Example Problems

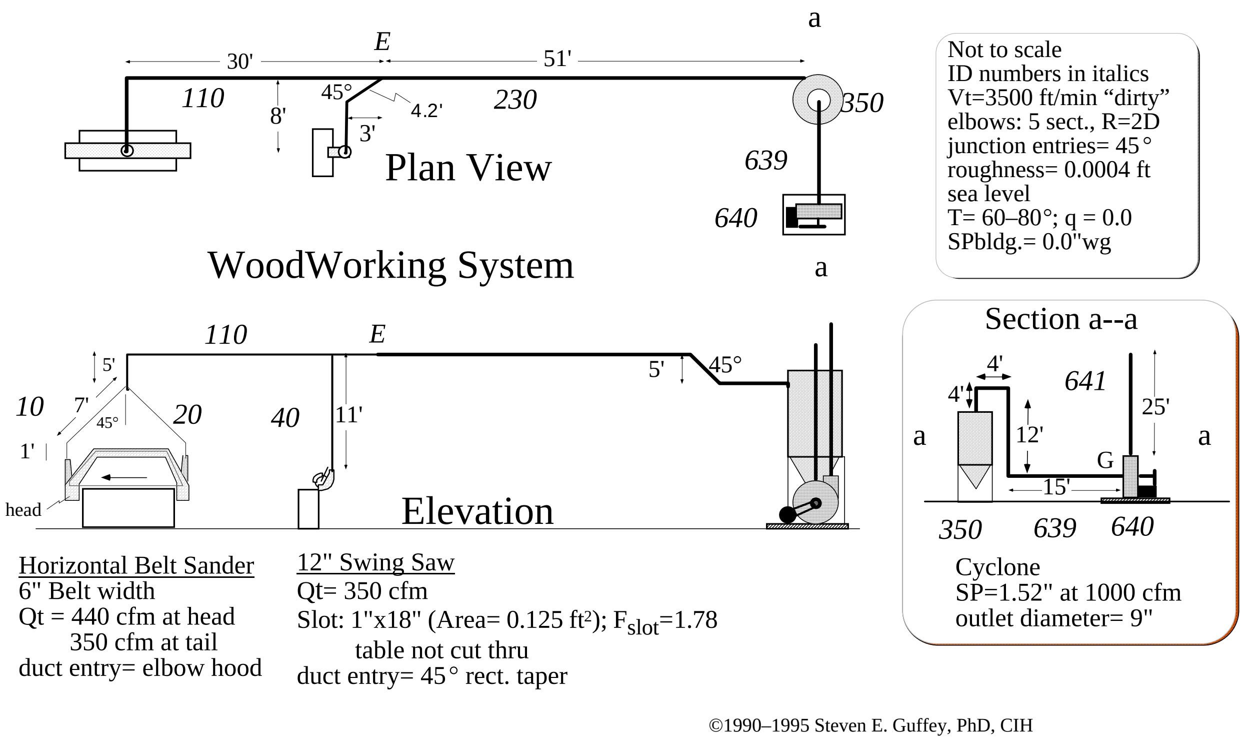
I will give you 2 pts of extra credit for each one you do.

For each problem produce the optimum solution: the least excess airflow at the least pressure, with no airflow below minimum levels and no duct velocities below minimum levels. Ideally, no duct velocities will be highly excessive (>200% of target value).

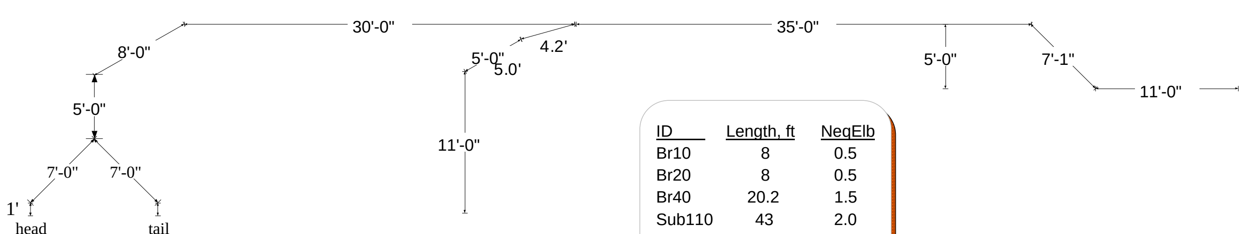
When you are finished, submit the .SEG file you have created plus a brief discussion of your methods, results, and conclusions. The results should include a table showing the duct ID, diameter, Qt, Qfinal, SPH, Spend, each loss coefficient, length, no elbws (etc.). A separate table should show the fan pressures. Don't just give me the Heavent printout.

EXAMPLE 1: WOODWORKING PROBLEM — NEW SYSTEM DESIGN

Given the information in the figure below, design an exhaust ventilation system that will meet all system airflow and velocity requirements at a minimal fan pressure and total airflow (Q). A more primitive version developed by the author and John Lumsden was (is?) used by at least one ACGIH Industrial Ventilation Conference. The solution follows the problem statement.



Note that the duct downstream from the cyclone should have a 9" diameter to match the cyclone exit. Keep in mind also that the ducts at the fan inlet and at the fan outlet must fit the fan. However, we cannot select the fan until we have computed the fan pressure, which requires selecting the ducts sizes! The solution is to pick something reasonable for the duct sizes, select the fan and note its inlet and outlet dimensions, change the fan inlet and outlet duct sizes to fit the fan, and then re-compute the fan pressure and select the fan rotation rate and motor size.



ID	Length, ft	NegElb
Br10	8	0.5
Br20	8	0.5
Br40	20.2	1.5
Sub110	43	2.0
Main230	52	1.0
FanInlet	35	3.0
FanExh	25	0

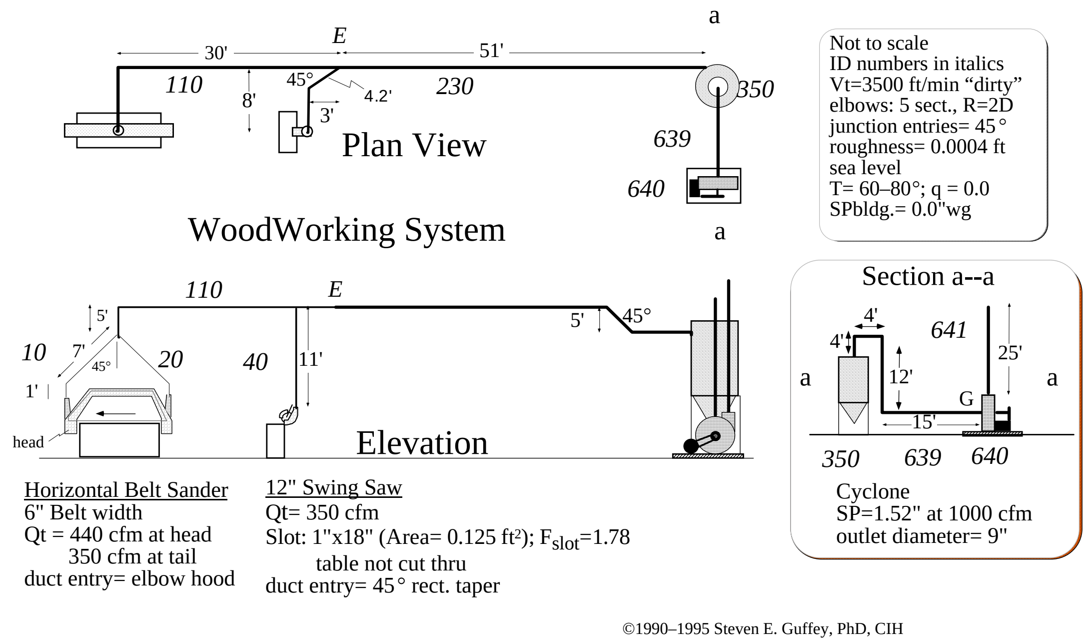
Interpreting hood design drawings can also be tricky, especially in determining the dimensions of slots in slot/plenum hoods. In this example problem, the horizontal belt sanders two hoods are “elbow scoops” (F_H=0.4) Since the “hood scoops” already include the effects of the 90 degree elbows built into it, do NOT count the either hood's elbows towards the total for its branch. The swing saw has a slot opening that is 1"x18" and a duct entry that is a rectangular to round 45 degree taper (i.e., F_H=0.25).

Note, also, that the solution below assumes that:

altitude is sea level; humidity is zero
the building pressure is zero
Heavent set for: author's method for junction calculations
compute effect of static pressure on density
distance offset for measurements= 4 D for SPJ; 2 D for SPH
ducts are specified by exact internal diameter

EXAMPLE 2: WOODWORKING PROBLEM — MODEL AN EXISTING SYSTEM USING MEASURED CONDITIONS AND ADD ON AN ADDITIONAL BRANCH

The system described in Problem No.1 was built. Some time later we have decided to make changes in the system, but first we must create a model of the system using measured pressures, flows, and duct diameters. The measured values are shown on the sketch and table below:

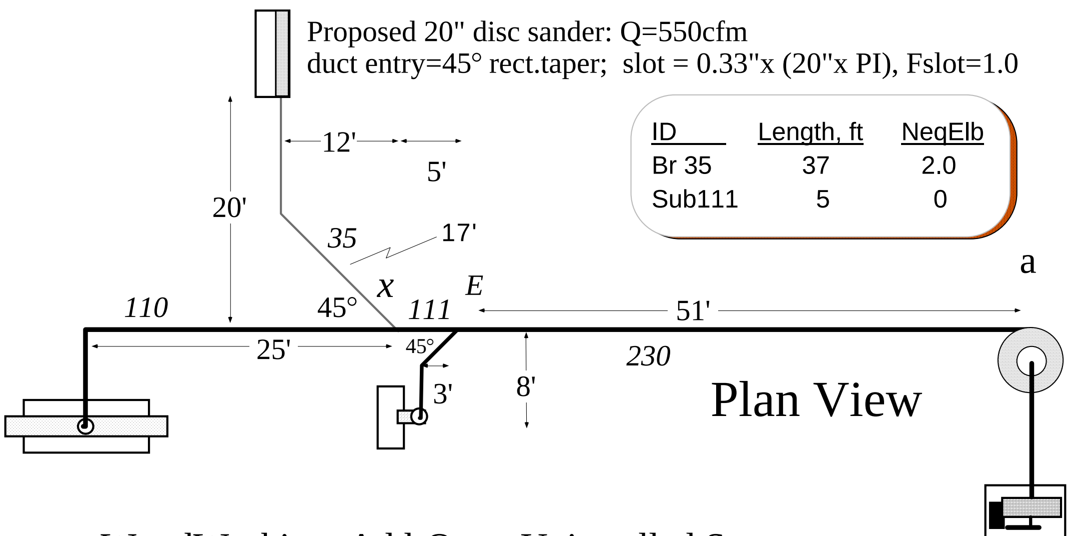


Measured Conditions with Dampers Fully Opened

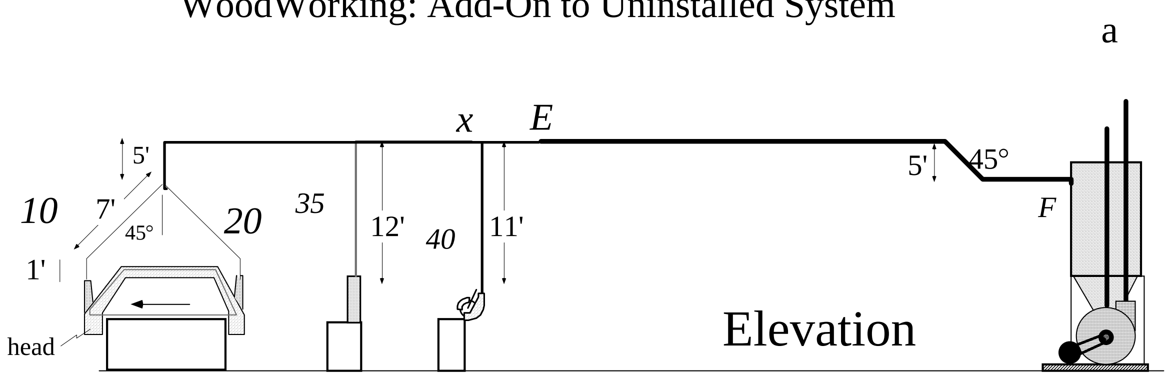
ID	Type	Dia.	V_{avg}	SPH'	SP'
10	Branch	4.50	4152	1.544	-2.00
20	Branch	4.00	4030	1.456	-1.955
40	Branch	4.00	4389	2.565	-4.31
110	Submain	6.00			-4.752
230	Submain	8.00			-5.771
350	Collector				-7.88
639	CollectExi	9.00			-8.806
640	Fan				-8.806
641	Stack	9.00			0.25

To model an existing system simply start a new file from scratch, then toggle Heavent to "no dampers" and "measured values" in the Toggles menu. Next enter the measured values of duct velocity (V_{meas}) and pressures at the hood (SPH_{meas}) and just upstream of the junction ($SPend_{meas}$). We have left lengths as zero values, but you may as well hazard a guess, as long as you don't over-estimate.

It is desired to add a new branch (35) to the existing system we just modeled. The proposed new duct (Branch 35) is shown on the revised figure with dashed lines. Following hoary tradition, we wish to “tap on” to the existing system without making any changes in duct diameters or otherwise altering the rest of the system. In addition, we will not change the fan speed or replace the motor unless forced to. The arget airflows for the old branches remain the same as in Problem No.4, and the requirements for the new branch are shown on the sketch. All airflow requirements are based on values in scfm since the client indicated a strong desire to follow the values recommended on the “VS-plates” in <u>Industrial Ventilation</u>, which do not consider the effects of air density on required airflow.

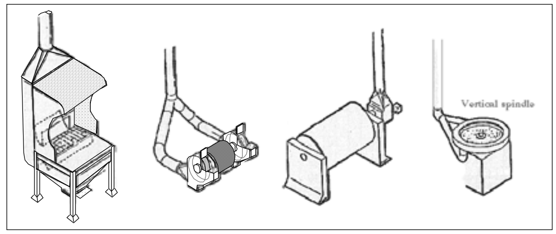


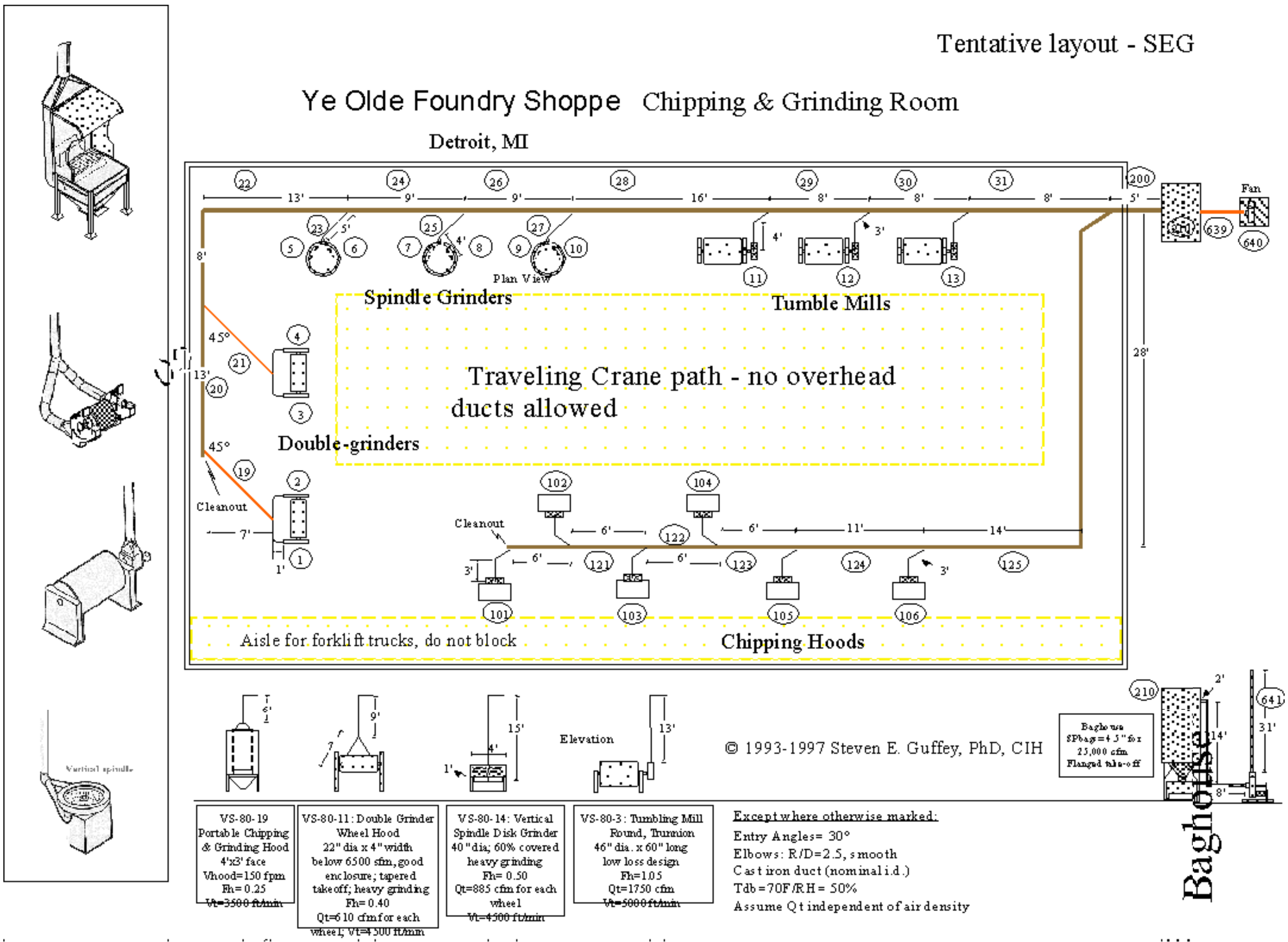
WoodWorking: Add-On to Uninstalled System



EXAMPLE 3: **YE OLDE** FOUNDRY: SMALL CHIPPING & GRINDING ROOM

For the system depicted below, design a new ventilation system based on the information contained in the Special Topics chapter of Industrial Ventilation - a manual of recommended practice, but use the "author's method" for junctions.





EXAMPLE 4: AGRICOLA FERTILIZERS — NEW DESIGN

Agricola Fertilizers
– A Nightsoil Industry
4444 Outlying Place
Prairie View, Iowa 98765-43210
office: 241-178-4866 fax: 241-178-4900

6 April 1992

Steven E. Guffey, PhD, CIH
4212 Wallingford Avenue North
Seattle, WA 98103

re: request for work – job number 428139 CV

Dear Dr. Guffey:

As you and I discussed by telephone last week, we recently employed the firm of "Tin-knockers R'Us" to design and install a ventilation system for our fertilizer packaging operation here in Praire View. We have received their plans and some "calculation sheets" (see attached sketches and calculation sheets). Before we give the go-ahead to install, I would like your opinion on their design and calculations.

In addition, I would like to know what modifications you would make to their design, if any. In our telephone conversation you seemed skeptical that the fan should be located on top of the baghouse. To answer the questions you raised then: We have determined that the fan can be located on the roof. If it is installed on the roof, the vertical distance from the top of the air-cleaner to the centerline height of the fan inlet would be 40'. The horizontal distance from the hole in the roof to the fan inlet would be four feet. I understand that you would prefer more straight length to the inlet, but that is not possible. Considering the room taken up by the elbow, the straight duct length just upstream of the fan is going to be pretty short. Furthermore, as I predicted, the owner will not accept a stack height more than 12 feet above the top of the fan (not including the rain protection extension).

For your design, please compute all system flows and pressures and choose a fan, driven speed, and motor size. By the way, we plan to let the contract for the fittings and ducts to a local firm, A. T. Smythe and Sons, Ltd.

Summing up, we want you to:

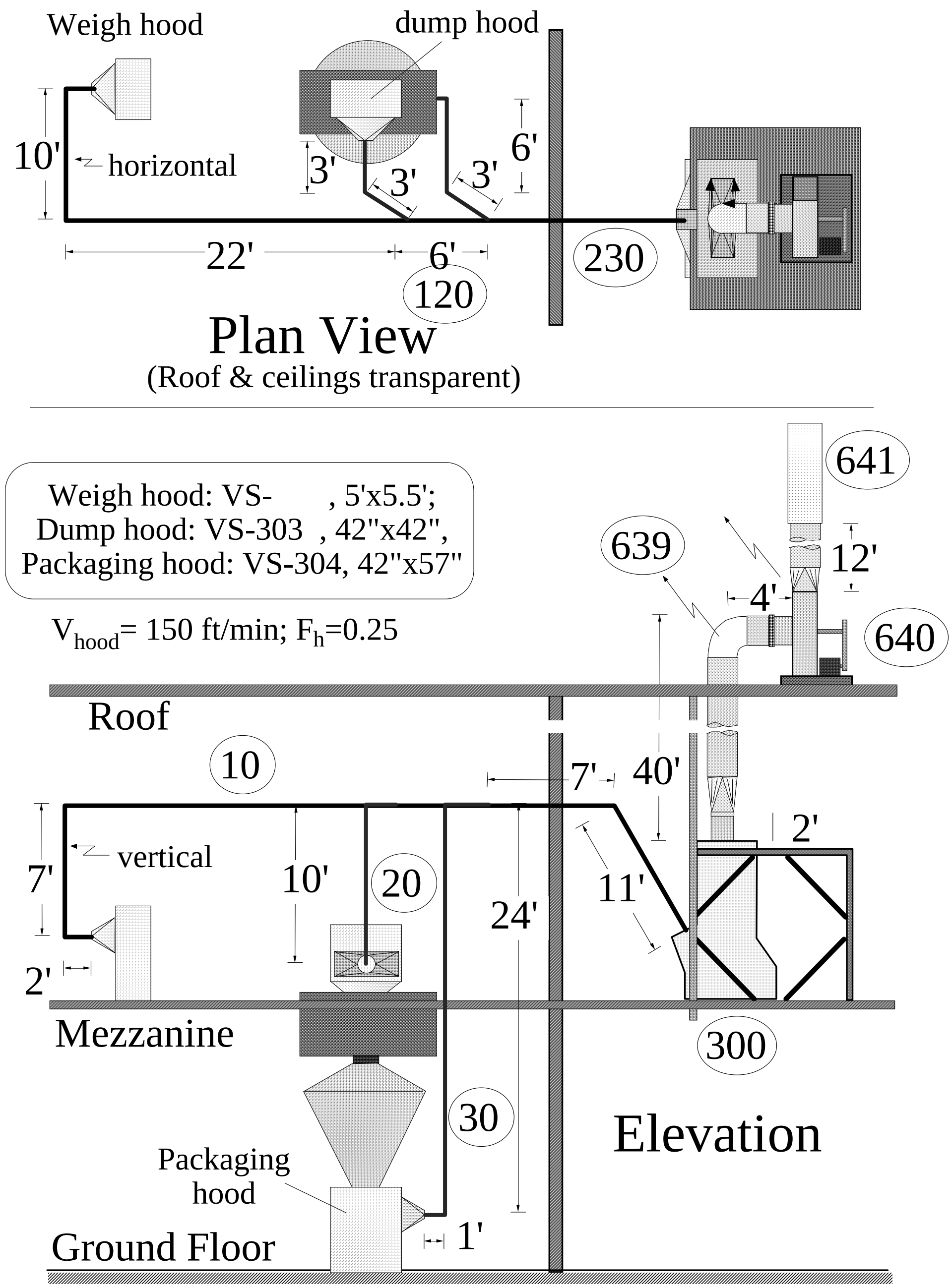
1. Check the attached work product for calculation errors and misjudgments. (How significant are they?).
2. Move the fan to the roof and compute your best estimate of the new system pressures and flows (including hood static pressures).

Sincerely yours,

Gould Oldboy, P.E.

Agricola Fertilizers

Mixing/Weighing Ventilation System



Notes: all elbows R=2.5D, 5 sections; junction entries 30Þ
Ducts: 16 gauge, nominal i.d., standard galvanized steel
Located near Iowa City, Iowa (altitude= ft)
Assumed SP_{bags} = 4" w.g. at 10,000 cfm
Fan on roof as directed by Mr. G. O'Buoy
VS refers to drawings in Industrial Ventilation

EXAMPLE 5: OVEN_IVM

This problem is taken from the static pressure calculations chapter of Industrial Ventilation, which should be referred to for problem details. Note the differences in the your solution and the solution presented in Industrial Ventilation.