DESIGN PROCEDURE
VACUUM HOLSTER™ FLEET SERVICE

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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™ fleet service application. The Vacuum Holster™ simplifies vehicle exhaust removal by using the static pressure of the exhaust fan to assist in storage of the exhaust hose, eliminating the expense and maintenance of equipment like 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 fleet service Vacuum Holster™ uses 6" diameter hose to exhaust 600 CFM per drop. 5" diameter hose for 400 CFM per Vacuum Holster™ is also available, but is not recommended as strongly as 6" diameter hose. For either 5" or 6" hose sizes, the Vacuum Holster™ is suitable for applications with intermittent airstream temperatures up to 700 degrees F.

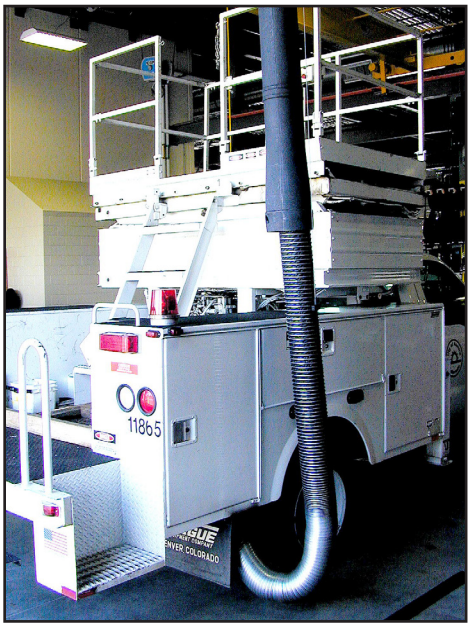
Before beginning design, it is important to note that the fixed-mounted Vacuum Holster™ is **not** intended for the following applications:

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 6" 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 determine the CFM requirement and size the fan, 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. As mentioned above, the Vacuum Holster™ relies on the static pressure from the exhaust fan to store the exhaust hose, and pages 4-5 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.



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Finally, page 7 depicts typical fleet service layouts and gives suggestions for the location of the equipment. Page 8 provides dimensions and weights for common product selections.

OTHER RESOURCES

This manual explains how to design 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™ FLEET SERVICE

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.
6" exhaust hose (for 600 CFM) is recommended for commercial truck and heavy equipment applications. 5" is available for applications with airflow requirements of 400 CFM.

B. Length of Exhaust Hose.
5-6" diameter exhaust hoses come in standard lengths of 17', 20', and 25'. For 16' wide bays, a hose length of 20' is sufficient; for 20' wide bays, select a hose length of 25'. 17' lengths should be considered only when the vehicle is in close proximity to the Vacuum Holster™.

C. Height of Hose Holster Storage Cylinder.
The Extended Hose Holster is the standard Hose Holster size, and is 72" high for either 5" or 6" hose. The Extended Hose Holster is the default Hose Holster selection, and should be specified in almost all cases.

The Compact Hose Holster is available for 5-6" 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 installation when the duct manifold height is low - 14' for 5-6" Holsters. If the bottom of the duct manifold is higher than the above guidelines, the extended model is recommended.

D. Type of Exhaust Hose.
High Temp Silicon-Kevlar Hose can withstand temperatures up to 600 degrees F continuous, 700F intermittent. It is available in 5-6" diameters, and should be selected for diesel applications such as commercial trucks or heavy equipment.

E. Tailpipe Adapter and Rotational Damper.
Based upon the selection of the exhaust hose, the appropriate tailpipe adapter and rotational damper assembly are implicit in the part number.

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 Bracket Suspension Kit is the more commonly selected and more economical suspension kit. It can be used when there is no bridge crane present and when the extended coverage and versatility of pivoting boom arms are not required. Part # A(5/6)BHS.

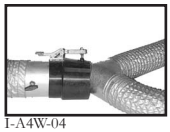

I-A6B-01

2) 6" Pivoting Boom Arms are recommended if the facility in question has a bridge crane. Boom arms may also be selected for their additional coverage and versatility. The boom may have a Holster fixed-mounted at the end, or may be equipped with a slide track to allow the Holster to travel the length of the arm.


I-A6P-03

STEP #2: SELECT SYSTEM OPTIONS

Please refer to product details for more detailed descriptions of system options. In the fleet service/HD market, the most common options are as follows (same for 5" or 6" hose):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1) Wye Assemblies for connection to dual exhaust pipes, part # A4WYE.


I-A6E-05

2) Exhaust Canes for connection to vertical stacks, part # A6EXC-07 for standard height cane. Short cane: (A6EXC-05); Longer cane (A6EXC-10).


I-H6S-11

3) Extension Hoses for additional reach, which include a tailpipe adapter without a damper assembly. Part # H6S??-EX, with "??" indicating the length.


I-A3C-01

4) Remote Start fan control panel (part # A3CP, one per exhaust fan) and Start Transmitter (part # A3TK, one per Vacuum Holster), for fan on-off control from the Hose Holster.

STEP #3: SELECT THE 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 correct exhaust fan.

DESIGN PROCEDURE - VACUUM HOLSTER™ FLEET SERVICE PART NUMBERS AND NOMENCLATURE

(VH) = **V**acuum **H**olster™

(5/6) = Diameter of the Exhaust Hose

(??) = Length of the Exhaust Hose
Standard Length, 5-6" Hose: 17, 20, or 25'

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

(S) = Type of Exhaust Hose
"S" for High Temp Silicon-Kevlar

(B/PBF(12,16,20)/PBS(12,16,20) = Type of Suspension Kit
B = Bracket Suspension
PBF (12, 16, 20)= Pivot Boom with Fixed Holster. 12', 16' or 20' arm.
PBS (12, 16, 20)= Pivot Boom with Slide Track. 12', 16' or 20' arm.

VH - 5 25 E S - B = Vacuum Holster™ with 5" x 25' High Temp Silicon Hose, Extended Hose Holster, and Bracket Suspension Kit.

VH - 6 20 C S - PBF16 = Vacuum Holster™ with 6" x 20' High Temp Silicon Hose, Compact Hose Holster, and 16' Pivoting Boom Arm with Fixed Hose Holster.

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; and
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 # A4WYE**
- **Exhaust Canes for connection to vertical stacks, part # A6EXC-07 for standard height. Shorter canes (A6EXC-05) and longer canes (A6EXC-10) are available.**
- **Extension Hoses (with tailpipe adapter) for additional reach. Part # H6S??-EX. Replace "??" with desired exhaust hose length.**
- **Remote Start exhaust fan control. One control panel (part # A3CP) per fan is needed; one transmitter per Vacuum Holster is recommended (part # A3TK).**

STEP #2: SYSTEM OPTIONS

Please refer to product details for 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 correct exhaust fan.

FAN DESIGN PROCEDURE - VACUUM HOLSTER™ - FLEET

A. CALCULATING THE CFM REQUIREMENT

The recommended CFM per Vacuum Holster™ is given in Table 1. 6" exhaust hose is the standard product and is strongly recommended for commercial truck and heavy equipment applications. 5" exhaust hose is available for applications that fall between the performance parameters of 4" and 6" exhaust hoses.

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	5"	6"
CFM	400	600

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 canes or 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, Vacuum Holster™ at Standard Conditions		
Hose Length	5" dia.	6" dia.
17'	1.55" wg	1.45" wg
20'	1.85" wg	1.70" wg
25'	2.25" wg	2.15" wg

2. Pressure Drop from System Options

Table 3 below shows the pressure drop though system options. Again, this table assumes the CFM rates recommended in Table 1.

Table 3 - Pressure Drop from System Options at Standard Conditions			
Options	Pressure Drop	Options	Pressure Drop
4" Wye Assembly	.40" wg	Exhaust Cane, 6"	0.90" wg
Extension Hose/ft	.09"	Pivot Boom	1.2" + .08" per foot

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 loss 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 exists 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 straightfoward, the designer must make an assumption about the inlet temperatures of a vehicle exhaust system. Primarily due to the dilutionary air from the tailpipe adapters, and the cooling of air en route to the fan inlet, Ascent Systems recommends an inlet temperatures of 150F for fleet service 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 on the previous page. 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 exhaust hose retraction.

FAN DESIGN PROCEDURE - VACUUM HOLSTER™ - FLEET

D. EXHAUST HOSE RETRACTION, CONTINUED

The requirement of static pressure is dependent upon the diameter, length, and composition of exhaust hose. 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.

Table 6 - Static Pressure for Exhaust Hose Retraction

Length, ft.	5" dia.	6" dia.
17'	6.1" wg	5.2" wg
20'	6.5" wg	5.6" wg
25'	7.0" WG	6.1" 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.

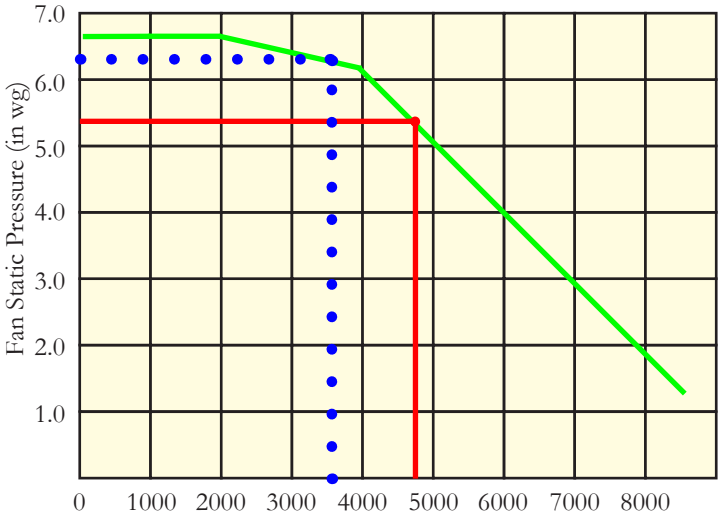
Multiple Vacuum Holsters™ per Exhaust Fan

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 8 Vacuum Holsters™ with 6" x 25' exhaust hose on one exhaust fan, for a total CFM requirement of (600 CFM x 8) 4,800 CFM. The static pressure at the point of maximum operation is 5.3". The static pressure needed to retract 25' of hose is 6.1" (Table 6). As seen from the dotted line, this pressure is present when CFM is 3,300 or less; thus a Vacuum Holster™ would retract readily even when five 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 3,300-4,800 CFM range.



Please refer to Ascent Systems Exhaust Fan Manual For Specific Fan Selection.

DESIGN WORKSHEET - VACUUM HOLSTER™ - FLEET

SELECTION CRITERIA #1: CFM-STATIC PRESSURE REQUIREMENT

CFM CALCULATION

Number of Vacuum Holsters™ ..... 1 _____
CFM per Vacuum Holster™ (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 (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 5) ..... 10 _____
Altitude-adjusted static pressure (Multiply Line 8 by Line 9 and Line 10) ..... 11 _____

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

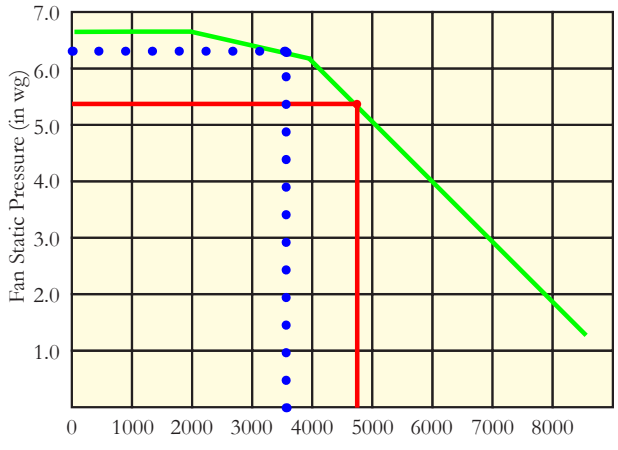
SELECTION CRITERIA #2: EXHAUST HOSE RETRACTION REQUIREMENT

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

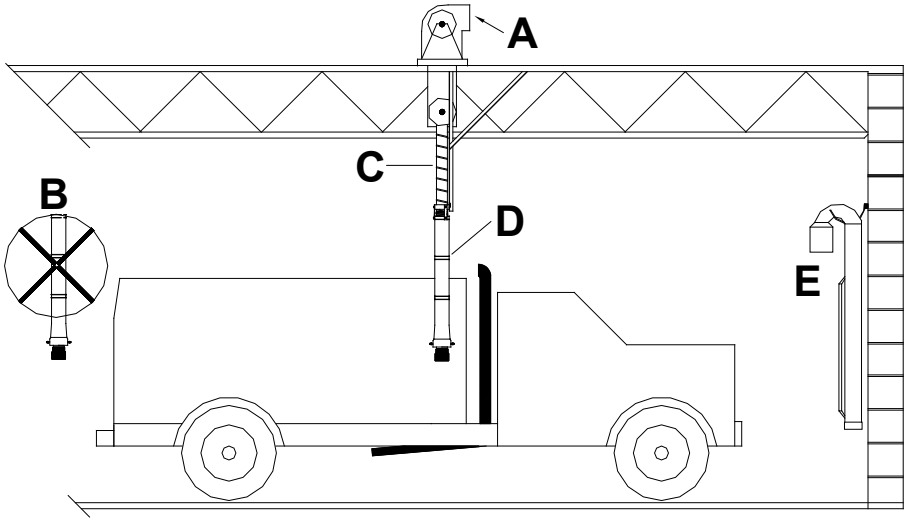
The fan curve below presents an example of a system with 8 Vacuum Holsters with 6" x 25' exhaust hose on one exhaust fan, for a total CFM requirement of (600 CFM x 8) 4,800 CFM. The static pressure at the point of maximum operation is 5.3". The static pressure needed to retract 25' of hose is 6.1" (Table 6). As seen from the dotted line, this pressure is present when CFM is 3,300 or less; thus a Holster would retract readily even when five 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 3,300-4,800 CFM range.



DESIGN PROCEDURE - VACUUM HOLSTER™ FLEET SERVICE GUIDELINES FOR LOCATION OF VACUUM HOLSTERS™

GUIDELINES FOR LOCATION OF 5-6" VACUUM HOLSTERS™, SIDE VIEW

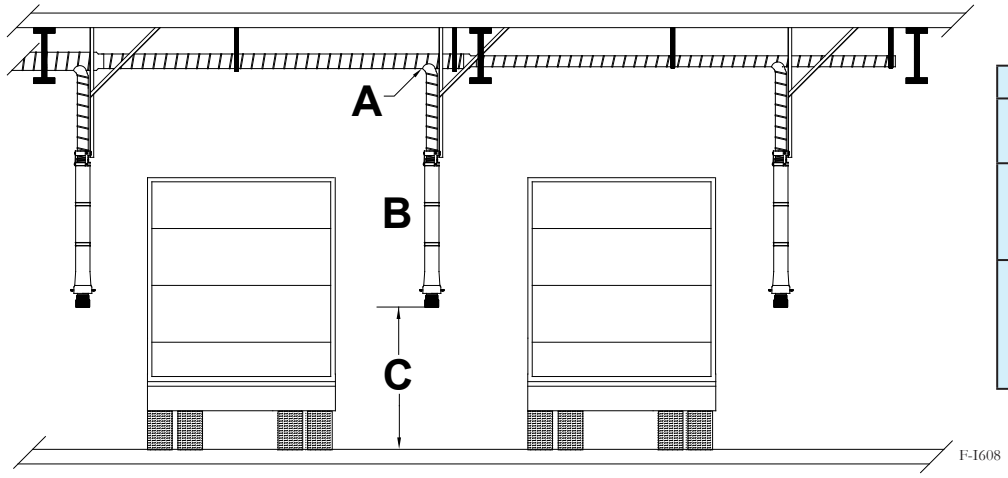
Ascent Systems recommends that fleet service Vacuum Holsters™ generally should be suspended so they are positioned at the midpoint of the service bay, where the vertical stack or undercarriage exhaust is located. However, the designer is encouraged to review the fleet being serviced; some applications, like school buses, may have exhaust pipes at the bumper of the vehicle.



Note	Comment
A	Outdoor fan placement is strongly recommended.
B	WRONG LOCATION: The Vacuum Holster™ is too far back, potentially creating a coverage issue.
C	Uni-Strut or angle iron bracing from structure by contractor. Cross-bracing is strongly recommended.
D	CORRECT LOCATION: The Vacuum Holster™ hangs just behind the cab, near the undercarriage pipe or vertical stack.
E	Exhaust cane is used for vertical stack connection. The hood is placed over the stack, and the base of the cane attaches to the tailpipe adapter.

GUIDELINES FOR LOCATION OF 5-6" VACUUM HOLSTERS, END VIEW

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

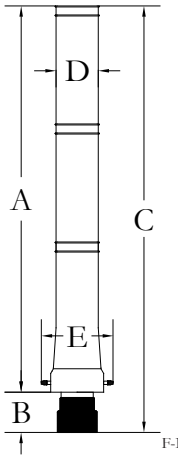


Note	Comment
A	Diameter of take-off fitting to match exhaust hose.
B	CORRECT LOCATION: The Vacuum Holsters hang between the service bays.
C	Bottom rim of tailpipe adapter to be 6'6" AFF. Confirm with owner rep. prior to installation.

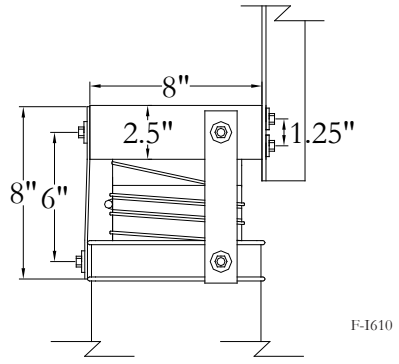
DIMENSIONS AND WEIGHTS - VACUUM HOLSTER™ FLEET

6" VACUUM HOLSTER ASSEMBLY

Dimensions & Weights - Vacuum Holster™ Assembly		
Hose Holster Model	6" Compact*	6" Extended
A - Hose Holster Height	50"	72"
B - Tailpipe Adapter below Hose Holster	7 1/2"	7 1/2"
C - Total Height Vaccum Holster™	57 1/2	79 1/2"
D - Width, Hose Holster Body	7 7/8"	7 7/8"
E - Width, Damper Axle	14"	14"
*Note: For Compact Holsters, A, B, and C are minimums. The installer may field-cut the Holster to a length between the two figures.		
Weight - Vaccum Holster w/ 17' Hose	38 lbs.	41 lbs.
Weight - Vaccum Holster w/ 20' Hose	41 lbs.	44 lbs.
Weight - Vaccum Holster with 25' Hose	n/a	49 lbs.

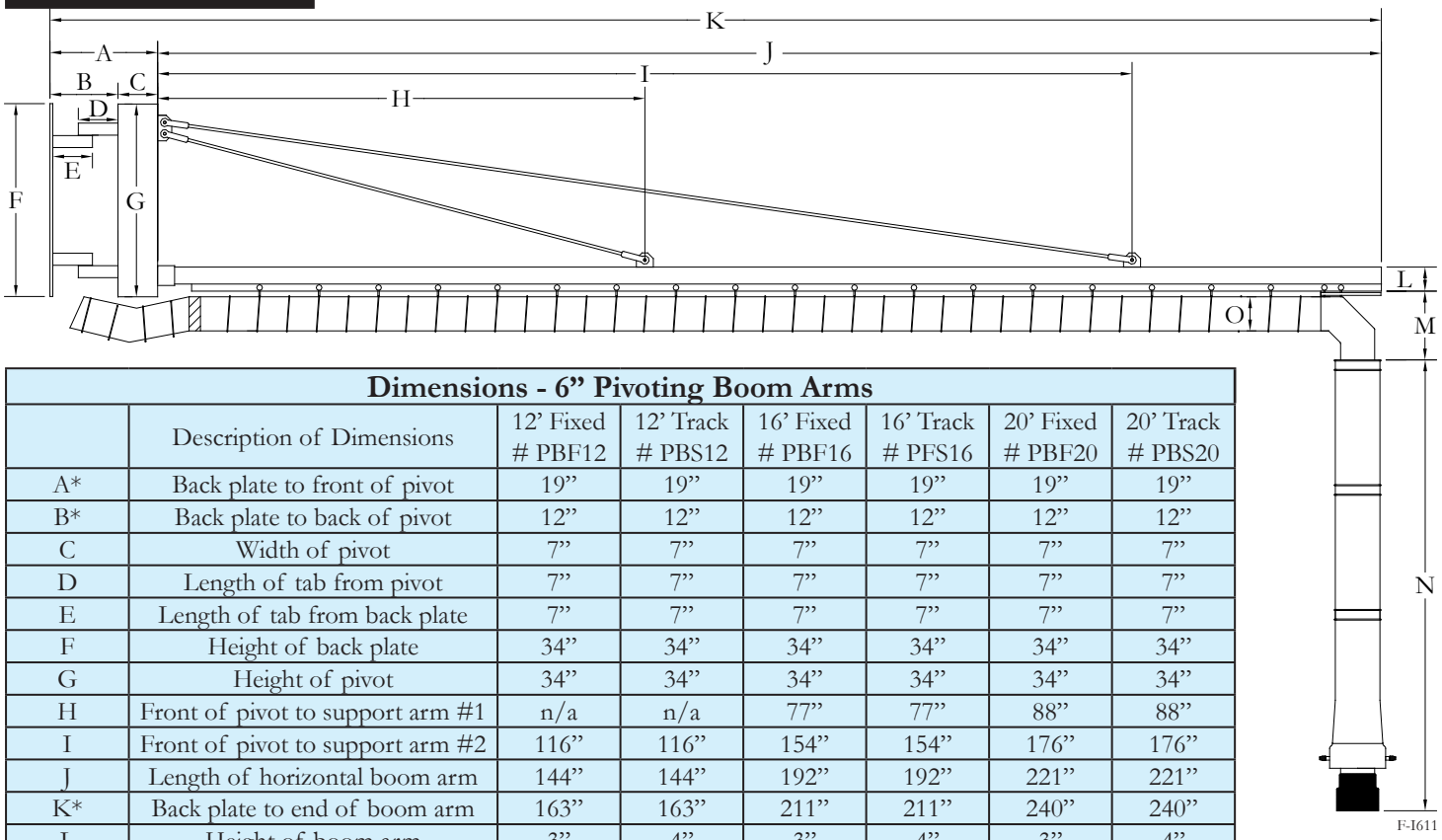


6" BRACKET SUSPENSION KIT



Weight of kit: 3 lbs. Part # A6BHS

PIVOTING BOOM ARMS



Dimensions - 6" Pivoting Boom Arms							
	Description of Dimensions	12' Fixed # PBF12	12' Track # PBS12	16' Fixed # PBF16	16' Track # PFS16	20' Fixed # PBF20	20' Track # PBS20
A*	Back plate to front of pivot	19"	19"	19"	19"	19"	19"
B*	Back plate to back of pivot	12"	12"	12"	12"	12"	12"
C	Width of pivot	7"	7"	7"	7"	7"	7"
D	Length of tab from pivot	7"	7"	7"	7"	7"	7"
E	Length of tab from back plate	7"	7"	7"	7"	7"	7"
F	Height of back plate	34"	34"	34"	34"	34"	34"
G	Height of pivot	34"	34"	34"	34"	34"	34"
H	Front of pivot to support arm #1	n/a	n/a	77"	77"	88"	88"
I	Front of pivot to support arm #2	116"	116"	154"	154"	176"	176"
J	Length of horizontal boom arm	144"	144"	192"	192"	221"	221"
K*	Back plate to end of boom arm	163"	163"	211"	211"	240"	240"
L	Height of boom arm	3"	4"	3"	4"	3"	4"
M	Boom arm to top of Holster	12"	12"	12"	12"	12"	12"
N	Height of Holster and adapter	79 1/2"	79 1/2"	79 1/2"	79 1/2"	79 1/2"	79 1/2"
O	Diameter - Duct or Slide Track	6"	6"	6"	6"	6"	6"
	Weight, including Holster w 25' hose	250 lbs.	265 lbs.	285 lbs.	305 lbs.	310 lbs.	335 lbs.
Note: Dimensions marked with an asterisk (*) assume the boom arm is perpendicular to the back plate.							