Lifts and transports it to the Vacuum Center tanks. While the arrangement of the overhead piping network is unique for every installation, the following basic rules apply to the piping design and installation:

SLOPE & BRACING
The horizontal piping **must** be installed with a slope of 1/8" per 12" (1 mm per 100 mm) toward the Vacuum Center, and supported or braced every 6' (1.8 m) minimum and against thrust load at every change of direction. See additional bracing details in Section 6.

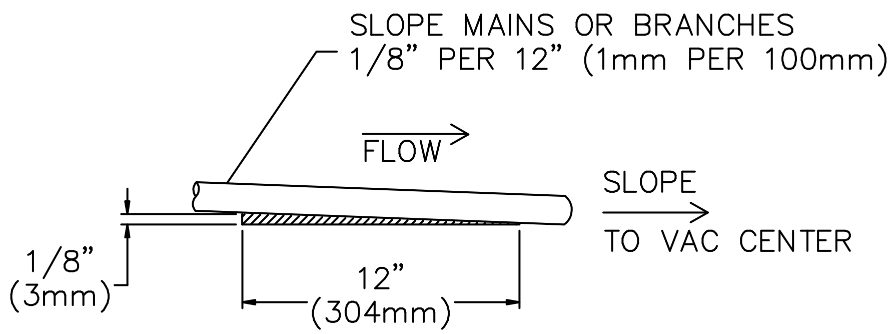


FIG. 14

SLOPE MAKE UP
The slope of the horizontal piping can be adjusted as shown in Fig. 15, as needed.

The diameter of the horizontal piping may be increased, but not decreased, in the direction of flow toward the Vacuum Center.

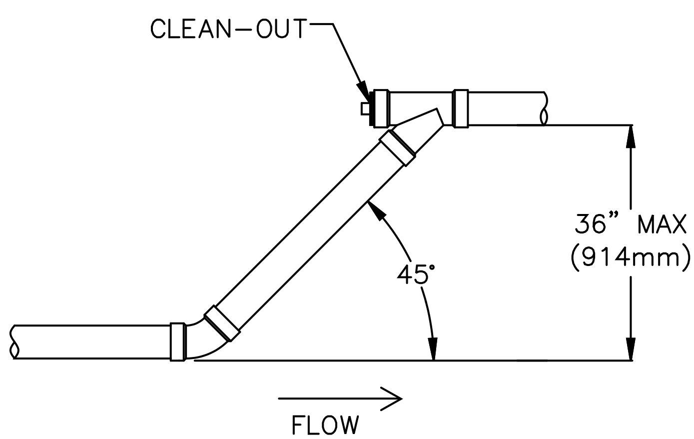


FIG. 15

HORIZONTAL DIRECTIONAL CHANGES
Horizontal piping should be installed in a straight path toward the Vacuum Center. Use a single long sweep DWV elbow or two 45 degree PVC Schedule 40 elbows for any 90 degree change in direction.

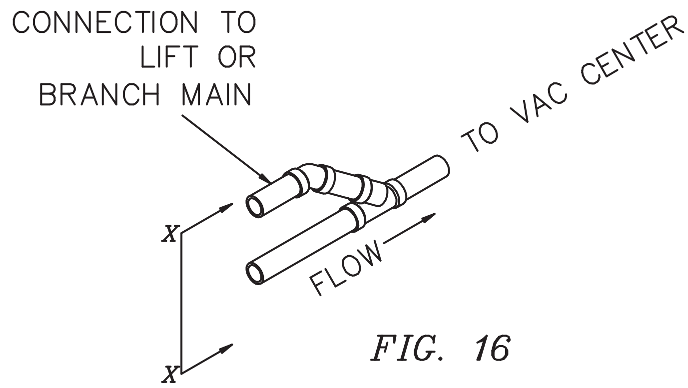
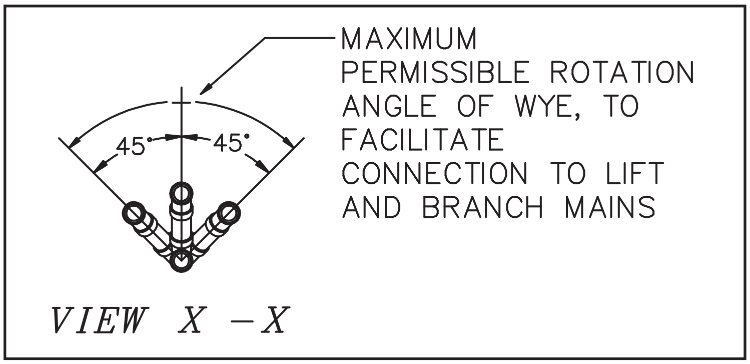


FIG. 16

BRANCHES
The horizontal piping should include a single main line to the Vacuum Center.

Branch from outlying locations should be tied to the main with a wye fitting installed in the direction of flow toward the Vacuum Center. The branch should be connected to the main from above. The wye may be rotated up to 45 degrees from vertical.



Leave a minimum of 3’ (.9 m) between the connection of the branch to any down stream elbows in vertical or horizontal piping.

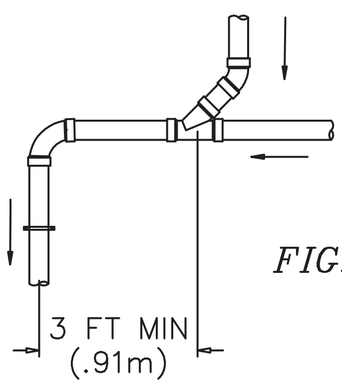


FIG. 17

OBSTRUCTIONS

Where an obstruction exists that cannot be accommodated with a standard slope makeup, an obstruction bypass can be used.

The piping installation should include a small collector pocket as illustrated below prior to its return to the original horizontal slope on the downstream side of the obstruction.

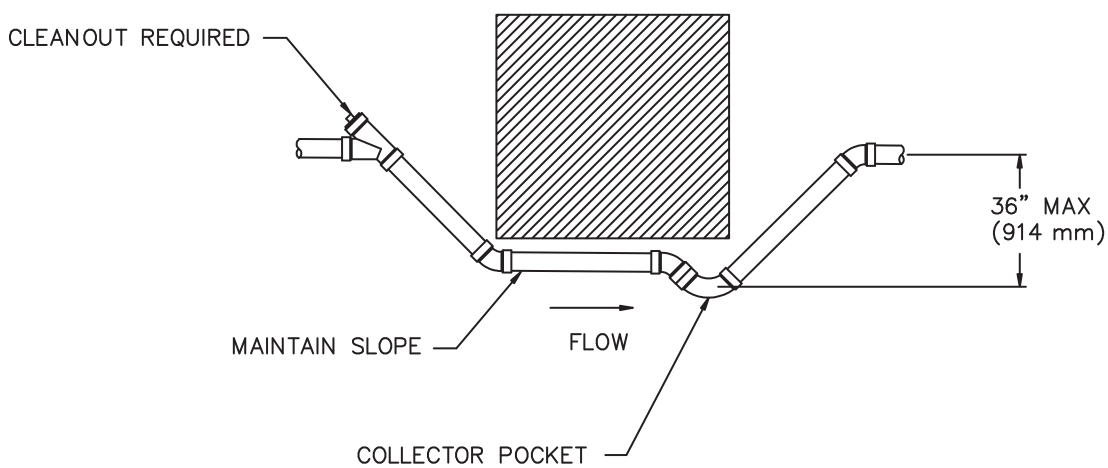
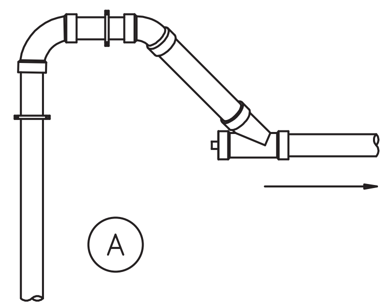
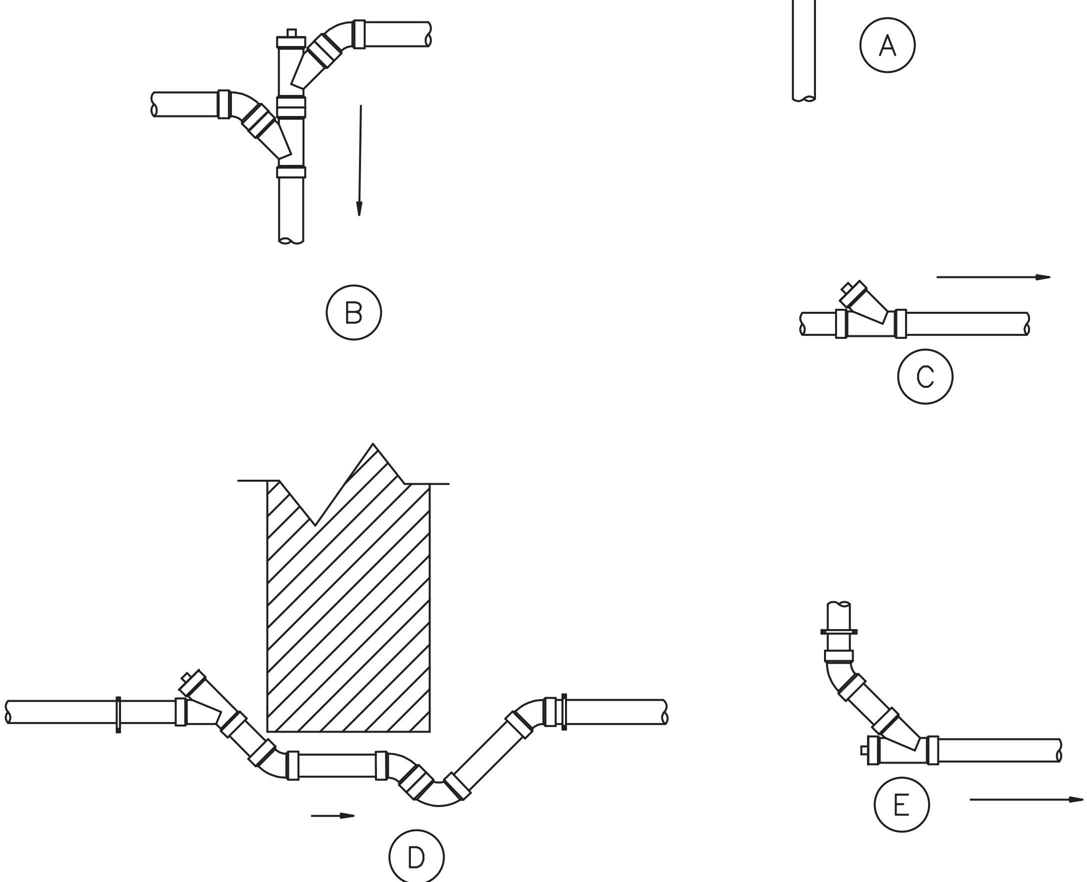


FIG. 18

CLEANOUTS
Cleanouts should be installed in such a way as to ensure that the piping can be reached at all points. The maximum distance between clean outs cannot exceed code requirements.

Ensure that all threaded joints are installed air tight.





Locations:
A. At the end of horizontal pipelines
B. At the upper end of vertical stacks
C. At maximum code intervals.
D. At change of location around obstruction
E. At 90 degree directional changes
in mains and branches.

FIG. 19

Note: See Appendix C for Overhead Pipe Sizing

TYPICAL ACCUMULATOR INSTALLATION DETAILS

1. Slope all horizontal piping (gravity or vacuum) 1/8" per 12" (1mm per 100mm) toward the Accumulator and away from it in the direction of the flow.
2. Use a single long sweep elbow or two 45 degree elbows for any 90 degree change in direction. Either DWV or **PVC Schedule 80 fittings may be used.**
3. Inside pipe surfaces and joints must be smooth and free of burrs.
4. Ensure that connection from the Accumulator sensor port to the Controller does not dip below top of Accumulator or contain any traps.

Note: See Appendix B for Accumulator Sizing

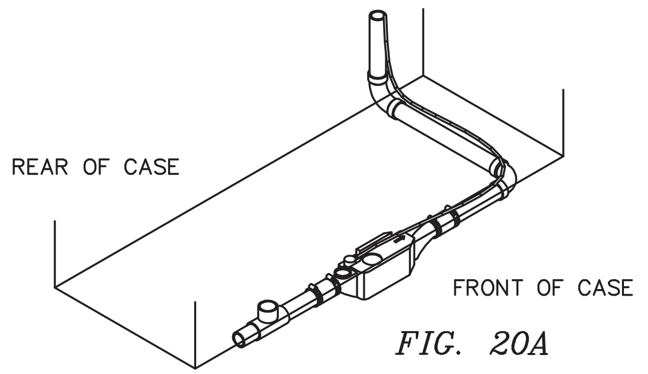


FIG. 20A

PIPE ROUTING FOR CASE INSTALLATION

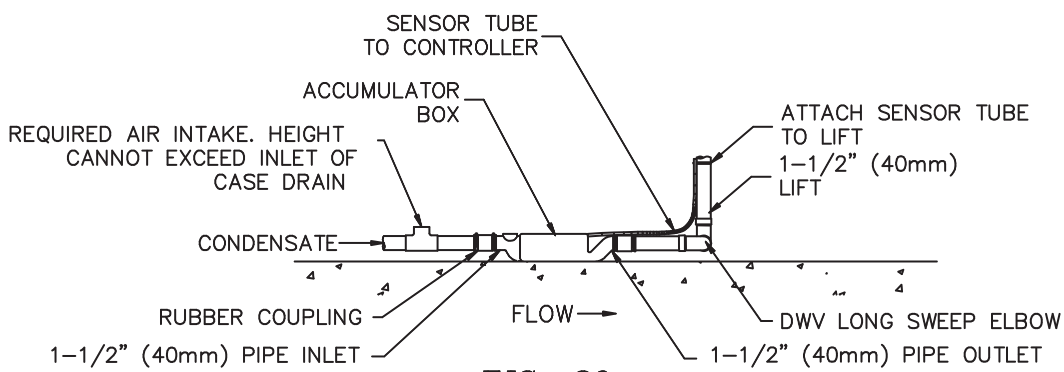


FIG. 20

TYPICAL ACCUMULATOR CONNECTION

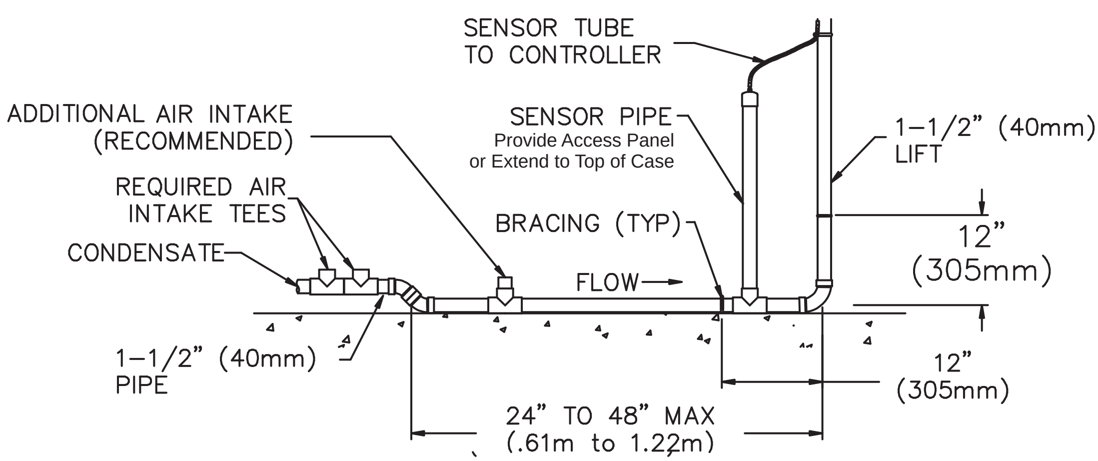


FIG. 21

TYPICAL PIPE ACCUMULATOR CONNECTION

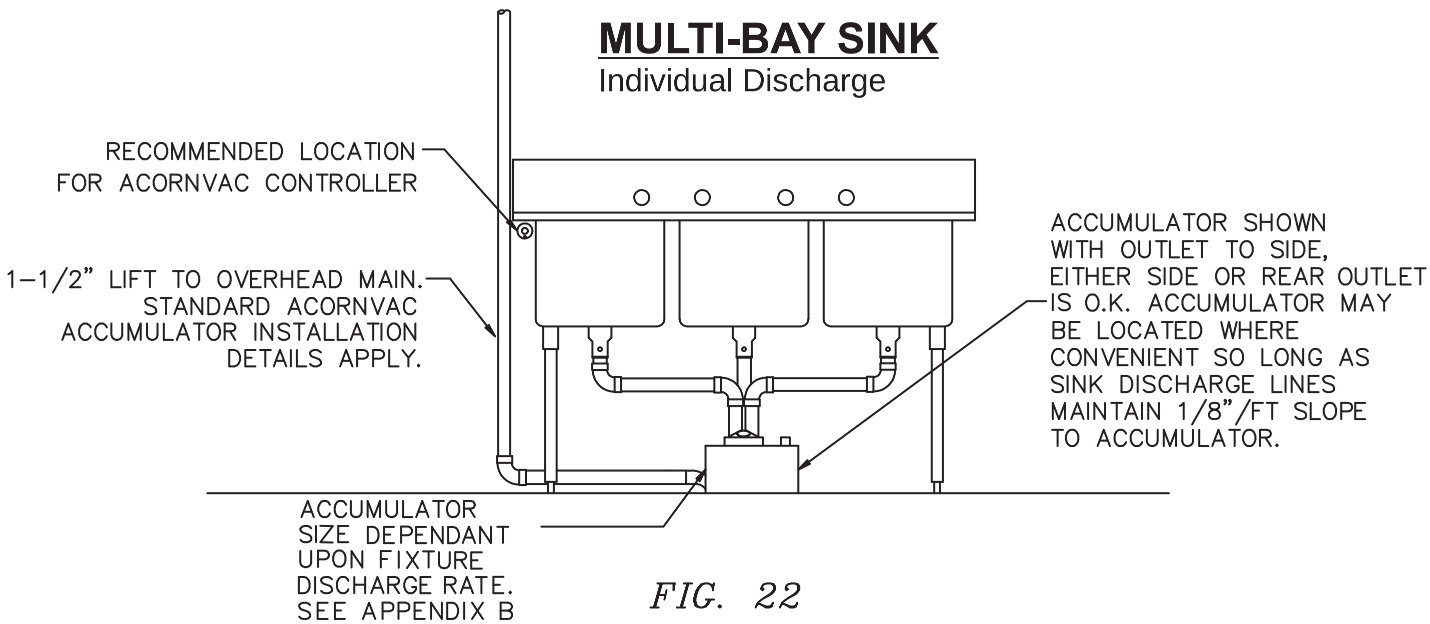

MULTI-BAY SINK
Individual Discharge
RECOMMENDED LOCATION FOR ACORNVAC CONTROLLER
1–1/2" LIFT TO OVERHEAD MAIN. STANDARD ACORNVAC ACCUMULATOR INSTALLATION DETAILS APPLY.
ACCUMULATOR SHOWN WITH OUTLET TO SIDE, EITHER SIDE OR REAR OUTLET IS O.K. ACCUMULATOR MAY BE LOCATED WHERE CONVENIENT SO LONG AS SINK DISCHARGE LINES MAINTAIN 1/8"/FT SLOPE TO ACCUMULATOR.
ACCUMULATOR SIZE DEPENDANT UPON FIXTURE DISCHARGE RATE. SEE APPENDIX B

FIG. 22

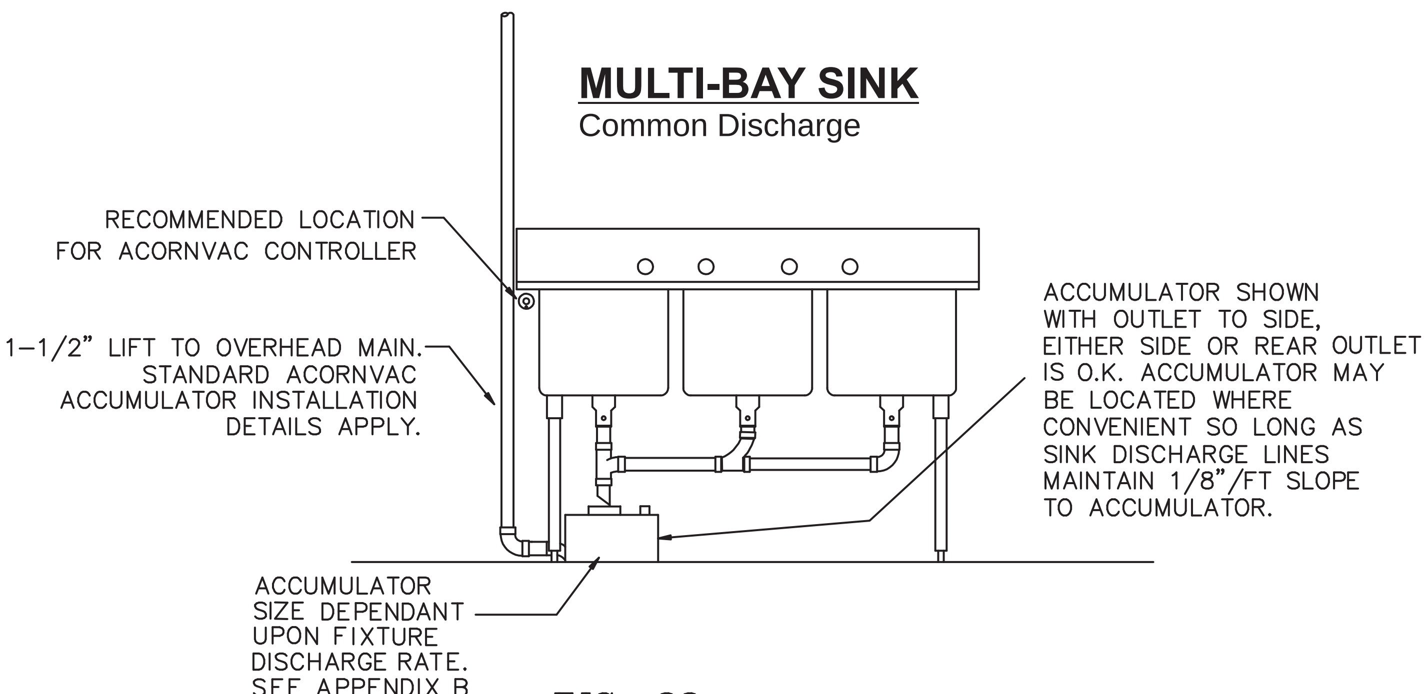

MULTI-BAY SINK
Common Discharge
RECOMMENDED LOCATION FOR ACORNVAC CONTROLLER
1–1/2" LIFT TO OVERHEAD MAIN. STANDARD ACORNVAC ACCUMULATOR INSTALLATION DETAILS APPLY.
ACCUMULATOR SHOWN WITH OUTLET TO SIDE, EITHER SIDE OR REAR OUTLET IS O.K. ACCUMULATOR MAY BE LOCATED WHERE CONVENIENT SO LONG AS SINK DISCHARGE LINES MAINTAIN 1/8"/FT SLOPE TO ACCUMULATOR.
ACCUMULATOR SIZE DEPENDANT UPON FIXTURE DISCHARGE RATE. SEE APPENDIX B

FIG. 23

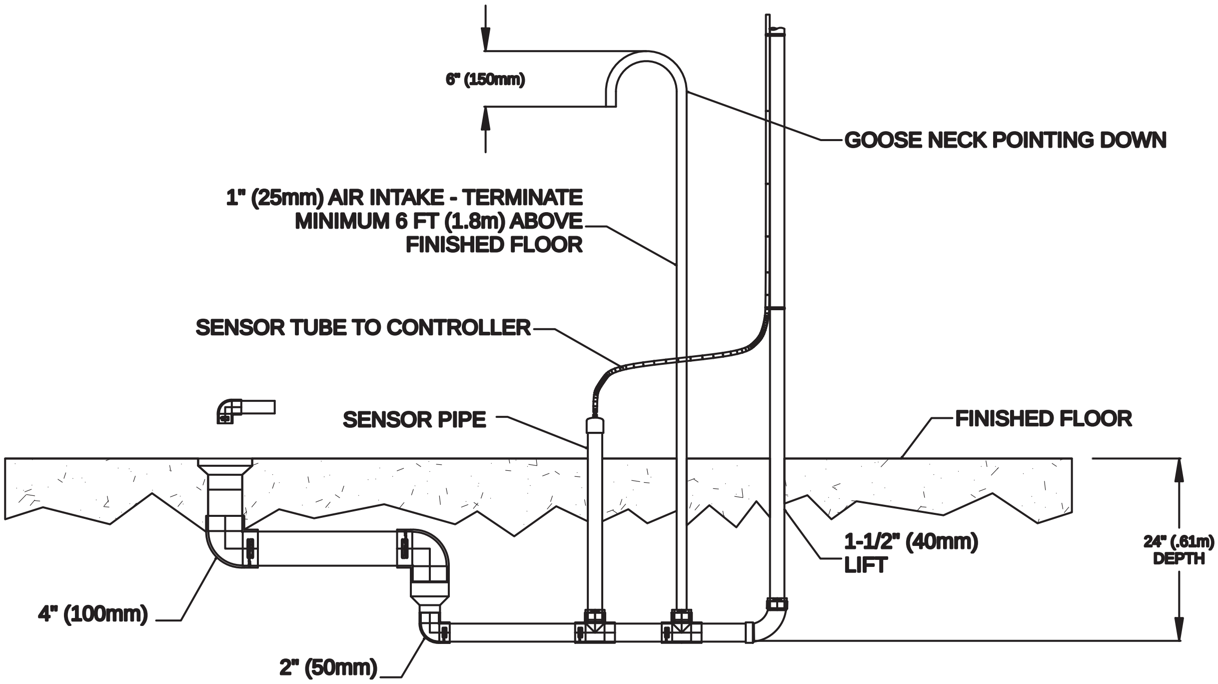


FIG. 24

FLOOR DRAIN ACCUMULATOR

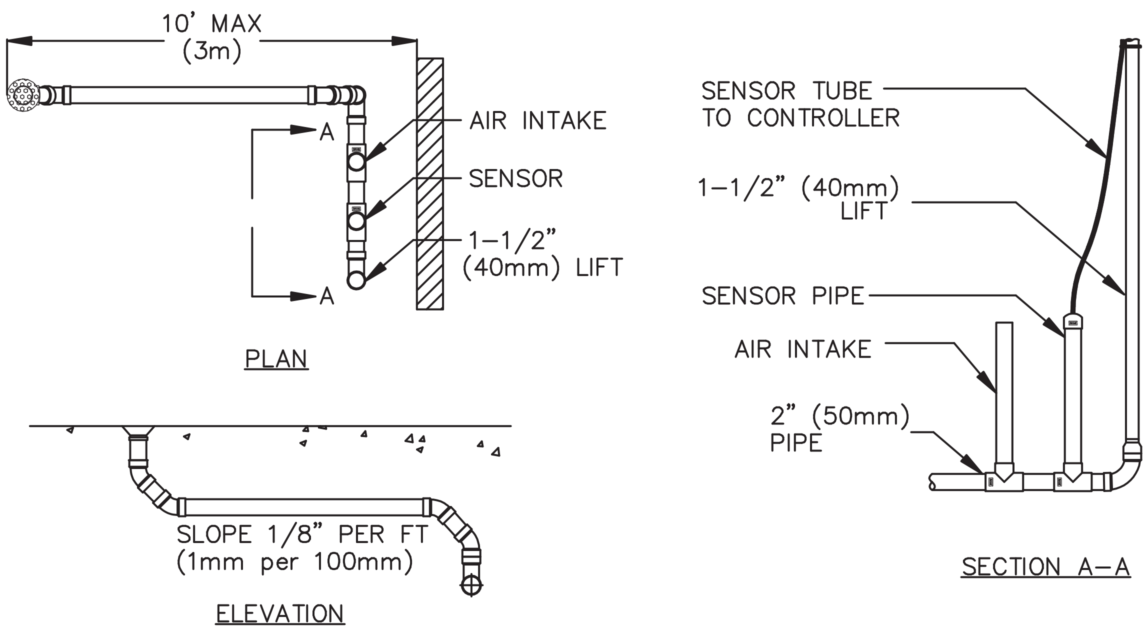


FIG. 25

FLOOR DRAIN WITH ANGLED ACCUMULATOR

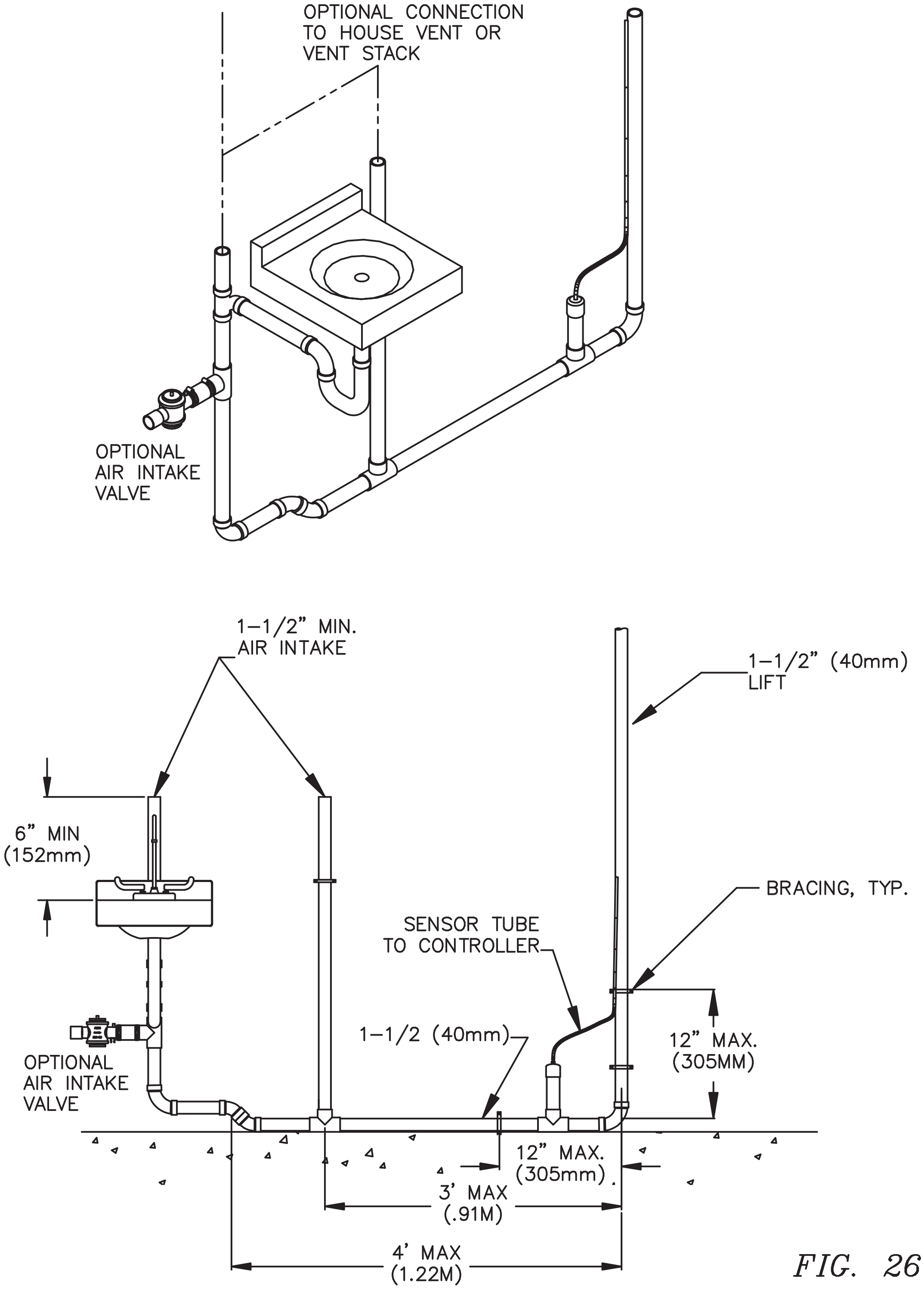
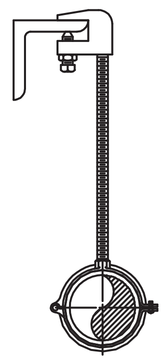


FIG. 26

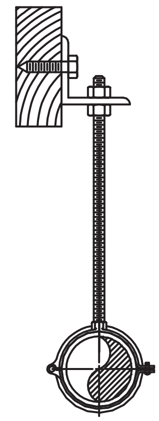
HAND SINK CONFIGURATION WITH P-TRAP & PIPE ACCUMULATOR

VACUUM SYSTEM BRACING GUIDELINES

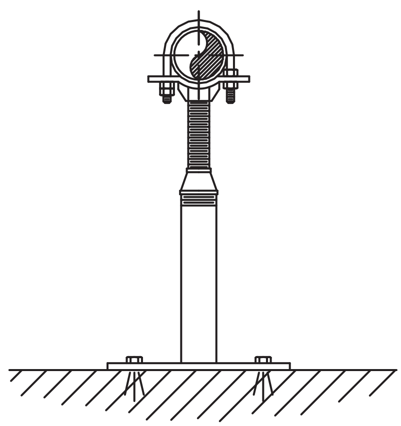
- ALL piping must be supported, braced, and secured to resist thrusting forces and minimize movement.
- ALL piping must be braced per AcornVac specs or per local code requirements whichever is more restrictive.
- All bracing assemblies must be attached to structural steel, rigid studs, or wooden backings. Drywall, thin sheet metal case backing, and HVAC duct work are NOT acceptable anchor points.
- Bracing of horizontal piping should be in six foot intervals when installation is done in PVC, and eight foot intervals for copper, or as required by local code.
- Sagging of the piping between supports is not permitted; 1/8" per foot of slope is to be maintained at all times.
- Lateral or seismic bracing should be added every 25' when the hanger assembly is greater than 36" long, or as required by local code.
- When a Uni-Strut trapeze is used, piping must be clamped down securely.
- Vertical Lifts are to be secured in six foot intervals.
- Bracing is required at the top of all vertical Lifts.
- An approved bracing assembly must be installed within one foot of every directional change, on both sides of the fitting.
- An approved bracing assembly must be installed within one foot of every Extraction Valve, on both the inlet and the outlet side.



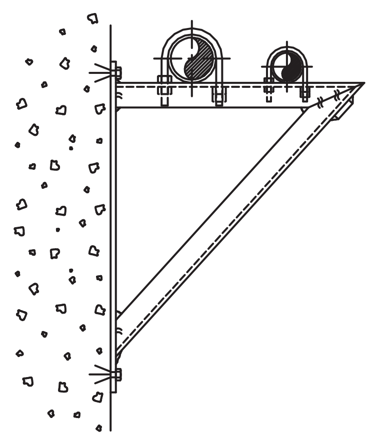
Beam Clamp with All Thread & Split Ring Hanger



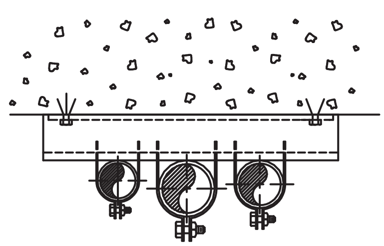
Angle Bracket with All Thread & Split Ring Hanger



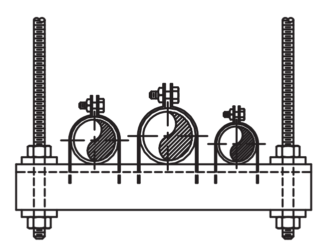
Pipe Stand



Welded Bracket

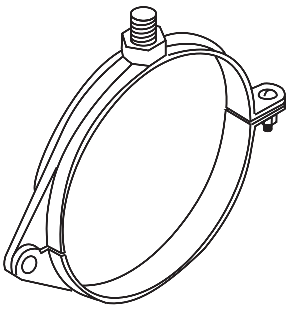


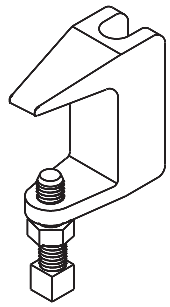
Strut & Strut Clamps

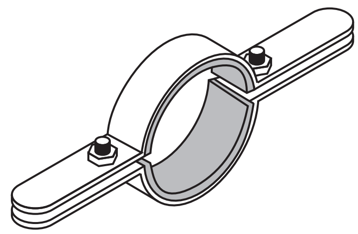


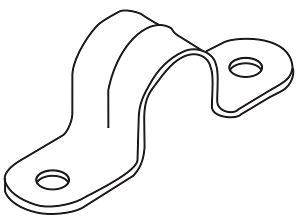
Trapeze with Strut & Strut Clamps

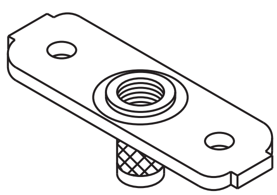
APPROVED VACUUM PIPING BRACING MATERIALS

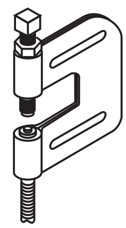

Split Ring Hanger


Beam Clamp

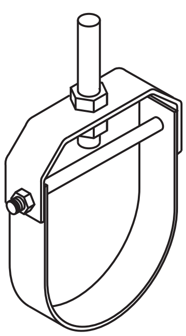

Riser Clamp

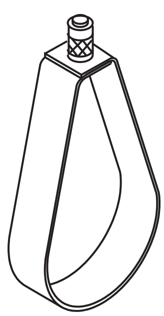

Two-Eared Strap Hanger

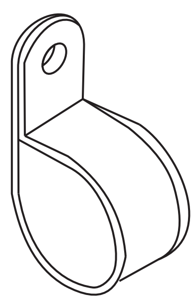

Wall Plate

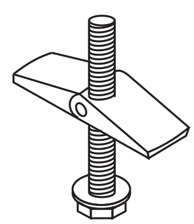

"C" Clamp

INAPPROPRIATE VACUUM BRACING MATERIALS


Clevis Hanger


Autogrip Hanger


Single-Eared Strap Hanger


Toggle Bolt

Other Inappropriate Materials: Tie Wraps, Wire Ties, Zip Ties, Drywall Inserts

DEFINITIONS LIST

Accumulator
A device for the temporary collection of liquid waste product before introduction into the vacuum waste piping network.

Collection Tank
A device for the temporary collection of waste product from the vacuum waste pipingnetwork before dispatch to sanitary sewer mains or waste treatment facility.

Controller
A vacuum switch that receives a signal, either mechanical, electrical or pneumatic, and allows vacuum pressure to open a normally closed extraction valve.

Directional Changes
Any change in vacuum piping layout within or between vertical and/or horizontal planes.

Extraction Valve
A normally closed pinch valve that acts as an interface point, separating atmospheric pressures at the accumulator from vacuum pressures within the vacuum waste pipingnetwork. The extraction valve is operated (opened & closed) by a controller.

Lifts
A vertical assembly of fittings and piping that routes from the accumulator to the point atwhich it connects into a primarily horizontal assembly of fittings and piping.

Mini Check Valve
An in-line style valve typically installed in combination with flexible rubber hose that allows air to pass through in only one direction.

DEFINITIONS LIST

Primary Lift
The vertical portion of the vacuum piping routing from the accumulator to the first change in direction to horizontal, which remains lower in elevation than the horizontal main or horizontal branch line piping.

Secondary Lift
A vertical portion of the vacuum piping routing from the horizontal piping beginning at the end of a primary lift to the horizontal main or horizontal branch line piping.

Swing Check Valve Assembly
A device which prevents backward flow of waste product by means of a hinged flapper which seals the valve passage way.

Vacuum Center
The vacuum generating system that includes, but is not limited to: collection tank(s) for the temporary collection of waste from the vacuum waste piping network; vacuum pump(s) for the creation of vacuum pressure within system collection tanks and waste piping network, and system controls which monitor and automate the operation of system.

Vacuum Source Port
A point of connection within the vacuum waste piping network, to act as a source of vacuum pressure for control purposes.

Vacuum Waste Piping Network
The horizontal and vertical network of waste piping beginning at the accumulator and routing to the Vacuum Center collection tanks.

AcornVac Accumulator Sizing & Selection

General Notes

This section describes how to select and size accumulators in an AcornVac Vacuum Plumbing System. The AcornVac Vacuum Plumbing System combines differential air pressures and gravity to affect waste drainage and as such is subject to certain constraints and requirements. For this reason, it is important to note that the standards and codes typically used in gravity drainage system designs do not completely correspond to vacuum sewer systems design. In particular the Drainage Fixture Unit (DFU) concept used in the design of gravity drainage systems doesn't fully reflect the dynamics of vacuum drainage systems and therefore doesn't translate well for use as a guide for selecting vacuum system accumulator sizes or piping.

Accumulator Options

There are several options to choose from when selecting an accumulator as summarized in the table below:

Table 8.1 Accumulator Options

Accumulator Type	Part Number	Total Volume (in^3)	Working Volume (in^3)	Max Flow (gpm)*	Recommended applications
AcornVac Plastic Accumulator	**2801-305-001** **2801-320-001**	126	54	1.0	Refrigerated display cases Freezer cases
AcornVac 4 Gallon S.S. Accumulator, Single Port	**2801-340-001** **2801-345-001**	864	576	10.0	Food prep sinks
AcornVac 4 Gallon S.S. Accumulator, Multi-Port	**2801-410-002**	864	576	10.0	Sinks, multiple Other multiple loads
AcornVac 10 Gallon Box	**2801-330-001**	2,200	1,380	20*	Food prep sinks Other large sinks
Pipe Accumulator, Field Fabricated	NA	Variable. See pipe accumulator sizing charts			Handwash basins Mop sinks Lavatory sinks Service sink

* Contact factory for accumulator sizing assistance when the total drainage flow rate exceeds 20 GPM

Table Definitions

Total Volume (in^3): Total volume available inside the accumulator, in cubic inches.
Working Volume (in^3): Volume of liquid the accumulator holds when the liquid level reaches the extraction valve controller's activation setpoint, in cubic inches.
Max Flow (gpm): Maximum continuous flow the accumulator can handle assuming continuous flow with a limit of 4 operations of the extraction valve per minute.

Accumulator Selection Criteria
An accumulator for any application is selected based on two key factors:

1. Physical compatibility with the installation.
2. Drainage flowrate of the connected load or loads into the accumulator.

The procedure for selecting an accumulator for an installation is detailed below.

Accumulator Sizing and Selection Procedure
Accumulators may be selected and sized using two methods; the “AcornVac Factory Recommendation Method”, or the “Flowrate Method”.

The AcornVac Factory Recommendation (AVFR) method utilizes a lookup table (Table 8.2) that provides a listing of most common applications, the appropriate accumulator working volume and a recommended accumulator type or types. The data in this table is based on detailed engineering analysis supported by numerous successful installations, and is the preferred method for selecting and sizing accumulators.

In the flowrate method, the drainage flowrate of the load is used to calculate the required accumulator size.

Accumulator Selection - AcornVac Factory Recommendation Method
Use the following steps to use the AVFR method to select and size an accumulator:

1. Identify the load or loads which will be connected to an accumulator.
2. Look up the load in Table 8.2.
3. Read any associated notes associated for the load in Table 8.2.
4. Note the minimum required working volume for the load in Table 8.2.
5. If multiple loads are to be connected to a single accumulator:
   a. Calculate the sum of the minimum working volumes of each load.
   b. Confirm that the selected accumulator's working volume is greater than or equal to the sum of the minimum working volumes.
6. If more than one accumulator type is recommended, select the type which best suits the physical constraints of the associated installation.
7. Select the recommended accumulator type for the load.
8. If a pipe accumulator is recommended, determine the size of the pipe accumulator.
   a. Use the recommended pipe accumulator dimensions or,
   b. Use the pipe accumulator sizing guide to determine the required pipe accumulator dimensions.

Table 8.2 Load Specific Working Minimum Volumes & Recommended Accumulators

Load	**Minimum Working Volume** (in3)	**Peak Flow** (gpm)*	AcornVac Recommended Accumulator	Notes
Refrigerated Display Case	9.63	1.0	AcornVac Plastic Accumulator Alternate: Equivalent pipe accumulator	Up to 6 cases may be connected to a single AcornVac Plastic Accumulator.
Produce Cases with misting system (3 case minimum)	550	9.5	AcornVac 4 Gallon Box Accumulator	4 Gallon Box Accumulator is designed to fit under produce cases.
Handwash Basin	31	0.5	Pipe accumulator 1.5" x 12" minimum	Pipe accumulator fits well under smaller sinks.
Service Sink	550	9.5	AcornVac 4 Gallon Box Accumulator	4 Gallon Box Accumulator is designed to fit under sinks. Allows for intermittent high loading resulting from draining a full sink.
Mop Sinks	150	2.6	Pipe accumulator 2" x 48" minimum	Pipe accumulator fits well along side the mop sink on the floor. Box type accumulators not recommended.
Floor drains	150	2.6	AcornVac 4 Gallon Box Accumulator Alternate: Equivalent pipe accumulator	4 Gallon Box Accumulator allows for intermittent high loading.
Food Prep Sink, 1 Bay	150	2.6	AcornVac 4 Gallon Box Accumulator Alternate: Equivalent pipe accumulator	4 Gallon Box Accumulator is designed to fit under sinks. Allows for intermittent high loading resulting from draining a full sink.
Food Prep Sink, 2-3 Bay w/ Common discharge for all bays	150	2.6	AcornVac 4 Gallon Box Accumulator Alternate: Equivalent pipe accumulator	4 Gallon Box Accumulator is designed to fit under sinks. Allows for intermittent high loading resulting from draining a full sink.
Food Prep Sink, 2 Bay w/ Individual discharge for each bay	300	5.2	AcornVac 4 Gallon Box Accumulator Alternate: Equivalent pipe accumulator	4 Gallon Box Accumulator is designed to fit under sinks. Allows for intermittent high loading resulting from draining a full sink.
Food Prep Sink, 3 Bay w/ individual discharge for each bay	900	15.6	AcornVac 10 gallon Box Accumulator	Allows for simultaneous draining of all sink bays. Pipe accumulators not recommended.

Table Definitions

Minimum Working Volume (in^3): Minimum recommended working volume of an accumulator servicing the associated load, in cubic inches.

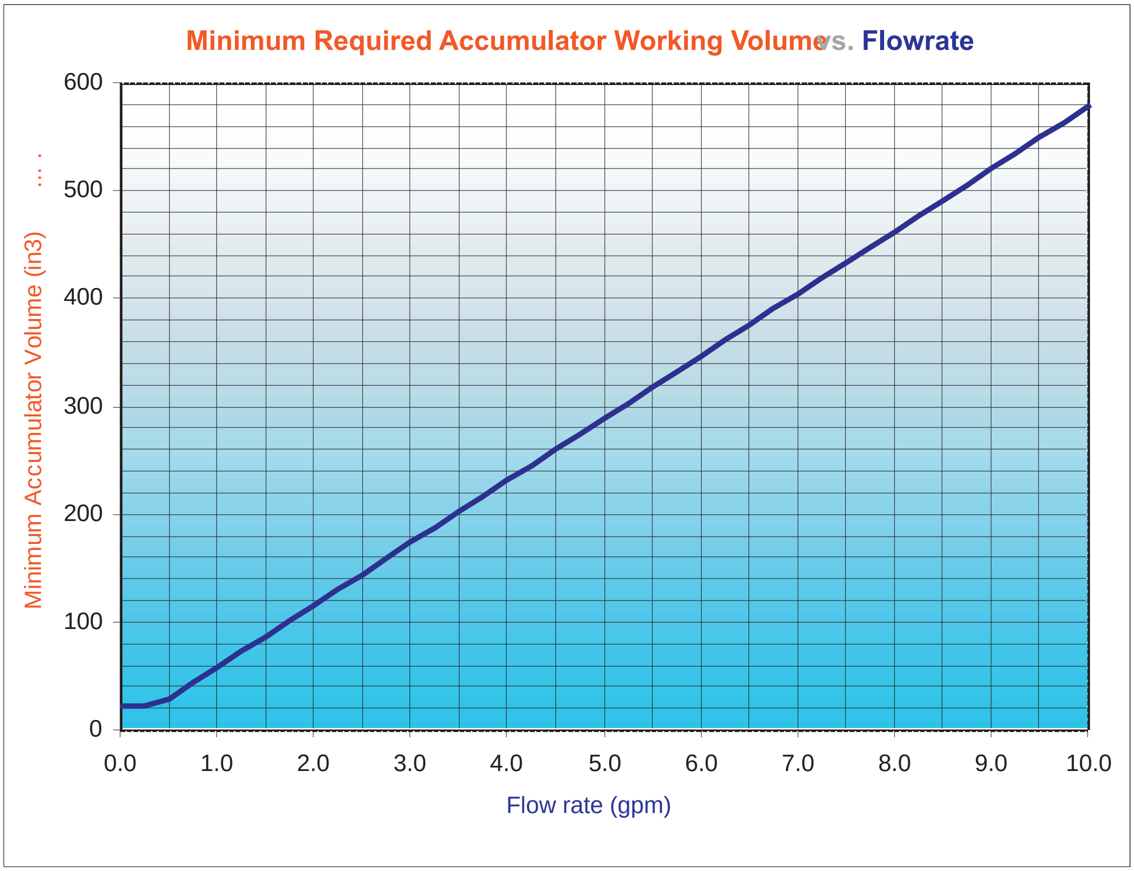
Peak Flow (gpm): The peak flow value is the peak flow that is allowed by the listed minimum accumulator volume. The actual peak capacity of the recommended accumulator device may be higher.

Accumulator Selection- Flowrate Method

If the drainage flowrate of the attached device is known, the flowrate method may be used to select the accumulator size. The flowrate method is summarized below. If the flowrate of the attached device is not known, then revert to the AVFR method.

1. Determine the sum of all drainage flowrates of all loads attached to the accumulator.
2. Use Chart 8.1 to determine minimum required accumulator working volume.
3. Select the smallest accumulator from Table 8.1 which has a working volume greater than or equal to the required minimum working volume.
4. If more than one accumulator type is recommended, select the type which best suits physical constraints of the associated installation.
5. If a pipe accumulator has been selected, go to the pipe accumulator sizing instructions to determine the required pipe accumulator dimensions.

Chart 8.1- Minimum Required Accumulator Working Volume vs. Flowrate



Notes: To use the chart, simply locate the sum of all drainage flowrates into the accumulator on the X (Flow rate) axis. Use the line on the chart to determine the associated minimum accumulator volume on the Y (Volume) axis for the selected flowrate.

Details on how the information illustrated in Chart 8.1 is calculated is described in the section titled *"Determining the Minimum Working Volume of Accumulators".*

Determining the Minimum Working Volume of Accumulators

Accumulator size must be selected such that the attached extraction valve does not operate to empty the accumulator more than four times per minute.

The frequency that the extraction valve operates is a function of the accumulator's working volume and the flow rate into the accumulator. The working volume of the accumulator is the volume of liquid the accumulator holds when the liquid level reaches the extraction valve controller's trigger level setpoint.

The accumulator is therefore always sized such that the working volume of the accumulator is equal to no less than 25% of the maximum total volume which can be expected to flow into the accumulator in a 60 second period.

The required accumulator volume for any application can be quickly calculated using the following equation:

$$\textit{Working Volume Required (inches}^3\textit{)} = \textit{Flow (gpm)} \times 57.75$$

See Chart 8.1 for a graphical illustration of the results of this equation. Chart 8.1 provides a simple way to quickly relate flowrate into the accumulator to the required minimum working volume which meets 4 cycles per minute criteria described above.

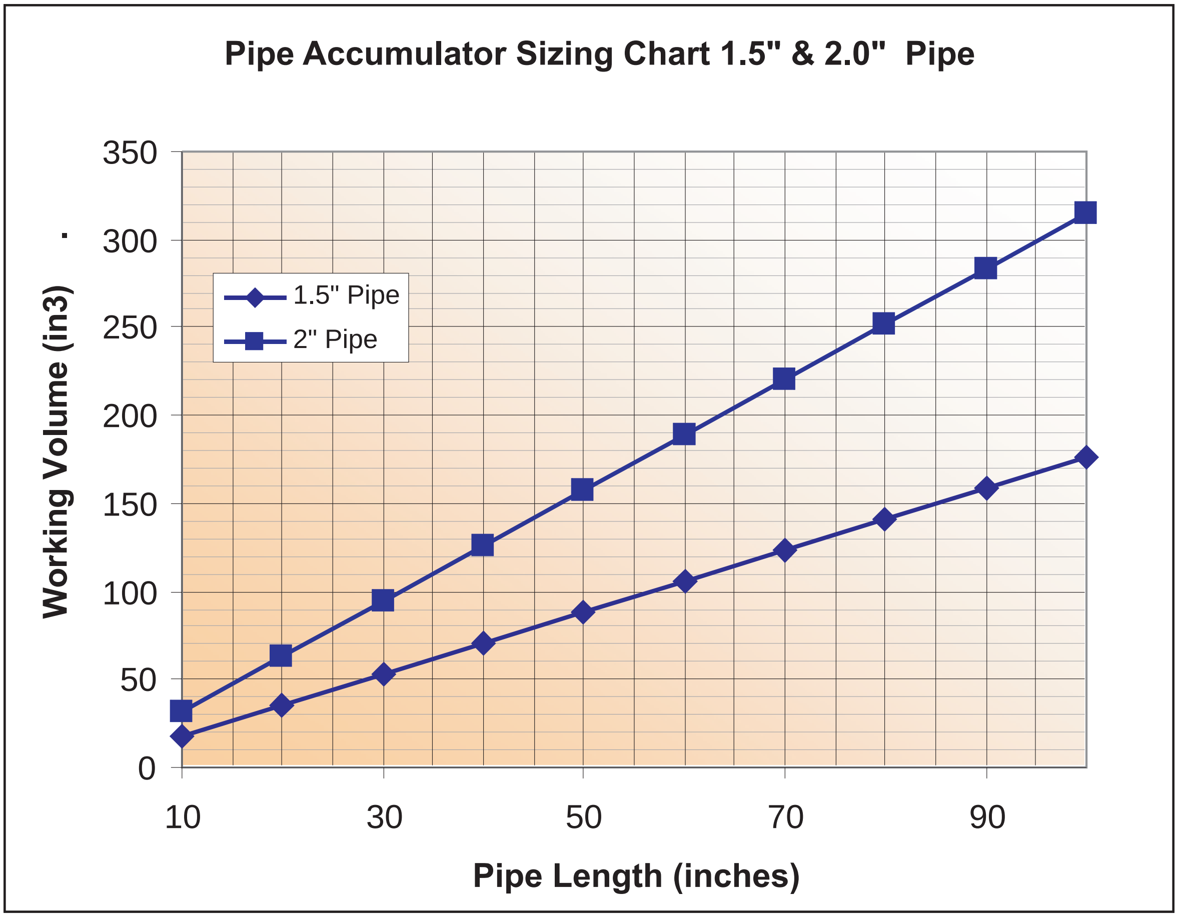
Pipe Accumulator Sizing Chart

Chart 8.2 below provides the working volume of pipe accumulators for various diameters and lengths.

To use the pipe accumulator sizing charts:

1. Determine the desired working volume of the pipe accumulator.
2. Select the desired pipe accumulator diameter.
3. Use the chart below to lookup the required pipe length for the desired working volume for the selected diameter.

Chart 8.2 Pipe Accumulator Sizing Chart, 1.5" and 2.0" Pipe



Note: Overall pipe accumulator length should be limited to 72". If load exceeds this constraint, contact the factory for additional pipe accumulator sizing assistance.

AcornVac Overhead Pipe Sizing

General Notes
Waste liquid and air are drawn from the accumulators into vertical risers and then into horizontal overhead piping which carries the waste to the vacuum center collection tanks. A detailed description of how to appropriately size the overhead piping for various vacuum system configurations is summarized below.

Vertical Riser Sizing
The vertical risers must always be 1.5” pipe. This is a design requirement dictated by the need to keep the velocity of the air/liquid mass moving at the proper velocity for efficient lifting into the horizontal overhead piping.

Horizontal Overhead Pipe Sizing
The horizontal overhead piping may be 2”, 3” or 4” pipe. Pipe size is selected based on the type and quantity of devices connected to the vacuum system. A calculated number referred to as the “total vacuum load factor” value (TVLF) is used to determine the appropriate pipe size. The method for calculating the TVLF and how to use this value to select pipe size is detailed below.

Overhead Pipe Routing
Routing of the overhead piping network for any facility is dictated by the physical arrangement of the devices being serviced and the layout of the facility. Overhead piping may be arranged into branches, branches are then tied to main lines which connect the branches to the vacuum center. Each branch pipe is sized individually using the criteria described below. Main lines which service multiple branches are similarly sized based upon the sum of the load created by the connected branches.

Calculating Total Vacuum Load Factor (TVLF)

An individual vacuum load factor value (IVLF) has been assigned to devices which are often connected to a vacuum system. A listing of IVLF values for commonly used devices is provided in Table 9.1.

Table 9.1 Individual Vacuum Load Factors (IVLF's)

Device	IVLF Value
Refrigerated Display Case	0.4
Handwash Basin	1
Service Sink	5
Mop Sinks	5
Food Prep Sink - (per bay)	10
Misting Systems	0.4
Floor Drains	5

The TVLF value for any system or branch is calculated by summing all of the individual IVLF values for all connected devices.

For systems with multiple branches, a TVLF value should be calculated for each branch. Each branch is sized individually based on the branch TVLF value. Where multiple branches join a main line, the sum of the connected branch TVLF values is used to size the main line.

Examples of both single branch and multiple branch TVLF calculations and overhead pipe size selection are provided later in this document.

Selecting Horizontal Overhead Pipe Size Using TVLF Value

Table 9.2 below provides the recommended horizontal pipe sizes for a range of TVLF values.

Table 9.2 Pipe Size Recommendation based on TVLF Value

TVLF Value	Recommended Pipe Size	Notes
0-30	2"	
31-120	3"	
121 +	4"	Consult AcornVac Factory for design assistance for any 4" applications

Examples of TVLF Calculation and Pipe Size Selection

Table 9.2 provides the recommended horizontal pipe sizes for a range of TVLF values. The examples shown below to illustrate how calculate the TVLF value for a branch or system and how to use this value to select the appropriate pipe size.

Example 1: TVLF Calculation & Pipe Size Selection Single Branch System

Physical Arrangement:

10 Refrigerated display cases
2 Mop sinks
1 Single bay food prep sink
All loads in the system are connected to a single line as shown in the figure below:

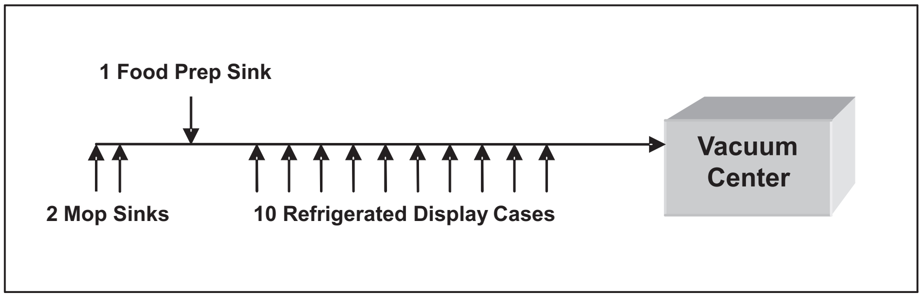


Figure XX Single Main Line System

Step 1: Look up IVLF values for all connected loads in the IVLF's Table.

Step 2: Calculate TVLF Value using the worksheet method shown below:

TVLF Calculation Worksheet

Device Type	Qty	Multiply by	IVLF Value		Device Subtotal
Refrigerated Display Cases	10	x	0.4		=4
Mop Sink	2	x	5		=10
Food Prep Sink (1 bay)	1	x	10	+	=10
			TVLF:		**24**

Notes: Calculated TVLF values should be rounded up to the nearest whole number

Step 3: Lookup calculated TVLF value of 24 in pipe size recommendation table**:**

TVLF Value	Recommended Size
0-30	**2"**
31-120	3"
121 +	4"

Step 4: Select pipe size, in this case 2" is recommended by the table.

Example 2: TVLF Calculation & Pipe Size Selection Multiple Branch System

Physical Arrangement:

2 Branches (Branch A and Branch B)

Branch A services the following loads:

- o 10 Refrigerated display cases
  - o 2 Mop sinks
  - o 1 Single bay food prep sink

Branch B services the following loads:

- o 1 Single bay food prep sink
  - o 1 Mop sinks

Branch A & B are connected to the vacuum center via a single main line:

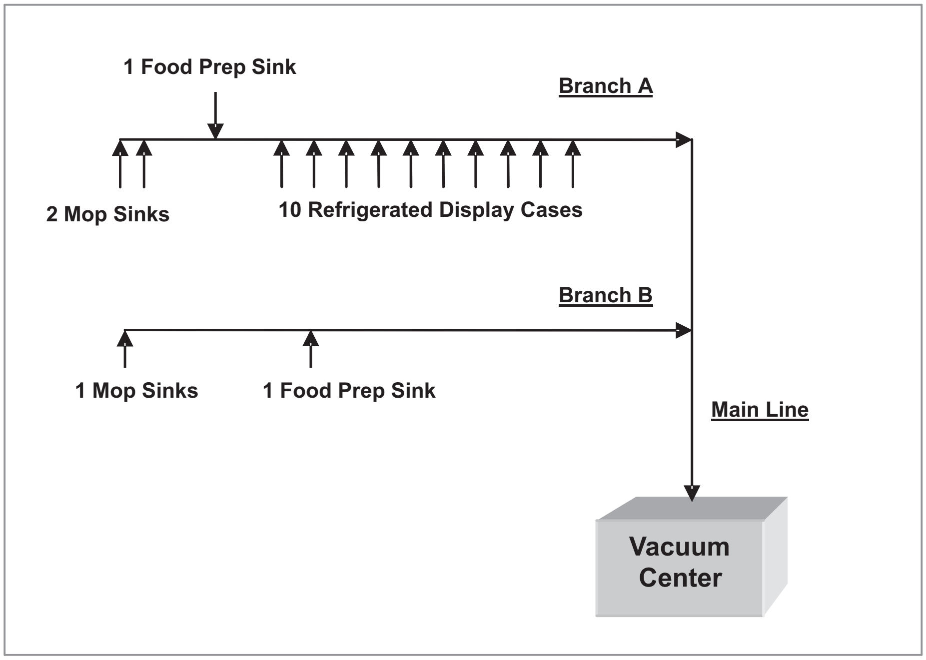


Figure XX Multiple Branch System

Step 1: Look up IVLF values for all connected loads in the IVLF's Table.

Step 2: Calculate the TVLF Value for each branch individually using the worksheet method shown below:

Branch A TVLF Calculation Worksheet

Device Type	Qty	Multiply by	IVLF Value		Device Subtotal
Refrigerated Display Cases	10	x	0.4		=4
Mop Sink	2	x	5		=10
Food Prep Sink (1 bay)	1	x	10	+	=10
			Branch A TVLF:		**24**

Notes: Calculated TVLF values should be rounded up to the nearest whole number

Device Type	Qty	Multiply by	IVLF Value		Device Subtotal
Mop Sink	1	x	5		=5
Food Prep Sink (1 bay)	1	x	10	+	=10

Branch B TVLF: 15

Notes: Calculated TVLF values should be rounded up to the nearest whole number

Step 3a: Lookup the calculated Branch A TVLF value of 24 in pipe size recommendation table:

TVLF Value	Recommended Size
0-30	**2**
31-120	3
121 +	4

Step 3b: Lookup the calculated Branch B TVLF value of 15 in pipe size recommendation table:

TVLF Value	Recommended Size
0-30	**2**
31-120	3
121 +	4

Step 4: Determine Main Line TVLF value by summing all connected branch TVLF Values.

Main Line TVLF Calculation

Branch A TVLF		24
Branch B TVLF	+	15
Main Line TVLF		**39**

Step 5: Lookup Main Line TVLF value of 39 in pipe size recommendation table:

TVLF Value	Recommended Size
0-30	2
31-120	**3**
121 +	4

Step 5: Summarize Results:

Branch A = 2 pipe
Branch B = 2 pipe
Main Line = 3 pipe

Additional Horizontal Overhead Pipe Sizing Criteria

In addition to the TVLF value some additional criteria must also be considered when selecting pipe size. These additional criteria are listed below:

1. Use 3” pipe for any system with an AcornVac 10 Gallon Box accumulator installed in the system regardless of TVLF value.
2. If TVLF values exceeds 121 contact AcornVac for design assistance.

Notes: Calculated TVLF values should be rounded up to the nearest whole number

Introduction

When circumstances prevent lift piping from existing in close proximity to a fixture, it is acceptable to develop a below grade piping and accumulator network as illustrated in this Appendix.

Figure 27 illustrates a typical fixture layout with multiple condensate or grey water fixtures attached to an underground piping network which constitutes the branch portion of the accumulator assembly. Figure 28 illustrates how the fixtures are typically attached to the underground piping and Figure 29 describes a typical accumulator arrangement. Sizing instructions and criteria for the sump is provided in Table 10.1.

TYPICAL UNDERFLOOR LARGE VOLUME ACCUMULATOR APPLICATION

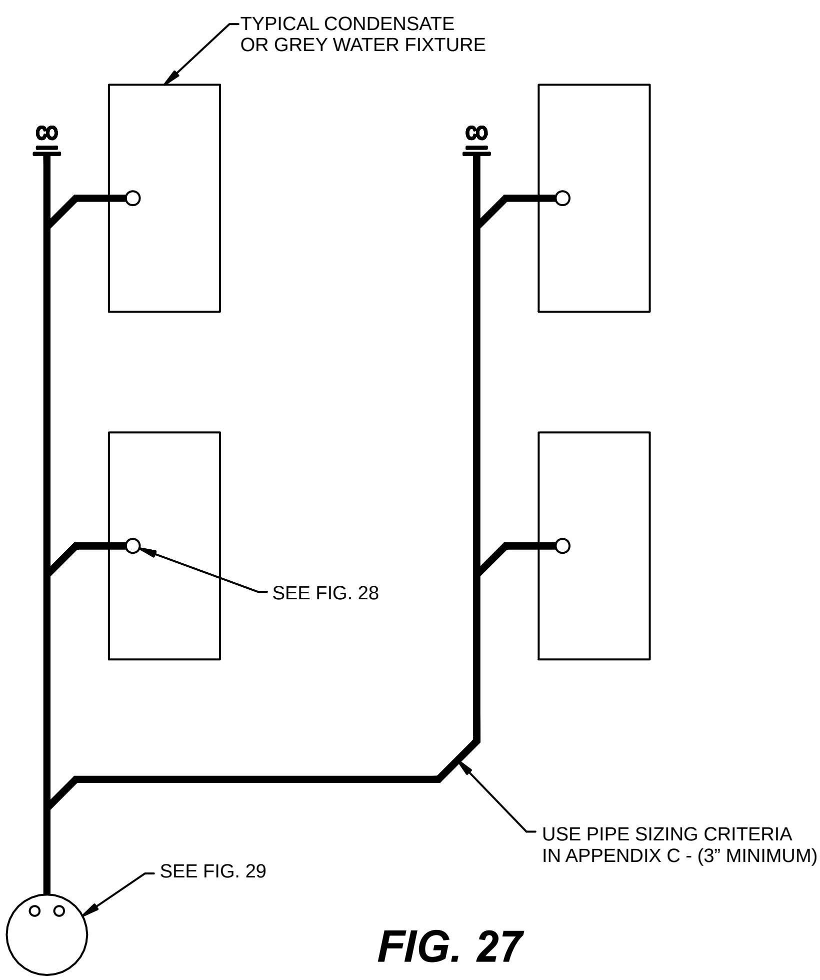


FIG. 27

TYPICAL VACUUM DRAINAGE PIPING SLOPED TO BELOW FLOOR ACCUMULATOR

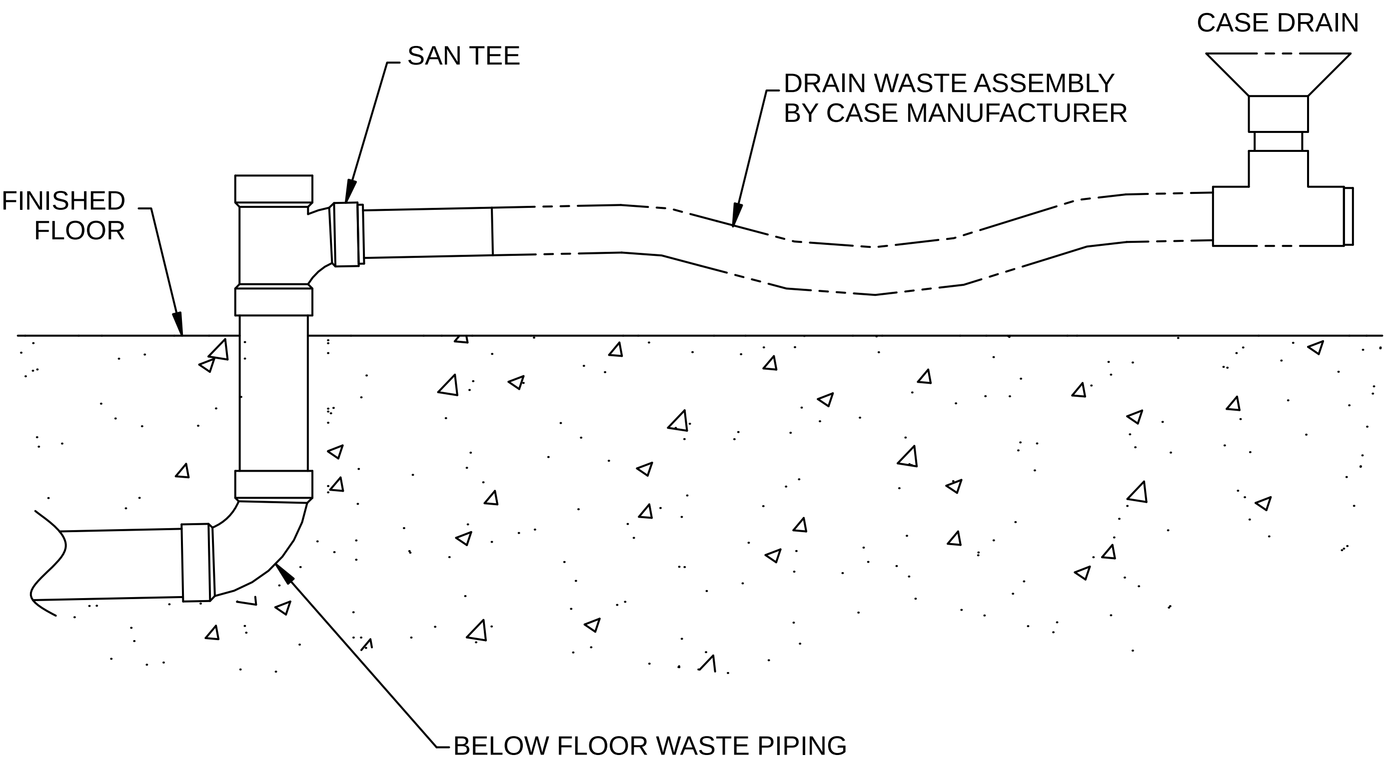


FIG. 28

BELOW FLOOR ACCUMULATOR DETAIL

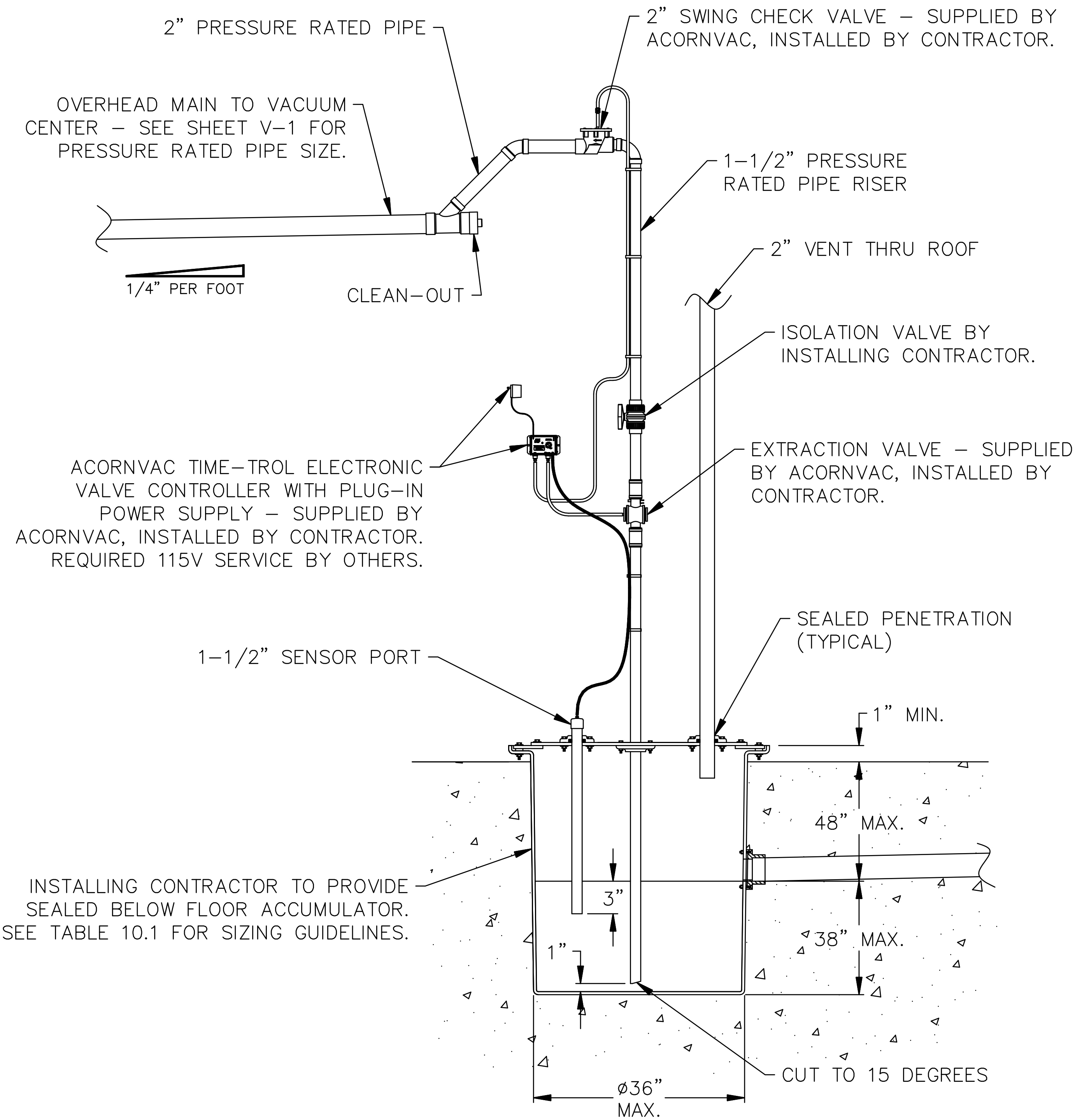


FIG. 29

Table 10.1 - Accumulator Working Depth by Flow Rate

	Minimum Accumulator Diameter							
GPM	4"	6"	8"	10"	12"	16"	12"	16"
0.5	9	4						
1.0	18	8	5					
1.5	28	12	7	4				
2.0	37	16	9	6	4			
2.5		20	11	7	5			
3.0		25	14	9	6			
3.5		29	16	10	7	4		
4.0		33	18	12	8	5		
4.5		37	21	13	9	5		
5.0			23	15	10	6		
5.5			25	16	11	6	4	
6.0			28	18	12	7	4	
7.0			32	21	14	8	5	
8.0			37	24	16	9	6	4
9.0				26	18	10	7	5
10.0				29	20	11	7	5
11.0				32	22	13	8	6
12.0				35	25	14	9	6
13.0					27	15	10	7
14.0					29	16	10	7
15.0					31	17	11	8
16.0					33	18	12	8
17.0					35	20	13	9
18.0					37	21	13	9
19.0						22	14	10
20.0						23	15	10

Definitions:

GPM — Maximum estimated simultaneous flow rate in Gallons Per Minute (GPM) from all fixtures connected to the accumulator and expected to operate at the same time.

Working Depth — Distance between invert of lowest connected fixture and the bottom of the accumulator

Accumulator Diameter — Nominal ID of accumulator

To Use the Chart:

1. Estimate the maximum simultaneous flow rate (GPM) from the fixtures that will be connected to the accumulator and expected to operate at the same time.
2. Enter the chart horizontally at the next highest flow rate above your estimated maximum GPM.
3. Select the Minimum Accumulator Diameter and Working Depth that best match your mechanical requirements.

Notes:

1. Working Depths less than 4" or greater than 38" not recommended. Contact the factory for assistance.
2. Contact the factory for applications generating more than 20 GPM maximum flow rate.
3. All dimensions are in inches unless otherwise noted.
4. It is acceptable to make the Working Depth longer than recommended by this chart, but never shorter.
5. It is acceptable to use a prefabricated sump of a larger diameter than the minimum stipulated in this table so long as the distance from the bottom of the sump to the invert of its lowest inlet is not less than 4" nor more than 38", the distance from the finished floor to the lowest invert is not more than 48", and the diameter is not more than 36" as shown in Figure 29. If these dimensional criteria are not suitable for your application, please contact Acorn Vac for assistance.

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