DESIGN PROCEDURE
FIXED VACUUM HOLSTER™ - AUTOMOTIVE

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INTRODUCTION

The following pages explain how to select vehicle exhaust equipment and size an exhaust fan for a fixed-mounted Vacuum Holster ™ automotive application. The Vacuum Holster™ simplifies vehicle exhaust removal by using the static pressure of the exhaust fan to assist in retraction of the exhaust hose, eliminating the expense and maintenance of hose storage equipment such as hosereels or retracting balancers.

This design manual is for applications in which the Vacuum Holsters™ are fixed-mounted in the facility (as opposed to being incorporated into an Apex Rail system).

The standard automotive Vacuum Holsters™ use 4" diameter hose to exhaust 300 CFM per drop. The exhaust hose of the 4" Vacuum Holster™ has a 5' lower section of silicon-Kevlar hose for 700 F degrees intermittent; the remainder of the hose is 300 F neoprene. More high temp hose can be specified if desired.

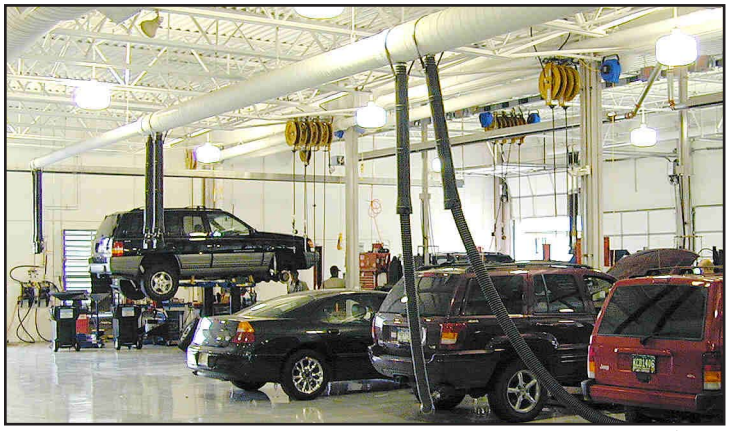
Before beginning design, it is important to note that the fixed-mounted Vacuum Holster™ is **not** intended for the following applications:

A. **Fire station/emergency vehicle applications**, in which the vehicle exhaust system follows the vehicle to the garage door and automatically disconnects.
B. **Diesel dynamometer applications**. These applications may require extreme temperature hose and higher CFM rates than are available with the 4" Vacuum Holster™. Ascent Systems offers systems to accommodate these situations, but not in a Vacuum Holster™ configuration.

PREVIEW

Page 2 is intended to assist the system designer in selecting the best Vacuum Holster™ assembly, suspension kit, and system options for each particular application. This page should be used in conjunction with page 3, which will enable the specifier to generate accurate part numbers for the desired equipment selections.

With the equipment selected, Page 4 describes how to size the exhaust fan, by calculating the CFM requirement and then accounting for the pressure drops from the Vacuum Holster™, system options, and ductwork; and including the effects of temperature and elevation on exhaust fan performance.



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As mentioned above, the Vacuum Holster™ relies on the static pressure from the exhaust fan to retract the exhaust hose, and pages 4 and 5 explain how to select a fan that will accomplish this function. Page 6 is a system design worksheet that is intended to give a step-by-step procedure for the items explained on pages 4-5.

Page 7 shows typical automotive service layouts and gives suggestions for the location of the equipment. Page 8 illustrates the two different methods of suspension - direct-to-duct or extended duct, as well as providing dimensions.

OTHER RESOURCES

This manual provides assistance in designing a Vacuum Holster™ system, but it is not comprehensive. There are other resources, all available at www.ascentsystemsinc.com, that are helpful in completing a design, including:

A. **Ascent Systems Exhaust Fan Manual**. This manual will enable the designer to determine the CFM-static pressure point of operation, but the Exhaust Fan Manual has performance curves, specifications, and dimensions as well.
B. **Product Specifications**. These specifications are available in Word format from the web site and can be inserted into project plans and specifications.
C. **CAD Files**. Available upon request, these installation diagrams and equipment schedules can be inserted into plans.

PRODUCT SELECTION - VACUUM HOLSTER™ AUTOMOTIVE

NOTE: This page should be used in conjunction with page 3, Vacuum Holster™ Nomenclature.

The purpose of these pages is twofold:

1) To assist the system designer in selecting the appropriate Vacuum Holster™ Assembly, Hose Holster suspension kit, and system options.
2) To enable the system designer or specifying engineer to generate correct part numbers for the desired equipment.

Please see the exhaust fan catalog to determine the proper exhaust fan selection and to generate the correct ordering information.

STEP #1a: SELECT THE VACUUM HOLSTER™ ASSEMBLY

A. Diameter of Exhaust Hose.
4" exhaust hose (for 300 CFM) is recommended for automotive applications. If there is a dedicated diesel bay where high CFM and temperatures are expected, it may be advisable to specify a 5" or 6" drop. Please see the Fleet Service/HD design procedure if this is the case.

B. Length of Exhaust Hose.
4" diameter exhaust hose comes in standard lengths of 17', 20', and 23'. For facilities such as auto dealerships, where bays are 12' wide, a hose length of 17' is sufficient. Longer lengths are available for wider service bays.

C. Height of Hose Holster.
The Extended Hose Holster is the standard Hose Holster size, and is 56" high for 4" Vacuum Holsters™. The Extended Hose Holster is the default Hose Holster selection, and should be used in almost all cases.

The Compact Hose Holster is available for 4" Hose Holster models, and may be used under special circumstances. This model can be selected only if the exhaust hose is 20' or less. The Compact model provides for easier instal lation when the duct manifold height is low - 12'6" or less for 4" Holsters. If the bottom of the duct manifold is higher than these guidelines, the extended model is recommended.

D. Type of Exhaust Hose.
Combination Hose uses high temperature silicon-Kevlar fabric (600F continuous, 700F intermittent) for the first 5' of hose, and switches to neoprene (300 degrees F) for the remaining length. The designer may specify more silicon-Kevlar hose if desired, including the entire length.

E. Tailpipe Adapter and Rotational Damper.
Based upon the selection of the exhaust hose, the appropriate tailpipe adapter and rotational damper are included.

STEP 1b: SELECT THE HOLSTER SUSPENSION KIT

A. Diameter of the Corresponding Hose Holster.
Ensure that the size of the Hose Holster Suspension Kit corresponds to the diameter of the exhaust hose of the Vacuum Holster™.

B. Two Suspension Methods

1) The Direct to Duct kit is easier to install and more economical of the two. A strap is looped over the duct manifold, and the Holster is suspended from this strap. The duct manifold must be 13' AFF or lower. Part #: A4DHS.


I-A4D-01

2) The Extended Duct Suspension Kit is necessary when the bottom of the duct manifold 13' AFF or more. The installer supplies a piece of spiral duct between the Holster and manifold to attain the correct mounting height. Ascent supplies the other items in the kit. Part # A4EHS.


I-A4E-02

STEP #2: SELECT SYSTEM OPTIONS

Please refer to product details for more detailed descriptions of system options. In the automotive market, the three most common options are as follows:


I-A3W-02

1) Wye Assemblies for connection to dual exhaust ports, part # A3WYE.


I-A3C-01

2) Remote Start fan control panel (part # A3CP, 1 per exhaust fan) to start/stop fan from the Holster and Remote Start Transmitter (part # A3TK, 1 per Hose Holster).


I-H6S-11

3) Extension Hoses for additional reach, which include a tailpipe adapter without a damper assembly. Part # H4S??-EX, with "??" indicating the length.

STEP #3: SELECT THE EXHAUST FAN

Please refer to the other pages in this design procedure and the Ascent Systems Exhaust Fan Manual to select and specify the correct exhaust fans.

DESIGN PROCEDURE - VACUUM HOLSTER™ AUTOMOTIVE PART NUMBERS AND NOMENCLATURE

(VH) = **V**acuum **H**olster™

(4) = Diameter of the Exhaust Hose

(??) = Length of the Exhaust Hose
Standard Length, 4" Hose: 17, 20, or 23'

(E/C)= Height of Hose Holster
"E" for Extended (any length of exhaust hose)
"C" for Compact (20' of less exhaust hose only)

(C/S) = Type of Exhaust Hose
"C" for Combination (5' high temp, remainder neoprene)
(Note: If more than 5' is desired, indicate length of high temp hose after "C.")
"S" for High Temp Silicon Kevlar

(D/E) = Type of Suspension Kit
D = Direct-to-Duct Suspension
E = Extended Duct Suspension

VH - 4 17 E C - D = Vacuum Holster™ with 4" x 17' Silicon/Neoprene Combination Hose, Extended Hose Holster, and Direct-to-Duct Suspension Kit.

VH - 4 20 C C10 - E = Vacuum Holster™ with 4" x 20' Silicon/Neoprene Combination Hose, (with 10' high temp), Compact Hose Holster, and Extended Duct Suspension Kit.

STEP #1a-b: VACUUM HOLSTER™ ASSEMBLY AND SUSPENSION KIT

This step includes selections concerning the:

A) Diameter of the exhaust hose
B) Length of the exhaust hose
C) Height of the Hose Holster
D) Type of exhaust hose.
E) Type of suspension kit.

The appropriate tailpipe adapter and rotational damper are automatically included in the assembly.

Common System Options Include:

- **Wye Assembly for connection to dual exhaust ports, part # A3WYE**
- **Remote Start exhaust fan control. One control panel (part # A3CP) per fan is required; one transmitter per Hose Holster is recommended (part # A3TK).**
- **Extension hoses with tailpipe adapters for additional each, H4S??-EX (indicate length where "??").**

STEP #2: SYSTEM OPTIONS

Please refer product details for detailed descriptions and part numbers of system options.

STEP #3: EXHAUST FAN

Please refer to the other pages in this design procedure manual and the Ascent Systems Exhaust Fan Manual to select and specify the optimal exhaust fan.

FAN DESIGN PROCEDURE - VACUUM HOLSTER™ AUTOMOTIVE

A. CALCULATING THE CFM REQUIREMENT

The recommended CFM per 4" automotive Vacuum Holster™ is given in Table 1.

To obtain the CFM requirement, multiply the total number of hosedrops by the recommended CFM per hosedrop as given in Table 1 (Confirm CFM rates with local codes).

Table 1 - CFM Rates	
Diameter	4"
CFM	300

B. DETERMINING STATIC PRESSURE

The static pressure arises primarily from four sources:

1) the hose and tailpipe adapter of the Vacuum Holster™ ;
2) system options such as wye assemblies;
3) runs of straight duct;
4) elbows in the exhaust duct.

1. Pressure Drop from Exhaust Hose and Tailpipe Adapter

Table 2 shows the pressure drop though the different Vacuum Holsters™, assuming the CFM rates as shown in Table 1.

Table 2 - Pressure Drop through Vacuum Holster™ at Standard Conditions	
Hose Length	Pressure Drop
17'	1.65" wg
20'	1.95" wg
23'	2.25" wg

2. Pressure Drop from System Options

Table 3 above below the pressure drop though system options. This table assumes the CFM rates as recommended in Table 1.

Table 3 - Pressure Drop through Options, Standard Conditions			
Option	Pressure Drop	Option	Pressure Drop
4" Wye Assembly	.40" wg	Extension Hose, per ft.	.10"

3. Pressure Drop from Straight Duct

Ascent Systems recommends that the ductwork be sized for an airstream velocity of 2,500 FPM. The static pressure from straight duct can be referenced from a standard pressure drop chart. For rough dimensioning, estimate .006" wg for each foot of straight duct.

4. Pressure Drop from Elbows

The static pressure from elbows may likewise be found in standard pressure drop charts. For estimation, add .06" wg per elbow.

C. DENSITY CORRECTIONS

Most fan performance curves are predicated on an air density that occurs when the temperature is 70 degrees F and the elevation is zero, resulting in a density of .075 pounds per cubic foot. When there is variance from these standard conditions, multiply the required static pressure by the correction factors in Tables 4 and 5 below.

While determining the elevation is straightforward, the designer must make an assumption about the inlet temperatures of a vehicle exhaust system. Due to the primarily to the dilutionary air from the tailpipe adapters, and the cooling of air en route to the fan inlet, Ascent Systems recommends an inlet temperature of 100F for automotive applications, as determined from field testing.

Table 4 - Elevation Correction Factors			
Elevation	Factor	Elevation	Factor
1,000'	1.04	4,000'	1.16
2,000'	1.08	5,000'	1.20
3,000'	1.12	6,000'	1.24

Table 5 - Temperature (F) Correction Factors			
Temperature	Factor	Temperature	Factor
70	1.0	100	1.06
80	1.02	110	1.08
90	1.04	120	1.09

D. EXHAUST HOSE RETRACTION

Similar to any emission extraction system, the system designer must first determine the CFM-static pressure requirement of the system, as described above. The exhaust fan is selected to meet this requirement.

However, when designing a Vacuum Holster™ system, one more design consideration is necessary to consider - the static pressure to the "left" of the CFM-static pressure requirement on the fan performance curve (the lower CFM range).

The static pressure of the exhaust fan is the force that assists in the retraction of the exhaust hose. The designer must ensure that sufficient static pressure is present to cause the exhaust hose to compress, thus aiding the operator in storing the exhaust hose.

The requirement of static pressure is dependent upon the diameter, length, and type of exhaust hose (high temp or combined). Table 6 shows the amount of static pressure necessary to compress a given exhaust hose. If the static pressure does not equal or exceed this number, then the retraction of the exhaust hose will be unwieldy.

FAN DESIGN PROCEDURE - VACUUM HOLSTER™ AUTOMOTIVE

Table 6: Static Pressure for Retraction		
Length	4" Combo	4" Silicon
17'	5.7" wg	6.2" wg
20'	6.1" wg	6.6" wg
23'	6.5" wg	7.0" wg

The simplest design scenario occurs when there is only one Vacuum Holster™ on an exhaust fan.

One Vacuum Holster™ per Exhaust Fan

When the damper of the Vacuum Holster™ is closed, the CFM in the system equals 0. When there is no air flow throughout the system, the entire ductwork and hosedrop reach equilibrium, where the static pressure is equal to where CFM = 0 on the performance curve. To determine the static pressure, simply look at the vertical axis of the performance curve, where CFM = 0. This is the amount of static pressure generated by the exhaust fan that is available for exhaust hose retraction.

NOTE: On smaller systems in which only one Vacuum Holster™ is operational, the RD Series is most suitable to achieve higher static pressures in the low CFM range.

Multiple Vacuum Holsters™ per Exhaust Fan

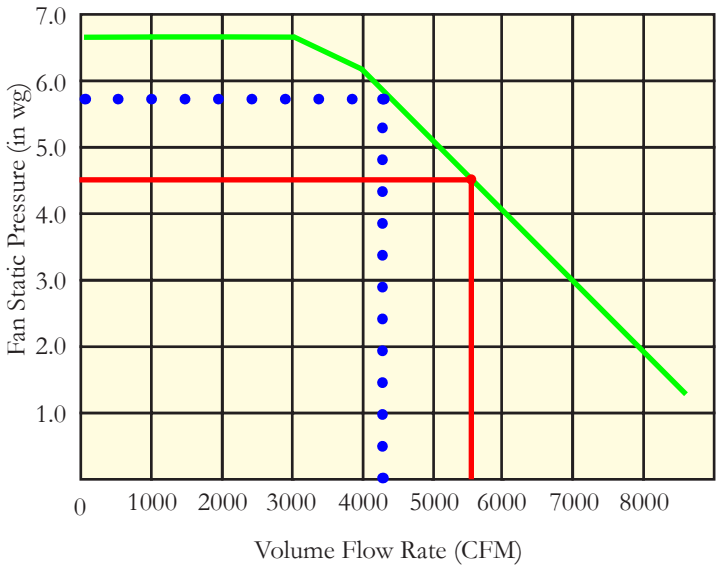
On larger systems with multiple service bays and service technicians, more than one Vacuum Holster™ may be in operation at the same time. When this situation arises, one exhaust hose will have to retract while another hosedrop is open. If a hosedrop is opened, the CFM in the system is not equal to zero, and therefore the corresponding shut off pressure (when CFM = 0) will not be present throughout the entire system.

The exhaust fan must operate along its performance curve. By computing the amount of CFM running through the system, the corresponding static pressure available for retraction in the other closed hosedrops (where CFM = 0 from the damper to the duct manifold) can be determined by ascertaining the pressure at the fan inlet and deducting the pressure drop (usually negligible) through the intermediate duct.

NOTE: In larger systems, the BD or BB Series is recommended. These fans have backwardly inclined airfoil wheels, which (unlike flat-bladed backwardly inclined wheels) provide smooth operation over the entire operating range.

The fan curve below presents an example of a system with 18 Vacuum Holsters™ with 4" x 17' combo hose on one exhaust fan, for a total CFM requirement of (300 CFM x 18) 5,400 CFM. The static pressure at the point of maximum operation is 4.6", as seen from the solid lines.

The static pressure needed to retract 17' of hose is 5.7" (Table 6). As seen from the dotted line, this pressure is present when CFM is 4,200 or less; thus a Holster would retract readily even when fourteen others are open and in operation. If a 100% usage factor is desired, it would be necessary to select a fan with higher static pressure in the 4,200-5,600 CFM range.



DESIGN PROCEDURE WORKSHEET - HOLSTER AUTOMOTIVE

SELECTION CRITERIA #1: CFM-STATIC PRESSURE REQUIREMENT

CFM CALCULATION

Number of hosedrops .....1 _____
CFM per hosedrop (see Table 1 on page 4, confirm with local codes).....2 _____
Total CFM requirement (Multiply Line 1 x Line 2).....3 _____

STATIC PRESSURE CALCULATION

Loss through longest section of exhaust hose of Vacuum Holster™ (see Table 2 on page 4).....4 _____
Loss through system options (see Table 3 on page 4) .....5 _____
Loss through straight duct (Use standard chart, or estimate .006" wg per foot).....6 _____
Loss through elbows (Use standard chart, or estimate .06" wg per elbow) .....7 _____
Total Static Pressure (Add lines 4-7).....8 _____

DENSITY CORRECTIONS

Altitude correction factor (see Table 4 on page 4) .....9 _____
Temperature correction factor (see Table 5 on page 4).....10 _____
Altitude-adjusted static pressure (Multiply Line 8 by Line 9 by Line 10).....11 _____

SELECT THE FAN TO MEET THE CFM-SP REQUIREMENT (LINE 3 AND 11)

SELECTION CRITERIA #2: EXHAUST HOSE RETRACTION REQUIREMENT

Total system CFM (See line 3 above).....12 _____
Assumed peak usage factor .....13 _____
Maximum CFM at assumed peak usage (Multiply Line 12 x Line 13) .....14 _____
Static pressure needed for retracting exhaust hose (See Table 6 on page 5) .....15 _____
Static pressure available for retracting exhaust hose (See Fan Performance Curve).....16 _____
(Observe static pressure at the CFM value on line 14)

Take the CFM value from line 14 and locate it on the fan performance curve that was selected according to criteria #1. Note the corresponding static pressure, and enter that value on line 16. Compare lines 15 and 16. For adequate retraction, line 16 should equal or exceed line 15. If not, consider a fan with higher static pressures in the lower CFM range.

EXAMPLE

The fan curve below presents an example of a system with 18 Vacuum Holsters™ with 4" x 17' combo hose on one exhaust fan, for a total CFM requirement of (300 CFM x 18) 5,400 CFM. The static pressure at the point of maximum operation is 4.6", as seen from the solid lines
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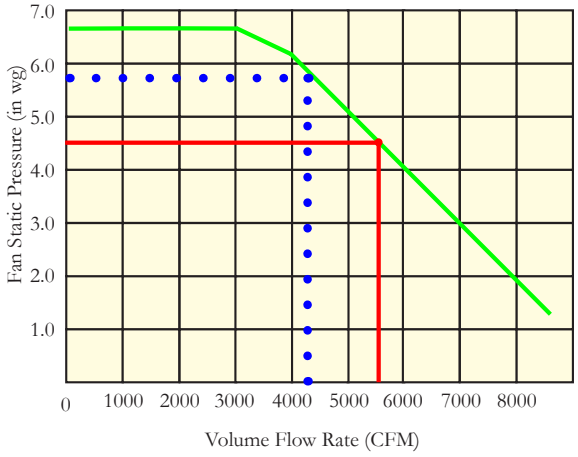
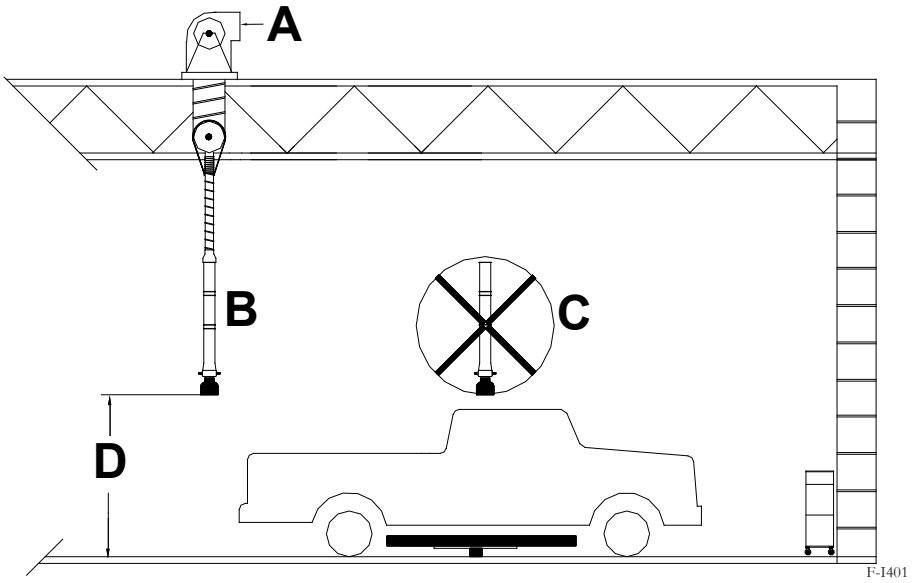


DESIGN PROCEDURE - VACUUM HOLSTER™ AUTOMOTIVE GUIDELINES FOR LOCATION OF VACUUM HOLSTERS

GUIDELINES FOR LOCATION OF 4" VACUUM HOLSTERS™, SIDE VIEW

Ascent Systems strongly encourages the system designer to consider the location of the vehicle hoists when designing the spiral duct manifold.

Determine what the probable longest vehicle will be, and estimate where its bumper will be located when the vehicle is positioned on the hoist. To ensure the exhaust hose does not have to wrap around a vehicle, locate the duct manifold 1 or 2 feet behind the bumper of the longest vehicle.



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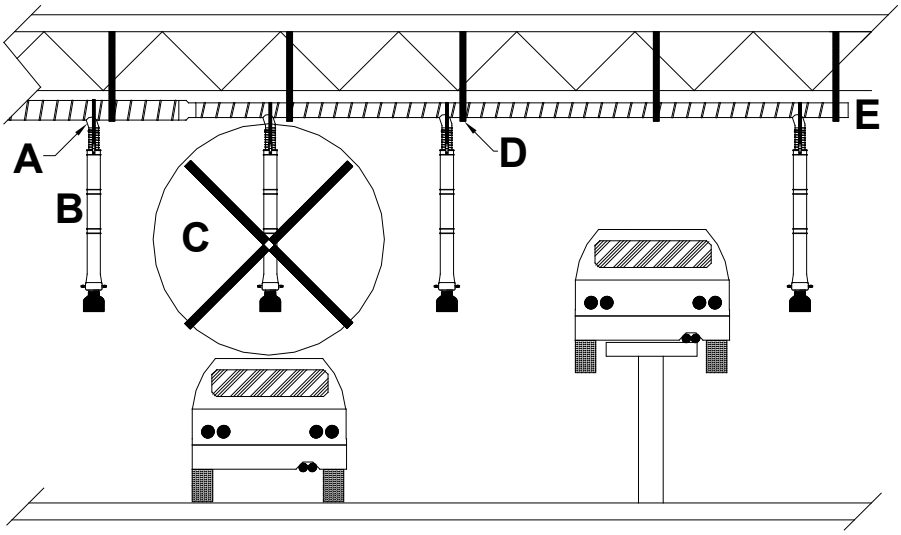
Note	Comment
A	Outdoor fan placement is strongly recommended.
B	CORRECT LOCATION: The Vacuum Holsters™ hang 1-2' behind the bumper of the largest vehicle on the hoist.
C	WRONG LOCATION: Here, the Vacuum Holster™ is too far forward, potentially creating a coverage issue.
D	Bottom rim of tailpipe adapter recommended to be 6'6" AFF. Please confirm with owner rep before installing.

GUIDELINES FOR LOCATION OF 4" VACUUM HOLSTERS™, END VIEW

Ascent Systems strongly encourages the system designer to locate the Vacuum Holsters™ between the service bays.



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Note	Comment
A	Use a take-off fitting with 4" diameter.
B	CORRECT LOCATION: The Vacuum Holsters™ hang between the service bays.
C	WRONG LOCATION: Avoid placing Vacuum Holsters™ in the middle of the service bay.
D	Place a duct support strap near each Vacuum Holster.
E	Do not use elbows at the end of a run of spiral duct. Extend the duct manifold past the Vacuum Holster, and terminate the run with a plug. The suspension strap cannot loop over an elbow.

INSTALLATION AND DIMENSIONS - VACUUM HOLSTER™ AUTOMOTIVE

SUSPENSION OF 4" VACUUM HOLSTERS™

Typically, 4" Vacuum Holsters™ can be suspended directly from the exhaust duct manifold. In order to ensure that the bottom rim of the tailpipe adapter is 6'6" AFF, there are two basic installation arrangements.

1. Direct to duct suspension, in which the exhaust hose of the Vacuum Holster™ is connected directly to the duct manifold. Typically, this method is suitable when the bottom of the duct manifold is 13' or less AFF (Diagram 1 below).

NOTE: If the duct is very low AFF (typically 12'0" or less), the installer may cut the Hose Holster to a shorter length, provided the cut does not exceed 16" (Diagram 2).

2. Extended direct to duct suspension is generally used when the bottom of the duct manifold is 13' or more AFF. The installation contractor supplies a piece of spiral duct (called the *duct spacer*), which is placed between the exhaust hose of the Vacuum Holster™ and the spiral duct manifold. To ensure that the bottom rim of the tailpipe adapter is 6'6" AFF, the length of the duct spacer must be sized per application. With extended duct suspension, it should never be necessary to cut the Hose Holster to a shorter length. See diagram 3 below.

The height of the duct manifold AFF is the key measurement to determine the proper suspension method. Due to variance in the types of takeoff fittings that may installed, the above measurements of duct manifold AFF should be used as guidelines, and not as hard-and fast-rules.

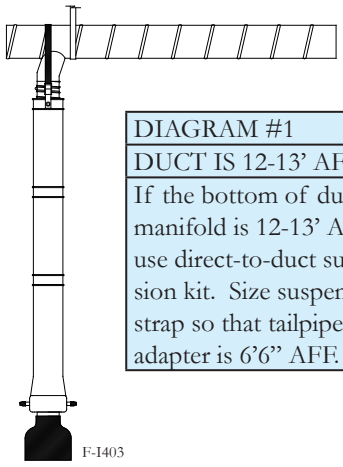


DIAGRAM #1
DUCT IS 12-13' AFF.
If the bottom of duct manifold is 12-13' AFF, use direct-to-duct suspension kit. Size suspension strap so that tailpipe adapter is 6'6" AFF.

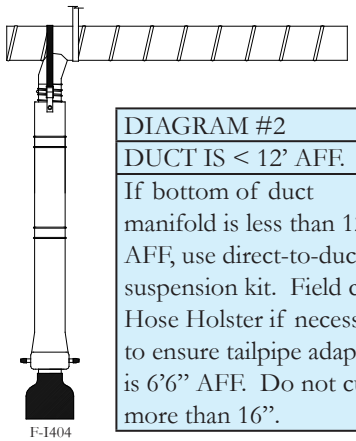


DIAGRAM #2
DUCT IS < 12' AFF.
If bottom of duct manifold is less than 12' AFF, use direct-to-duct suspension kit. Field cut Hose Holster if necessary to ensure tailpipe adapter is 6'6" AFF. Do not cut more than 16".

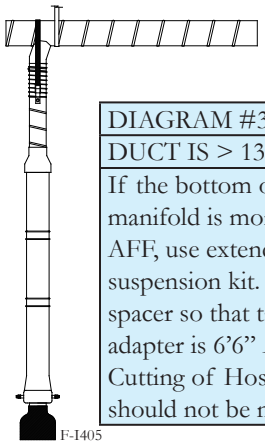
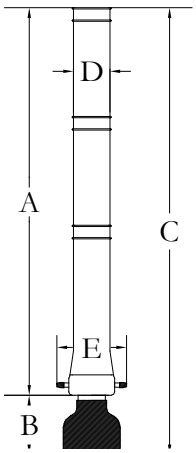


DIAGRAM #3
DUCT IS > 13' AFF.
If the bottom of duct manifold is more than 13' AFF, use extended duct suspension kit. Size duct spacer so that tailpipe adapter is 6'6" AFF. Cutting of Hose Holster should not be necessary.

DIMENSIONS & WEIGHTS: VACUUM HOLSTER™

Dimensions & Weights - Vacuum Holster™ Assembly		
Hose Holster Model	4" Compact*	4" Extended
A - Holster Height	40"	56"
B - Tailpipe Adapter below Holster	8 3/4"	8 3/4"
C - Total Height Vacuum Holster Assem.	48 3/4"	64 3/4"
D - Width, Holster Body	5 3/8"	5 3/8"
E - Width, Damper Axle	10 1/4"	10 1/4"
*For Compact Holsters, A, B, and C are minimums. The installer may field-cut the Holster to any length between these two boundaries.		
Weight - Vacuum Holster™ w/ 17' Hose	20 lbs.	22 lbs.
Weight - Vacuum Holster™ w/ 20' Hose	22 lbs.	24 lbs.
Weight - Vacuum Holster™ w/ 23' Hose	n/a	26 lbs.



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ASCENT SYSTEMS VACUUM HOLSTER™ EMISSIONS REMOVAL SYSTEM