DRAFT COPY (091583)

DETERMINATION OF CONDENSABLE PARTICULATE WOODSTOVE EMISSION FACTORS USING CONDAR'S EMISSION SAMPLER

Equipment needed:

1. Standard Condar Power Pack with variable control.

2. Either the 2" or 6" diameter sampling barrel. The 2" barrel samples for 1 minute and the 6" barrel for 9 - 14 Minutes. Thus, the 2" barrel produces a series of short interval samples and the 6" barrel provides continuous composite sampling. Because of this the 6" barrel provides more a-ate quantitative emission factor evaluation but the 2" barrel is superior for short interval "real time" analysis and spot checking.

3. Condar's manometer for measuring emission sampler flow in C.F.M. The sampler uses the fixed orifice pressure drop principle to measure sampler flow rate. (see appendix 1 for orifice calibration derivation).

4. Both S. & S. 595 (or 589 B.R.) paper and S. & S. 1HV fiber-glass filters in 5 or 15 an. diameters for 2" and 6" diameter sampler barrels respectively. Both a 595 and a back-up 1 HV are used for all **quantitative** sampling.

5. Am- of measuring stack temperature at the sampler's nozzle lip. A thermocouple system is best.

6. A means of measuring oxygen.
   Lynn Instruments in Lynn Mass. makes an electronic oxygen analyser for about $ 700.00. Other less expensive units are available and are preferable. We recommend the Fyrite 02 (0-21% scale) analyser by Bacharach, 301 Alpha Drive, Pittsburgh, PA 15238. Price is

$115.00.

7. A balance with a .001 gm. accuracy. If batch weighing is used .01 gm. accuracy can suffice. Items 1 - 4 are provided by Condar in their emissions sampling system. Ohaus scale Corp., 29 Hanover Rd. Florham Park, N.J. 07932, makes several balances which read to .01 gm. accuracy for $ 75.00 to $130.00. If money is no object probably the best balance available is the Mettler top loading quick reading (to 5 decimal places), digital AC 100 model. We have used two of then and they always agreed to within 1 milligram.

Set-up Proceedures

1. Set up the draft gauge following these gauge instructions. For your work, mount gauge on a wall or other fixed structure rather than on a flue pipe. Mount gauge within 3 - 4 feet of the the flue pipe of your stove. Attach upper left comer of gauge's backing plate to wall etc.with one of the self threading screws using one brass eyelet as a spacer. Tighten screw tight. Now, add draft gauge fluid to the left side of the glass tube. Make sure you carefully use the leveling lines on the gauge's aluminum back plate to insure you use the correct amount of gauge oil (provided). Then tentatively set the gauge at 0.0 C.F.M. Now, using a brass eyelet spacer, thread another screw through the middle of the vertical slotted hole on the upper right side of the backing plate. Finally insert the remaining two screws. Make a final liquid level adjustment and tighten all screws. Place the shorter rubber hose over right end (straight end) of glass tuba. Insert the 4" stainless tube in the other end of this rubber hose. This stainless tube will later be inserted in the flue pipe to measure draft at the saw height in the flue pipe as the emissions sampler.

   Place the longer rubber hose over upturned left end of the glass gauge tube. Orient upturned end of glass tube vertical. The other end of hose is attached to the 1/4" diameter stainless tube on the head of the emissions sampler.

With both hoses' distal ends not connected to flue pipe or sampler, carefully reset gauge at 0 C.F.M. For this final check make sure right end of gauge glass tube extends past the right edge of the backing plate 1" or match up a finely scratched line made by a diamond pencil with the right edge of the backing plate. The fine line takes precident over the 1 " overlap if the line is present. When the sampler is in operation the pressure differential between the flue's draft and the sampler's suction (you read this differential on the gauge) indicates flow through the sampler's nozzle in C.F.M. You simply read the C.F.M. directly.

Wnen operating the emissions sampler use the flow meter to allow you to operate at a constant sampler flow rate. Use the sampler's speed control to accomplish this. It is recommended that you choose a flow level and stick to it. (.40 or .45 C.F.M. is recommended). As the filter begins to collect condensable particulates, sampling flow rate will decrease. Using the speed control you can increase motor speed to maintain constant flow.

Drill a 1/2" diameter hole in the flue pips to accept the sampler's nozzle. The hole should be as high as practical, 3 to 4 feet above the stove. This will insure complete mixing of flue gases and complete condensation of the flue gases in the sampler barrel at highest tested burn rates. Drill a 1/8" hole in the stack 1" to 3" below the nozzle hole. Install a thermocouple 3/4" into the stack to measure the temperature at the nozzle's tip. Drill an additional 1/4" hole in the stack opposite the nozzle to accept your 02 probe.

Suspend a wire or rope from ceiling to told emissions sampler when it is in operation. An open ended hook attached to the lower end of this line is recommended to'insert into sampler's hook.

Run sampler's exhaust pipe outside.

Sampling Proceedures

Weighing Filter Papers (Paper and Fiberglass)

Number and weigh filter papers on an accurate balance before sampling and afterwards to obtain particulate collection weight. Wait 3 - 4 hours after sampling to begin weighing dirty filters. This time will allow any stack moisture you collected on your paper filters to evaporate. Additionally, changing room air moisture can cause the paper filters (not the fiberglass) to absorb moisture and cause weight changes. lb compensate for this problem weigh 5 filter papers labeled a - e, when you weigh your clean papers. All paper filters to be weighed should always be spread out for 15 minutes before weighing. As a double check weigh the a-e papers at 5 minute intervals until two successive weights show no change. Then weigh the other papers. In the meantime weigh the fiberglass filters. When you later reweigh the dirty papers reweigh the a - e papers. (Remember to wait 15 minutes with papers spread out). Subtract the original a - e weights and divide by 5 to obtain the average moisture gain or loss per paper. Apply this correction to your emissions weights for the paper filters. The more constant you can keep the humidity of your weighing room the netter. In practice this problem is negligable in the winter when indoor humidity remains quite constant but is a significant problem in the s-r. YOU should always sample with a paper filter in front and a fiberglass filter in back. Your filter numbering scheme should be #1 (paper), #1 a (fiberglass), then #2 (paper), #2 a (fiberglass) etc.

If your balance is accurate to only .01 gram weigh all filters to be used per sample run in a batch following the proceedures in the above paragraph (use 10 sheets, not 5, for moisture gain or loss analysis). Make sure you spread all paper filters out for 15 minutes. Weigh the batch of fiberglass filters you will use. Repeat the same procedure to weigh dirty filters.

NOTE: For most accurate quantitative average emissions factor determinations batch weighing is recommended no matter what scale you use. If the filters do not fit into your balance fold them and hold then with a rubber band. Weigh the rubber band and subtract it's weight.

Sampling Itself (6" diameter barrel)

1. Set stove up and start it following your predesigned schedule. The system most representative of home burning (especially with the more efficient stoves) is to get the stove up to a desired sidewall temperature on kindling and saw cordwood and then add a predetermined charge of cord& fuel (see accompanying Wood'n' Energy Reprint on Emissions sampling).

   Sampling should start immediately following the addition of a set fuel charge.

2. Insert fiberglass filter, smooth side up on screen holder on top of lower barrel of sampler. Then add rubber spacer ring. Then add the paper filter. Clamp top barrel to lower barrel using the toggle snaps. Making sure draft hose is connected to samplers' head, insert sampler in flue pipe, attach to overhead wire or rope and begin sampling at your desire3 rate. Sampling should continue for 9 to 14 minutes depending on filter clogging rate. In no event sample for longer than 15 minutes. It is important that once you have chosen a sample time length you stick with it. Otherwise results will be biased, especially if you batch weighed filters. We have found a 9 minute sample interval best. The filters are then charged within 1 minute and sampling resumed exactly 10 minutes after the last sample started. Sampling thus starts at 10 minute intervals.

   NOTE: We recommend 14 minute sample times at a sample flow rate of .40 C.F.M. for most effective quantitative work.

   A. Measure stack temperature and 02 every 5 minutes and record.

B. After each sample check that the inside lip at end of nozzle is clear. Using a 3/8" drill gently hard ream the nozzles lip after each sample to remove any buildup. By doing this the orifice diameter will be maintained and flow rates accurately measured. Do not clean creosote from inside recessed remainder of nozzle this time. When your sample run is canplete, remove hose from sampler head, unscrew nozzle assembly, clean creosote etc. off the outside of the nozzle and weigh nozzle head. Then, using Mr. Wscle oven cleaner, clean creosote etc from inside nozzle and reweigh. Subtract to obtain emissions quantity which did not reach the filter paper. Add this amount to your total filter weights to obtain total emissions collected (prorate if desired). Continue to sample for your predetermined sample period changing filter papers at your set interval. Measure stack temperature and 02 every 5 minutes. At the end of the sample run weigh the remaining wood to obtain a kg/hour burn rate. lhis is facilitated if the stove is on scales. You do not need this information to calculate the emission factor. However, obtain it to relate your emission factor to the bum rate for comparative purposes.

Calculating the Emission Factor

1. Weigh filters and then add paper and fiberglass particulate collections to obtain a total. Determine the quantity of particulates collection per hour of sampling time by division.

2. Determine your stack dilutim factor. Figure 1 was prepared by using the A.S.M.E. formula for stack dilution factor using their carbon loss system. This system does not require CO be measured if you measure just 02. The results are in fact unaffected by CD readings. If you measured CO2 obtain effective 02 by subtracting CO2 from 21%. Herein lies the disadvantage of measuring just CO2.

You will have to measure CO or assune a value to use figure 1 effectively. Ebr dirty buring stoves you can assume 2%, moderately clean stoves 1%. and very clean stoves 0%. Read 02, it is more effective. Read the dilution factor, from figure 1, by finding your . average 02 level for your sample run.

The stack dilution factor will be in error to some degree depending on the amount of unburned hydrocarbon in the flue gas. This will cause emission factors to err on the high side. However, the maximum error is only about 13% which occurs with the dirtiest burning stoves. Very clean stoves have practically no unburned hydrocarbon induced error however. (less than 1%)

3. Determine your stack temperature factor. The fact that the sample nozzle samples hot moist gases requires a flow correction factor to be made. The sampler flow rate corrected to S.T.P. is actually less than your gauge reads when hot gases are being sampled. The correction factor to S.T.P. is wall known and is reproduced here as table 1 from the North American Combustion Handbook. Obtain the correction factor associated with your average stack temperature. Note that table 1 only goes up to 650 degrees F. Do not sample above this temperature, as complete hydrocarbon condensation cannot be guaranteed at these high stack temperatures. Hopefully, this will encourage lower burning rates during emissions sampling than have historically been used.

Calculation of Emissions Factor

$$\text{Emission Factor (gm/dry kg of wood)} = \frac{\text{(particulate wt.gm./hour)(3.04)(stack dilution factor)}}{\text{(average sampler C.F.M.)(Stack temperature factor)}}$$

This formula can be either used to calculate an average emission factor for the entire sample run or data from particular individual filters can be used to determine emission factors for short time intervals. This data shows changes in emission factors during the burn cycle and by segmenting the sample run and adding the segments together a total emission factor can be obtained in this alternate manner.

See Appendix 2 for derivation of emission factor equation.

Using the 2 inch diameter sampling barrel

The above proceedures apply for the 2 inch barrel except that sampling times are restricted to 1 minute because it's filter paper has less area for particulate-accumulation. Other than that follow all proceedures. Sample for 1 minute either every 10 or 5 minutes.

You may find that when using two filters in the 2" barrel that you can not obtain a high enough sampler flow. Cover one of two of the 1/4" diameter air dilution tiles on the barrel's side (no more), and flow rate will increase.

PROBLEMS YOU MAY ENCOUNTER

Problem: Manometer reading does not move or it jerks.
Solution: You have fluid in your hose. Remove hose and blow it out with compressed air. If you have left the manometer without it's hoses attached draft fluid may thicken and stick. Clean glass tube with a mild dish detergent.

Problem: My filter clogs before 14 minutes.
Solution: If stack temperature is less than 250 degrees F cover as many dilution holes as necessary to maintain flow. If stack temperature is higher you can cover up to 3/4 of the holes after your flow drops. As a last resort after this has been done terminate the sample carefully noting the sample length on your form. This problem usually occurs at high burn rates, especially

with stoves using a grate and primary air coming from beneath.

Problem: When weighing filters individually a few paper filters may show a negative weight for a very clean burning stwe.

Solution: It is not known what causes this phenomenon. Fossibly fine carbon enters or blocks spaces which would normally be occupied by moisture. Consider these particular filters as having zero particulates.

Appendix`1:

The sampler's nozzle is a .375" I.D. fixed orifice. The flow rate readings on the sampler's manometer were calibrated by use of a .313" diameter square edged orifice placed 12 pips diameters downstream from the samplers' nozzle. All dilution air holes and seams were sealed shut. Flange taps were placed 1 inch upstream and downstream fran the fixed orifice in standard fashion. Pressure differentials were measured by a Dwyer manometer and related to flow by the American Gas Association's equation:

C.F.H.= 1658 (K)(a) wc/G, in cubic ft./hr.

K = .64 for square edged orifice with d/D less than .3 (from American Gas Association and North American Combustion Handbook)

a = Area of orifice in sq. inches.

wc = pressure differential in inches of water

G = Relative density of sampled air compared to room air.

d = Orifice diameter

D = Sampler tube diameter

Appendix`2:

Derivation-of-missicns~factor-fornula -

1. Emissions factor = (Flue gas production rate) x (Sampling Factor) (particulates collected) in gms/kg

2. Flue gas production rate*
Dry gas kg. per es-fired kg. of wood =

$$\frac{11(\%\,CO_2) + 8(\%\,O_2) + 7(\%\,N_2 + \%\,CO_2)}{3(\%\,CO_2 + \%\,CO)} \bullet (\%\text{ carbon in fuel})$$

Equation 2 indicates there are 6.22 kg of flue gas per dry kg of wood at 0% excess oxygen. Using 50% carbon in wood at S.T.P. this converts to 182.6 cu. ft/kg. of fuel. Figure 1 provides stack dilution factors to allow you to calculate S.T.P. cu. ft. flue gas at various excess air levels (as measured by % 02).

3. Sampling Factor=

$$\frac{182.6 \times (\text{stack dilution factor})}{(\text{average sampler flow in C.F.H.}) \times (\text{stack temp. factor})} \text{ in hr/kg}$$

• From <u>A.S.M.E. Short Form Calculation Sheets For Hydrocarbon Combustion</u>

The equation can be used for sampler flow in C.F.M. units by dividing the constant 182.6 by 60 to obtain 3.04, hence the form of eguation shown in <u>Calculation-of-Emissions.Factor</u> section and below is derived. Note that to calculate emissions factors the equation does not rely on a useofburn rate.

4. Emission Factor (gm/dry kg of wood) =

$$\frac{(\text{particulate wt. gm./hr.})(3.04)(\text{stack dilution factor})}{(\text{average sampler C.F.M.})(\text{Stack temperature factor})}$$

EXAMPLE:

Average stack temperature = 300 degrees F. (From stack thermocouple)
Stack temperature factor = .83 (from table 1)
Average sampler flow = .45 C.F.M. (From sampler's manometer)
Average 02 = 10% (From 02 Analyser)
Stack Dilution factor = 1.85 (from figure 1)
Total praticulate weight = 5 gm over 5 hours or 1 gm/hour

$$\text{mission factor} = \frac{(1)\cdot(3.04)\cdot(1.85)}{(.45)\ (.83)} = 15.1 \text{ gm/kg of wood.}$$

Appendix 3

(EXAMPLE)
SAMPLE DATA FORM FOR BULK WEIGHED FILTERS

(Only 2 Filters Used in Example)

Stove ________ Sidewall Temp. or Output ________

Date ________

'ilter	02 %	Stack Temp. (°F)	Stov Wall Temp	Sample Flow (CFM)	Fuel Added (kg)	Sample Start and Finish Time
	0.0	275	300		10	1:00
	9.5	280	305	.40		to
& la	0.5	29				1:14 (14 min)
	.0.0	280				1:15
2&2a	9.0	290	305	.40		to
	0.0	300	300			1:20 (14 min)
						(28 min total)

(1.) Wt. of standard a - e paper filters before sampling = 5.919 gm.

Ave. Sampler Flow = .40

(2.) Wt. of Standard a - e paper filters after sampling = 5.929 gm.

Ave. Stack Temp. = 286"

Correction Factor For Paper Filters = −(wt. (2) − wt. (1)) x no. of sample filters / 5

Stack Temp. Factor = .84

Paper Filter Correction Factor = −(5.929−5.919) x 2/5 = −.004 gm.

Ave. O_2 = 9.8

Wt. of Clean Sample Paper Filters. Papers = 3.210 gm.
Wt. of Dirty Filter Papers = 3.310 gm

Stack Dilution Factor = 1.85

Particulates on paper Filters = .100 gm.
Correction Factor = .004 gm.

Total Particulates = .301

Corrected particulates = .096gm.

Particulates/hr. = .645

Wt. of Clean Fiber-glass Filters = 4.200gm
Wt. of Dirty Fiber-glass Filters = 4.405 gm

Burn Rate =

Fiberglass Particulates = .205 gm.

Emission Factor = $\frac{(.645)(3.04)(1.85)}{(.40)(.84)}$ = 10.8 gm/kg

(Fiberglass Front and Fiberglass Backup)

Sidewall Temperature or Output ______________

lte:	O_2%	Stac Temp	Stove Wall Temp.	Sample Flow (CFM)	Fuel Added (kg)	Sample Start and Finish Time

Front Fiberglass Filters:

Clean Wt.=______ gm

Dirty Wt.=______ gm

Particulates=______ gm (Front Filter)

Backup Fiberglass Filters (Labeled B):

Clean Wt.=______ gm

Dirty wt.=______ gm

Particulates=______ gm (Backup Filter)

Total Particulates=______ gm

Front and Backup Filters combined in one pile:

Clean wt.=______ gm

Dirty Wt.=______ gm.

Total Particulates=______ gm (Front & Backup)

Average Total Particulates of both weighing systems=______ gm.

Standard Weight:

Before Sampling=______ gm.

After Sampling=______ gm.

Correction Factor=______ gm.

Ave. Sampler Flow =

Ave. Stack Temp. =

Stack Temp. Factor =

Ave. O_2 =

Stack Dilution Factor=

Total Particulates =

Particulates/hr. =

Burn Rate =

Emission Factor =

AMPLE DATA FORM: FOR SINGLE-WEIGHED FILTERS ONLY. (When using a paper front filter and fiberglass second filter).

tove ______________________ Sidewall Temperature or Output ______________________

ate ______________________

Filter#	O_2%	Stack Temp.	Stove Wall Temp.	Sampler Flow (CFM)	Fuel Added (kg)	Sample Start and Finish Time	Clean Filter Wt.gm.	Dirty Filter Wt.gm.	Wt. of Particulates

Ave. Sampler Flow =

Ave. Stack Temp. =

Stack Temp. Factor =

Ave. O_2 =

Stack Dilution Factor =

btal Particulates =

articulates/hr. =

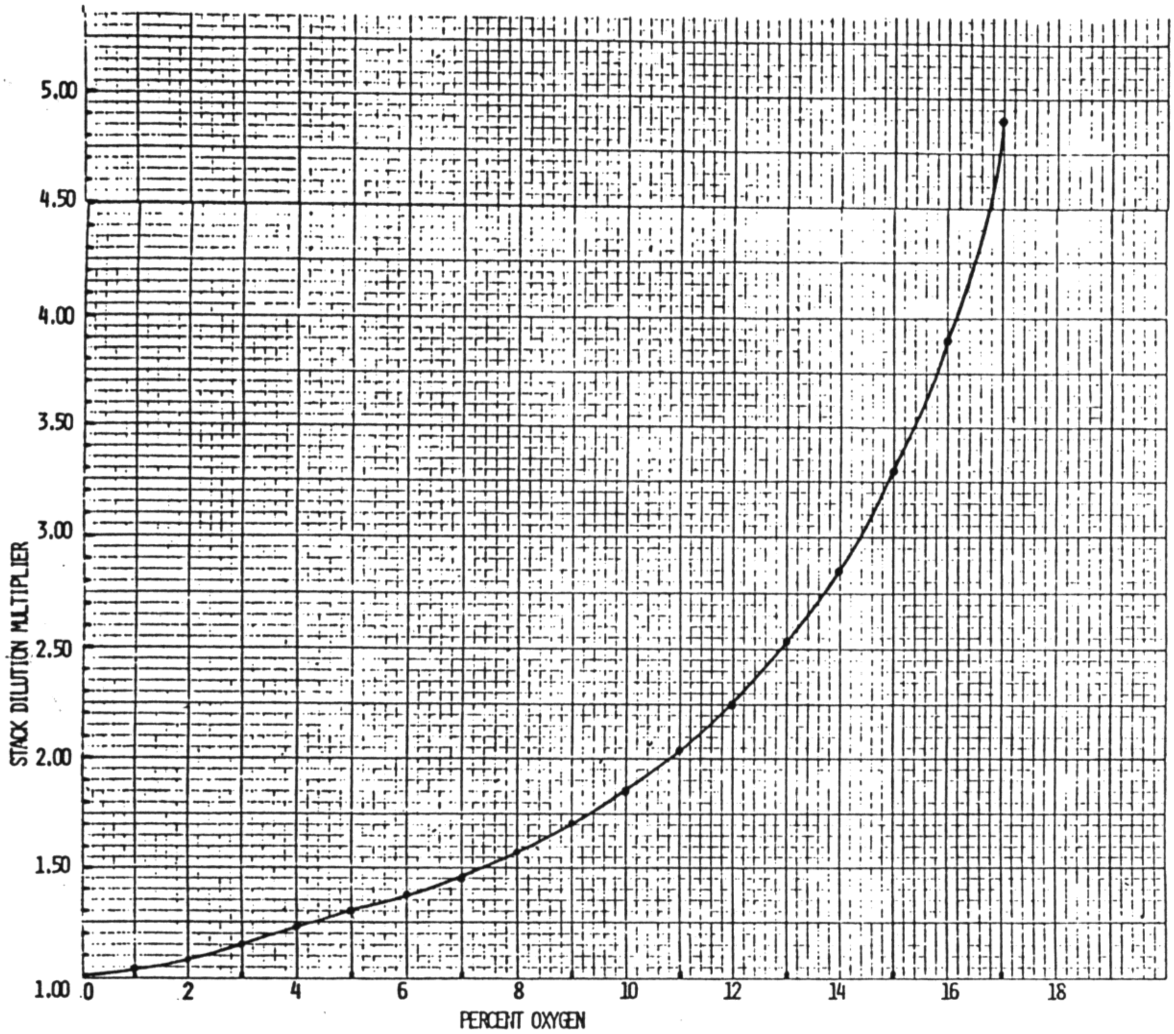
um Rate =

nission Factor =

TABLE 1

STACK TEMPERATURE FACTOR
(Multiply times sampler flow)

Stack Temp. °F at distal end of sampler nozzle	Factor
70°	1.0'
100°	.98
125°	.95
150°	.93
175°	.91
200°	.90
225°	.88
250°	.a7
275°	.85
300°	.83
325°	.82
350°	.81
375°	.80
400°	.78
425°	.77
450°	.76
475°	.75
500°	.74
525°	.73
550°	.725
575°	.715
600°	.705
625°	.70
650"	.69



STACK DILUTION MULTIPLIER
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0
2
4
6
8
10
12
14
16
18
PERCENT OXYGEN

Figure 1

TO: Users of the Condar Emissions Sampling System

FROM: Stockton G. Barnett

SUBJECT: The Most Effective Filter Setups to Use For Particular Sampling Objectives, With a Note On the Sampler Nozzle.

DATE: January 12, 1984

Our lab use of the Condar Emissions Sampler has further defined the filter combinations which best suit particular sampling objectives.

QUALITATIVE ANALYSIS (for most stove development and demonstration work):

Use just a single S&S #595 paper filter. Paper has the advantage of visually displaying relative emissions levels better than any other medium. Look at the creosotic emissions bleed-through on the back side of the filter when making comparisons. Make your own scale of relative particulate loading by arranging a series of filters in order from light to heavy. Assign them arbitrary numbers or actually weigh the particulate catch.

If you are concerned about the very fine particulates, use a backup fiberglass (S&S 1HV) filter too. However, it is difficult to visually judge particulate loading on fiberglass.

QUANTITATIVE EMISSIONS FACTOR DETERMINATIONS:

Use two fiberglass (S&S 1HV) filters one against the other, both smooth side up.

The advantages of this system over a paper-fiberglass combination are:

1) Fiberglass filter weights are unaffected by room moisture changes. Moisture compensation determinations do not have to be made. thereby simplifying the weighing process and increasing precision (especially at low emission factors below 2 gm/kg).

2) Particulate catch is greater. This effect systematically varies with emission factor and ranges from about 1% greater catch at emission factors in the 20-40 gm/kg range to 2% at 10 gm/kg to 4% at 5 gm/kg to 10% at l-2 gm/kg.

3) Sampling time can be increased because fiberglass has less clogging tendency than paper and more absorbitive capability. Thirty minute sampling per filter pair is possible without revolitization and/or bleed through taking place.

4) Sampling is essentially automatic because fiberglass's low clogging tendency allows long periods when no sampler adjustment is necessary.

DISADVANTAGE:

Visual inspection of fiberglass filters does not allow good qualitative comparisons to be made.

RECOMMENDED PROCEDURE:

Use the bulk weighing form (included). Filters can be weighed immediately as they come out of the box since room moisture...... Sequentially number your filter pairs with a thin magic marker but, put a B on the backup filters. Following the form, first weigh all clean front filters as a batch and record weight. Then weigh and record the batch weight of the backup filters. Add the two batch weights. Then batch weigh front and back filters together and record. This provides a valuable double check on your weighing system. The front plus back weight should agree within 3 mg. of the bulk total weight or weighing should be repeated. (Assuming balance reads to mg. level).

Sample for any length up to thirty minutes. We recommend 29 minutes with a 1 minute turnaround. If the emissions run does not use all filters (because it was unexpectedly short) weigh them all when you reweigh to determine particulate catch. The ones you did not use are a stable tare. Reweigh using the same double check technique you used for the clean filters. Be sure to record all sampling times (for use in emission factor calculation). Check flow meter zero after each sample.

If you want to weigh individual filters (weigh front and back as a pair) use the single filter form in the instructions. You can then determine short interval emissions factors (important in performance diagnosis). Sampling intervals might be 10-15 minutes for this purpose. You can check your weighing accuracy of the single filter pairs by adding all their particulate weights and comparing with the bulk weight. Particulate weights should agree within 1% for emission factors above 5 gm/kg and 2% from 2-5 gm/kg.

COMBINATION OF QUALITATIVE AND QUANTITATIVE ANALYSIS:

Here you want to visually watch the emissions progress of the stove throughout the burn as it takes place but also obtain a quantitative emission factor. The paper filter will give you good visual analysis and the paper-fiberglass combination will provide quantitative analysis.
Use the paper-fiberglass combination described originally in the instructions and use either bulk weighing and/or single filter weighing.

SAMPLER NOZZLE:

It is important to maintain the integrity of the inside diameter of the sampler nozzle. Clean it after each sample by gently turning backwards a 3/8" drill. Periodically check the inside diameter of the nozzle with the stock of a new 3/8" drill. If the diameter is more than 0.010" greater than the .375" drill or the tip has been dented, sampler flow accuracy will no longer be acceptable.

Our emissions testing experience indicates that the weight of particulates that accumulates on the nozzle (and catches-on the reaming drill) during a sample run is not worth measuring. It is almost always about 1% of the total particulate catch and only exceeds 2% on rare occurrences.

AMPLE DATA FORM: FOR BULK-WEIGHED FILTERS (Fiberglass Front and Fiberglass Backup)

tove ____________ Sidewall Temperature or Output ____________

ate ____________

Filter#	92 %	Stack Temp.	Stove Wall Temp.	Sampler Flow (CFM)	Fuel Added (kg)	Sample Start and Finish Time

Front Fiberglass Filters:

Clean Wt.6 ________ gm.

Dirty Wt.= ________ gm.

Particulates= ________ gm. (Front Filter)

Backup Fiberglass Filters (Labeled B):

Clean Wt.= ________ gm

Dirty Wt.= ________ gm

Particulates= ________ gm (Backup Filter)

Total Particulates= ________ gm

Front and Backup Filters combined in one pile:

Clean Wt.= ________ gm.

Dirty Wt.= ________ gm

Total Particulates= ________ gm (Front & Backup)

Average Total Particulates of both weighing Systems= ________ gm.

Standard Weight: Before Sampling= ________ gm. After Sampling= ________ gm.

Correction Factor= ________ gm

Ave. Sampler Flow =

Ave. Stack Temp. =

Stack Temp. Factor =

Ave. O_2 =

Stack Dilution Factor =

Total Particulates

Particulates/hr. =

Burn Rate =

Emission Factor =