Masonry Heater Association Of North America

MHA News

Volume 6 Number 3 Fall 1993

Tighter Emissions Requirements On The Horizon

According to an official at Washington State Department of Ecology, new fireplaces in the state, masonry or otherwise, will be required to meet 1990 EPA standards by 1997.

For years, many of us in the Northeast have been fairly complacent about clean air regulations, choosing to see it as mainly a West-Coast problem.

As an eye opener, read the following report from the current issue of SNEWS, the magazine for chimney professionals:

"EPA misses deadline on PM 10 review, American Lung Association objects"

Last summer the New York Times ran an article about recent studies that blamed 60,000 deaths per year on particulate air pollution. In July the American Lung Association (ALA) filed a notice of intent to sue EPA to require it to review its current standard that sets the maximum particulate loading standard in an airshed.

The Clean Air Act mandates that EPA review its air quality standards every five years, but the agency has missed its deadline for the particulate (PM 10) standard. It is expected that EPA will be instructed by the court to get on a fast track to completing its review of the standard and revise it if such action is appropriate.

Three days after the ALA notice, three EPA assistant administrators sent a joint memo to EPA's new top administrator Carol Browner, saying the evidence was compelling enough to make PM 10 review a high priority.

Official HPA reaction was swift. Carter Keithley was quoted in the November-December HPA NEWS:

(Continued on page 4)

1994 MHA RENO MEETING IMPORTANT INFORMATION INSIDE:

MHA Administrator Tina Subasic **will not** be sending you a separate mailing with details and hotel info. on the Reno Show.

You'll find this information in Tina's Column which begins on page 2.

The Reno MHA Meeting will make or break our certification efforts, so it is an important one for you to attend. The HPA show this year will also be very significant, and booth space has already sold out.

If you don't gamble, Reno is a cheap place to get to and to hang out in - not to be missed.

In This Issue:

Masonry Heater Association Of North America **MHA News**

Volume 6 Number 3............................Fall 1993

Published by:

The Masonry Heater Association of North America

Elected Officers: 92/93

President	*Rick Crooks P.Eng.*
Vice President	*Norbert Senf*
Secretary	*Stig Karlberg*
Treasurer	*Lucille Frisch*

Business Office:

Administrator: Tina Subasic, P. Eng.

The Masonry Heater Assoc. of N. America
11490 Commerce Park Drive
Reston, Virginia 22091

Telephone 703/620-0010

Editorial Office:

Editor Norbert Senf
c/o
Masonry Stove Builders
RR 5, Shawville
Québec J0X 2Y0

Telephone 819/647-5092
Fax 613/722-6485

Membership Policy:

Membership is open to anyone with an interest in masonry heating .

Annual membership dues:

Voting	200.00 (US)
Associate	100.00 (US)

IMPORTANT NOTE: Please check the membership list in the current issue and notify us immediately of any errors in your address, phone numbers, or dues status. Voting members are entitled to a set of in print back issues of MHA News.

Contact the Editor if you haven't received your back issues or if the information published in this issue's membership list needs correction.

ADMINISTRATOR'S COLUMN

by Tina Subasic

Hearth & Home Expo Update

March 11-14, 1994 - Reno, NV

News flash! March 1994 Hearth & Home Expo to feature Toolbox session on *Selling Masonry Heaters.*

I requested and obtained a spot in the Retailers Toolbox on masonry heaters. As a result, I need 5 MHA members to serve as panelists for presentation given on Friday and Saturday, March 11 and 12. I plan to present some general information on heaters and their construction, followed by a panel Question & Answer segment. If you have experience and advice to share on selling masonry heaters, please contact me.

This is our opportunity to make a strong presence at the HPA show and to recruit members for the association. *Help me tell why retailers should be selling masonry heaters instead of metal stoves and fireplaces!*

MHA Booth

MHA has once again received a complimentary indoor booth from HPA. Now is the time to submit photographs of your work for display in the booth and to think about any changes to the booth format. Please submit any photographs and suggestions by January 30, 1994.

MHA Annual Meeting - March 9-11, 1994

Please contact President, Rick Crooks (206) 455-2869 to be included on the agenda.

SCHEDULE:

Wed., March 9

5-6 pm ....Board Meeting
6-9 pm......................Welcome Reception
.........................(hors d'ouvres, cash bar (?))

Thursday

9-12 ....General Meeting / nominations
1-6 pm.....................Training/Certification

Friday

9-12 .... General Meeting / Election
1-5 ....New Board Meeting
.............(overflow business if necessary)
7 pm ?...........................Banquet / dinner
.............New Officers as guests of honor

In an effort to add some entertainment to our activities, we have tentatively planned a

Welcoming Reception on Wednesday evening, March 9th, from 6:00 pm to 9:00 pm. and a banquet on Friday evening, March 11th. These social events will be open to spouses and friends and may have a nominal cost.

The EXPO Industry Reception will be held on Sat. March 12.

Members interested in reserving hotel accommodations and pre-registering for the Expo contact the MHA office **before January 28.** Our hotel will be the Peppermill Hotel Casino. Rooms are $73 s/d per night. The hotel provides a complimentary shuttle to the airport, convention center and downtown.

Press Release — HPA

The preceding information will be included in a press release prepared jointly by MHA and HPA for distribution to masonry institutes and associations throughout the country. The press release will be distributed by HPA to mailing lists provided by MHA. Contact the MHA office if your would like to receive a copy for distribution.

Membership Services Update

Information Inquiries

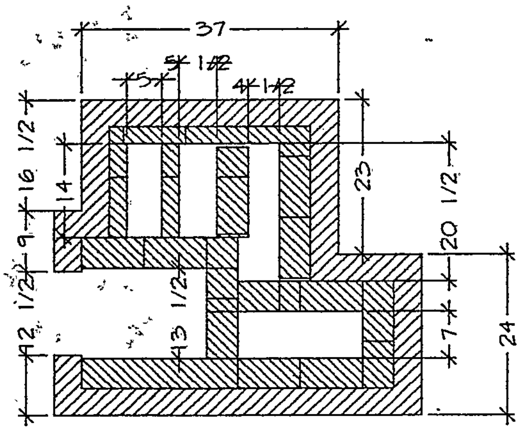
The article "Can Wood Burn Clean?" in the September issue of Aberdeen's *Magazine of Masonry Construction* generated a mailing of 37 packets of information in the month of September. For the period January 1993 to October 1993, the MHA office has received 163 inquiries. These leads are available to voting members of MHA. Contact Stig Karlberg at Royal Crown (815) 968-2022 to be placed on the lead distribution list.

Articles

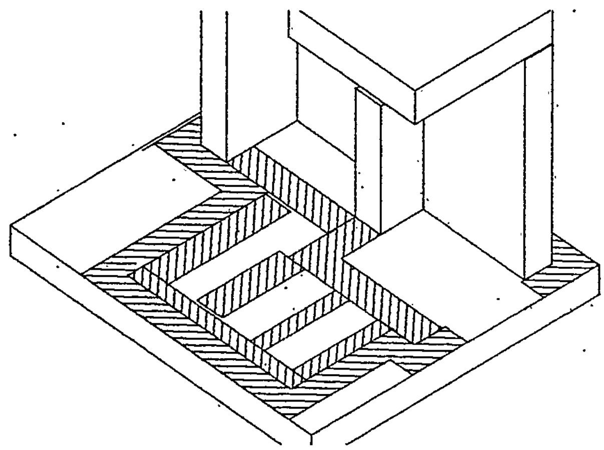
In addition to the article on masonry heaters in Aberdeen's *Magazine of Masonry Construction,* look for an article on the MHA in November or December's issue of MCAA's *Masonry Magazine.* The MHA is profiled in the Industry Associations column.

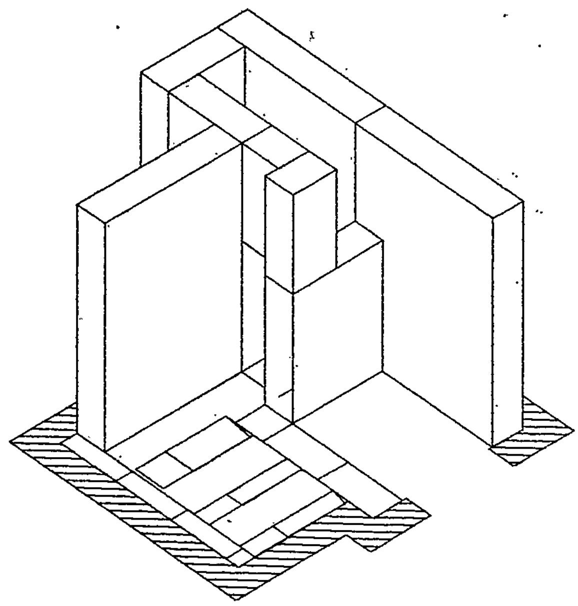
Other Activities

I am looking for someone to translate a paper on the emissions of wood burning stoves and fireplaces which is written in Finnish. The translation would appear in future editions of MHA News. Please contact me if you, or someone you know, can translate Finnish.



Custom Grundofen - Summer Workshop at Bill and Ginny Derrick's





Air Quality - Cont'd from Page 1

"If the standard is significantly reduced by EPA as a result of its review, new areas, including many areas in the East, will fall out of compliance and be forced to adopt wood-smoke curtailment strategies. This could mean that cities and towns in the East may have to ban the installation of wood-burning fireplaces and adopt other woodburning restrictions of the types which we have in the West."

HPA has contributed $2,000 to a coalition formed by the American Iron and Steel Institute (AISI) to examine, at a cost of over $500,000, the studies which came up with the figure of 60,000 deaths under the current emissions standard.

renewable energy source, with zero net CO_2 impact. Bear in mind that this is still considered to be a controversial claim in many scientific circles. It should be qualified with "sustainably grown". While in my area of Quebec firewood is still mainly a byproduct of slash-and-burn forestry practices, Germany now has woodlots that sell certified sustainably grown firewood. Since sustainable forestry practices automatically generate huge amounts of firewood from thinnings, etc., this is a win-win scenario.

On the downside, the spread between the best and the worst combustion practices out there is around 100 to 1 in terms of PM 10 emissions. Cancer-causing PAH's (polycyclic aromatic hydrocarbons, aromatic as in "that nice woodsy smell") are on the horizon.

WHILE IN MY AREA OF QUEBEC FIREWOOD IS STILL MAINLY A BYPRODUCT OF SLASH-AND-BURN FORESTRY PRACTICES, GERMANY NOW HAS WOODLOTS THAT SELL CERTIFIED SUSTAINABLY GROWN FIREWOOD

Initial reports from consulting firms hired to re-examine studies were presented at a September 22 meeting of the coalition. According to HPA Technical Director Gary Satterfield, the studies were characterized as "massively flawed" and the conclusions unwarranted.

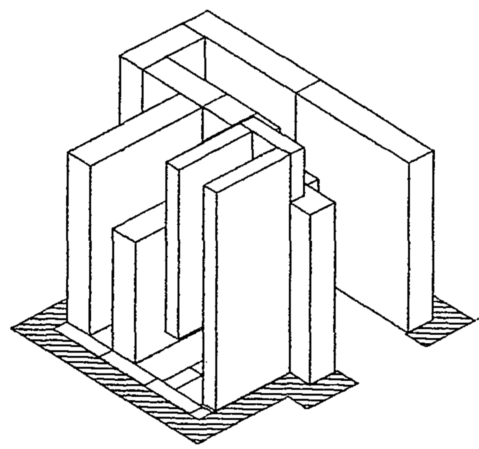
This is, however, an immensely complicated subject and there is real risk that EPA will opt to tighten its standards."

I think it is fair to say that the air quality issue is not going to go away. Later on you will find a report by Walter Moberg on recent developments in Colorado. The German magazine for the stovemasonry trade "Kachelofen und Kamin" continuously carries items about the need to fight wood-burning bans on a locality by locality basis in Germany. They also have to continuously remind stovebuilders that they can't afford to be complacent but instead have to inform themselves on the issues so that they can take a more proactive approach.

As builders of masonry heaters we do, indeed, have good news for local regulators, if we only know where to look. Do you know what BACM and AP-42 are? What they have to say about masonry heaters? Where to get a copy? Who your regulators are?

The issues surrounding wood heat are complex. On the upside, Biomass is the ideal

The November/December issue of Environmental Building News - A Bimonthly Newsletter on Environmentally Sustainable Design and Construction has a feature article entitled "Heating Fuel Choices: Weighing the Alternatives". It argues, convincingly, that energy use is the most significant environmental impact of buildings. For example, U.S. energy use for residential heating and cooling is stated to produce, according to EPA figures, 420 million tons of CO_2 and 8.9 million tons of atmospheric pollutants per year. The various options are analyzed comprehensively. Conservation and Solar are concluded to be the best choices. Biomass is given a mixed scorecard. *(Strictly speaking, biomass is solar).*



19 categories of energy are tabulated into 7 categories of emissions. Some of the numbers are instructive, since the magazine's research tends to be above-average and the editorial bent is definitely in-tune with my own reasons for being in the masonry heating business.

Wood and gas receive roughly the same CO_2 score, which is interesting because the numbers are likely to be based on very conventional and accepted assumptions. Increasing your own knowledge in this area is the only answer here.

The worst electricity on the block, that nasty midwestern stuff (as millions of damaged sugar maples, downstream and across the border, can attest - including my own) comes in with about half the PM of a pellet stove, but fittingly, 300 times the sulfur. Those sexy babes, the heat pumps, get pretty good scores from the judges (check out last month's Consumer Reports for a reality check on these technological boy-toys). End result? Thousands of Ontario homes heated with nuclear power.

O.K., I better stop ranting and raving - back to Environmental Building News, November/December issue (see chart):

With EPA regs, an awful lot has changed in wood heating since 1984. Let's hope Washington DoE has updated its data, or we're all going to end up being tarred with a ten year old brush. To be fair, the article does go on to state

> "Certain wood stoves and pellet stoves have significantly lower emissions than older (pre-EPA certification) wood stoves...Masonry heaters (sometimes called Russian fireplaces) are also better than wood stoves in terms of certain emissions. Masonry heaters burn small *(50 lbs is small?)* amounts of wood at very high temperatures and then radiate heat from the thermal mass of the heater. Particulate emissions are similar to those from pellet stoves - less than half the level from the best wood stoves."

All of this is a very roundabout way of leading into the main theme of this issue of MHA News: Testing and the need to expand the database on masonry heater performance.

Recently MHA member **Dr. Ernst Rath** (Rath Refractories, Austria) sent in some new issues of Klima und Raum, the Austrian stovebuilding and ceramics journal. They contain reports on some very interesting recent testing that has been done there, including country-wide field tests on a total of 34 heaters. We follow that up with a little refresher on combustion basics for stovemasons. You should be getting up to speed by then, so we finish off with the

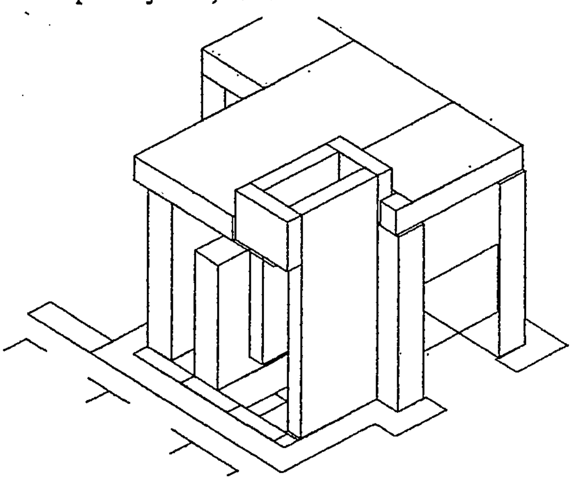
IT'S AN EXCITING TIME TO BE IN THE MASONRY HEATING BUSINESS. EVEN THOUGH THE TECHNOLOGY IS A HUNDRED YEARS OLD, A LOT OF THE BASIC EMISSIONS AND PERFORMANCE RESEARCH JUST SIMPLY HASN'T BEEN DONE YET - WE'RE AT THE CUTTING EDGE.

Winter Emissions from Major Sources, State of Washington - 1984

Pollutants (tons per year)

	SO_2	NO_x	PM	CO	VOC
Residential Wood Combustion	680	5,100	64,700	399,000	134,000
Industrial Point Sources	95,200	39,100	22,500	180,000	16,400
Transportation	15,400	187,000	58,900	1,057,000	116,000
Slash Burning	20	460	2,400	12,900	2,100

Source: "Wood Smoke: Emissions, Impacts, and Reduction Strategies", Washington State Department of Ecology, December 1986



contraflow data from the '93 Lopez Labs tests.

I think that one thing is becoming clear - woodheating issues won't be getting any simpler. Not only that, but we're not going to be getting by just on stovebuilding word-of-mouth for very much longer, either. I still see promo stuff from bright-eyed newcomers to the masonry heating world that are still claiming 90% efficiency for heaters and that you can heat a 3000 sq. ft. house on 20 lbs. of wood per day - let's get real.

We're the good guys, and we've got the best technology - so let's get informed and do some justice to it. We're not a flavor-of-the-month.

It's an exciting time to be in the masonry heating business. Even though the technology is a hundred years old, a lot of the basic emissions and performance research just simply hasn't been done yet - we're at the cutting edge.

Sources:
SNEWS, POB 98, Wilmore, KY 40390, (606)858-4043, $68 US/year.
Environmental Building News, RR1 Box 161, Brattleboro, VT 05301, (802)257-7300, $60 US/year. "Published bimonthly, EBN covers a wide range of issues: everything from site planning and energy-efficient design, to material selection and what to do with construction waste. Learn how you can reduce the environmental impact of your building projects."

HEIKKI HYYTIÄINEN TO VISIT NORTH AMERICA

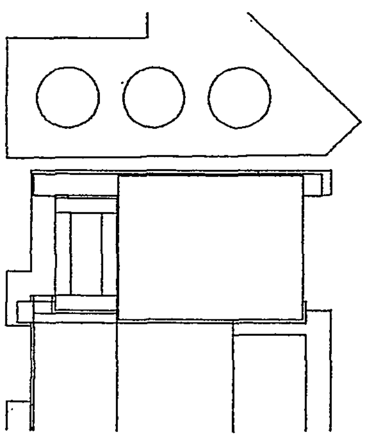
New Book in the Works

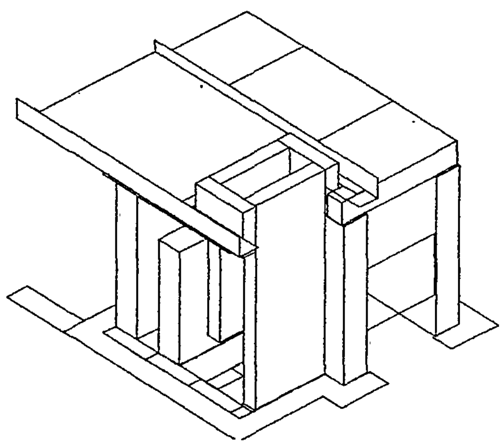
Heikki Hyytiäninen is well known to most people who've been in the masonry heater scene for any length of time. Heikki is a Finnish architect and author, and had a large hand in reviving the masonry heating tradition in Finland in the 1970's. Heikki has enjoyed a diverse career. He studied with Alvar Aalto, worked on the Finlandia Hall, and has edited a number of design and building related publications. His most recent project was the design of 7 fireplaces for the new Finnish President's Palace.

ALBIE BARDEN ARRANGED HEIKKI'S FIRST VISIT TO NORTH AMERICA IN 1981, AND AT THE ENSUING WORKSHOP I THINK IT WOULD BE FAIR TO SAY THAT THE MODERN DOUBLE SKIN CONTRAFLOW HEATER WAS BORN

Albie Barden arranged Heikki's first visit to North America in 1981, and at the ensuing workshop I think it would be fair to say that the modern double skin contraflow heater was born. About thirty people were in attendance and at the time this probably constituted the entire East Coast masonry heating scene. I had been building Grundofens until then, and Heikki was my first exposure to the contraflow.

I built my neighbour's heater the week after, and it's a pretty safe bet that he's the owner of Canada's first modern contraflow heater. He's been happily heating with it ever since. (I was up on his roof this summer building another chimney, and I couldn't resist having a peek at his heater flue. It's never seen a brush, and you can still see the red flue liner - I had a camera, so





there's now a flue shot in my portfolio. Significantly, this heater has no grate, a leaky old UPO door with a fairly small air inlet, and a 22.5" wide firebox. In light of what we've been learning lately from testing, you have to laugh - more on that later. The cast iron inner screen on the UPO door is as good as new. When I retrofitted one of our own heaters with a grate, a similar screen burned up after about a week of use. I've never cleaned my chimney either, but it's not as clean as my neighbour's. It's picked up about 1/8 of an inch of soot over ten years.)

English language masonry heater information was non-existent 13 years ago. Heikki's 1979 book "Muuratut tulisijat" was a highly prized item, and there's many a well-thumbed Finnish/English dictionary sitting on bookshelves in the Northeast. His second book, Tulisijat ja sydänmuurit, was subsequently revised and translated into English as "Finnish Fireplaces - Heart of the Home" with Albie Barden as co-author.

THE NEXT BOOK WILL ADDRESS MASONRY HEATER PERFORMANCE AND PLACE IT IN AN INTERNATIONAL CONTEXT

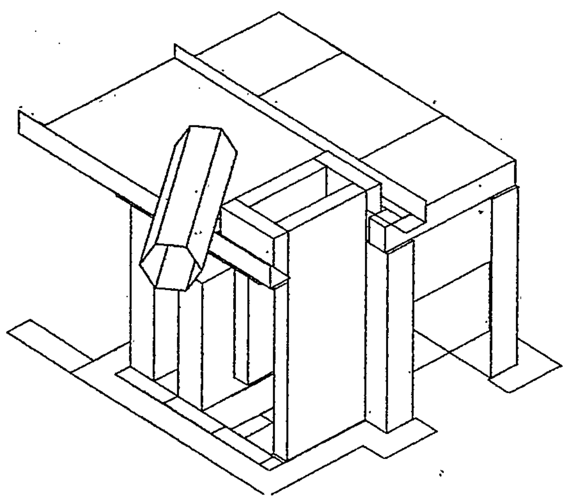
The next book will address masonry heater performance and place it in an international context. It will also have a look at test methods and results in Europe and North America and attempt to form a bridge between the two. In addition, it will look at related contemporary housing issues that we've grown to love such as indoor air quality (IAQ). It will probably be published first in German.

As of this writing (early December), Heikki has visited labs in France, Germany, Austria and Sweden. Some interesting research has been done in Austria recently by Herman Hofbauer for the Austrian stovemason's guild, who have their own testing lab. Of course, you'll be reading about it first right here in MHA News (in this very issue, in fact).

Heikki will be making a two week tour of North America starting December 9. First stops on his itenerary will be BIA headquarters in Virginia, (there will be an emphasis on brick in the book). BIA engineer Tina Subasic is better known to MHA members as our very capable administrator. After that, it's off to Dennis Jaasma's combustion lab at Virginia Tech, site of the first ever masonry heater tests for PM. Next stop is Seattle, for a visit to the EEMC lab. and to meet with Tom Stroud, Jerry Frisch and Rick Crooks. Next its Sacramento to meet with HPA emissions and legislative specialist John Crouch. Last stop on the West Coast is Portland, Oregon, to check out OMNI labs, who did the EPA-audited in-field masonry heater tests. Also in Portland, Heikki will meet with Walter Moberg, whose Colorado report you'll read later in this issue.

After a stop in Chicago to meet with Stig Karlberg, it's off to MHA News headquarters here in Shawville, Quebec. We'll be going over the '92 and '93 Lopez tests, reviewing the '94 testing plans (see report elsewhere in this issue), checking out FLUESIM and WOODSIM, and discussing all of the testing to date. We'll spend a day in Ottawa to meet with some of the folks at Canada Mortgage and Housing's (CMHC) Research Division, who have probably done more work with IAQ and venting issues over the years than anyone. We're trying to get the Energy Mines and Resources (EMR) Canada CCRL (Combustion and Carbonization Research Lab.), directed by Skip Hayden, on the agenda as well.

Heikki will then join Vermont heater mason Doug Wood for a drive to Albie and Cheryl Barden's, a visit with Mark McKusick and then back to Helsinki in time for Christmas. Whew. Wait for the book.



NEW MEMBERS

We would like to extend a warm welcome to the following new members:

VOTING

Albie Barden
The Maine Wood Heat Co.
RFD 1 Box 640
Norridgewock
ME 04957

Steve Bushway
Deer Hill Masonry Heat
224 West St.
Cummington
MA 01026

Alan Gossett
Alan Gossett Masonry
11818 Golden Given Rd. E.
Tacoma
WA 98445-3024

Russel R. May
May's Masonry
4262 William Mill Rd.
Burlington
NC 27215

David McGee
Masonry Concepts
P.O. Box 611
Ocean City
MD 21842

Martin Pearson
Pearson Masonry
40 Rhodes St.
Cumberland
RI 02864

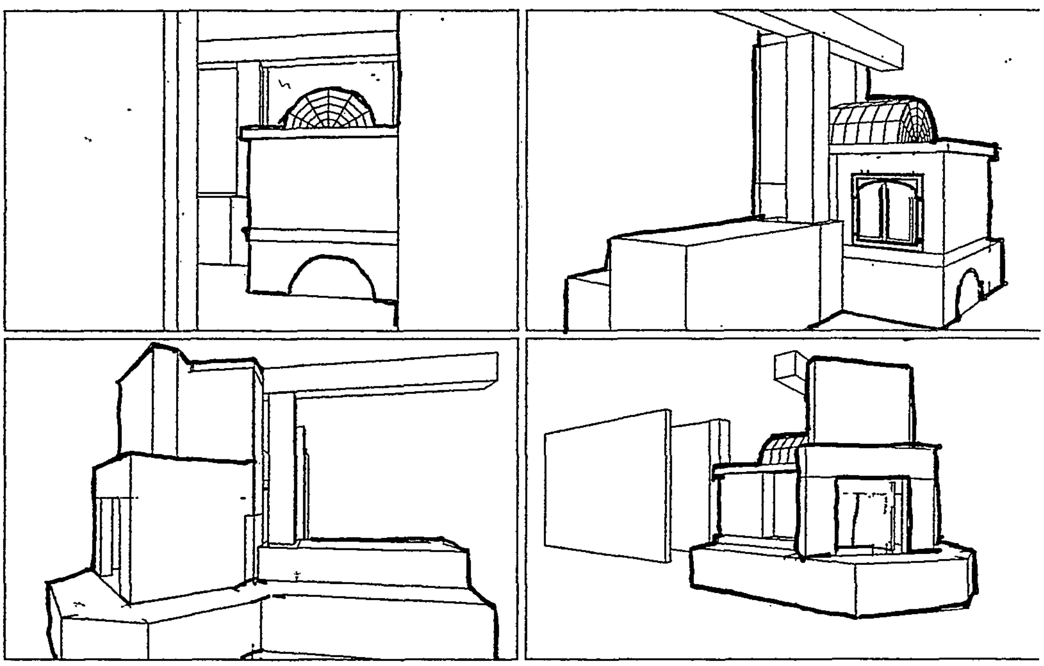
Ron Williams
Kentuckiana Chimney, Inc.
9216 Cornflower Ave.
Louisville
KY 40272

ASSOCIATE

Marcus Flynn
Pyro Mass
4390 Coloniale
Montreal
QC H2W 2C6

Ernst Heuft
The Master Stove Setter
15933 - 26 Ave.
RR 5 Surrey
BC V4B 4Z5

Uwe Mirsch
Holzworks
19 W 161 Rochdale Circle
Lombard
IL 60148



MHA VOTING MEMBER LIST AS OF 11/22/93

Name	Company	Address	Town	State/Prov.	Tel(B)	Tel(FAX)	Tel(H)	Dues
Gunther Bartsch	DBA Masonry	200 Pepi Drive	Garnerville	NV 89410	(702)782-3008		same	93
Albie Barden	Maine Wood Heat Co.	RFD 1, Box 640	Norridgewock	ME 04957	(207)696-5442	696-5856		93
Ulli Baumhard	Canadian Ceramic Wood Heat	R.R. 1	Sutton West	ON L0E 1R0	(416)478-8843		same	93
David (Buck) Beckett	Thermal Mass Fireplaces	P.O. Box 1562	Jackson Hole	WY 83001				93
Steve Busch	Maine Masonry Stove Co	Rte 1 Box 569	Buckfield	ME 04220	(207)336-2056		336-2065	93
Steve Bushway	Deer Hill Masonry Heat	224 West St.	Cummington	MA 01026	(413)634-5792	634-5037		93
Gabriel Callender	Foyer Radiant DeBriel	1000 RR 2	Frampton	PQ G0R 1M0	(418)479-2601	479-5640	479-2601	93
Rick Crooks	Mutual Materials Co.	PO Box 2009, 605 - 119th Ave. NE	Bellevue	WA 98009	(206)455-2869	454-7732	432-4562	93
Timothy Custer	Top Hat Chimney Sweeps	12380 Tinkers Creek Rd.	Cleveland	OH 44125	(216)524-5431			93
A. Michael D'Arcangelo	Kachelofen Unlimited	1407 Caves Camp Road	Williams	OR 97544	(503)846-6196		same	93
Bill Derrick	Alternate Energy Systems	Star Route Box 344	Peru	NY 12972	(518)643-9374	643-2012	643-3012	93
Jerry Frisch	Lopez Quarries	111 Barbara Lane	Everett	WA 98203	(206)353-8963	742-3361	353-3616	93
Doug Fry	Fry Masonry Construction	66605 N. Lakeview	Sturgis	MI 49091	(616)651-1262		651-9289	93
George Gough	Gough Masonry Ltd.	634 Old River Road	Sault Ste. Marie	ON P6A 6JA	(705)253-4314	945-1408	942-3553	93
Alan Gossett	Alan Gossett Masonry	11818 Golden Given Rd. E.	Tacoma	WA 98445-3024	(206)537-6077		537-4786	93
Douglas Hargreave	Inverness Masonry Heat	1434 Dairy Rd.	Charlottesville	VA 22903	(804)979-7300	979-6416	979-4906	93
Jerry Haupt	Kent Valley Masonry	23631 S.E. 216th St.	Maple Valley	WA 98038	(206)432-0134		same	93
Dale Hisler	Lightning Arrow Stove Works	Box 25	Pray	MT 59065	(406)333-4383			93
Mike Homchick	Masonry Construction Co.	P.O.Box 82102	Kenmore	WA 98028	(206)481-2783	771-4175		93
Stan Homola	Mastercraft Masonry	P.O. Box 73	Brush Prairie	WA 98606	(206)892-4381		same	93
Steven R. Jackson	Village Sweep Chimney Service	2183 Colorado Ave.	Elgin	IL 60123	(708)742-3583		same	93
David Johnstone	D. Johnstone Masonry & Design	P.O. Box 198	Errington	BC V0R 1V0	(604)248-6535			93
Stig Karlberg	Royal Crown	333 E. State - Suite 206	Rockford	IL 61104	(815)968-2022	968-0739	963-3285	93
John Lagamba	Temp-Cast Ind. Ltd.	63 Rosedale Ave. P.O. Box 40	Port Colborne	ON L3K 5V7	(416)835-6611	835-6612		93
David Lyle	Heating Research Co.	Box 300	Acworth	NH 03601	(603)835-6109			93
Russell May	May's Masonry	4262 William Mill Rd.	Burlington	NC 27215	(919)584-1575			93
David McGee	Masonry Concepts	P.O. Box 611	Ocean City	MD 21842	(410)213-7622			93
Mark McKusick	Hearth Warmers	RR 1 Box 27	Colrain	MA 01340-9705	(413)624-3363	624-3367	800-552-1245	93
Joe McLaughlin	J. McLaughlin Agency	PO Box 14249	East Providence	RI 02914-4249	(800)472-3780	434-5521		93
Walter Moberg	W. Moberg Design/ FireSpaces	921 SW Morrison St. Suite 439-440	Portland	OR 97205	(503)227-0547	227-0548	236-7419	93
David R. Moore	MTC Construction	11817 Vail Rd. S.E.	Yelm	WA 98597	(206)458-4866		same	93
Erik Nilsen	Thermal Mass Inc.	RR 1 Box 367	Littleton	NH 03561	(603)444-6474		same	93

Brian/Marsha Olenych	Olenych Masonry Inc.	Star Route, Box 3	Bovina Centre	NY 13740	(607)832-4373	832-4561		93
Steve Patzer	Patzer & Co. Masonry	3N 743 RTE 32	St. Charles	IL 60174	(708)584-1081		584-1081	93
Walter Pearce	W.E. Pearce Inc.	4161 Kiehl Rd.	Friday Harbor	WA 98250	(206)378-2094			93
Martin Pearson	Pearson Masonry	40 Rhodes St.	Cumberland	RI 02864	(508)528-8420		(401)333-6583	93
Ron Pihl	Cornerstone Masonry	Box 83	Pray	MT 59065	(406)333-4383		same	93
Frank Pusatere	Colonial Associates Inc.	48 Radnor Ave.	Croton on Hudson	NY 10520	(914)271-6078		271-5698	93
Stanley Sackett	Sackett Brick Co.	1303 Fulford Street	Kalamazoo	MI 49001	616-381-4757/	381-2684	800-848-9440	93
Fred Schukal	Sleepy Hollow Chimney Supply	85 Emjay Blvd.	Brentwood	NY 11717	(516)231-2333	231-2364		93
Norbert Senf	Masonry Stove Builders	RR 5	Shawville	PQ J0X 2Y0	(613)722-6261	722-6485	(819) 647-5092	93
Christine Subasic	Brick Institute of America	11490 Commerce Park Drive	Reston	VA 22091	(703)620-3171	620-3928		93
Tom Trout	Vesta Masonry Stove Inc.	373 Old Seven Mile Ridge Rd.	Burnsville	NC 28714	(704)675-5247	same		93
Jack West	TULIKIVI	P.O. Box 300	Schuyler	VA 22969	(804)831-2732	831-2732	(800)843-3473	93
Don Wilkening	Wilkening Fireplace Co.	HCR 73 Box 625	Walker	MN 56484	(800)367-7976	(218)547-3393	652-3113	93
Ron Williams	Kentuckiana Chimney Inc.	9216 Cornflower Ave.	Louisville	KY 40272	(502)935-0752			93

MHA ASSOCIATE MEMBER LIST AS OF 11/30/93

Lonnie Alexander	Alexander Construction	P.O. Box 1077	Sedona	AZ 86336	602-284-9669		same	93
Jonathan Brind	Solid Fuel / Harper Trade Journals	Harling House, 47-51 Great Suffolk Street	London SE1 0BS	England				recip-rocal
Kevin Charyk	Fire Kan Fireplaces	RR 3 Box A5	Sutton West	ON L0E 1R0	(416)476-0065		same	93
Marcus Flynn	Pyro Mass	4390 Coloniale	Montreal	QC H2W 2C8				93
Sam Foote, P. Eng.		Suite 210, 14924 Yonge St. S.	Aurora	ON L4G 6H7	(416)727-6950		(416)727-6950	93
Bob Gossett	Gossett Masonry Design	141 Sisotow Belle Lane	Yakima	WA 98903	(509)966-9683			93
Thomas Hagelund	Armstrong Masonry	Box 139, Rt. 1	Winthrop	NY 13697	(315)328-4883		same	93
Jay Hensley	SNEWS	P.O.Box 98	Wilmore	KY 40390	(606)858-4043	same, call		reciproc
Ernst Heuft	The Master Stove Setter	RR 5, 15933 26th. Ave.	White Rock	BC V4B 4Z2	(604)531-0987		same	93
Ken Hooker	Masonry Construction Magazine	426 S. Westgate	Addison	IL 60101				reciproc
Geoffrey Kenseth	The Chimney Swift	28 Hulst Road	Amherst	MA 01002	(413)256-0157			93
Bill Kjorlien	BIA Region 9	5885 Glenridge Dr. #200	Atlanta	GA 30328	(404)255-7160	843-3278	760-9421	93
Hope Lockwood	Lockwood Design Group	P.O. Box H	Phillips	ME 04966	(207)639-3300	639-3301	639-2652	93
Uwe Mirsch	Holzworks	19 W. 161 Rochdale Circle	Lombard	IL 60148	(708)916-8329	same		93
Christopher Prior	Adirondack Chimney Co.	2315 Rte. 29	Middle Grove	NY 12850	(518)882-6091	882-6091	882-6080	93
Dr. Ernst Rath	Aug. Rath jun. AG	Walfischgasse 14 A 1010	Wien 1	Austria				93
Gene Sengstake		4000 NW 49th Street	Lincoln	NE 68524			402-470-2533	93
Peter Solac	Woodland Way, Inc	1203 Washington Ave. So.	Minneapolis	MN 55415	(612)338-6606		724-1661	93
G. Ronald Telfer	Ronjan Inc.	1540 Charlton Road	Victoria	BC V8X 3X1	604\479-2528	943-0177		93
Alex Wilson	Environmental Building News	RR 1 Box 161	Brattleboro	VT 05301	(802)257-7300	257-7304		recip-rocal
Brian Yanik	Ontario Woodheat Leaders	RR 4, 34 York Rd.	Niagara on Lake	ON L0S 1J0	(416)984-8884	984-8469	984-6523	93
Helmut Ziehe	IBE	P.O. Box 387	Clearwater	FL 34615	(813)461-4371			reciproc

Certification Update

Copies of the HEARTH and WETT manuals have been making the rounds for comment.

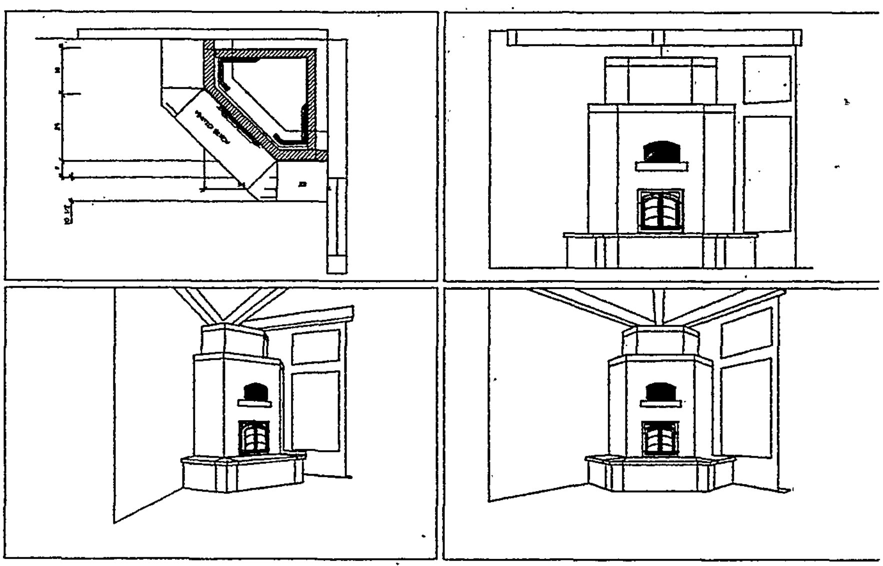
Jerry Frisch, who is heading up the certification effort along with Tom Trout, reports that as of Dec. 1 he had received only four responses, including the Occupational Analysis manual. Jerry writes:

> **"Let's speed it up guys, let's stay in the time frame, so I have some time to do an overview before Reno.**
>
> In talking with members, I've suggested using the WETT and HEARTH as is for the Safety Certification and then our own manual for actual building.
>
> One scenario could be: Use and Development of:
>
> 1: Occupational Analysis for our own needs.
>
> 2: Outline a Recommended Code Book, based on ASTM, without copyright infringement.
>
> 3: An Installers Guide or Builders Manual from Ernst or a revised German or Finnish guide.
>
> 4: Then use the WETT and HEARTH Occupational Analysis and Manual with certification recommended.
>
> I feel that the more issues addressed the better.
>
> Tina's comments on the two manuals are worth repeating, she saw them from a different perspective than I did and I think she has a good point.
>
> P.S.: I desperately need responses from the members to move forward on this effort."

"Let's speed it up guys, let's stay in the time frame, so I have some time to do an overview before Reno"

Tina Subasic's comments on the HEARTH manual were as follows:

> Dear Jerry:
>
> Thank you for the opportunity to review the HEARTH Training Manual. As with the WETT manual, I think it provides some good ideas for developing a MHA Training Manual. I do not have any specific comments but I do have some general ones.
>
> The content of the HEARTH manual is generally good. I think the discussion of combustion is better than the WETT manual. The masonry heater manual should discuss combustion in depth, since the design of masonry heaters has a direct correlation to the extent of wood combustion. Similarly, the section in Chapter 6 on location of the appliance is similar to what is needed for the masonry heater manual. The WETT manual discusses codes in more depth, but I think the treatment given in the HEARTH manual is adequate.
>
> Overall, the HEARTH manual is more complete, and of the scope I would recommend for our manual.
>
> However, the format of the HEARTH manual is more difficult to follow than the WETT manual was. I don't know if it's the three column format or the lack of white space, but the HEARTH manual is more difficult to use. I prefer an indexed format so that one can easily go to the desired section or page for specific information or as a quick reference.
>
> Thank you for all your efforts in organizing this committee. I think we will have much to work on in Reno in March. ..."



MASONRY HEATER TEST RESULTS FROM AUSTRIA

Austria has one of the richest masonry heating traditions in the world. The only masonry heaters built in Austria are of the Grundofen (all masonry) type, and always have been. The Einsatz (metal insert) system, popular in Germany, has never made inroads here. Furthermore, Austria has an uninterrupted stovebuilding tradition. Most other countries stopped building heaters during the cheap oil era, thus losing much trade-based knowledge.

Previous issues of MHA News have carried reports on Austrian activities. About three years ago, ***David Lyle*** *sent in a copy of an article from "Klima und Raum", the Austrian stovebuilding and ceramics journal, that detailed the joint development of the "Bio-Firebox" by Rath Refractories and the Austrian stovemason's guild. MHA News ran a full translation, which included the North American debut of the "Top-Down" burn.*

After the '92 Phoenix MHA meeting, we ran a report on our meeting with ***Dr. Ernst Rath,*** *who had made a special trip to meet with the North American stovebuilding community. Dr. Rath is CEO of Austria's largest refractory company and an MHA member. He recently sent us a new batch of "K+R" issues, containing reports on recent Austrian testing.*

The Austrian stovebuilder's guild has its own test facility and commissioned several test series over the last two years.

The 1991 series was prompted by the increasing concern with emissions from solid fuel burning devices. The approach was to field test 34 stoves of the Grundofen type in order to get a "snapshot" of the current situation, and generate enough data so that some meaningful conclusions could be drawn.

The results were published in the June '92 issue of K+R in an article by ***Dr. Herman Hofbauer.*** *A summary follows: (translation by N. Senf)*

Emissions are influenced by three factors: the appliance, the fuel and the operator. Laboratory testing only addresses one of the these, the appliance, even though fuel and operator are large factors in actual use.

The goal of the field tests was to generate representative data on emissions and efficiency for wood-fired masonry heaters.

The tests were to include a number of different Grundofen configurations, and fueling factors were to be addressed as well. In order to meet these goals and obtain a representative sampling, an Austria-wide set of field tests of actual stoves in normal use was required.

THE GOAL OF THE FIELD TESTS WAS TO GENERATE REPRESENTATIVE DATA ON EMISSIONS AND EFFICIENCY FOR WOOD-FIRED MASONRY HEATERS

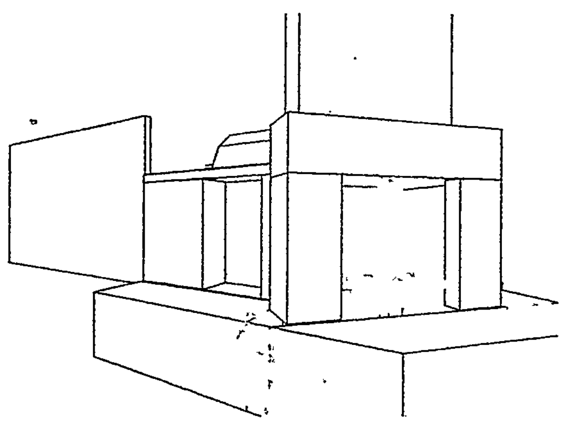
Another deciding factor in the design of this test series was the fact that, aside from laboratory data, existing field data consisted mostly of individual tests on single stoves, and usually on extremely bad examples of the stovebuilders art. The aim of the this test series was to generate a database to serve the following purposes:

- ❑a general purpose database for regulatory and other considerations
- ❑a basis for overall country-wide emissions estimates
- ❑a basis for comparison with other wood heating systems

Conducting the Tests

The choice of masonry heaters to test was done by technical representatives of the individual Austrian states. A uniform data form was designed and used.

Testing was done with "test-suitcases"



normally used in the combustion trades for domestic heating systems. Samples were taken at the final flue run just before entry into the chimney connector. In cases where this wasn't possible, it was noted on the data form.

Tests burns were carried out by the homeowner with the homeowner's normal fuel. Various parameters such as type of ignition (top, bottom, etc.) were recorded and measurements were made at 5 minute intervals for the following:

- ❑... O_2, CO_2 and CO concentrations
- ❑ Flue Temperature
- ❑ Excess Air
- ❑ Stack Losses

The design of the test protocol was done by

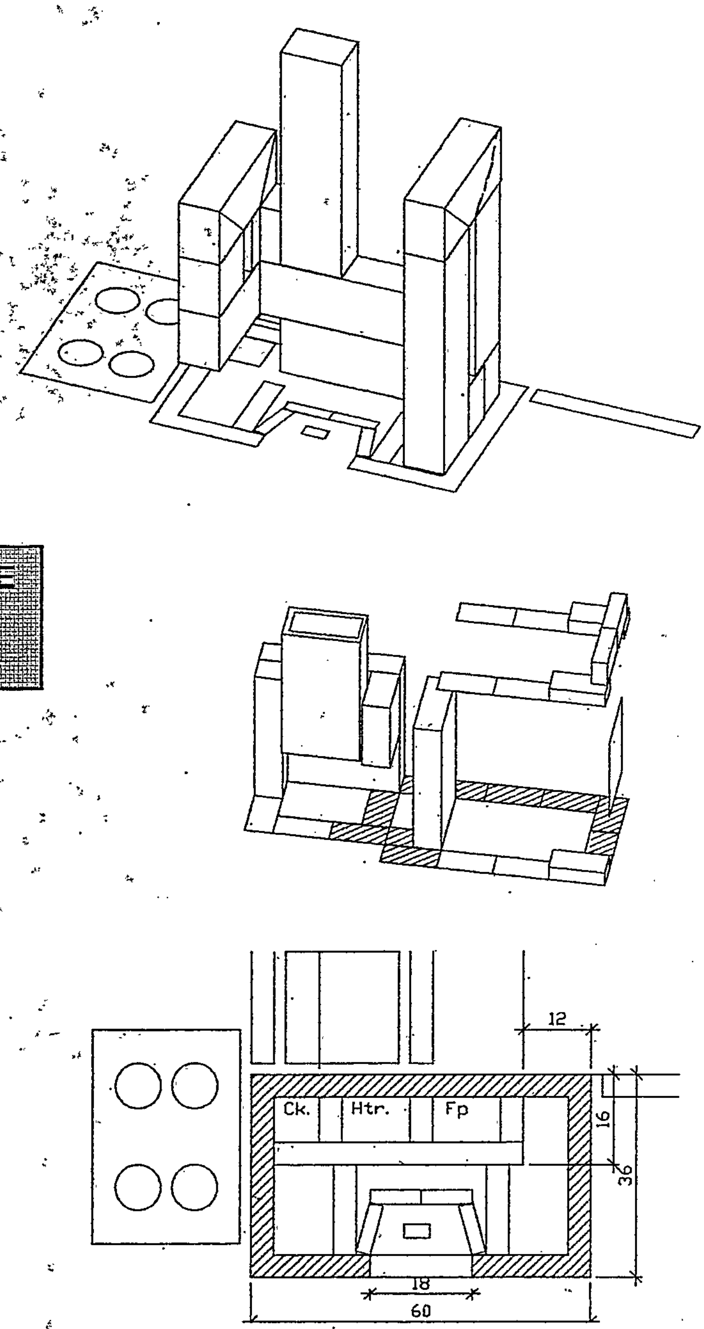
TESTS BURNS WERE CARRIED OUT BY THE HOMEOWNER WITH THE HOMEOWNER'S NORMAL FUEL

the Testing Laboratory of the (Austrian) Stovemason's Guild. The heaters were compared on the basis of average CO number and average efficiency.

The CO Emissions Factor

This serves as an indicator of combustion quality and of emissions, since the emissions of CO and hydrocarbons go hand in hand.

(editor's note: There is no evidence that this applies to particulates (PM). Recent North American masonry heater testing in general has shown no correlation between CO and PM-10 in the 1-5 gm range. The 1993 Lopez Labs testing (see report elsewhere in this issue) also indicated a strong relationship between real-time hydrocarbon numbers from a SUN digital gas analyzer and real-time PM numbers from a CONDAR dilution tunnel.)



Custom Grundofen
St. Johns, Newfoundland

Firebox in basement, first floor heat exchangers site-fabricated with local labour from 8x12 Refratco flue liners.

Table 1: Summary of Austria-Wide Field Test Series

Stove Nr	Design kW	FBox Type	Firebox Dimensions L	W	H	Fuel	Am'nt kg.	Ignition	CO mg/MJ	Effic. %
1	6.5	N	70	40	75	C	15	B	1200	87
2	5.6	N	70	35	75	C	12	B	2300	79
3	7.4	N	98	37	82	C	18	B	3400	87
4	5.2	B				C	10	T	1460	86
5	5.2	N				C	10	T	2150	89
6	5.2	N				C	10	T	2230	88
7	7.5	N				B	10	T	970	77
8	4.2	N	73	55	55	C	6.5	B	1680	81
9	7.5	B	66	50	84	C	3	B	2060	73
10	7.5	B	66	50	84	C	14	T	3250	77
11	8.2	N				C	20	T	1230	80
12	6.5	N				C	10	REAR	1100	82
13	6.8	B	61	40	79	C	17	B	470	81
14	7.0	NB	50	50	60	B	10	B	1470	92
15	7.0	NB	100	37	68	B	15	B	940	83
16	4.8	N	100	35	75	C	11	B	910	85
17	4.5	N	50	40	70	C	6	B	3300	81
18		B	80	70	90	C	15	T	1060	78
19	8.0	N	60	60	45	C	15	T	11140	79
20	7.0	B	45	59	80	C	15	T	1550	94
21	7.0	B	45	59	80	C	15	T	2120	93
22	7.8	N	109	50	66	C	15	T	1400	86
23	6.0	N	70	60	75	C	15	T	1270	89
24		N	90	60	50	C	15	T	3660	80
25	6.1	N	58	54	150	C	12	T	4890	90
26	7.4	N	60	50	90	C	12	T	2640	86
27	4.2	N	50	40	70	C	10	B	3440	77
28	3.0	N	40	25	60	C	6	B	1890	75
29	7.5	N	70	50	80	C	12	T	4590	87
30	6.7	N	75	40	61	C	15	T	9960	90
31	4.5	B	45	53	42	C	8.5	T	4600	61
32	5.4	N	70	50	65	C	12.5	T	980	75
33	5.5	N	60	40	60	C	8	B	9730	93
34	4.0	B	48	45	55	C	8	B	1860	90

Notes:

Firebox: N=Normal...................... B=Bio NB=Normal firebox with boiler section

Fuel:: C=Cordwood................. B=Briquettes

Inition: T=Top............................ B=Bottom

CO factors are given in mg/MJ (milligrams CO per MegaJoule of heat output). This allows direct comparison with other heating systems and fuels.

Emissions and efficiencies were calculated according to the following formulas:

$$Eco = \frac{\sum X_{CO}}{} K$$

$$Eco = \frac{\sum X_{CO}}{\eta m \sum X_{CO_2}} K \sum X_{CO_2}$$

$$K = \frac{1.250 CO_2 max \, V_{go}}{100 H_u}$$

(=approx 72 for wood @ 15% moisture)

where:

Eco	mg/MJ	Emissions factor for CO (=3.6 mg/kWh)
Xco	%	CO concentration in exhaust gas
X_{CO_2}	%	CO_2 concentration in exhaust gas
ηm		Average efficiency
CO_2max	%	Maximum CO_2 concentration
Vgo	Nm^3/kg	Stochiometric exhaust gas volume per kg of fuel (dry basis)
Hu	MJ/kg	Heating value

Average Efficiency

The average efficiency was obtained by the Siegert stack loss method. Losses due to incomplete combustion were ignored *(ie., combustion efficiency of 100% is assumed)*. The average efficiency calculation also assumes that the exhaust gas rate (liters per second) is approximately constant throughout the burn.

$$\eta = 1 - qv$$

$$\eta m = \frac{\sum X_{CO_2}}{\sum X_{CO_2}}$$

where:

ηm	%	Average efficiency during one complete burn cycle
η	%	Efficiency
qv	%	Stack Loss (Siegert)
X_{CO_2}	%	CO_2 concentration in exhaust gas

The average efficiency was obtained by taking into account the complete burn cycle, from ignition to the closing of dampers. The most recent research at the Guild's test lab. indicates that this is a good approximation, and a write-up will appear elsewhere. This allows us to calculate a good approximate average efficiency number from CO and CO_2 measurements alone.

THE DESIGN OF THE TEST PROTOCOL WAS DONE BY THE TESTING LABORATORY OF THE (AUSTRIAN) STOVEMASON'S GUILD. THE HEATERS WERE COMPARED ON THE BASIS OF AVERAGE CO NUMBER AND AVERAGE EFFICIENCY.

Test Results

Field tests were conducted on thirty four installations in 7 different (Austrian) states in order get a representative sample of different construction methods, rated heat outputs (ie., stove sizes), firing methods and fuel types.

Results are summarized in Table 1.

All results were used in calculating averages, including outlying data points, in order to obtain a representative sampling of existing installations. It should be stated that this test series yielded valuable data on the performance of different masonry heater types.

(Translator's note on the Great Confusion in masonry heater terminology: strictly speaking, the German-language term "Kachelofen" applies to any stove with a Kachel (=structural clay tile) facade, including a hot air convection stove with a metal insert (="Einsatz"). "Grundofen" is the German and Austrian generic term for an all-masonry, high mass, fast burn, heat storing stove, ie., a masonry heater as defined in draft ASTM E-06.57.07. The Einsatz was introduced in Germany to speed up stove

construction. The Austrians have never used the Einsatz, so in Austria the term "Kachelofen" automatically implies "Grundofen". By contrast, in Germany there is a "Kachelgrundofen" and a "Warmluftkachelofen", ie., a warm-air Kachelofen, aka. "Einsatzkachelofen". To confuse matters even more, in North America the term "Grundofen" is applied to a vaguely defined subset of masonry heater types. In Germany the term "Grundofen" would apply equally to a Finnish Contraflow, a Swedish Kakelugn or an Austrian Kachelofen. In this article, we therefore translate the Austrian term "Kachelofen" as masonry heater.)

The data generated by the test protocol allows us to draw meaningful conclusions regarding design-based causes of poor performance. In future, those stove designs that exhibited a high emissions factor will no longer be allowed by the Austrian Stovemason's Guild.

THE DATA GENERATED BY THE TEST PROTOCOL ALLOWS US TO DRAW MEANINGFUL CONCLUSIONS REGARDING DESIGN-BASED CAUSES OF POOR PERFORMANCE. IN FUTURE, THOSE STOVE DESIGNS THAT EXHIBITED A HIGH EMISSIONS FACTOR WILL NO LONGER BE ALLOWED BY THE AUSTRIAN STOVEMASON'S GUILD

If we break the results down by emission factor into 1000 mg/MJ intervals, there is a clear indication of a Gaussian (probability) distribution in the 1000 to 5000 mg/MJ range. We therefore conclude that this range depicts typical performance for the (Austrian) masonry heater. There were no values in the 5000 to 9000 mg/MJ nor in the 10,000 to 11,000 range. There were two stoves in the 9000 to 10,000 and one stove in the 11,000 to 12,000 range. Statistically, the three stoves are outlyers. It can also be stated that all three of these stoves exhibit very obvious deficiencies in their design/construction that would account for their high emission factor.

Other Conclusions

One obvious question is: how is stove performance affected by the more recently introduced design changes? A few brief conclusions are summarized below:

The so-called Bio-firebox was developed and introduced in the last few years. How did it perform? Table 3 indicates that, on average, the Bio-firebox had lower CO emissions than standard fireboxes.

Another emissions-reducing technique recommended in the last few years has been the top-down burn (ignition from the top). One surprising result from this test series was that the top-down burn performed worse than front (bottom) ignition.

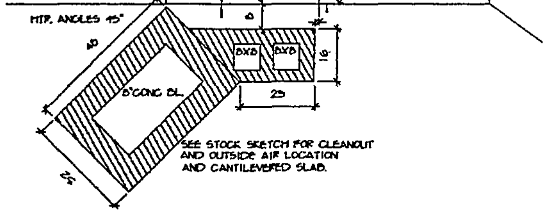
A more thorough analysis yields a plausible explanation for this effect. The top-down burn results in a longer burn time, resulting in a lower burn rate (kg/hr). At rated heat output (maximum wood load), we see a positive influence, since the lower burn rate assures that there is an adequate oxygen supply during all phases of the burn.

With a partial fuel load - which is usually the case, in practice and in this test series - top ignition can result in too low a burn rate, leading to lower firebox temperatures and an adverse effect on the quality of the burn. A higher burn rate is more advantageous with partial loads, and this is achieved with bottom ignition or reloading onto a coal bed.

Wood briquettes have been available in Austria for several years, and have been recommended for masonry heater use. Tests at the Guild's labs have shown the combustion quality to be excellent. This is also confirmed by the field tests, although with only 3 data points, more testing is indicated.

Comparison with other Solid Fuel Burning Devices

Table 4 compares the woodfired Grundofen CO result (2500 mg/kg) with other systems. All values are taken from the 1988 Austrian



Government Report on Energy. The data clearly shows the Grundofen to have better emissions performance than all other solid fuel domestic appliances and central heating systems. Only central heating systems for well-split wood achieve the same value. Significantly lower values are only achieved in large industrial systems.

Conclusions and Outlook

The data from this test series allows us to draw reliable conclusions about the overall performance vis-a-vis CO emissions and overall efficiency of existing Grundofen installations under typical conditions.

The test data cannot be compared with and should not be exchanged with laboratory results. Laboratory testing usually results in better numbers, since standardized fuel is burned under optimum conditions, and operator influence is factored out.

	Number	Carbon Monoxide mg/MJ
Firebox		
Normal	22/25	2250/3130
Bio	9	2030
Ignition		
Top	18	2280
Bottom	13	1920
Fuel		
Wood	28	2235
Wood Briquettes	3	1130

Table 3: Influence of Various Parameters on CO Factor

LABORATORY TESTING USUALLY RESULTS IN BETTER NUMBERS, SINCE STANDARDIZED FUEL IS BURNED UNDER OPTIMUM CONDITIONS, AND OPERATOR INFLUENCE IS FACTORED OUT.

The advances over the last few years in continuous-burn *(metal)* stoves have led to demonstrably better combustion performance. With increasing environmental awareness, the Grundofen will also come under closer scrutiny and be asked to demonstrate performance improvements. Technical advances on several fronts are in the development stage, and will soon be seen in the marketplace.

Number	Carbon Monoxide mg/MJ	Efficiency %
34(all)	2850	83.3
31 (no outliers)	2130	83.0

Table 2. Average CO Emissions Factors and Efficiencies for Wood-Fired Grundkachelöfen.

(<u>Editor's Note</u>: European efficiency numbers in general do not reflect the boiling of water loss (see Lopez Labs report in this issue). In the 1993 Lopez Labs tests, boiling of water loss averaged 11.4 %. Also not counted in the Austrian tests were CO losses, which averaged 4.24% in the Lopez tests, nor hydrocarbon losses, which averaged 1.37%. Therefore, comparable North American numbers would be around 17 % lower, for an Austrian average of 65.7 (all tests) or 66.0 (no outliers).

Appliance	CO in mg/MJ
Masonry Heaters fired with wood	2,500
Conventional Stoves	
Anthracite Coal	5,500
Bituminous Coal	6,000
Briquettes	5,000
Coke	5,500
Cordwood	7,000
Central Heating Systems	
Anthracite Coal	4,500
Bituminous Coal	5,000
Briquettes	4,000
Coke	4,500
Cordwood	6,000
Well-split wood (Waste Wood)	2,500
District Heating Plants	
Anthracite Coal	1,000
Bituminous Coal	1,000
Waste Wood	1,000

Table 4

Interestingly, the average from 22 tests in the '93Lopez Labs series is 65.5% (all tests) and

66.9 (without the single underfire air test). By comparison, OMNI's EPA-audited field tests of 6 masonry heaters (42 burns total) yielded the following results: All six heaters: 59.1%; four overfire air heaters only: 60.4%; 2 underfire air heaters only: 56.5%.

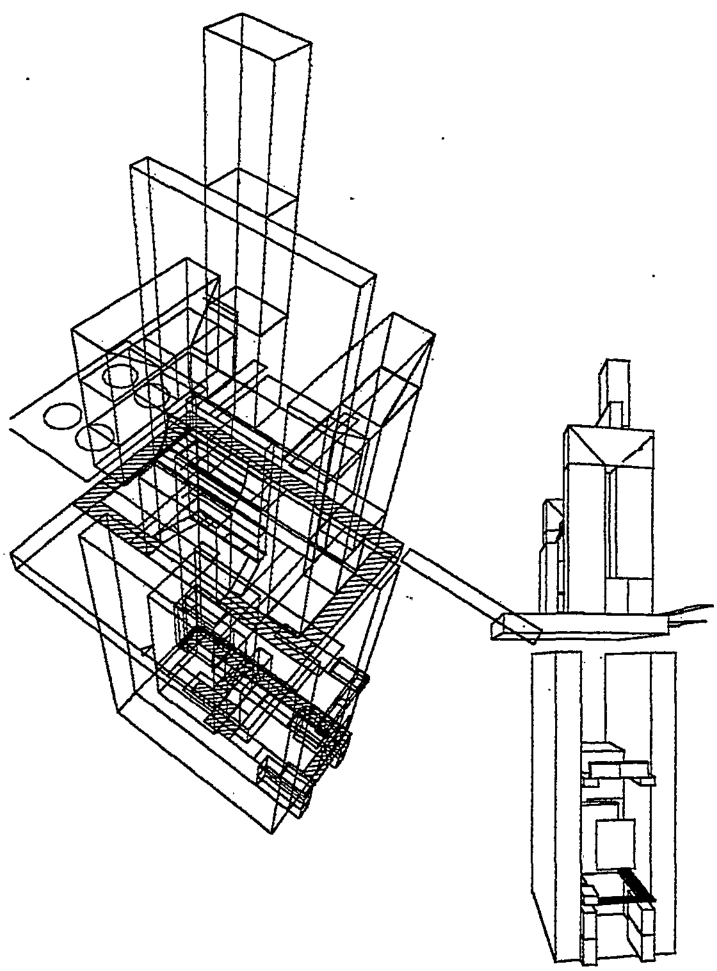
A second round of testing was then carried out, and the results were reported by Dr. Hofbauer in the 10/92 issue of K+R:

OPERATOR INFLUENCE IN GRUNDOFEN EMISSIONS

by Herman Hofbauer

The Kachelofen is surely the most tradition-rich heating system that we know of. This by no means implies that it is behind the times. A comprehensive field test series was undertaken in 91/92 and reported on above. One question remained unanswered, however: How much influence does the operator have on emissions?

A SURPRISING RESULT WAS THAT STOVES WHICH WERE USED WITH A TOP-DOWN BURN HAD NO BETTER EMISSIONS NUMBERS THAN THE AVERAGE



Introduction

The first tests series attempted to arrive at an average value for all wood-fired masonry heater emissions. The goal was to test as large and as varied a group of stoves as possible, since this reflects the real-word situation. It was found that all the masonry heaters studied were fired with 50 to 80% of their rated capacity.

A surprising result was that stoves which were used with a top-down burn had no better emissions numbers than the average.

This finding contradicts previous laboratory test results. This discrepancy became the springboard for the next series of tests.

Test Design

The goal of the second series was to determine the extent of operator influence and type of ignition on emissions performance. Four masonry heaters in the field and one in the lab were tested according to the following matrix:

	75% of max. fuel load	45% of max. fuel load
Top ignition		
Front ignition (bottom)		
Ignition from coal bed		

Fuel with 15% moisture was used for all tests. Wood size was approx. 6 x 8 x 25 cm. One heater was also tested with wood briquettes. The influence of wood moisture, fuel size and similar parameters will be the subject of a future test series. Emissions were compared on the basis of CO emissions in mg/MJ.

Conducting the Tests

Testing was conducted with the same protocol used in the first series of field tests. The results of the 6 matrix variants are presented in graphical form. CO emissions are indicated on the basis of the average burn rate. Average burn rate is calculated as fuel load divided by burn time.

Results

EVERY MASONRY HEATER DESIGN IMPLIES AN ASSOCIATED OPTIMUM BURN RATE

Optimum Burn Rate

An analysis of the results shows that the different ignition schemes either increase (ignition from coal bed) or decrease (top ignition) the burn rate. A similar relationship holds for fuel load mass. A larger fuel load, all things being equal, results in a higher burn rate. The burn rate therefore includes an ignition and a fuel load component. The highest burn rate is achieved by igniting the largest fuel load on a charcoal bed, and the lowest rate results from igniting the smallest fuel load from the top.

By plotting the CO emission factor versus the burn rate, a characteristic relationship is evident and more or less pronounced depending on the appliance. Chart 1 (*in the original document, not shown here*) shows this relationship for one of the four heaters. It is clear that each heater has an optimal burn rate, for which CO emissions are the lowest. A lower or higher burn rate results in higher CO. In other words, the burn becomes less than optimum.

If the burn rate is too high, then the available chimney draft is insufficient to introduce enough oxygen at the height of the burn - it's a bad burn. If the burn rate is too low, then the chimney draws too much air through the firebox, the excess air number is high, and the firebox temperature is lowered by the extra air - again resulting in less than optimum combustion.

Chart 2 is similar to chart 1 and shows the corresponding results for a masonry heater in the lab. In addition to values for cordwood are values for wood briquettes. You will note that the optimal burn rate for both fuels is practically identical. In addition, we again see evidence that CO numbers for briquettes are lower than for cordwood.

Chart 3 shows all data points for the 4 stoves that were field tested. The excess air number refers to the average excess air for the entire burn. The excess air number is actually lower during the peak of the burn and higher at either end. Plotting CO against the average excess air number, we again see a characteristic relationship that can be divided into 3 regions:

- Excess air less than 2.5:

  Here there is a high probability that the peak of the burn will experience a lack of air with resulting poor combustion.

- Excess air between 2.5 and 3.5

  The best combustion conditions are to be seen in this region.

- Excess air greater than 3.5

  Too much excess air leads to lower combustion temperatures and a poorer burn.

The next article in this series will elaborate on these results as they relate to firebox design and optimum stove operation.

Optimum Excess Air Number

Chart 3 shows the relationship between combustion quality and excess air. The excess air number refers to how many more times than the theoretical (stochiometric) amount of combustion air is supplied. A theoretically complete burn with stochiometric air (excess air number = 1) would result in zero oxygen in the flue gas. Complete combustion without some excess air is impossible with almost all fuels.

(This article was continued in the 1/93 issue of K+R:)

Firebox Dimensioning and Operation of Low-Emissions Wood-Fired Masonry Heaters

by Herman Hofbauer

In view of the recent research results, the next question is "How does this affect guidelines for firebox design and how does this affect the operation of masonry heaters?"

THE CONDITIONS FOR AN OPTIMUM BURN RATE ARE DETERMINED BY THE LAYOUT OF THE STOVE, PARTICULARLY THE FIREBOX

Here is a brief summary of the research results so far:

1. Every masonry heater design implies an associated optimum burn rate. This translates directly into an optimum fuel charge, since burn rate equals fuel charge divided by burn time. This follows from the fact that, with heat storage at our disposal, we don't attempt to control the burn time itself through regulating the combustion air supply. Optimized fuel charge translates into optimized combustion (low CO emissions). With a fuel charge that is higher or lower than the optimum, we are able to detect a rise in CO.

2. The conditions for an optimum burn rate are determined by the layout of the stove, particularly the firebox.

3. With an existing Grundofen, we can vary the burn rate in several ways. The most important ones are the fuel charge size and configuration, and the kindling method. Wood moisture and wood sizing are surely additional factors. In the current round of testing, only the first two factors were investigated.

4. A good burn is achieved with an excess air number of 2.3 to 3.

The design goal must be to optimize the burn through design factors of firebox and heat exchange channel dimensioning, and chimney connection. This is achieved when the result is an optimized burn rate. The following discussion deals with the design factors that have to be accounted for.

Design Implications

The basis for sizing the heater is a calculation of the house or room heating load. For heater A we require a heat output of 5.1 kW.

In order to meet the required output, we need the following fuel charge per burn:

$$m_H = \frac{P_n t}{H_U \eta}$$

where:

m_H	wood charge per burn (kg)
P_N	rated heat output (kW)
t	heating cycle (h)
H_U	heat content of fuel (kW/kg)
η	efficiency

For heater A, these variables were given the following values:

P_N	= 5.1 kW (calculated heat load
t	= 13 h (results from medium-heavy construction style, 1 hour reserve)
H_U	= 4.028 kWh/kg
η	= 0.8

When we plug these values into the above equation, we get a fuel charge (per 13 hour heating cycle) of

$$m_{H13h} = \frac{5.1 \times 13}{4.028 \times 0.8} = 20.6\text{kg}$$

The heat load was calculated for an outside temperature of 15C. This temperature is only reached for a few days a year, and therefore the calculated output is also only required for a few days. It would therefore not make much sense to optimize the burn rate for this heat output.

The sensible thing to do is to size the heater for a smaller output, namely an output that matches the most often required heat load. Note, however, that we still need to use the 13 hour heating cycle in our calculations. Established practice (see, for example, Reference 1) is to use a size equivalent to reducing the heating cycle from 13 hours to 8. Alternatively, this can be expressed as using a size that would give us 62% of calculated full output. Using the above equation, this reduces our fuel charge from 20.6 kg to 12.7 kg.

From the viewpoint of outside temperature, we see that this amounts to saying that, on an 8 hr. heating cycle, we can cover a climate with a minimum outdoor temperature of 0C.

Burn rate should therefore become the starting point for Grundofen combustion design. The burn rate gives us the required rate of combustion air, from which follows the exhaust gas flux and which therefore gives us a rational basis for sizing and laying out firebox and exhaust gas (heat transfer) channels.

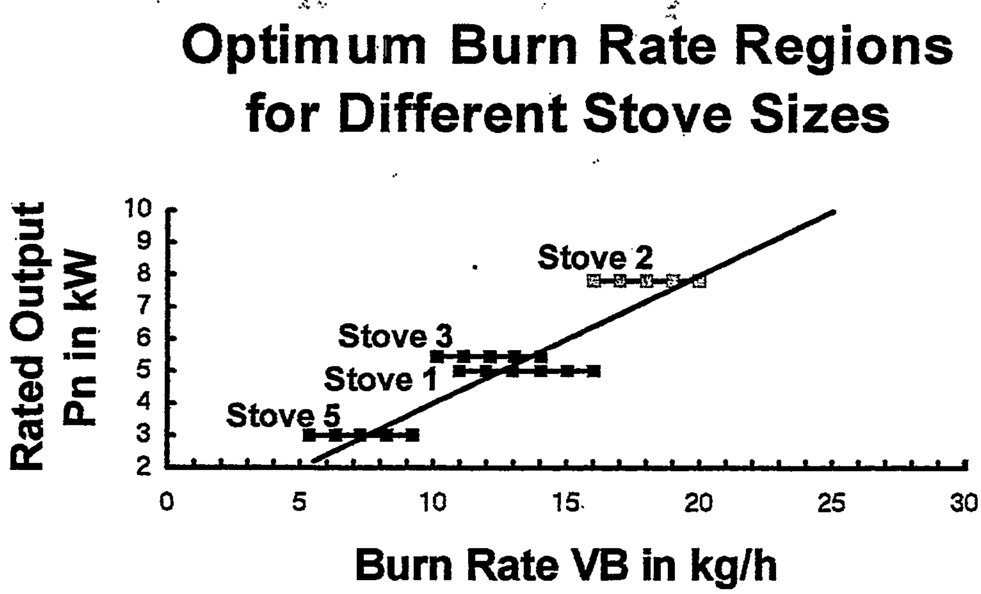
Existing guidelines in use to date have been based on accumulated trade experience, but a broad, systematic series of tests has never been undertaken until recently.

Experience has taught us that it is advantageous to burn the fuel for an eight hour heating cycle in one hour. This is how we determine our optimized burn rate. The solid line on the chart below shows this relationship, with values for four stoves. Therefore, for stove 1, our optimum burn rate is 12.7 kg/hr., as calculated in the previous example.

In addition, the field tests enable us to give values for optimized (minimum CO) burn rates for stoves 1 to 3 and for stove 5. These are indicated by the horizontal lines for each stove.

Inspecting the graph makes it clear that the generally accepted (trade) practice for calculating

BURN RATE SHOULD THEREFORE BECOME THE STARTING POINT FOR GRUNDOFEN COMBUSTION DESIGN



burn rates is confirmed by the tests.

In order to lay out a stove we also require the excess air number. Accepted practice is to use a value averaged over the burn cycle, in the same fashion as burn rate values. Accepted trade practice to date has been to use a value of 2.4. From the chart *(in the original)*, we see that the tests give us optimal values in the range 2.5 to 3.

In theory, we should keep the excess air number as low as possible. Less excess air gives us higher firebox temperatures, which are desirable for good combustion. Not only that, but the lower amount of dilution air reduces our stack losses, since less room air is heated to chimney temperatures and then exhausted.

One lower limit on the excess air number is the fact that during the fast gaseous combustion phase of the burn, we will get an air starved or lean condition. This can lead to incomplete combustion and high CO emissions .The burn goes "over the edge" ("Umkippen der Verbrennung", literally "the burn tips over").

(Editor's note: around this "critical point" in excess air number, we can get two completely different CO curves with a very slight change in air. Analytically, this is a "non-linear" condition know as a bifurcation. The road forks and the burn travels an alternate path. We can't recover the initial condition through a simple air adjustment and see a large CO spike instead. See Lopez Labs tests elsewhere in this issue. Note that the phenomenon described here is specific to fast burn, heat-storing appliances with an unregulated air supply, and shouldn't be confused with conventional stove phenomena. The solution is design-based and obvious: increase excess air.

For regulators who are truly serious about cleaning up their air sheds, it would be appropriate to establish a separate category for high-mass heat storing appliances (see Walter Moberg's report elsewhere in this issue): Clean-burning, no fuss, systems that are site built according to well established, trade based, parametric design rules backed up by field testing. You will get a cleaner air shed by requiring trade certified installers than you will from laboratory testing of individual appliances. You also won't see any performance deterioration over time).

As mentioned, the values we use are understood to be average values, averaged over the whole burn. It should not go unmentioned here that the excess air number is dependent on the instantaneous burn rate, and is constantly changing. If we divide the burn into three phases, we see the following typical values:

Burn Phase	Excess Air Number
Ignition	2.5-8
Main Burn	1.5-2.5
Charcoal	2.5-5

The traditionally used design value of 2.4 for excess air has been validated by the testing. For the five stoves tested from a minimum emissions standpoint, we see a small, virtually insignificant, adjustment upwards. We refer you to the Madaus book, cited above, for practical examples of design calculations.

THE CALCULATION OF FIREBOX AND FLUE SIZES SHOULD BE SEEN INSTEAD AS A VERY EFFECTIVE INSTRUMENT WITH WHICH WE CAN LOWER STOVE EMISSIONS.

We emphasize the point that the calculation of firebox and flue sizes is more than just one more useless task burdening the stovemason. It should be seen instead as a very effective instrument with which we can lower stove emissions.

All of the stoves tested for burn rate versus emissions show us that, when we use the optimized burn rate regimen for each stove, that they are more than capable of meeting the strict new CO emissions regulations for 1995 (1300 mg/MJ). Furthermore, this is easily achieved under field conditions, even though the regulations require "only" laboratory tests.

What this means for you

The tests series clearly demonstrates that for each heater there is an optimal burn rate (*Ed: ie., an optimum fuel charge and ignition protocol*). The goal therefore has to be to operate the appliance in this region. The next step is to formulate a clear set of design guidelines encompassing the field test results.

The burn rate in a given stove can be varied to some degree by the weight of the fuel charge and the kindling method. (There are no doubt other factors, such as fuel sizing , that are outside the scope of the present test series).

We need to differentiate two cases:

- Case 1: Use with optimum amount of wood (based on stove design)

We know that the optimum fuel charge is for 60 to 65% of rated output over 13 hours, ie., rated output over 8 hours. With this optimum fuel charge, we don't see much effect of kindling method on emissions.

As mentioned earlier, it is not really a matter of one exact burn rate that we need to achieve. Rather, there is a more or less broad region in which we can get a first class burn. If we happen to use the optimum fuel charge, we find ourselves right in the center of this region. Changing the kindling method here doesn't affect the burn enough to take us outside of this excellent burn zone. If we deviate quite a bit from the optimum fuel charge, then we need to start paying attention to the kindling method

- Case 2: Use minimum or maximum amount of wood

Maximum amount

With a maximum fuel charge, top ignition is advantageous, since it has the effect of reducing the burn rate.

Minimum amount

Here we see advantages for bottom ignition, or ignition onto a charcoal bed, since this tends to increase the burn rate.

This realization regarding kindling method is fully compatible with the field test results, which showed no advantage for top ignition. Seen from our new vantage point, we realize that the tests, on average, took place in the fairly broad optimum burn zone and therefore we would not expect top ignition to have an effect.

The goal of the field test series was to obtain real-world numbers for masonry heaters as they are actually used every day. The results show us that typically these appliances are operated with a fuel charge that is between 45% and 75% of maximum (rated 13 hr output). This fact confirms our thesis that it is better to optimize masonry heaters for 8 hr (62%) output than for rated output.

Outlook

This test series sought answers to two questions:

1. How much effect on burn quality is there from different operating conditions as seen in actual everyday use?

2. How does commonly accepted current stove design and layout practice stack up against recent requirements to minimize emissions?

Positive Results

Variations in actual operator practice as seen in the field results in burn rate variations. In addition, kindling method can affect burn rate. Detailed measurements carried out on five different heaters showed that each heater had an optimum burn rate zone that allowed excellent combustion. However, chimney draft and flue gas channel calculations for each heater establish a design burn rate. This design value was determined for each stove, based on established historical trade practice. The data shows that these design values result in masonry heaters with low in-field CO emissions in compliance with 1995 Austrian clean air regulations. The calculated burn rates, in view of emissions performance, were therefore classed as optimum.

THE DATA SHOWS THAT THESE DESIGN VALUES RESULT IN MASONRY HEATERS WITH LOW IN-FIELD CO EMISSIONS IN COMPLIANCE WITH 1995 AUSTRIAN CLEAN-AIR REGULATIONS

Stove Calculations as Insurance

Stove calculations should not be regarded by the trade as a nuisance or an inconvenience. Rather, they should rightly be viewed as insurance for maximum masonry heater performance.

References:

1.) Der Kachelgrundofen, Planung, Konstruction und Aufbau, Madaus, Chr. and Henhapl, N., published by Verlag Gustav Kopf GmbH, Box 1490,Waiblingen-Bittenfeld, Germany, 4th edition, 1992. (42.00 DM).

The only English language reference is:

Kachelgrundöfen - A Guide for the Practitioner, Heinz Maresch, 1972, 16 pages, translated by N. Senf, available from Masonry Stove Builders, RR 5, Shawville, Québec, J0X-2Y0.

A Crash Course in Combustion

by N. Senf

Wood combustion is a complicated process consisting of several main chemical reactions and a very large number of intermediate reactions. Depending on the conditions in the firebox, many alternate paths are available to the reacting compounds. As you know, when wood is burned the range of possible products that can leave the stack is very wide.

Elementary Analysis

Wood has a complicated chemistry, but it can be broken down into an elementary analysis as follows:

Carbon	(C)	41.0%
Hydrogen	(H_2)	4.5%
Oxygen	(O_2)	37.0%
Water	(H_2O)	16.0% (Air dried)
Ash		1.5%

The brackets give the molecular formula. For example, C refers to 1 atom of carbon, which for carbon also happens to be one molecule. H_2 refers to one molecule of hydrogen, which consists of two atoms. There is also about 1% Nitrogen, which we will ignore.

The atomic weights of the different elements are as follows, and refer to the atomic weight of Hydrogen, the lightest element, which is 1.

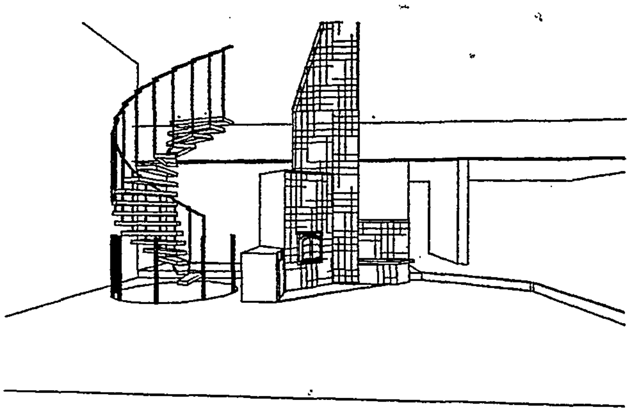
H..................1

C..................12

O..................16

Thus we get the molecular weight of carbon dioxide, CO_2, as 44 and carbon monoxide, CO, as 28.

44 grams of CO_2 and 28 grams of CO both have the same number of molecules, and therefore the same volume. A litre of CO_2 therefore weighs 44/28=1.57 times as much as a litre of CO at the same temperature.



Combustion Reactions

During complete combustion, the following chemical reactions take place:

$C + O2$ .... $= CO_2$

$2H_2 + O_2$..... $=2H_2O$

During incomplete combustion, we get the following:

$2C + O_2$....... $=2CO$

The CO can itself be combusted as follows:

$2CO + O_2$.... $=2CO_2$

As wood is heated, it releases hydrocarbons in the form of volatiles or gases, and they are given the general molecular formula C_mH_n. The products from complete combustion of hydrocarbons are CO_2 and H_2O (water vapor or steam). During the charcoal phase, we're combusting C without any H_2, so we get CO_2 or CO, but no H_2O.

Emissions

The emissions question revolves around the subject of incomplete combustion. Incomplete hydrocarbon combustion gives rise to carbon monoxide (CO), soot (C), free hydrogen (H_2) and numerous tars and other organic compounds.

All of these reactions are exothermic, ie., they result in a conversion of chemical energy into heat, namely:

1kg C + 2.67kg O_2 = 3.67kg CO_2
.... + 8,000 kcal or 33,820 kJ

1kg C + 1.33kg O_2 = 2.33kg CO
.... + 2,400 kcal or 10,200 kJ

1kg CO + 0.57kg O_2 = 1.57kg CO_2
.... + 2,400 kcal or 10,200 kJ

1kg H_2 + 8.0kg O_2 = 9.0kg H_2O
.... + 34,000 kcal or 144,500 kJ

One kcal equals about 4 BTU's.

Once the chemical composition of a fuel is known, the above formulas can be used to calculate the heat content.

If we oven dry the wood, then it becomes 98.5% combustibles, We've taken out the water, and everything except the ash (and nitrogen) is combustible. The elementary analysis now becomes:

C.......................... 50.0%
H_2.......................... 6.0%
O_2.......................... 42.0%
Ash.......................... 2.0%

Combustion Air

The theoretical combustion air requirement can be calculated from the chemical composition of the fuel.

With complete combustion and dry air:

$Air_{th} = 8.8\ C + 26.5\ H_2 - 3.3\ O2\ \ Nm^3/kg$, or cubic meters per kilogram of fuel, where Nm is a normalized cubic meter, ie., atmospheric pressure and 0 C.

Example

Let's run through an example:

Calculate the theoretical air requirement for wood combustion as well as the actual combustion air if the exhaust gas contains 10% CO_2:

For wood with the following analysis:
C = 41%
H_2 = 4.5%
O_2 = 36%
N_2 = 1%
H_2O = 16%
Ash = 1.5%

Air_{th}........... = 8.8 x 0.41 + 26.5x0.045+ 3.3 x 0.36
= 3.60 Nm^3/kg

Excess Air

In reality, more than the theoretical amount of air is required, since some air passes through the firebox without taking part in the combustion. This is called excess air.

Excess air = CO_2max./CO_2measured

The maximum CO_2 possible in wood fuel flue gas is 20.9%

Our excess air is therefore n = 20.9/10 = 2.09, ie., 209% excess air.

1993 Lopez Labs Tests

by Norbert Senf

In the last issue of MHA News we ran a preliminary report on testing that Jerry Frisch and I did at Jerry's Seattle lab last spring. We learned a lot, and had a whole lot of new questions. There are plans afoot to do a new, even more extensive test series in the spring of 94, after the Reno show. We're planning to add a second contraflow unit and are trying to get some of the manufacturers interested as well (we had some support from TULIKIVI last year and were able to add a TU-800 to the database).

WE LEARNED A LOT, AND HAD A WHOLE LOT OF NEW QUESTIONS.

I drew some preliminary conclusions in the last article, and won't repeat them here. A more extensive analysis of the data will have to wait for the heater business to slow down a bit this winter.

Instead, I thought we might run some of the raw data in this article to give you a little of the overall flavor of the thing and perhaps give you a chance to draw some conclusions of your own.

The Procedure

Here's a brief rundown of the lab setup and procedure we developed. All of the procedures have been broken down and are on a checklist so that there is quality control.

The heaters were fired on a 24 hour cycle, ie., once a day. Usually we did 3 test runs on three different units per day. The wood was all from the same batch of old growth Douglas Fir. We measured the moisture content of each piece of wood, weighed each piece, and measured it's circumference. We then batch weighed the wood and the kindling, stacked it in the heater, and took a photo of the fuel load. We then lit the heater.

We had a number of thermocouple locations, but only tracked the flue gas temp.

We used a Condar dilution tunnel to draw a calibrated flow of flue gas through a filter and backup filter. Filters were both changed 15 minutes into each burn. All four filters then went into a desiccation (drying) cabinet for 24 hours to get rid of the flue gas moisture, leaving behind the particulate matter (PM). The filters were weighed before and after on a laboratory balance with a resolution of .1 mg (.0001 gm.). Because the filters also react with ambient moisture, a control filter went in and out of the drying cabinet with the others. Weighing the control every time also tips you off in case there is a problem with the balance.

A separate, small stream of exhaust gas goes through a dryer and some filters and then into a SUN SGA-9000 four gas digital analyzer. Every 5 minutes, we turn on the pump on the SUN and it then goes through a self-calibration cycle before giving a real-time readout of the Oxygen (O_2), Carbon Dioxide (CO_2), Carbon Monoxide (CO) and Hydrocarbons (HC). The SUN comes with a bottle of calibration gas which is used to recalibrate it from time to time. The instrument had had a fresh rebuild when Jerry bought it, so it should last for a while.

The gas readings were entered into a spreadsheet, along with any comments on how the burn was progressing. Below is a copy of the blank spreadsheet form. A little square dot in any of the cells in the 'Time" column means there's a comment attached to that set of readings.

Also on the spreadsheet is a blank chart which draws three of the gas curves and a flue temperature curve as you enter the data.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	
Wood Moisture	#DIV/0!
Total Weight	
Kindling Weight	
Number of Pieces	
Run Length	
Av. Stack Temp	#DIV/0!
Av. O2%	#DIV/0!
Av. CO%	#DIV/0!
Stack Temp. Factor	#DIV/0!
Stack Dilution Factor	#DIV/0!
Burn Rate dry kg/hr	#DIV/0!
Boiling of Water Loss	#DIV/0!
CO Loss %	#DIV/0!
HC Loss %	#DIV/0!
Dry Gas Loss %	#DIV/0!
Filter Catch gm.	#DIV/0!
g/kg Condar	#DIV/0!
g/kg M7 equiv	#DIV/0!
g/kg CO	#DIV/0!
Combustion Effic.	#DIV/0!
Heat Trans. Effic.	#DIV/0!
Overall Efficiency	#DIV/0!

SYSTEM		DATE	
Time since last burn		Ambient Temperature	
Start Time		Weather	
FUEL			
Type	DF-og		
Surface/Volume	#DIV/0!		
Density	30.6		
Unburned Fuel			
Av. Sampler Flow	.4 cfm		

Time	StackTemp	O2% x10	CO%x1000	CO2%x10	HC ppm
0					
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					
55					
60					
65					
70					
75					
80					
85					
90					
95					
100					
105					
110					
115					
120					
125					
130					
135					
140					

Filter Number	Clean Filter Wt.	Dirty Filter Wt.	Wt. of Particulat
1			0.0000
2			0.0000
3			0.0000
4			0.0000
Ctrl:Bef	0.5135		
Ctrl:Aft	0.5135		
	Adjust		#DIV/0!
	Total		#DIV/0!

Batch Wt. Clean	
Add Individual	0.0000
Batch Wt. Dirty	
Add Individual	0.0000

Piece #	Weight	Moisture	Circumf	Length	SCRATCH
1					0
2					0
3					0
etc.	etc.	etc.	etc.	etc.	etc.
17					0
18					0
19					0

Shown below is the same spreadsheet that is shown above as the data entry form. In this view, the items without borders are the actual titles from the spreadsheet and describe the contents of the adjacent cells.

The other cells input or process data, and are shown inside boxes for clarity.

Some of these cells are blank. These cells have data entered into them that is not processed any further. For example, the date and the run number.

Other cells have repeating names in them. These are "named" data entry cells. This allows us to use the actual data name (e.g., StackTemp) when we write formulas, such as =AVERAGE(StackTemp) rather than the more cryptic older spreadsheet terminology, which would go something like =AVERAGE($D4:$D16). Blank cells, such as for the hydrocarbon readings off the gas analyzer, don't appear in any of the calculations, so they aren't named. The data in them is still used to draw the charts, however.

Other cells, such as a lot of the ones in the "Calculation Section" below, contain formulas. Normally, these formulas sit "underneath" the cell and you don't see them. What you see instead is the result of a calculation based on the formula. This is what you see in the "Lopez Labs Emissions Test Data Form" after the filters are weighed and the data entry is complete (You have to let the filters dry out in a desiccation cabinet for 24 hours before you can weigh them because they absorb moisture from the flue gas. However, you can weigh them wet, discount the water, and get preliminary numbers right away). Once all the data has been entered off the gas analyzer and the filters, then all of the losses, efficiencies, PM numbers, etc., magically appear in the appropriate locations. The charts appear dynamically as the flue gas readings are entered at 5 minute intervals. You actually watch the curves develop in real time as the burn unfolds.

Most of the formulas in the Calculation Section were taken from a spreadsheet developed by the late Dr. Stockton (Skip) Barnett. We added the fuel formulas and modified the dry gas loss formula to use actual ambient temperature rather than 70F, which dropped overall efficiency about 1.5%.

LOPEZ LABS EMISSIONS TEST SPREADSHEET \\ FORMULA VIEW

CALCULATION SECTION:

RUN No.

Wood Moisture	=SUM(SCRATCH)/(AVERAGE(PcWt)*COUNT(PcWt))
Total Weight	WtFuel
Kindling Weight	WtKindl
Number of Pieces	Number OfPieces
Surface/Volume	=(AVERAGE(Length)+SUM(Circumf))/(WtFuel-WtKindl)
Run Length	Run Length
Av. Stack Temp	=AVERAGE(StackTemp)
Av. O2%	=AVERAGE(Oxy)/10
Av. CO%	=AVERAGE(CO)/1000
Stack Temp. Factor	=SQRT(528/(460+AvStackTemp))
Stack Dilution Factor	=20.9/(20.9-AvO2)
Burn Rate dry kg/hr	=((WtFuel-(UnburnedFuel*(1+AvMoisture/100)))/RunLength)*(1-(AvMoisture/100))/2.2
Boiling of Water Loss	=(8.05+0.0035*(AvStackTemp-Ambient))+(2.58+0.00114*AvStackTemp)
CO Loss %	=gmKgCO*9.75/86
HC Loss %	=gmKgM7*33/86
Dry Gas Loss %	=((1.5*DilutionFactor*(AvStackTemp-Ambient))/8600)*100
Filter Catch gm.	=Catch
g/kg Condar	=(Catch/RunLength)*3.04*(DilutionFactor)/(0.4*StackTempFactor)
g/kg M7 equiv	=(1.5711*gmKgCondar)-(0.022*(gmKgCondar^2))+0.033
g/kg CO	=59.3*AvCO*DilutionFactor
Combustion Effic.	=100-COLoss-HCLoss
Heat Trans. Effic.	=100-DryGasLoss-BoilWaterLoss

Overall Efficiency	=HTransEffic*CombustEffic/100
Time since last burn	TimeSinceLast
Ambient Temperature	Ambient
Av. Sampler Flow	.4 cfm

GENERAL INFO. SECTION:

SYSTEM		DATE	DATE
START TIME		WEATHER	
FUEL			
TYPE			
DENSITY			
UNBURNED FUEL			

DATA ENTRY SECTION:

Time	Stack Temp	O2% x10	CO% x1000	CO2% x10	HC ppm
0	StackTemp	Oxy	CO		
5	StackTemp	Oxy	CO		
10	StackTemp	Oxy	CO		
etc.	etc.	etc.	etc.	etc.	etc.
130	StackTemp	Oxy	CO		
135	StackTemp	Oxy	CO		

DETAILED FUEL INFO

Piece #	Weight	Moisture	Circumf	Length	SCRATCH
1	PcWt	Moisture	Circumf	Length	=PcWt*Moisture
2	PcWt	Moisture	Circumf	Length	=PcWt*Moisture
3	PcWt	Moisture	Circumf	Length	=PcWt*Moisture
etc.	etc.	etc.	etc.	etc.	etc.
18	PcWt	Moisture	Circumf	Length	=PcWt*Moisture
19	PcWt	Moisture	Circumf	Length	=PcWt*Moisture

FILTER SECTION WITH CONTROLS

	Filter Number	Clean Filter Wt.	Dirty Filter Wt.	Wt. of Particulate
	1	FiltClean	FiltDirty	=IF(FiltDirty-FiltClean>0,FiltDirty-FiltClean,0)
	2	FiltClean	FiltDirty	=IF(FiltDirty-FiltClean>0,FiltDirty-FiltClean,0)
	3	FiltClean	FiltDirty	=IF(FiltDirty-FiltClean>0,FiltDirty-FiltClean,0)
	4	FiltClean	FiltDirty	=IF(FiltDirty-FiltClean>0,FiltDirty-FiltClean,0)
Ctrl:Before		CleanControl	DirtyControl	
Ctrl:After		CleanControl	DirtyControl	
		Adjust		=+COUNT(FiltClean)*(AVERAGE(CleanControl) -AVERAGE(DirtyControl))
		Total		=SUM(J35:J38)+J40
Double Check: >>>>		Batch Wt Clean		
		Add Individual		=SUM(FiltClean)
		Batch Wt Dirty		
		Add Individual		=SUM(FiltDirty)

O.K., let's look at some data:

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A02
Wood Moisture	19.4
Total Weight	28.0
Kindling Weight	3
Number of Pieces	5
Run Length	2.0
Av. Stack Temp	112
Av. O2%	16.40
Av. CO%	0.21
Stack Temp. Factor	0.96
Stack Dilution Factor	4.65
Burn Rate dry kg/hr	5.13
Boiling of Water Loss	10.91
CO Loss %	8.48
HC Loss %	0.90
Dry Gas Loss %	4.07
Filter Catch gm.	0.0822
g/kg Condar	1.51
g/kg M7 equiv	2.36
g/kg CO	57.12
Combustion Effic.	92.62
Heat Trans. Effic.	85.02
Overall Efficiency	78.75

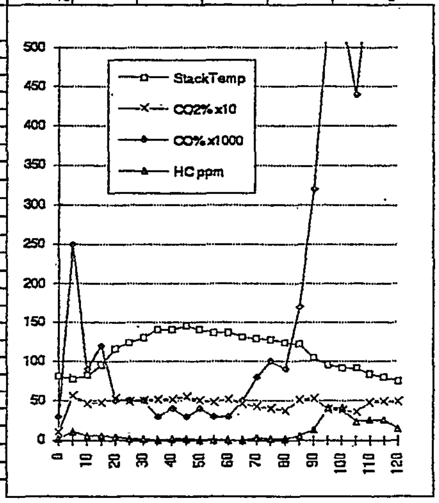
SYSTEM	HEATKIT	DATE	3/26/93
Time since last burn	24 hrs	Ambient Temperature	62
Start Time	2:00 PM	Weather	Sunny
FUEL			
Type	DF-og	221	
Surface/Volume	4.17	Air through door leaks	
Density	30.6	and cracked door only	
Unburned Fuel		13 ft vert, 7ft horiz single wall pipe	
Av. Sampler Flow	.4 cfm	10 ft insulated pipe	

Time	StackTemp	O2% x10	CO% x1000	CO2% x10	HC ppm	check
0	81	199	30	10.1	2	20.91
5	78	157	250	56.9	11	21.39
10	82	163	90	47.1	8	21.01
15	96	162	120	48.0	6	21
20	116	158	50	52.5	4	21.05
25	124	163	50	49.3	2	21.23
30	130	162	50	50.2	2	21.22
35	141	162	30	51.7	0	21.37
40	140	161	40	52.2	2	21.32
45	146	155	30	55.1	2	21.01
50	140	163	40	50.6	1	21.36
55	137	163	30	49.2	1	21.22
60	137	161	30	51.9	0	21.29
65	132	166	50	46.2	0	21.22
70	129	169	80	42.5	3	21.15
75	128	172	100	40.0	2	21.2
80	124	172	90	38.1	2	21.01
85	122	160	170	51.3	6	21.13
90	104	153	320	53.6	13	20.66
95	96	169	540	39.1	41	20.81
100	92	170	540	38.1	41	20.81
105	91	171	440	36.2	24	20.72
110	84	159	610	47.7	26	20.67
115	80	156	690	48.6	26	20.46
120	75	155	710	48.6	15	20.38
125						
130						
135						
140						
145						
150						
155						
160						
165						

Filter Number	Clean Filter Wt.	Dirty Filter Wt.	Wt. of Particulat
1	0.5867	0.6089	0.0222
2	0.5755	0.5772	0.0017
3	0.5374	0.5669	0.0295
4	0.6000	0.6020	0.0020
5	0.5880	0.6145	0.0265
6	0.6618	0.6621	0.0003
Control			
	Adjust		0.0000
	Total		0.0822

Batch Wt. Clean	
Add Individual	3.5494
Batch Wt. Dirty	
Add Individual	3.6316

Piece #	Weight	Moisture	Circumf	Length	SCRATCH
1	5	21	17	17	105
2	5	20	16	15	100
3	5	21	19	18	105
4	5	18	17	16.5	90
5	5	17	19	16	85
6					0
7					0
8					0
9					0
10					0



This was the second contraflow run. There were equipment problems on the first run, so we threw it out.

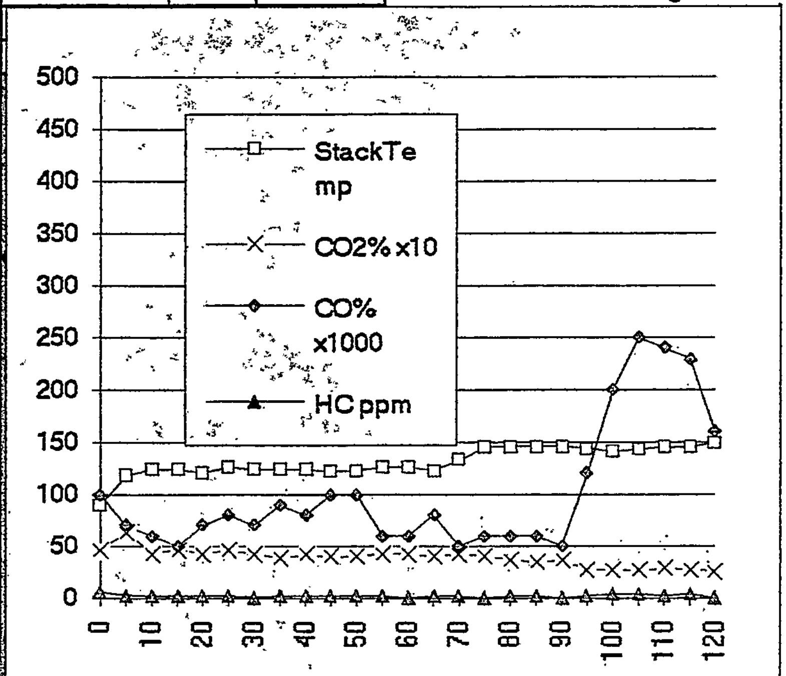
This is all of the data for this run. We'll condense it a bit from here on in, since some of it is redundant.

This was a baseline run, to check out the equipment. There was no air supply at all - just a slightly cracked door. There were also 20 ft. of uninsulated single wall pipe, which got fixed after this run. Check out the stack temperatures and the overall efficiency as a result.

Check out the CO spikes and compare them with later runs.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A03	FUEL		
Wood Moisture	15.9	Type	DF-og	221,kindling on top right
Total Weight	28.0	Surface/Volume	4.30	next to big piece
Kindling Weight	2.5	Ambient Temperatur	62	1x2 air slot at bottom edge of doo
Number of Pieces	5			
Run Length	2.0			
Av. Stack Temp	133			
Av. O2%	17.04			
Av. CO%	0.11			
Stack Temp. Factor	0.94			
Stack Dilution Factor	5.41			
Burn Rate dry kg/hr	5.35			
Boiling of Water Loss	11.00			
CO Loss %	3.99			
HC Loss %	0.74			
Dry Gas Loss %	6.67			
Filter Catch gm.	0.0562			
g/kg Condar	1.22			
g/kg M7 equiv	1.92			
g/kg CO	35.17			
Combustion Effic.	95.27			
Heat Trans. Effic.	82.33			
Overall Efficiency	78.44			



An interesting run - relatively small charge (for a North American heater), large firewood, dry.

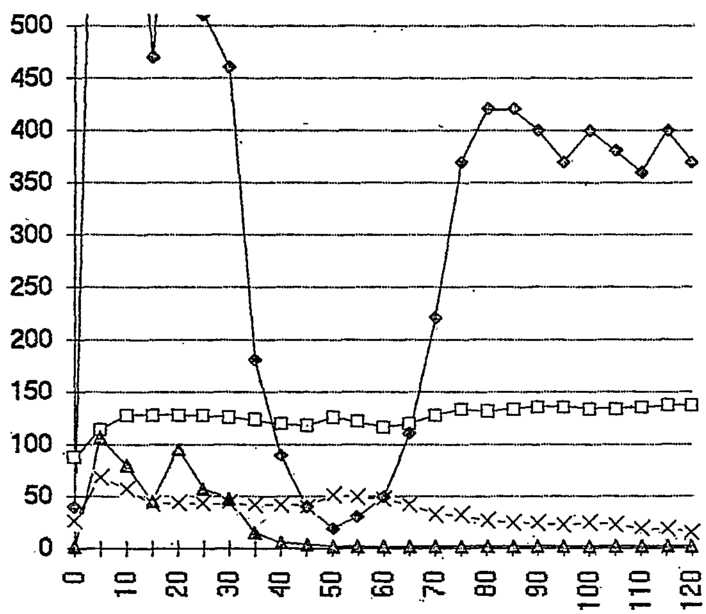
Excess air is a bit high, as it is in all of the runs.

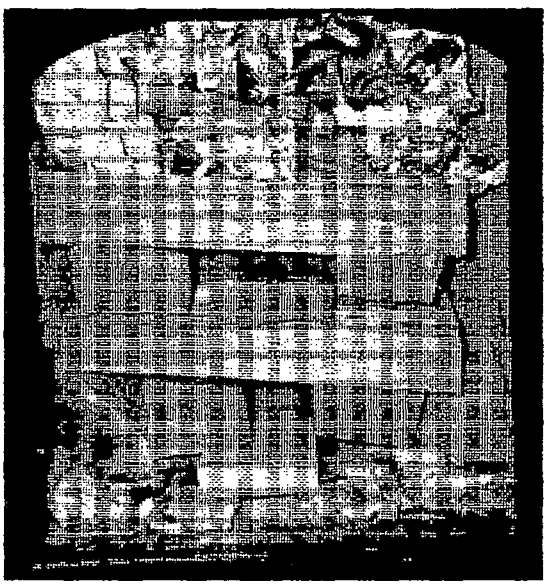
Combustion air system - very basic, you can do this one while falling off a log. This will be an interesting one to replicate, because, in my opinion, it is a very convincing argument for having design-based masonry heater building codes, rather than having to get a lab test for a particular model and then being locked-in the way EPA stoves are to needing a new test every time there is a small change in the firebox.

Again the same argument: <u>Burn rate independence because of heat storage ability</u> - not to be lumped together with other appliances simply because they also happen to burn wood.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A04	FUEL		
Wood Moisture	18.8	Type	DF-og	2332, Top Down
Total Weight	28.0	Surface/Volume	5.46	Squarish wood, same load as
Kindling Weight	3	Ambient Temperatur	55	CFA-03 except split in two
Number of Pieces	10			
Run Length	2.0			
Av. Stack Temp	126			
Av. O2%	17.15			
Av. CO%	0.35			
Stack Temp. Factor	0.95			
Stack Dilution Factor	5.58			
Burn Rate dry kg/hr	5.17			
Boiling of Water Loss	10.97			
CO Loss %	13.03			
HC Loss %	2.75			
Dry Gas Loss %	6.94			
Filter Catch gm.	0.2181			
g/kg Condar	4.87			
g/kg M7 equiv	7.16			
g/kg CO	114.94			
Combustion Effic.	84.22			
Heat Trans. Effic.	82.09			
Overall Efficiency	69.13			



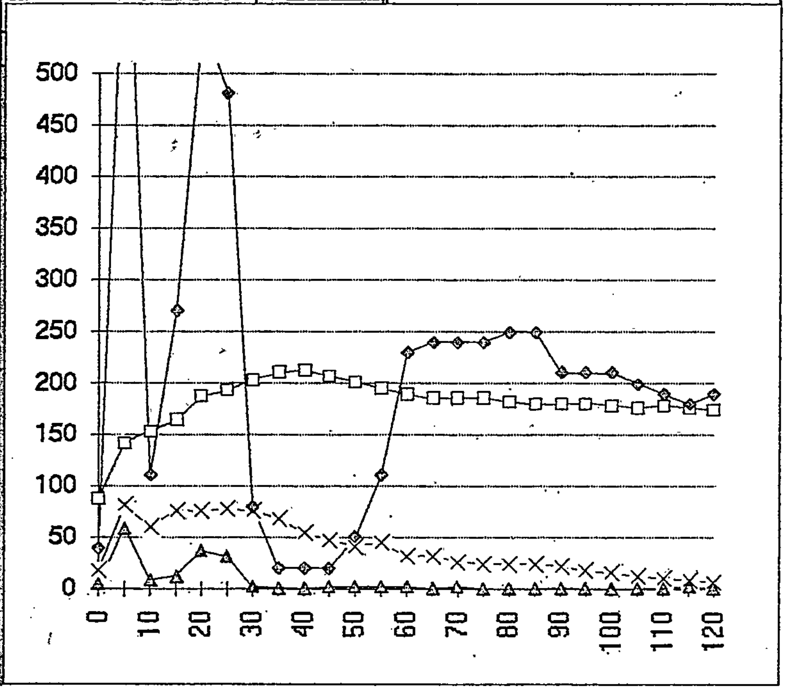


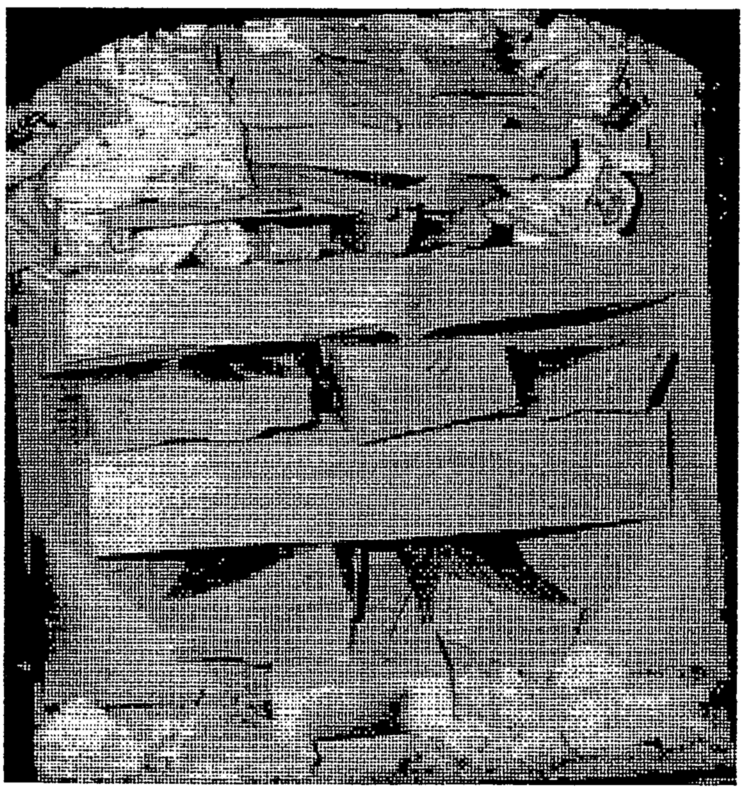
Same run as before, except each piece of firewood is split in two. Check out that CO spike at startup! The only variable to change here is the amount of wood surface area. There is strong evidence of a critical point. (See the discussion of this in the article on Austrian testing).

Note also the rise in PM to 7 grams. This appears to be related to the area under the hydrocarbon curve (Run CF-A02 being an exception). Note how the hydrocarbon curve at startup mirrors the double spike in the CO curve.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A05	FUEL		
Wood Moisture	19.2	Type	DF-og	2332 Top Down
Total Weight	28.0	Surface/Volume	5.48	Same as CF-A04
Kindling Weight	3	Ambient Temperatur	50	
Number of Pieces	10			
Run Length	2.0			
Av. Stack Temp	180			
Av. O2%	16.88			
Av. CO%	0.21			
Stack Temp. Factor	0.91			
Stack Dilution Factor	5.20			
Burn Rate dry kg/hr	5.14			
Boiling of Water Loss	11.22			
CO Loss %	7.41			
HC Loss %	2.39			
Dry Gas Loss %	11.83			
Filter Catch gm.	0.1923			
g/kg Condar	4.18			
g/kg M7 equiv	6.22			
g/kg CO	65.36			
Combustion Effic.	90.20			
Heat Trans. Effic.	76.95			
Overall Efficiency	69.41			



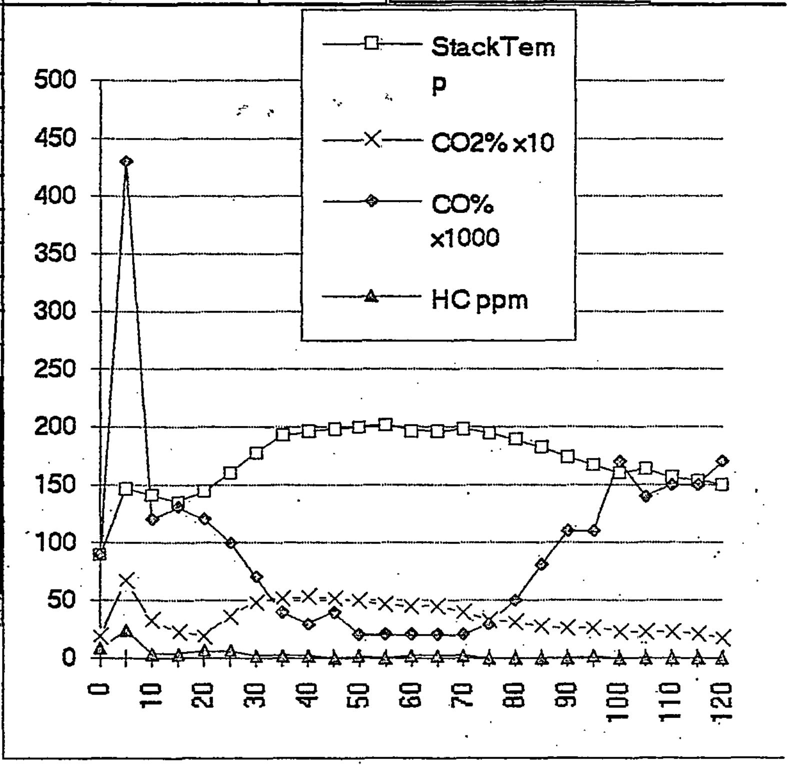


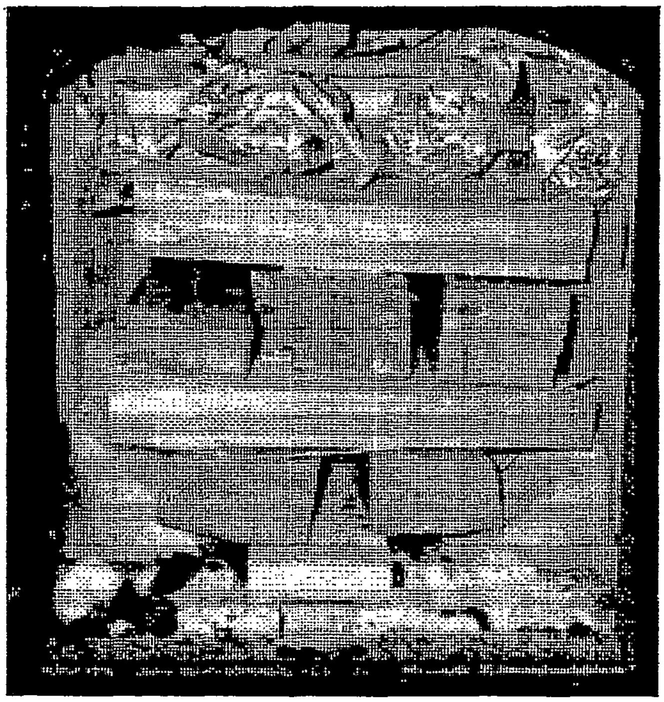
This was a repeat of the previous run. The numbers change slightly, but the curves preserve their characteristic shapes. Note particularly the CO curve (diamond shaped markers). Note the double dip at the front, barely visible on the previous run because the spike is almost off the map. Full scale on the graph (500) is ½% CO.

The tail spike on the CO curve is flattened - this could depend on just exactly how the wood charge looses structure and collapses at the end. You'll note that all of the burns have a CO spike at the end - this is characteristic of a wood fire in the charcoal stage and happens with metal stoves also. Once this tail end curve starts to dip the fire is almost out.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A06	FUEL		
Wood Moisture	22.0	Type	DF-og	2332 same as CF-A04, except
Total Weight	33.3	Surface/Volume	4.96	wetter wood. Top down.
Kindling Weight	3	Ambient Temperature	55	4 sq in air, front centre
Number of Pieces	10	Unburned Fuel		Two top pieces are 20%
Run Length	2.0	Av. Sampler Flow	.4 cfm	LEAK IN STACK AT ENDOFRUN
Av. Stack Temp	171			
Av. O2%	17.37			
Av. CO%	0.10			
Stack Temp. Factor	0.92			
Stack Dilution Factor	5.92			
Burn Rate dry kg/hr	5.89			
Boiling of Water Loss	11.18			
CO Loss %	3.87			
HC Loss %	1.40			
Dry Gas Loss %	11.94			
Filter Catch gm.	0.0967			
g/kg Condar	**2.38**			
g/kg M7 equiv	**3.65**			
g/kg CO	**34.15**			
Combustion Effic.	**94.73**			
Heat Trans. Effic.	**76.88**			
Overall Efficiency	**72.83**			





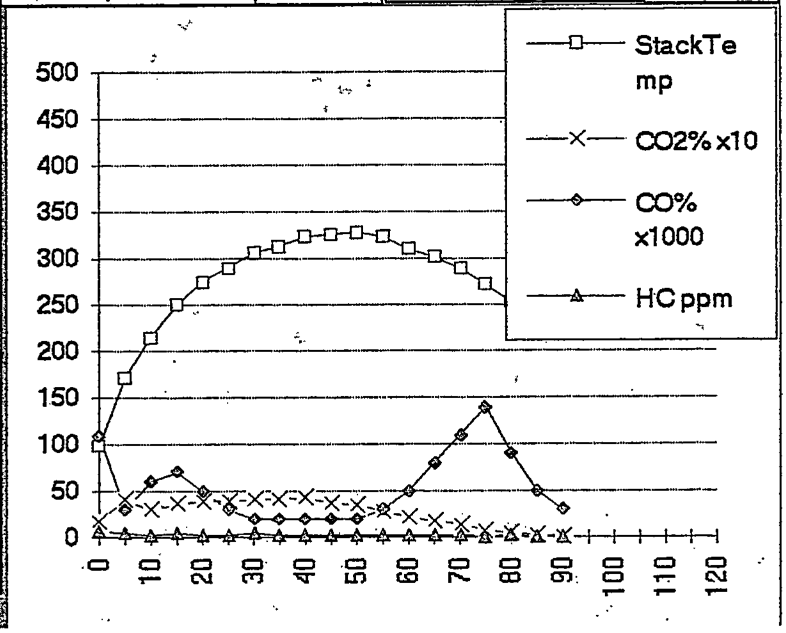
Air opening is doubled to 4 sq. in. Wood is slightly wetter. PMs down considerably. Note what is happening to the CO curve at startup.

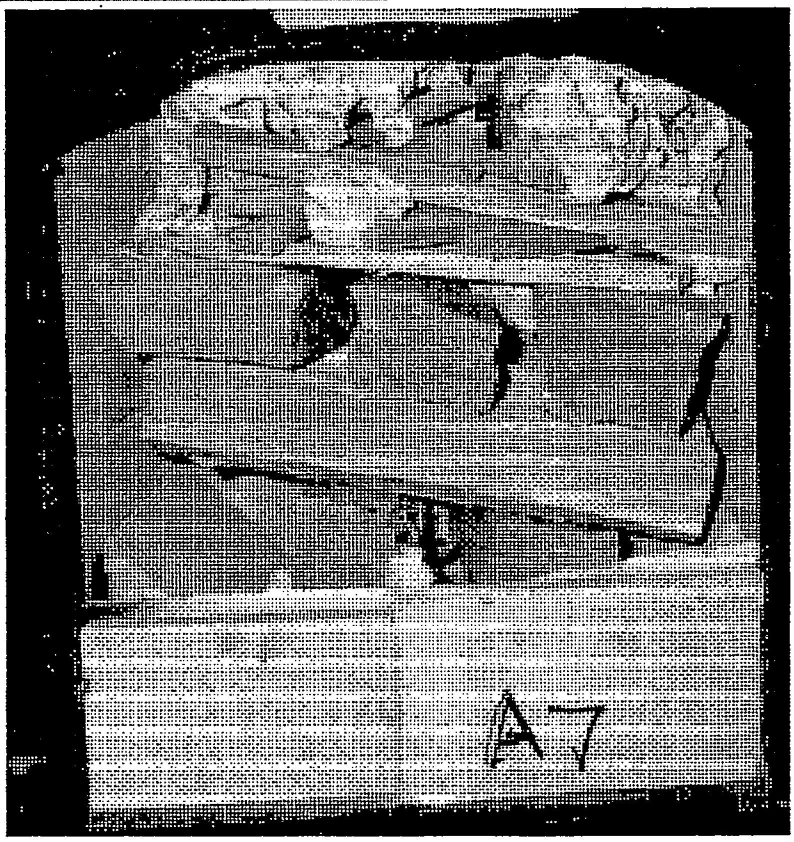
Note also how there is a 5 minute spike on all 4 curves.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A07	FUEL		
Wood Moisture	18.5	Type	DF-og	233 Top down
Total Weight	28.0	Surface/Volume	5.48	6x1 air slot between firebox lintel
Kindling Weight	3	Ambient Temperatur	65	and face. Semi preheated.
Number of Pieces	8	Unburned Fuel		Approx 1.5 sq in in ashdump
Run Length	1.5	Av. Sampler Flow	.4 cfm	4 kerfs in long direction

Av. Stack Temp	269
Av. O2%	18.36
Av. CO%	0.05
Stack Temp. Factor	0.85
Stack Dilution Factor	8.22
Burn Rate dry kg/hr	6.92
Boiling of Water Loss	11.63
CO Loss %	3.00
HC Loss %	1.19
Dry Gas Loss %	29.21
Filter Catch gm.	0.0412
g/kg Condar	**2.02**
g/kg M7 equiv	**3.11**
g/kg CO	**26.43**
Combustion Effic.	**95.81**
Heat Trans. Effic.	**59.16**
Overall Efficiency	**56.68**





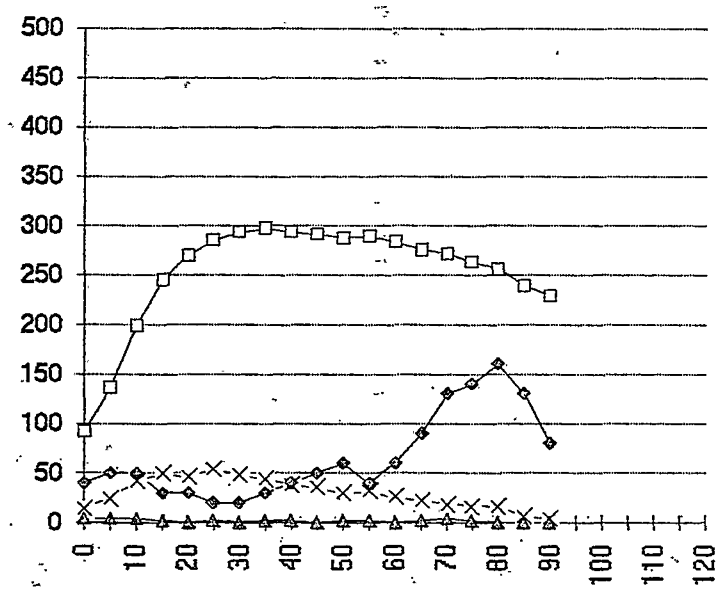
We change the air slot to an airwash location at the top of the door. In addition, we use a standard cast iron fireplace ashdump in the floor.

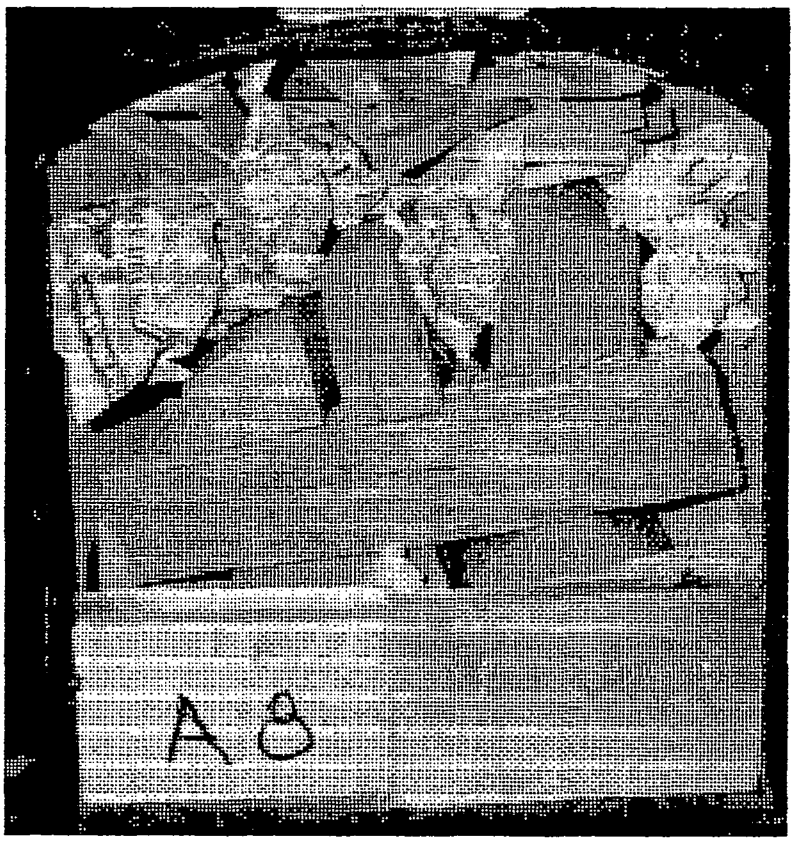
We cut slots into the ashdump plate to give a small amount of bottom air, about 1.5 square inches. We see underfire air effects - excess air is up, stack temp is up, efficiency is down. PM, however, is not bad.

Note how the flue temp curve looks different - it has a different shape. We saw this shape in all of the underfire air runs in 1992. Check out run CF-A18, the only true underfire air run in this series, to see where this is heading.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A08	FUEL		
Wood Moisture	19.8	Type	DF-og	232 same as CF-A07
Total Weight	28.0	Surface/Volume	#DIV/0!	Air slot reduced from 1 x 7
Kindling Weight	3	Ambient Temperature	55	to 3/4 x 7
Number of Pieces	7			
Run Length	2.0			
Av. Stack Temp	252			
Av. O2%	18.05			
Av. CO%	0.07			
Stack Temp. Factor	0.86			
Stack Dilution Factor	7.33			
Burn Rate dry kg/hr	5.11			
Boiling of Water Loss	11.56			
CO Loss %	3.24			
HC Loss %	0.41			
Dry Gas Loss %	25.22			
Filter Catch gm.	0.0208			
g/kg Condar	**0.67**			
g/kg M7 equiv	**1.08**			
g/kg CO	**28.58**			
Combustion Effic.	**96.35**			
Heat Trans. Effic.	**63.22**			
Overall Efficiency	**60.91**			





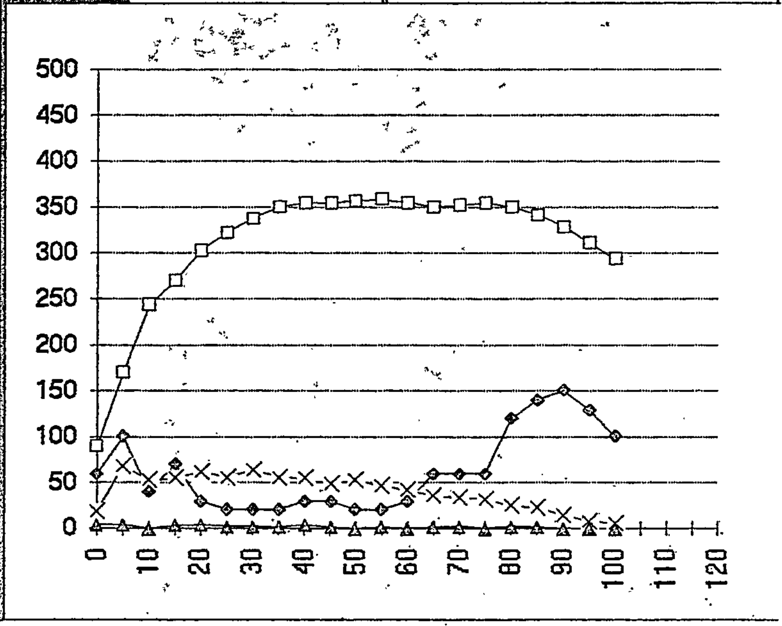
Slight air change.

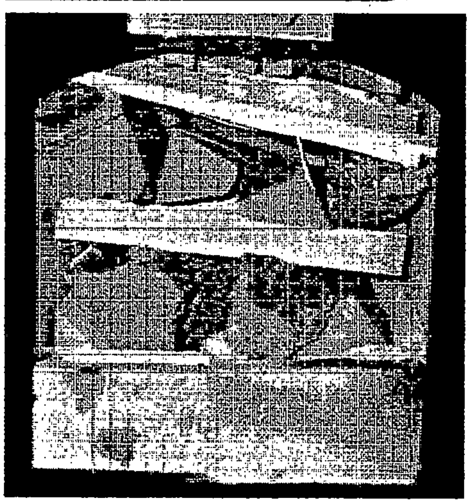
Large PM reduction - possibly an anomaly.

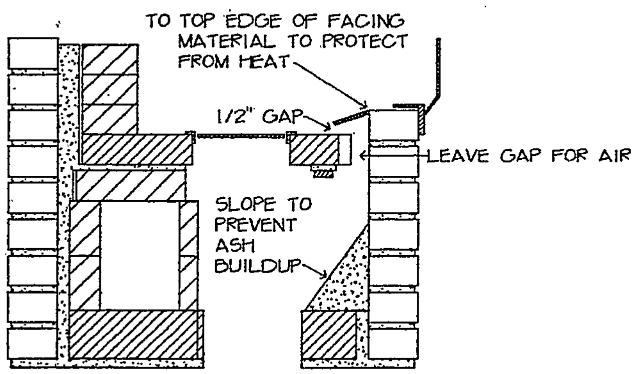
From here on, we start using larger fuel charges, feeling this to be more realistic in terms of real world use.

LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A09	FUEL		
Wood Moisture	19.9	Type	DF-og	3442 Top Down
Total Weight	45.0	Surface/Volume	4.45	Ignition top front
Kindling Weight	2.5	Ambient Temperatur	55	Air slot reducer fell out
Number of Pieces	13	X		sometime during or after run
Run Length	1.7			
Av. Stack Temp	312			
Av. O2%	17.01			
Av. CO%	0.06			
Stack Temp. Factor	0.83			
Stack Dilution Factor	5.37			
Burn Rate dry kg/hr	9.83			
Boiling of Water Loss	11.83			
CO Loss %	2.25			
HC Loss %	0.93			
Dry Gas Loss %	22.66			
Filter Catch gm.	0.0528			
g/kg Condar	1.56			
g/kg M7 equiv	2.44			
g/kg CO	19.87			
Combustion Effic.	96.81			
Heat Trans. Effic.	65.51			
Overall Efficiency	63.42			



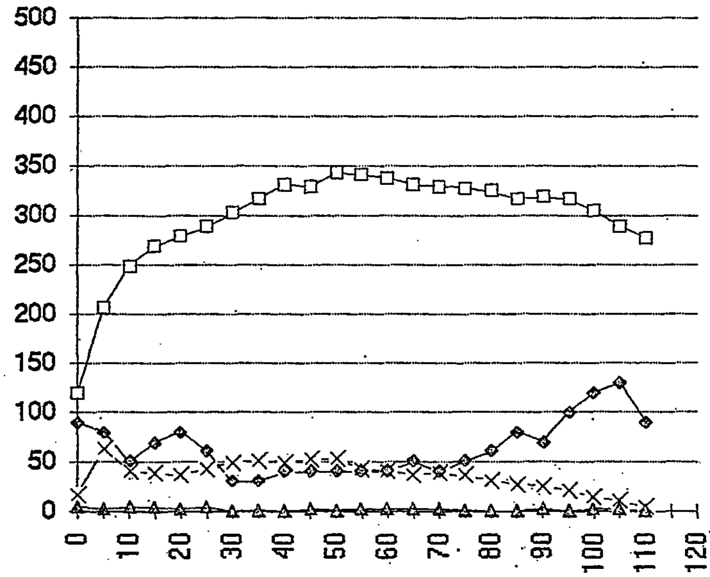


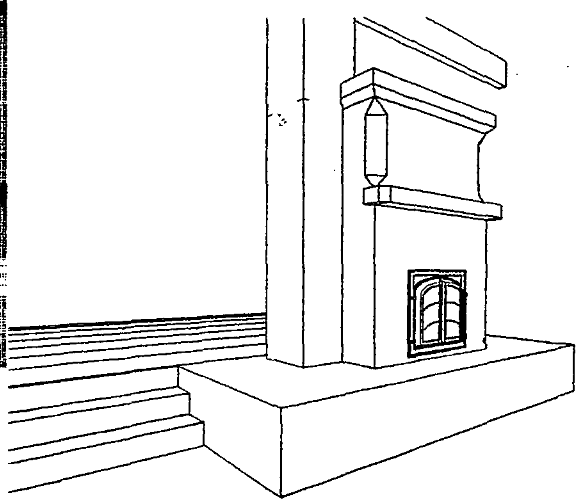


LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A10
Wood Moisture	25.3
Total Weight	44.0
Kindling Weight	4
Number of Pieces	10
Run Length	1.8
Av. Stack Temp	298
Av. O2%	17.58
Av. CO%	0.06
Stack Temp. Factor	0.83
Stack Dilution Factor	6.29
Burn Rate dry kg/hr	8.15
Boiling of Water Loss	11.77
CO Loss %	2.72
HC Loss %	0.83
Dry Gas Loss %	24.99
Filter Catch gm.	0.0441
g/kg Condar	**1.38**
g/kg M7 equiv	**2.16**
g/kg CO	**24.01**
Combustion Effic.	**96.45**
Heat Trans. Effic.	**63.25**
Overall Efficiency	**61.00**

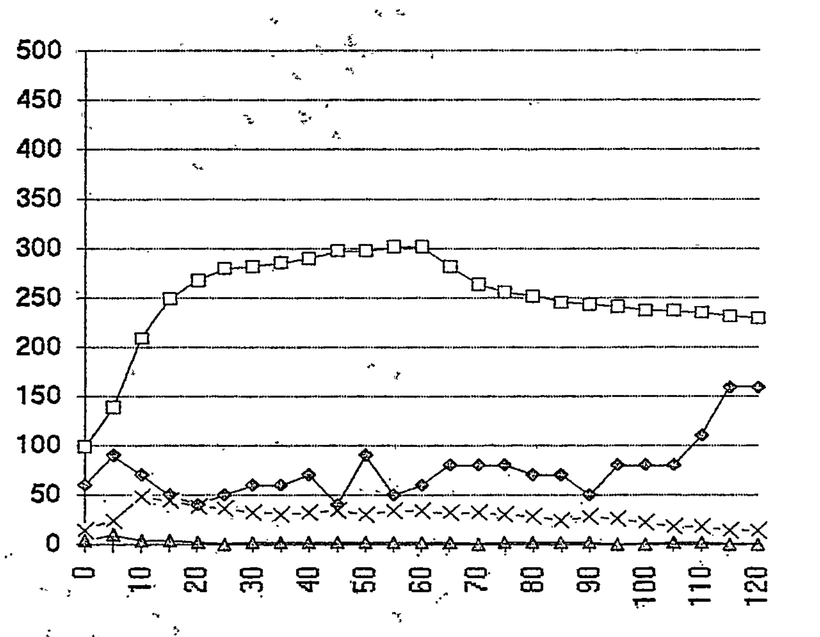
FUEL		
Type	DF-og	3331 Top down.
Surface/Volume	4.15	Kindling was 16% moisture
Ambient Temperatur	55	1/2 x 7 top slot
x		ash dump cover w. 15 5/16 holes
x		plus crack around edge

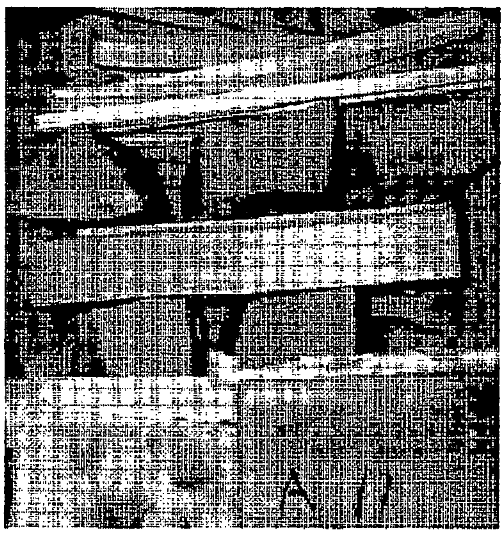




LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A11	FUEL		
Wood Moisture	24.9	Type	DF-og	Same as CF-A10
Total Weight	45.5	Surface/Volume	4.30	No bottom air
Kindling Weight	3.5	Ambient Temperature	65	
Number of Pieces	11			
Run Length	2.1			
Av. Stack Temp	249			
Av. O2%	18.40			
Av. CO%	0.08			
Stack Temp. Factor	0.86			
Stack Dilution Factor	8.35			
Burn Rate dry kg/hr	7.45			
Boiling of Water Loss	11.54			
CO Loss %	4.40			
HC Loss %	0.95			
Dry Gas Loss %	26.09			
Filter Catch gm.	0.0449			
g/kg Condar	1.58			
g/kg M7 equiv	2.47			
g/kg CO	38.84			
Combustion Effic.	94.65			
Heat Trans. Effic.	62.37			
Overall Efficiency	59.03			



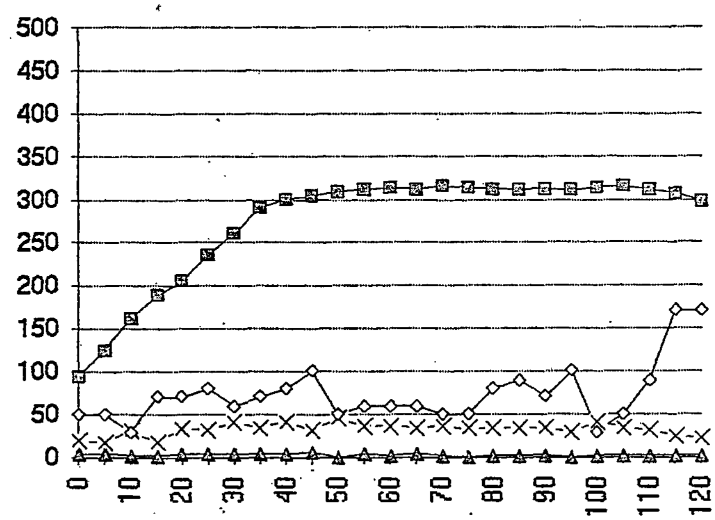


Even though CF-A09 only had about 1 sq. in underfire air, note the change in shape of the stack temp curve (top line) when this is deleted.

For the remaining 12 runs, we'll just give you the data - you'll find the photos at the end. There's a summary of all the runs in last summer's issue of MHA News —Have Fun!!

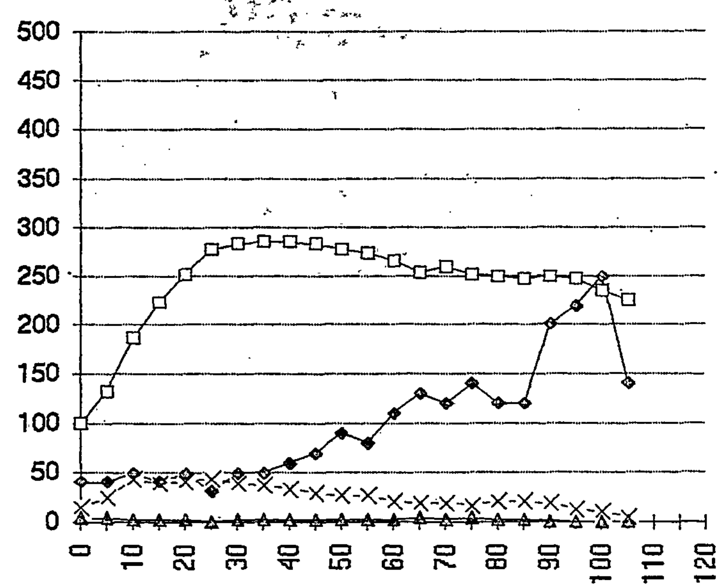
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A12	FUEL		
Wood Moisture	24.5	Type	DF-og	2333 Topdown
Total Weight	45.5	Surface/Volume	#DIV/0!	(3) 1/4x4 top fblintel airslots
Kindling Weight	3	Density	30.6	1/8 x firebrick bottom air.
Number of Pieces	11	Unburned Fuel	1.5	Bottom of crib closer to floor,
Run Length	2.2	Ambient Temperature	60	front angle removed
Av. Stack Temp	275			
Av. O2%	17.90			
Av. CO%	0.08			
Stack Temp. Factor	0.85			
Stack Dilution Factor	6.98			
Burn Rate dry kg/hr	6.91			
Boiling of Water Loss	11.66			
CO Loss %	3.79			
HC Loss %	0.78			
Dry Gas Loss %	24.90			
Filter Catch gm.	0.0452			
g/kg Condar	1.30			
g/kg M7 equiv	2.05			
g/kg CO	33.40			
Combustion Effic.	95.43			
Heat Trans. Effic.	63.44			
Overall Efficiency	60.54			



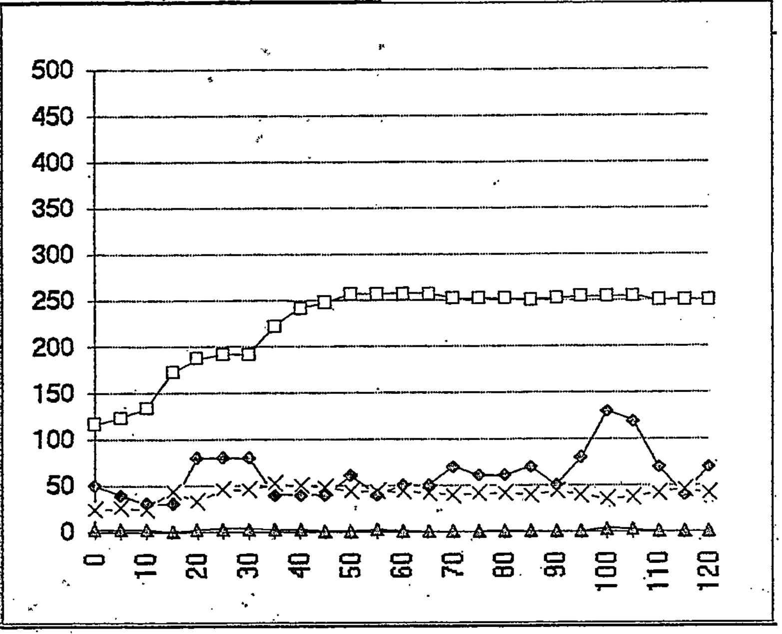
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A13	FUEL		
Wood Moisture	20.0	Type	DF-og	2333 Top Down
Total Weight	30.0	Surface/Volume	#DIV/0!	Preheated top air
Kindling Weight	3	Ambient Temperature	55	CF-A12 bottom air
Number of Pieces	11			
Run Length	2.0			
Av. Stack Temp	243			
Av. O2%	18.37			
Av. CO%	0.10			
Stack Temp. Factor	0.87			
Stack Dilution Factor	8.25			
Burn Rate dry kg/hr	5.45			
Boiling of Water Loss	11.51			
CO Loss %	5.55			
HC Loss %	0.71			
Dry Gas Loss %	24.92			
Filter Catch	0.0325			
g/kg Condar	1.18			
g/kg M7 equiv	1.85			
g/kg CO	48.95			
Combustion Effic.	93.74			
Heat Trans. Effic.	63.57			
Overall Efficiency	59.59			



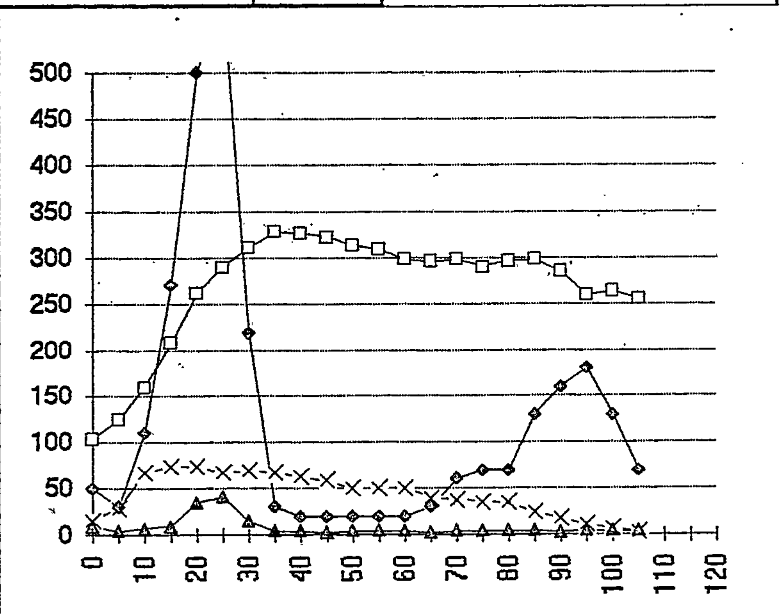
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A14	FUEL		
Moisture	20.0	Type	DF-og	2221
Total Weight	41.0	Surface/Volume	#DIV/0!	1x6 inches front bottom
Kindling Weight	3	Density	30.6	1/8 x7 FB
Number of Pieces	7	Ambient Temperature	55	Flue open overnight
Run Length	2.3			
Av. Stack Temp	227			
Av. O2%	17.16			
Av. CO%	0.08			
Stack Temp. Factor	0.88			
Stack Dilution Factor	5.58			
Burn Rate dry kg/hr	6.63			
Boiling of Water Loss	11.44			
CO Loss %	3.04			
HC Loss %	0.70			
Dry Gas Loss %	15.30			
Catch	0.0537			
g/kg Condar	1.16			
g/kg M7 equiv	1.82			
g/kg CO	26.84			
Combustion Effic.	96.26			
Heat Trans. Effic.	73.26			
Overall Efficiency	70.52			



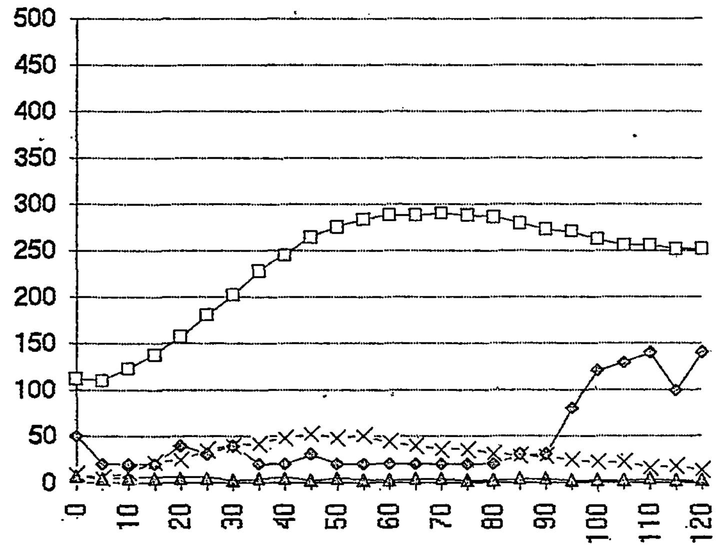
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A15	FUEL		
Wood Moisture	20.6	Type	DF-og	234331 Top Down
Total Weight	43.5	Surface/Volume	4.94	Same air as CF-A14
Kindling Weight	3	Density	30.6	NOTE: WIND 30 -40 mph
Number of Pieces	16	Ambient	57	
Run Length	1.8			
Av. Stack Temp	268			
Av. O2%	16.95			
Av. CO%	0.13			
Stack Temp. Factor	0.85			
Stack Dilution Factor	5.30			
Burn Rate dry kg/hr	8.97			
Boiling of Water Loss	11.63			
CO Loss %	4.53			
HC Loss %	2.06			
Dry Gas Loss %	18.32			
Filter Catch gm.	0.1324			
g/kg Condar	3.58			
g/kg M7 equiv	5.37			
g/kg CO	39.98			
Combustion Effic.	93.41			
Heat Trans. Effic.	70.05			
Overall Efficiency	65.43			



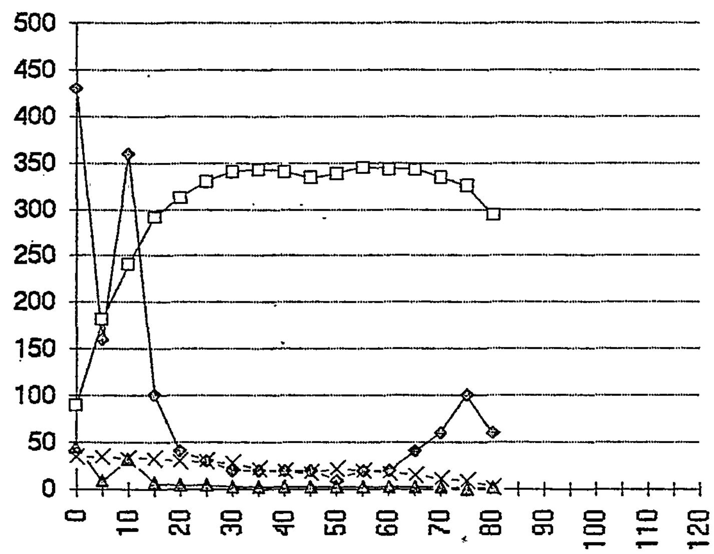
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A17	FUEL		
Wood Moisture	20.3	Type	DF-og	Same air as CF-A16
Total Weight	39.5	Surface/Volume	4.64	experimented w. throat air
Kindling Weight	2.5	Ambient Temperatur	58	2261 first two tiers flattish
Number of Pieces	11	Av. Sampler Flow	.4 cfm	Larger wood, tighter stacking
Run Length	2.1			
Av. Stack Temp	235			
Av. O2%	18.50			
Av. CO%	0.05			
Stack Temp. Factor	0.87			
Stack Dilution Factor	8.72			
Burn Rate dry kg/hr	6.87			
Boiling of Water Loss	11.48			
CO Loss %	3.00			
HC Loss %	0.57			
Dry Gas Loss %	26.95			
Filter Catch gm.	0.0257			
g/kg Condar	**0.94**			
g/kg M7 equiv	**1.49**			
g/kg CO	**26.46**			
Combustion Effic.	**96.43**			
Heat Trans. Effic.	**61.58**			
Overall Efficiency	**59.38**			



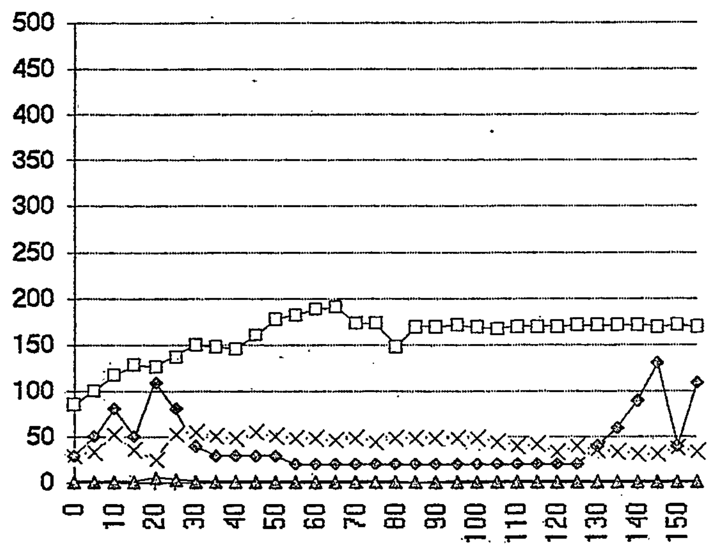
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A18	FUEL		
Wood Moisture	19.6	Type	DF-og	Standard air (grate + fr. slot)
Total Weight	43.0	Surface/Volume	#DIV/0!	Heater cold.
Kindling Weight	2	Ambient Temperatur	55	234, large pieces to try and get ar
Number of Pieces	9	Av. Sampler Flow	.4 cfm	even burn.
Run Length	1.3			
Av. Stack Temp	302			
Av. O2%	19.11			
Av. CO%	0.09			
Stack Temp. Factor	0.83			
Stack Dilution Factor	11.65			
Burn Rate dry kg/hr	11.78			
Boiling of Water Loss	11.79			
CO Loss %	6.96			
HC Loss %	3.50			
Dry Gas Loss %	50.21			
Filter Catch gm.	0.0795			
g/kg Condar	**6.34**			
g/kg M7 equiv	**9.11**			
g/kg CO	**61.36**			
Combustion Effic.	**89.55**			
Heat Trans. Effic.	**38.00**			
Overall Efficiency	**34.03**			



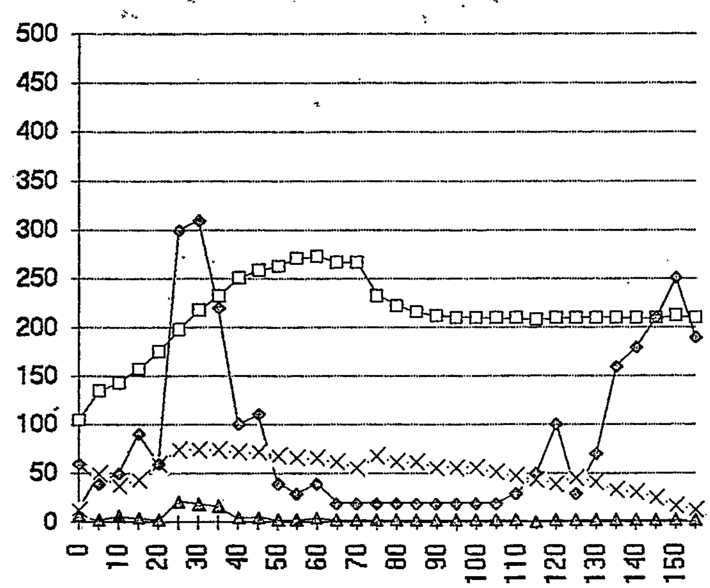
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A19	FUEL		
Wood Moisture	19.9	Type	DF-og	2221, tight, Top Down
Total Weight	49.5	Surface/Volume	3.35	1x3Air slot facing charge
Kindling Weight	4	Ambient Temperatur	55	Special top end.
Number of Pieces	7	Unburned Fuel	1	4 lbs 16% kindling
Run Length	2.7			
Av. Stack Temp	159			
Av. O2%	17.34			
Av. CO%	0.04			
Stack Temp. Factor	0.92			
Stack Dilution Factor	5.88			
Burn Rate dry kg/hr	6.60			
Boiling of Water Loss	11.12			
CO Loss %	1.64			
HC Loss %	0.68			
Dry Gas Loss %	10.66			
Filter Catch gm.	0.0621			
g/kg Condar	1.13			
g/kg M7 equiv	1.77			
g/kg CO	14.48			
Combustion Effic.	97.68			
Heat Trans. Effic.	78.22			
Overall Efficiency	76.40			



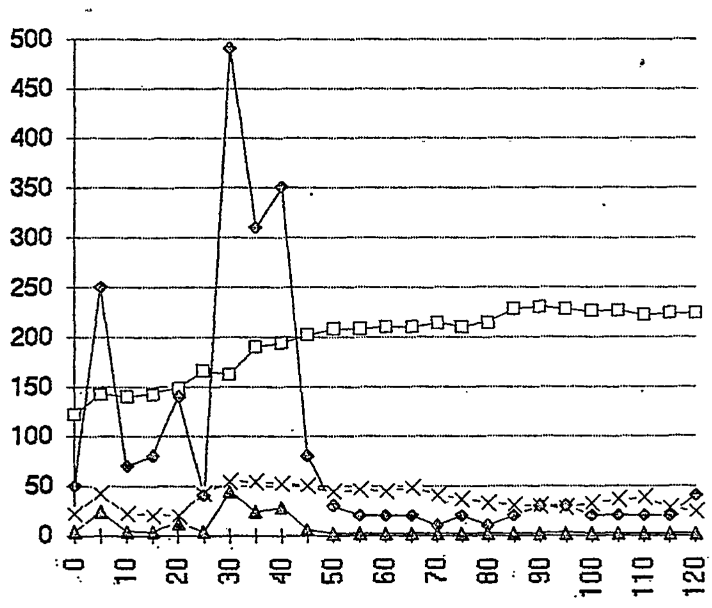
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A20	FUEL		
Wood Moisture	20.9	Type	DF-og	233 top row tight
Total Weight	47.0	Surface/Volume	3.60	Deleted two side spacers
Kindling Weight	2	Ambient Temperatur	55	underneath centre firebrick
Number of Pieces	8			
Run Length	2.7			
Av. Stack Temp	213			
Av. O2%	16.76			
Av. CO%	0.09			
Stack Temp. Factor	0.89			
Stack Dilution Factor	5.05			
Burn Rate dry kg/hr	6.33			
Boiling of Water Loss	11.37			
CO Loss %	3.08			
HC Loss %	0.84			
Dry Gas Loss %	13.90			
Filter Catch gm.	0.0859			
g/kg Condar	1.40			
g/kg M7 equiv	2.18			
g/kg CO	27.13			
Combustion Effic.	96.09			
Heat Trans. Effic.	74.72			
Overall Efficiency	71.80			



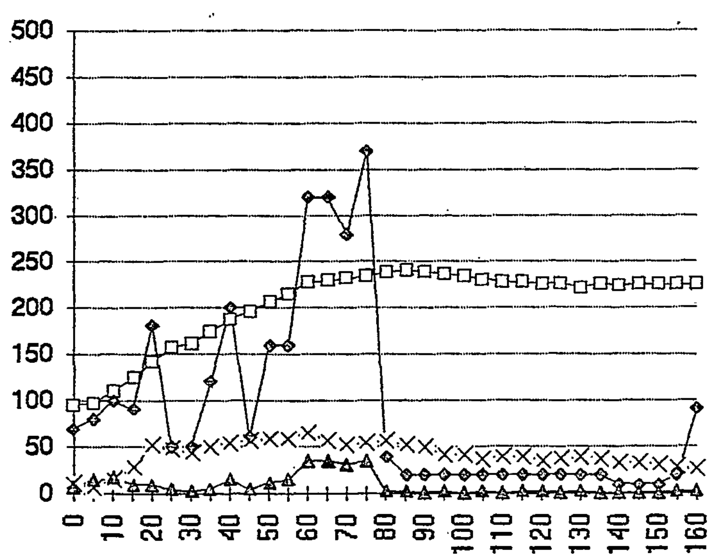
LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A21	FUEL		
Wood Moisture	20.4	Type	DF-og	Same as CF-A20
Total Weight	46.5	Surface/Volume	3.54	No bottom air
Kindling Weight	2.5	Ambient Temperatur	55	
Number of Pieces	8			
Run Length	2.3			
Av. Stack Temp	199			
Av. O2%	18.03			
Av. CO%	0.08			
Stack Temp. Factor	0.90			
Stack Dilution Factor	7.29			
Burn Rate dry kg/hr	7.48			
Boiling of Water Loss	11.31			
CO Loss %	3.97			
HC Loss %	1.40			
Dry Gas Loss %	18.29			
Filter Catch gm.	0.0868			
g/kg Condar	2.39			
g/kg M7 equiv	3.66			
g/kg CO	35.04			
Combustion Effic.	94.62			
Heat Trans. Effic.	70.40			
Overall Efficiency	66.61			



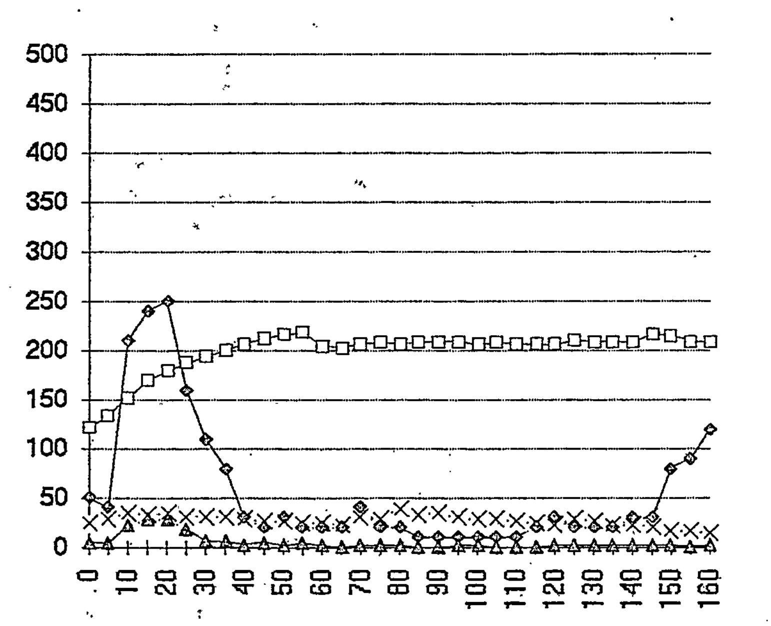
LOPEZ LABS EMISSIONS TEST DATA FORM

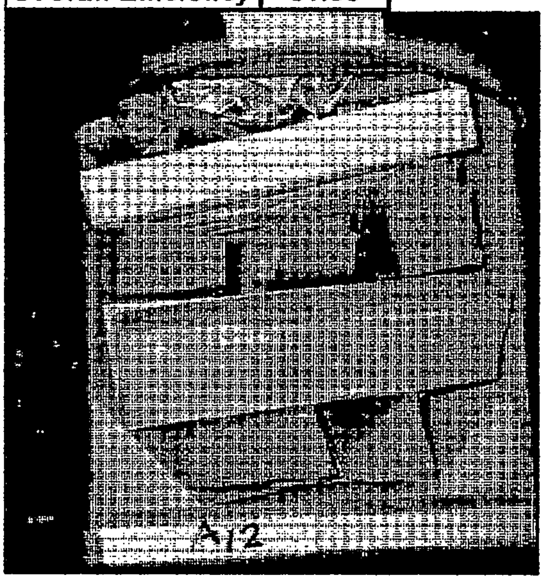
RUN No.	CF-A22	FUEL		
Wood Moisture	20.0	Type	DF-og	223, tight
Total Weight	55.3	Surface/Volume	#DIV/0!	6"x1/8 sideways bottom air as
Kindling Weight	2.25	Ambient Temperatur	55	Second tier (transverse) lines up \
Number of Pieces	8	Unburned Fuel		air slot (ie., closer to door)
Run Length	2.7			
Av. Stack Temp	203			
Av. O2%	17.61			
Av. CO%	0.09			
Stack Temp. Factor	0.89			
Stack Dilution Factor	6.36			
Burn Rate dry kg/hr	7.53			
Boiling of Water Loss	11.33			
CO Loss %	3.90			
HC Loss %	2.10			
Dry Gas Loss %	16.37			
Filter Catch gm.	0.1796			
g/kg Condar	3.65			
g/kg M7 equiv	5.47			
g/kg CO	34.38			
Combustion Effic.	94.00			
Heat Trans. Effic.	72.30			
Overall Efficiency	67.97			



LOPEZ LABS EMISSIONS TEST DATA FORM

RUN No.	CF-A23	FUEL		
Wood Moisture	20.2	Type	DF-og	2221 same as CF-A19
Total Weight	51.0	Surface/Volume	3.26	
Kindling Weight	4	Ambient Temperature	60	NOTE:Preliminary Filter Weights
Number of Pieces	7			
Run Length	2.8			
Av. Stack Temp	199			
Av. O2%	18.70			
Av. CO%	0.06			
Stack Temp. Factor	0.90			
Stack Dilution Factor	9.51			
Burn Rate dry kg/hr	6.72			
Boiling of Water Loss	11.31			
CO Loss %	3.76			
HC Loss %	2.30			
Dry Gas Loss %	23.08			
Filter Catch gm.	0.1366			
g/kg Condar	**4.01**			
g/kg M7 equiv	**5.98**			
g/kg CO	**33.18**			
Combustion Effic.	**93.94**			
Heat Trans. Effic.	**65.61**			
Overall Efficiency	**61.63**			





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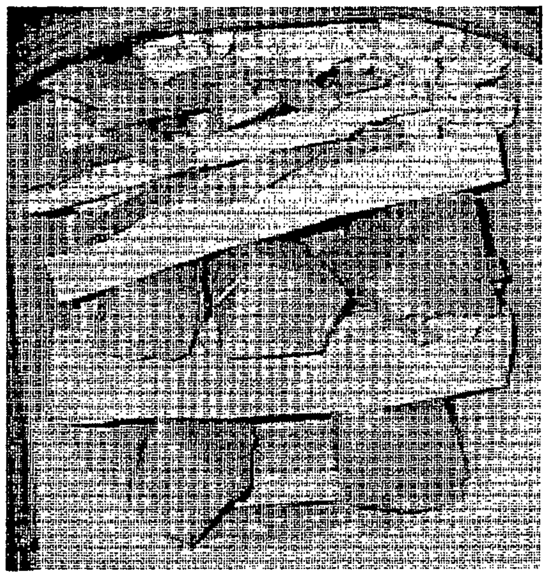

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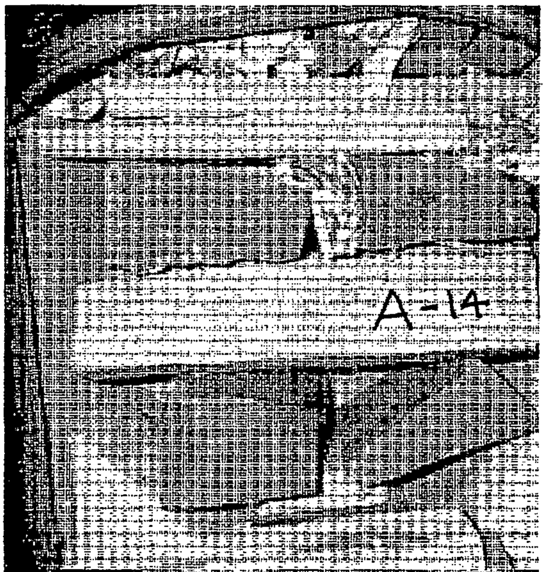
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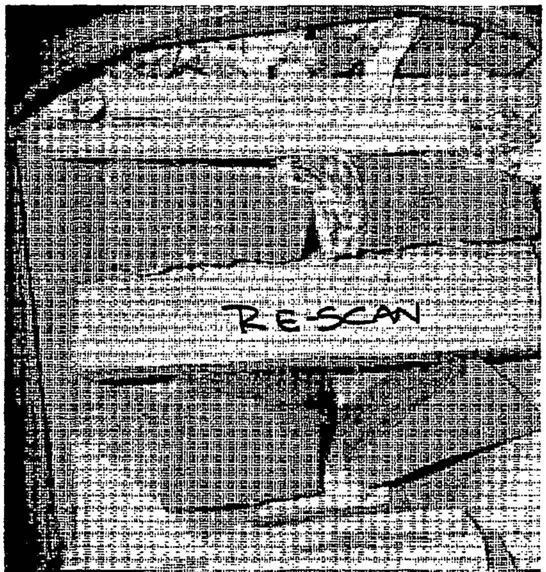
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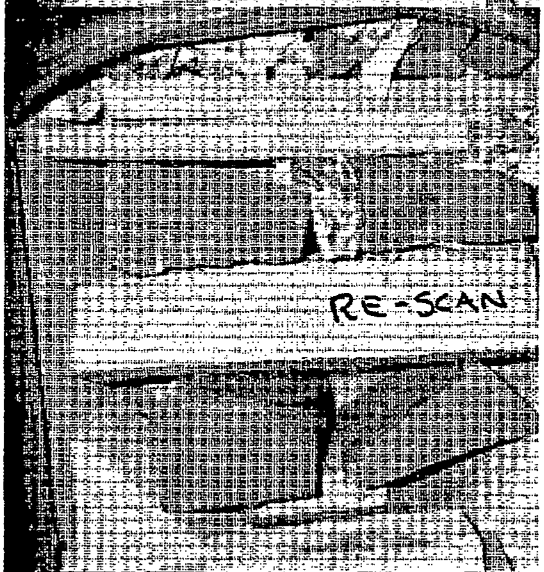
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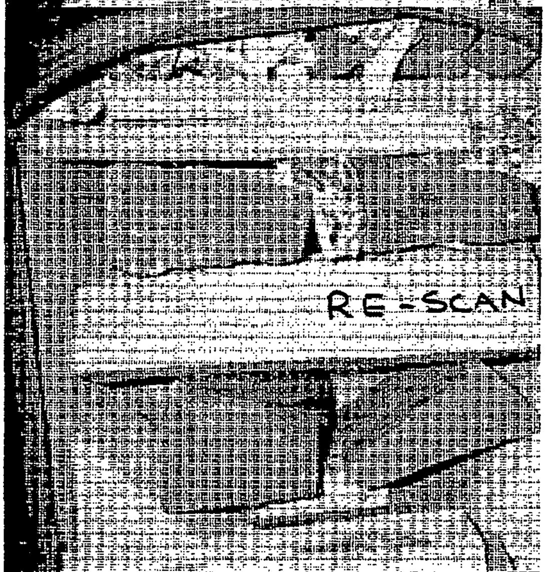
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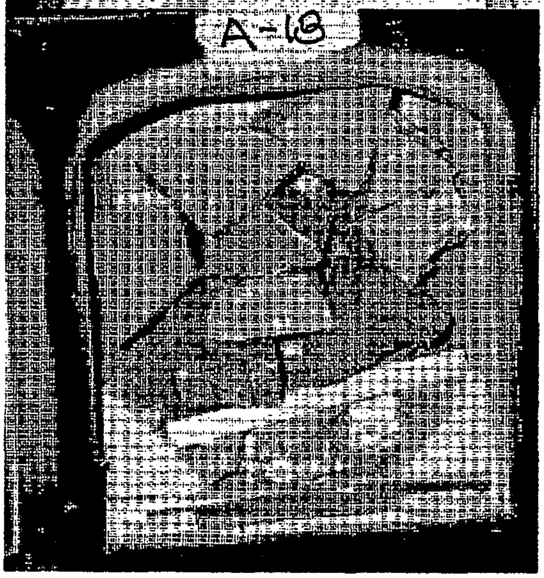
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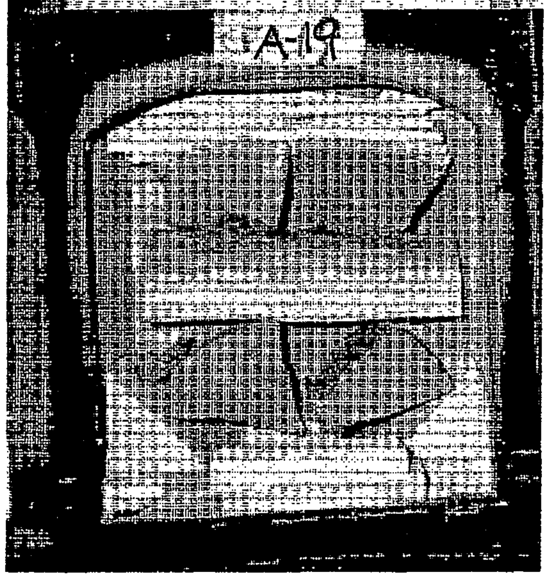
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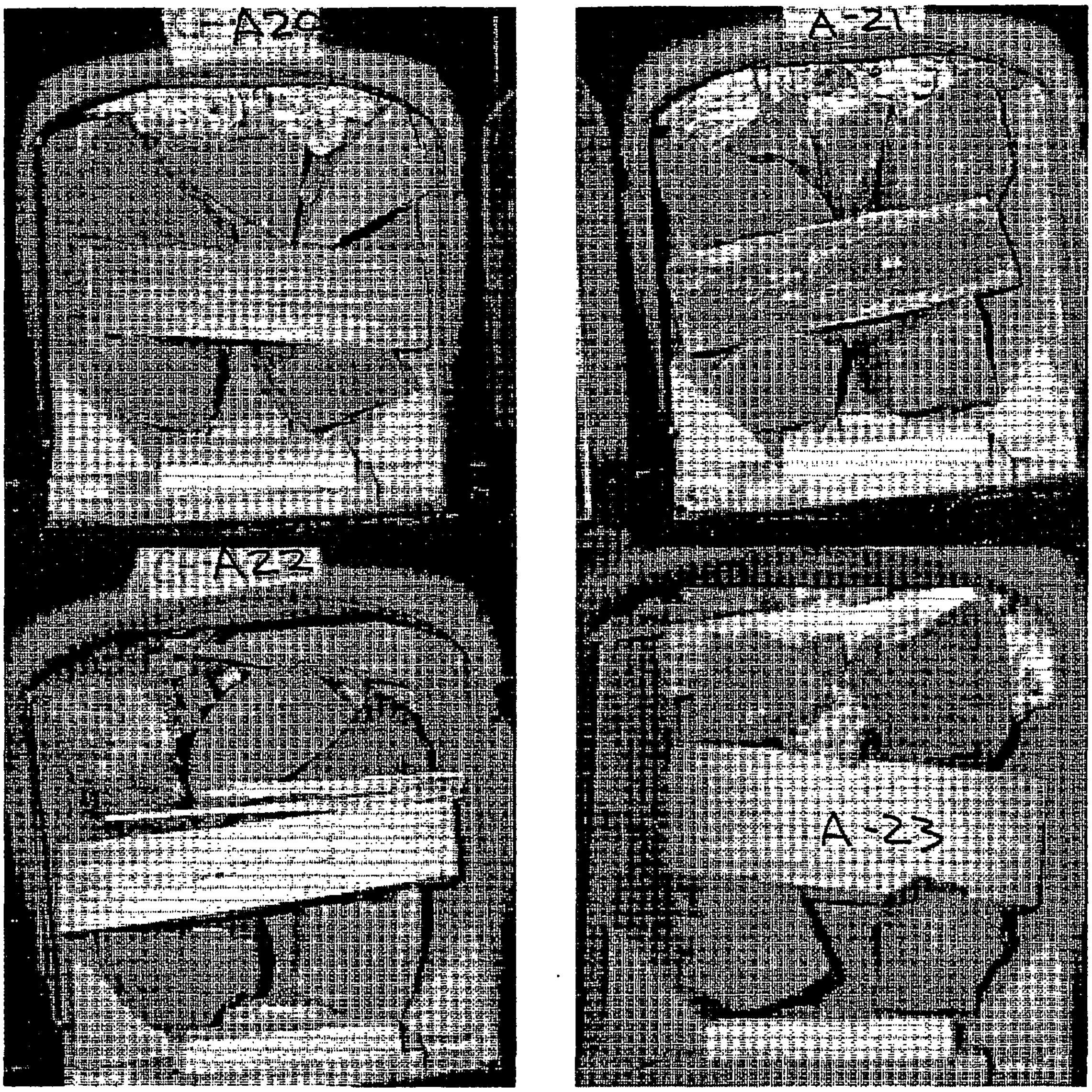
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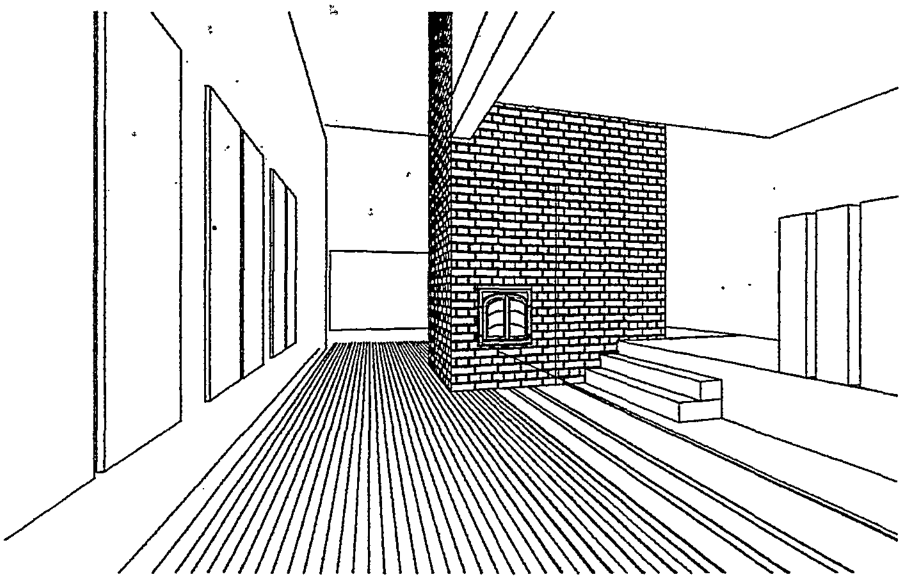


Report From the Battlefront: Colorado

*The following correspondence was sent in by **Walter Moberg** (Walter Moberg Design Inc., 921 S.W. Morrison Street, Suite 440, Portland, Oregon 97205, (503)227-0547 FAX 227-0548)*

July 23, 1993

Enclosed is my most recent communication with the Colorado Air Quality Commission regarding our proposed masonry heater amendments of their regulation (which currently excludes all masonry heaters in regulated areas of Colorado). I met with folks at the Colorado Department of Health in June and have been working with a group of MHA members since April to refine our proposals and to educate the Colorado bureaucracy about masonry heaters.

We have not received an easy endorsement of our products, and in spite of our recent E.P.A.-audited testing and subsequent national E.P.A. recognition (through SIP guidance documents), the Colorado Department of Health "remained unconvinced" about including masonry heaters. They were concerned both about testing methods and verifying real-world applications; in particular, they were concerned to prevent open masonry fireplaces from slipping in under the guise of being a heater. Consequently we have provided a detailed definition of masonry heaters, first outlined by Dennis Jaasma for the VPI report, and made it quantifiable. The idea is to have a testing laboratory like OMNI or VPI provide the State with some security about the nature of the stoves that were tested. Coupled with test data showing "equivalency" to E.P.A. Phase II woodstoves, we hope to have an acceptable approval procedure for masonry heaters.

I have been successful, however, in gaining an audience before the Air Quality Commission on August 19, 1993, and encourage anyone with an interest in Colorado to attend. At this point, the proposed regulation amendments and definition are not meant to eliminate site-built units using commonly manufactured masonry components (versus strictly pre-manufactured masonry heater components), but the concept of building a consistent "model or design" will undoubtedly have to be defended in the coming weeks before the hearing. Your certification program may be the additional assurance needed by states to allow "custom-built" units as part of regulating masonry heaters. We'll see what they say.

The Department of Health will not put itself in a position of doing on-site inspections and our proposed ASTM standard is still far from being code, so I am hoping that all tested models will be approved by testing and design alone. Our definition should be a relatively simple but reliable method of establishing a new classification and, if successful here, may be useful in future regulatory battles. After all, they don't inspect chimneys as a performance component of woodstove installations, so there is some precedent for not inspecting masonry heaters either; that's what our "field-testing" of heaters is supposed to sort out.

I will advise you if there is a revised proposal before we go to the hearing, and invite any and all comments by MHA members; Rick Crooks is also available to answer and discuss questions about our proposals.

On another matter, I have been involved since April as an expert witness in a fireplace-related house fire in California and my copy of the HEARTH manual has been taken as evidence (!). Therefore, with MHA funds (per Rick), I have ordered one from HEARTH to be sent directly to Jerry, and I assume it will become a permanent MHA library document. Good luck with your certification program; as soon as I finish with Colorado, I should have more energy for other projects..........Best Regards......

> "...IN SPITE OF OUR RECENT E.P.A.-AUDITED TESTING AND SUBSEQUENT NATIONAL E.P.A. RECOGNITION (THROUGH SIP GUIDANCE DOCUMENTS), THE COLORADO DEPARTMENT OF HEALTH "REMAINED UNCONVINCED" ABOUT INCLUDING MASONRY HEATERS

Walter sent the following enclosures:

MHA Standard Definition for Wood Burning Masonry Heater

July 21, 1993

<u>DEFINITION</u>

A masonry heater,

1) is a factory-built or site-built wood burning stove constructed primarily of masonry materials and weighing at least 800 kg.

2) stores a substantial portion of the heat of combustion in its relatively-high mass, through the use of internal heat-absorbing masonry ducts

3) has one or more air-controlling door(s) for fuel loading that are closed during combustion and

4) burns at such high temperatures that it emits the same or less particulate effluent than an E.P.A.-certified non-catalytic woodstove or masonry fireplace.

<u>SPECIFICATION OF DEFINITION</u>

1) **High mass**. In order to store a substantial portion of the heat of combustion, the masonry heater mass is at least 800 kg. (1764 lbs.) and its construction is predominantly masonry (i.e., stone, cemented aggregate, clay, tile, or other non-combustible non-metallic solid materials).

2) **Heat Exchange**. In order to exchange a substantial portion of the heat of combustion, the firebox effluent of the masonry heater travels horizontally and/or downward through one or more masonry duct(s) for a distance

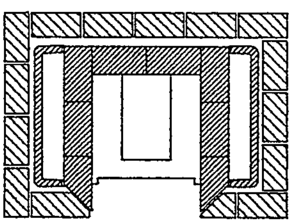
at least the length of the largest single internal firebox dimension before leaving the masonry heater.

A. Horizontal or downward travel distance is defined as the net horizontal and/or downward internal duct length, measured from the top of the uppermost firebox door opening(s) to the exit of the masonry heater as traveled by any effluent on a single pathway through duct channel(s) within the heater (or average net internal duct length for multiple pathways of different lengths, if applicable). Net internal duct length is measured from center of the internal side or top surface of a duct, horizontally or vertically to the center of the opposite side or the bottom surface of the same duct, and summed for multiple ducts or directions on a single pathway, if applicable. For duct channel(s) traversing horizontal angles of less than ninety degrees from vertical, only the net actual horizontal distance traveled is included in the total internal duct length.

B. The largest single internal firebox dimension is defined as the longest of either the length or the width of the firebox hearth or the height of the firebox, measured from the hearth to the top of the uppermost firebox door opening(s).

3) **Closed combustion**. In order to achieve higher efficiencies and higher combustion temperatures, the masonry heater firebox is loaded through one or more door(s) which are designed to be closed during the combustion of fuel loads, and which control the entry of combustion air [beyond simple spark arresting screen(s)] to one or more inlet(s) as prescribed by the masonry heater manufacturer.

4) **Clean Burning**. In order to limit the level of undesirable emissions, the masonry heater burns at relatively high temperatures and burn rates which optimize the complete combustion of wood fuel. Average emission levels of masonry heaters are always equal to or lower than the average of those achieved by the non-masonry, non-catalytic E.P.A.-certified wood burning stoves (as measured on a gram per kilogram basis).



FACING DETAIL AROUND FIREBOX

THEY WERE CONCERNED BOTH ABOUT TESTING METHODS AND VERIFYING REAL-WORLD APPLICATIONS; IN PARTICULAR, THEY WERE CONCERNED TO PREVENT OPEN MASONRY FIREPLACES FROM SLIPPING IN UNDER THE GUISE OF BEING A HEATER

Proposed Additions and Amendments, Version 1, to Colorado Air Quality Control Commission REGULATION NO. 4:

"Regulation on the Sale of New Wood Stoves and the Use of Certain Woodburning Appliances During High Pollution Days", version September 30, 1992.

Table of Contents

ADD: Section number and title for "Approval Procedure for Masonry Heaters".

Section I, Definition

ADD: A. (new) "Approved Masonry Heater" means a wood burning appliance as defined in Section I.A.(new) which has complied with all the requirements of Section (new).

ADD: A.(new) "Masonry Heater" means an appliance designed for or capable of burning wood, capable of and intended for domestic space heating or domestic water heating, which meets the definition of a clean-burning masonry heater as stated and specifies in the "MHA Standard Definition, July 21, 1993", and (b) the manufacturer and/or appliance builder constructs the masonry heater in conformance with the U.L.-listed or manufacturer specifications for its assembly.

AMMEND: A.4, A.5, A.7, A.10, A.14, A.15, A.18; after "wood burning stove", add "pellet stove or masonry heater".

ADD:

Section (new): Approval Procedure for Masonry Heaters

A. On or after September 1, 1993, a manufacturer or builder of a masonry heater who wishes to have a model or design designated as an approved masonry heater, shall submit to the Division for their review, the following information:.

1. Field test results with have been conducted by an E.P.A.-accredited laboratory, showing particulate emission levels for that model or design of masonry heater equivalent to or less than "in-home" field test emissions of E.P.A.-certified Phase II woodstoves, as shown in the E.P.A. document AP-42, "External Combustion Sources", and as measured on a gram per kilogram basis.

2. A one-page letter by the laboratory president verifying the information required in Section (new) A.1 and that the methods used were conducted according to procedures audited by the E.P.A., and also verifying that masonry heater model or design

meets the "MHA Standard Definition, July 21, 1993".

B. Within twenty (20) working days after receipt of an application for approval, the Division shall notify the applicant if the application is complete. Within thirty (30) working days after receipt of a complete application, the Division shall notify the applicant whether the application satisfies all requirements for approval.

C. If the Division denies approval, the Division shall notify the applicant in writing of the opportunity for a hearing before the Commission pursuant to Section 24-4-104 (9), C.R.S., (1982).

D. The Division shall grant approval if all information required be Section (new) A. is submitted and test results in Section (new) A.1 do not exceed an average of 7.3 g/kg.

testing, since storage could be inferred from only two factors: stack loss and losses through the loading doors. Assuming that some simple "rule-of-thumb" approach for loading door losses can be developed, simple in-field stack loss measurements would adequately define a system.

Good luck in Colorado. I trust that the whole exercise will become a good precedent and ultimately strengthen our case...............

This story continues. The whole process should give you an idea of the kind of tasks that we'll all be facing eventually. Get informed, get your facts straight and you have a chance. An important asset will be the ability to communicate basic facts. You know your products a lot better than the local regulator. Witness the following correspondence:

MEMORANDUM

To:	Dave Ouimette
From:	Jim King
Date:	August 17, 1993

BUILDING A CLEAN-BURNING HEATER IS A STRAIGHTFORWARD MATTER WITH SIMPLE RULES

Comments (from N. Senf):

December 7, 1993

A couple of additional ideas come to mind regarding how one might specify, define, or test a masonry heater to exclude possible "back-door" entry of non-heaters:

Heat storage ability is our main difference with other methods of biomass combustion. Specifically, masonry is the storage medium (as opposed to water, etc.), and this is addressed by the '800 kg. of predominantly masonry' in the definition. It may be useful to narrow it a bit further and specify some kind of easily measurable performance criterion involving heat storage ability.

A narrower definition would probably include the Grundofen (ie., all-masonry) only. This could be done by being more specific about the "predominantly masonry" and whether or not there is a metal heat exchanger that produces hot air.

I'd also specifically address underfire air, although now we are getting several times stricter than EPA limits. One advantage here is that realistically (as opposed to politically) we could have a prescriptive masonry heater design code that would pretty much guarantee clean burning. We know that building a clean-burning heater is a straightforward matter with simple rules, and that proving this over and over in "blind" EPA-accredited testing is rapidly becoming redundant, with a lower and lower bang for the buck. Unfortunately, we have too little literature to support what is becoming obvious. The Catch-22 is that it is too simple (literally) for many a regulator or lawyer to understand.

Ideally, I'd like to see performance defined and measured in terms of two parameters: 1) how much of the chemical energy in the fuel gets stored 2) burn rate. Limiting hot air systems would eliminate the need for calorimeter room

Subject:

Proposed Revision to Reg 4: Masonry Heaters

I have reviewed the information that you sent me and have the following comments:

The woodburning strategies set forth in the PM10 SIP assume future projected emissions based on statutory and regulatory authority as it existed at the time of the submittal. A critical aspect of the Denver element was the fact that all new woodstoves must be EPA certified Phase II and than new construction of fireplaces was prohibited in the Metro area unless they were either gas, electric, or a Phase II EPA certified insert. The Commission also has the authority to allow other types of woodburning devices to be installed if they are considered to be equivalent (in regards to emissions) to an EPA certified stove or insert. The Commission has added pellet stoves to the list of acceptable devices providing that they have been tested at an EPA accredited lab and emit less than the Phase II catalytic stove standard of 4.1 grams/hour. There currently exists seven or eight years of emission test data on pellet stoves covering a wide variety of manufacturers, models, and designs and EPA has even certified several pellet stoves to their Phase II standards. Many of the pellet stoves that have been tested emit less than one-tenth of the non-catalytic Phase II standard, We have discussed the issue of pellet stoves with EPA during the development of the PM10 SIP. I am confident that the inclusion of pellet stoves and inserts in the SIP will not pose a problem in regards to SIP approval.

The emissions data available concerning masonry heaters is not very extensive at this time. Data provided by the Masonry Heater Association to the Division via Bob McCrillis of EPA (May 8, 1993) shows test data on only two masonry heaters.

I consider this to be an insufficient amount of test data on which to base a decision either for masonry stoves in general or even for those two stoves in particular.

The test data provided does not, in my opinion, show that these two stoves are particularly low-emitting. On a gram/hour basis (the units of the EPA standard), one of the stoves emits twice as much as a conventional woodstove and 6-7 times as much as an EPA Phase II stove.

The masonry heater manufacturers argue that the emissions from this type of device should be portrayed over a 24 hour period because that is the way they are meant to be operated. Averaging the emissions of a conventional woodstove or fireplace would also yield low daily emissions, but I don't believe that we should allow devices that are obviously not very clean-burning when they are being fired to be used in Colorado based on the assumption of how people will use them. I also see the potential for people to use masonry heaters to circumvent the open fireplace ban.

I DON'T BELIEVE THAT WE SHOULD ALLOW DEVICES THAT ARE OBVIOUSLY NOT VERY CLEAN-BURNING WHEN THEY ARE BEING FIRED TO BE USED IN COLORADO BASED ON THE ASSUMPTION OF HOW PEOPLE WILL USE THEM. I ALSO SEE THE POTENTIAL FOR PEOPLE TO USE MASONRY HEATERS TO CIRCUMVENT THE OPEN FIREPLACE BAN.

A few comments about the proposed revisions to Reg. 4:

The proposed masonry heater definition provided by the Masonry Heater Association is, in my opinion, unacceptable. Requiring that the internal ducting be at least as long as the longest firebox dimension is insufficient. I believe that many heatilator-type fireplaces probably meet that definition. The definition of "closed combustion" is likewise unacceptable and would apply to many fireplaces with glass doors. The definition of "clean-burning" in not technically correct since it uses the units of g/kg and the EPA standard is in grams/hour. One of the reasons that g/kg was not chosen for the units of the EPA standard was that a low g/kg emission rate coupled with a high burn rate can result in a high grams/hour emission rate. The airshed, of course, "sees" emissions in terms of grams/hour.

As I have expressed to you, I also have other concerns such as the lack of a standard fueling protocol and test method, the question of how field enforcement can be conducted, and the lack of qualified State personnel to review any test data that is submitted for review under the proposed framework.

In conclusion, I recommend that the Division not support the proposed revisions to Regulation No. 4 Should the Division wish to pursue this issue, I believe that the first step should be to obtain a letter from the SIP staff at EPA/OAQPS stating that, for purposes of the PM10 SIP, they will accept masonry heaters as equivalent to EPA Phase II certified stoves.

MEMORANDUM

DATE: August 17,1993

TO: Dave Ouimette, Manager
Stationary Sources Program
Air Pollution Control Division
Colorado Department of Health

FROM: Walter Moberg
Colorado Legislative Task Force
Masonry Heater Association of North America

RE: Point by point response to Memorandum of Jim King to Dave Ouimette

I believe that Mr. King's statements of facts about masonry heaters are inaccurate and his opinions are flawed, the in the memo we received today about their performance and our proposed amendment. My response follows.

1.) <u>Commission's authority to allow equivalent devices</u>. Here, we agree that the commission has the authority, and be believe, also the responsibility to allow wood burning devices which are shown to be equivalent to Phase II EPA certified woodstoves. However, the method for determining equivalency has been laid out by the U.S. EPA in their 1989 Guidance Document for Residential Wood Combustion Emission Control Measures and its subsequent written interpretations by the Particulate Matter Programs Branch (PMPB), Office of Air Quality Planning and Standards (OAQPS).

A careful look at our testing data and the EPA's review of that data will show that we have, in fact, shown equivalency. Specifically, from the EPA's 1992 BACM (Best Available Control Measures) document, "Equivalency is defined as RWC devices for which 'in-home' field testing data are available,. document emissions equivalent to or less than 'in-home' field test emissions of EPA-certified, Phase II stoves." and furthermore endorses masonry heaters in adding "for example, EPA has recently reviewed in-home field data for certain masonry stoves tested during the 1991/92 heating season and has accepted the resultant emissions data for use in SIP-related activities..."

Final clarification of this definition of equivalency, provided for use by agencies and divisions, such as yourselves, is included in the referenced memorandum from Fred Renner, Acting Chief of the EPA's PMPB/OAQPS, dated September 23,. 1991: "...the request [for conversion-equivalency] should be accompanied by a justification based on emissions reductions documented through 'in-home' field testing (versus laboratory testing)...that is reviewed by EPA prior to the start of testing."

With the conclusion of our 1992 EPA-audited and observed field testing of five masonry heaters (and subsequently three additional heaters), we have shown equivalency. I believe Mr. King's insistence on a letter from OAQPS restating its guidance specifically for Colorado is, in fact, out of order and beyond the scope of what is required for the Commission to rule on equivalency. Other states have reviewed these guidelines and come to a similar and, I believe, obvious conclusion.

(Mr. King was provided with complete copies of the above statements in April 1993, and our study was submitted to the Colorado Health Department on June 3, 1993. Additional copies are available as attachments to this rebuttal.)

2.) Extent of data, history on masonry heaters. Mr. King claims that the data on masonry heaters is based on only two heaters. This is completely erroneous and frankly an insult to the thoroughness of our preparations. The erroneous data, mistakenly provided by Bob McCrillis and attached to a copy of his May 8, 1992 memorandum was not from our EPA-audited study, but from an unrelated 1991 study of fireplaces. The data referred to in Mr. McCrillis's memorandum, however, was actually from the 1992 study of five heaters and clearly did not relate to the attachments.

MR. KING CLAIMS THAT THE DATA ON MASONRY HEATERS IS BASED ON ONLY TWO HEATERS. THIS IS COMPLETELY ERRONEOUS AND FRANKLY AN INSULT TO THE THOROUGHNESS OF OUR PREPARATIONS

Masonry heaters have five hundred years of operations (versus ten years for pellet stoves), successful clean burning performance in regulated airshed throughout Europe, and proven performance as the cleanest residential cordwood devices ever made. Now, the Masonry Heater Association has conducted the type of in-home testing required by EPA to prove equivalency, and EPA's OAQPS has audited this testing and found it acceptable both in method and extent. The statistical conclusions of our study and the reliability of the results received a rating which was "next the highest (best) rating". It is curious that Mr. King only referred to the erroneous attachments to this OAQPS memorandum and not to its clear and accurate statement: "the procedures used by OMNI were acceptable to EPA".

3. Relative clean burning performance of masonry heaters. Mr. King repeatedly refers to a comparison of woodstoves and masonry heaters on a gram per hour basis and claims that a) this is the "EPA standard" and b) that masonry heaters do not show well by this method. I believe that using the gram/hour method is, in fact, an outdated and biased method by which to judge all woodburning devices; the EPA has undoubtedly agreed and now evaluates airshed impacts (the most important factor in this whole process), by testing and listing devices on a gram/kilogram basis (reference EPA AP-42 and the McCrillis memo of May 8, 1992).

An airshed does not "see emissions" on a gram/hour basis as Mr. King contends, it sees emissions as they are produced by an appliance over the course of burn cycles and heating cycles. All emission studies which model airshed impacts make assumptions base on typical performance of appliances; even woodstoves are not emitting every hour of the day. The difference is that masonry heaters burn their fuel quickly (and cleanly), and experience far fewer burn cycles per day. While some masonry heaters may emit more emissions for one hour than a woodstove, for most of the next eleven hours, it emits **no** emissions while the woodstove continues to pollute.

This alleged "gram/hour EPA standard" only relates to the **laboratory** protocol for metal stoves and is not relevant for thermal mass type appliances. Based on the study of five heaters, a community with, for example 50 masonry heaters, heating the same size homes as another community with 50 EPA-certified woodstoves, would produce only about 1/3 as many PM-10 emissions during a single day and over the course of a year. Woodstoves and masonry heaters have similar heating efficiencies, so it is ultimately the weight of wood burned that is the common denominator. Airshed impact is therefore clearly best projected by grams per kilogram emissions. It is not uncoincidental that EPA has rejected the EPA Phase II laboratory data, for grams/kilogram field testing data to publish allowable emissions factors.

Mr. King also sees a potential for people to circumvent the open fireplace ban, but he clearly does not understand either our definition or masonry heater operations. Certainly, a user could overfire any appliance, and increase the number of burn cycles per day, but excessive indoor temperatures moderate that occurrence. The consistent even heating of masonry heaters usually means less wood is used than in the sporadic hot episodes of woodstoves, resulting in even lower airshed emissions. Masonry heaters are not open fireplaces, and are not more candidates for loopholes than certified inserts with glass doors.

Only when grams/hour emissions are averaged and "normalized" for equivalent heating levels can they be used for comparisons between appliances, and masonry heaters show very well by that score also (3.8 average daily grams/hour versus 7.3 for certified woodstoves, normalized at 13,000 BTU per hour).

4. Proposed MHA Definition of Masonry Heaters. Once again, Mr. King's selective reading of the text has come up with an erroneous conclusion. We worked very hard to produce a definition which excludes both heatilator-type and site-built masonry fireplaces and we challenge the Division to show how any of those devices would meet our definition.

The labyrinth of exhaust channeling required by the definition excludes the convective air ducting of heatilators, and its length exceeds by at least a factor of two any smoke chamber built within the building code of Colorado (or anywhere else for that matter). Fireplaces with glass doors cannot meet the definition, because they fail to meet the other three requirements, and the alleged "EPA standard" for clean-burning defined in grams/hour only relates to metal stoves. As for how the airshed "sees" emissions, me previous discussion should provide a more accurate simulation of real-world impacts.

5. Protocol, enforcement and evaluation of test data. When EPA decided to use in-home field test data instead of laboratory protocol data, it was a conclusion that the "standard protocol" methods were, in fact, unreliable predictors of airshed impact. Mr. King's insistence on standard protocol is old business; laboratory technicians cannot reliably simulate real-world conditions as well as homeowners themselves. What is standard, however, is a test method using AWES equipment which has been audited by EPA and shown to be accurate and reliable in now hundreds of tests of woodburning devices. The state can rely on the predictability of this testing.

WHEN EPA DECIDED TO USE IN-HOME FIELD TEST DATA INSTEAD OF LABORATORY PROTOCOL DATA, IT WAS A CONCLUSION THAT THE "STANDARD PROTOCOL" METHODS WERE, IN FACT, UNRELIABLE PREDICTORS OF AIRSHED IMPACT. MR. KING'S INSISTENCE ON STANDARD PROTOCOL IS OLD BUSINESS; LABORATORY TECHNICIANS CANNOT RELIABLY SIMULATE REAL-WORLD CONDITIONS AS WELL AS HOMEOWNERS THEMSELVES

Since the proposed amendment deals with tested and approved heaters, field enforcement is no more or less valuable than it would be for woodstoves, which are equally vulnerable to variety of installation (chimneys). The field test data, however, sorts out this variability, and the manufacturer's specifications promise consistency in product - just like woodstoves. With EPA accredited labs certifying the performance and construction of approved devices, there is no more or less required of the state than with pellet stoves.

6. Acceptance by EPA/OAQPS. Once again, from the EPA/BACM document, "EPA has recently reviewed in-home field data for certain masonry heaters tested during the 1991/92 heating season AND HAS ACCEPTED the resultant emissions data for use in SIP-related activities". Mr. King has requested a letter which apparently the OAQPS is not willing to produce; as I understand it, their job is guidance not endorsement; it seems to me, it is up to the State of Colorado to read the guidance already provided by OAQPS, adopt reasonable procedures, and to act accordingly.

I look forward to discussing this response with you by phone on Wednesday and in person on Thursday. I trust that the last minute nature of Mr. King's objections and these continuing discussions will not impede our ability to have the Commission motion for a public hearing on Thursday. Please advise me of the position you plan to take before we address the commissioners. Thank you.

ASTM UPDATE

Tina Subasic reports that the ASTM Standard Guide for the Construction of Solid Fuel Burning Masonry Heaters went out to committee ballot in August and came back with 2 negatives and 1 comment.

Tina has gone over the Standard and made style changes, such as conversion to SI (Metric) units and reorganizing the definitions.

She subsequently arranged a conference call with Jerry Frisch, myself (Norbert Senf), Tom Stroud and Rick Crooks, has contacted the persons who sent in the negatives, and has been able to resolve all of the outstanding issues. We are all indebted to Tina for her tireless effort.

Tina reports that she thinks the Standard has an excellent chance of being passed when it goes out to all of ASTM for the next ballot. Get that champagne ready!

LOPEZ TESTS PLANNED FOR SPRING 94

by Norbert Senf

Jerry Frisch and I have a further test series planned for his lab. this spring.

Jerry is continuing his Rosin fireplace development work, particularly in light of the planned 1997 requirements for all masonry fireplaces to meet EPA emissions standards.

We will also be adding a second contraflow heater. The second unit will have a 26.5 inch wide firebox. Since the firebox can be adjusted downward with filler panels, we should be able to get an idea of the relationship between firebox size and fuel load and how performance, particularly PM emissions, are affected. The Austrian testing, reported in this issue, indicates a fairly definite "optimum burn rate zone" that is specific to a given firebox size, as far as CO emissions are concerned. A given size charge of wood would therefore fall on different points of the respective burn rate vs. CO curves for two different sized fireboxes. Those who are unfamiliar with masonry heaters should be reminded that these relationships are premised on burn rate independence, i.e., you don't restrict the combustion air, you store the heat instead.

The Lopez setup can handle 3 units per day. We're aiming for 25 days of testing, and so should be able to get 75 runs in.

We've left a number of test slots open, and are offering these to the heater manufacturers at nominal rates. It seems fairly evident that a larger database on masonry heater performance is in everyone's interest. It is hoped that the data will eventually reduce down to a generic enough basis to include the needs of custom builders as well. It should be evident from what's happening in Colorado that we need to become even more knowledge-based as an industry in order to secure our future.

We held an open house toward the end of last year's testing, and quite a few West-Coast members attended. As always, you will be welcome to drop by. If you have some time and would like to help, let us know. The tests are scheduled from March 15 to April 9.

New Fireplace Book

"Since these fireplaces represent a considerable investment, be sure that the person you hire to build it is experienced in its design and construction."

Aberdeen Wants Your Photos

To: Tina Subasic, MHA Administrator
From: Kari Moosman
Book Editor
The Aberdeen Group
426 S. Westgate St.
Addison IL 60101

Do you remember our first book promoting fireplaces? *The Fireplace Book*? Did you think how nice some of your members' fireplaces would have looked in the book? Well, now's their chance.

The Aberdeen Group is currently looking for photos of fireplaces and chimneys for a **new pictorial book on fireplace design**. We will once again show a variety of fireplaces made out of different materials, but this time we are going to show more of the affordable, less complex fireplace designs.

Please encourage your members who build all masonry fireplaces and chimneys to show us what they have. They can send us photographs, slides, or 4x5 transparencies of fireplaces. The shots may be done professionally or taken by the contractor. They must be very clear and uncluttered. The shots should center on the fireplace, but show some of the room. Also, we prefer a fire burning in the firebox.

The photos may also be used in The Fireplace File in *Aberdeen's Magazine of Masonry Construction*.

We must receive all photos by **December 20, 1993.** Please send all masonry fireplace and chimney photos to the above address. Thank you for helping us show off masonry fireplaces!

Kacheln For Sale

I recently met a gentleman who has the following lot of Kacheln for sale:

At the price I paid in 1980, I am offering these Gutbrod Schüsselkacheln (dished), dark green, glazed edges:

54 full size (1/1)	@$31	$1674.
25 half (1/2)	23.	575.
22 Corners (1 1/2)	36.	792.
Total 1980 Value		3041.

This should be enough tiles for three medium sized two-sided stoves, or two three-sided ones. If needed, some of the corners could be cut in two and used in places where the cut would not be visible.

In addition, at no cost, 11 Kacheln to match above, ground edges, various sizes.

Included are a number of Sommerhuber samples. All are safely packed in a wooden crate.

Total pick-up price for the lot: ....$2000. (CDN)
..............................=approx. 1600. US

As we are moving in the near future, I am very much interested in a quick sale:

Bernd Maurach
3640 White Pine Court
Navan, Ontario K4B 1E7
(613) 835-3226

New Canadian Wood Heat Booklet

The following letter from John Gulland appears in the Nov. 93 issue of SNEWS:

Enclosed is a **Guide to Residential Wood Heating**, the new wood-heat booklet jointly published by NRCan (Natural Resources Canada) and CMHC (Canada Mortgage and Housing Corporation). This booklet replaces the outdated *Residential Wood Heating, A Homeowner's Guide*.

It was prepared by CWEI/WETT Inc. (Canada Wood Energy Institute and Wood Energy Technical Training) under contract to the federal government. The booklet is not a revision of the older book, but is composed of entirely new text and illustrations. The booklet covers such things as woodburning and the environment and the prevention of combustion spillage, as well as descriptions of modern wood energy technologies.

There are references throughout to WETT (Wood Energy Technical Training) certification and advice to the reader to use the services of qualified people. The first 80,000 copies "sold out" (actually, they are free) within a few weeks and the booklet is now in its second printing. It might be wise to order soon so you'll have a supply for your customers this winter.

To order 25 copies or less contact: Canada Communications Group, Ottawa, Ontario K1A 0S9; Fax: (613)994-1498. To order more than that contact: Energy Publications, Natural Resources Canada, 580 Booth Street K1A 0E4; Fax:(613)952-8169 (A case contains 120 copies)

CMHC will also be distributing copies of the booklet, although they may not ship in bulk quantities.

The first reviews of the booklet have been very positive. If you have comments or suggestions, please direct them to WETT Inc. and we will pass them on to NRCan and CMHC.

.............John Gulland

Editor's note: Every MHA member should read this excellent 41 page publication. It covers many aspects of wood heating such as venting, fuel, energy calculations and many more. There is even a short section on "High-thermal-mass masonry heaters", with a reworked illustration based on the one in the MHA brochure. The caption reads:

"MASONRY HEATER

Unlike conventional masonry fireplaces, masonry heaters can burn cleanly and produce high efficiencies. Heat is transferred to the mass of the masonry before being radiated into the room. Look for an emission rating similar to that carried by an EPA or CSA B415 certified appliance."

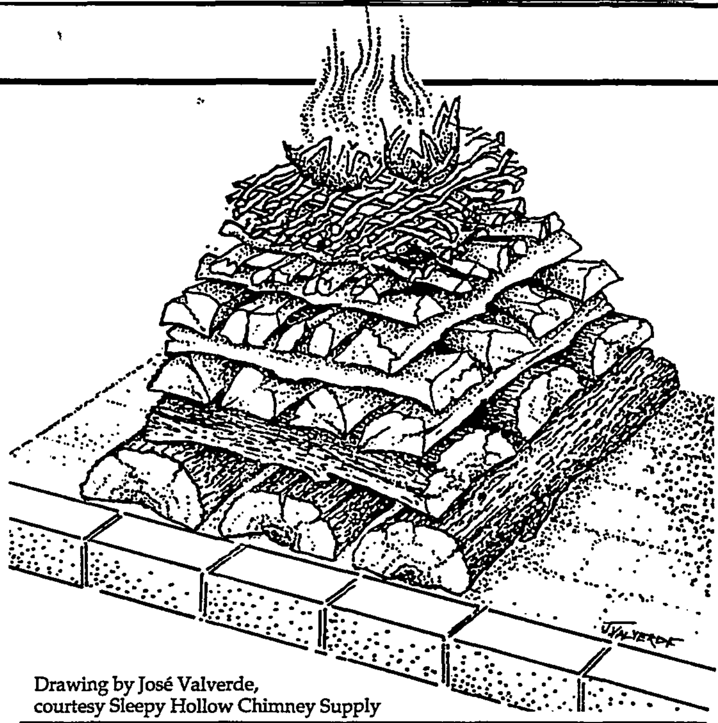
The text reads as follows:

"High-thermal-mass masonry heaters operate on a different principle than the previously-described high-efficiency fireplaces. Masonry heaters take advantage of tonnes of mass in the form of bricks or stone to store and later release the heat they produce. These heaters are completely different internally than conventional masonry fireplaces. The core of the fireplace is built from pre-cast, interlocking components that form the firebox and heat transfer passages. To complete the fireplace, the core is surrounded by brick or stone. With a masonry heater, you only have to build one or two fires per day to provide the heat needed for the home. The wood is burned quickly and the fire is allowed to go out while the heat stored in the masonry continues to radiate warmth for many hours thereafter. Since these fireplaces represent a considerable investment, be sure that the person you hire to build it is experienced in its design and construction."

This is a Canadian government publication - another sign that heaters are starting to arrive.

CLASSIFIEDS:

Wanted to Rent - Apartment or house in Seattle from March 15 to April 15. House-sitting arrangement in exchange for partial rent would be ideal. Norbert or Leila Senf : Tel. (819)647-5092 or (613)722-6261 (machine) FAX: (613)722-6485.



Drawing by José Valverde, courtesy Sleepy Hollow Chimney Supply

The most common mistake in building up the top-burn fire is not graduating to fine enough kindling. The best light-off material for the topmost layer is cedar shavings, but a bit of newspaper will do.

THE UPSIDE-DOWN FIRE

Centuries old, this European fire-building method is the latest word on safer, more efficient woodburning. Wood-heat buffs of the world, unite in adopting it as your own!

Just when some wood-burners thought they knew it all (a foolish notion!), along comes the top-burn fire. It promises more heat from less fuelwood, a safer burn and a bare minimum of pollutants released into the air we breathe.

I call it "the upside-down fire" because, starting with the biggest logs on the bottom, you graduate upwards to the smallest pieces of kindling and wood shavings or bits of paper. It is then lit off from the top and burns downward.

Hardly a new concept, it originated in Europe hundreds of years ago as the fire-building technique of choice for the massive tile stoves widely in use. This method produces a super-clean burn. The stove's masonry mass soaks up the heat, releasing it slowly into the living space for many hours from just one firing.

Tile stoves, or masonry heaters, have become popular again in Europe. In the U.S., a growing number of skilled stove masons are now building these heaters on site in new and remodeled homes.

But the top-burn is not limited to masonry stoves. It is being employed in conventional fireplaces and stoves, too, and in modular masonry refractory fireplaces.

The science and art of woodburning are as old as mankind. It is doubtful anything can erase from our ancestral memory the pleasure of building a fire, partaking of its warmth and watching it burn.

Picture those early cave-dwellers squatted by the fire on a winter's night, tolerating the smoky air because of the warmth the Fire God sends out from the blazing fire and heated rock walls.

The science of woodburning was given new impetus in this country in the 70's when wood heat suddenly came back in style. A few years later there was a hue and cry about the dangers of creosote build-up on flue walls, soon to be followed by urgent inquiry into the environmental and health hazards of wood smoke.

The top-burn fire addresses all of these concerns. The principle at work here is that as the bottom logs heat up and start to release their volatiles, there is enough heat and flame above to ignite them.

Otherwise, those first gases driven out of the wood travel unburned up the stack, condensing out the highly-flammable creosote onto flue walls and spewing particulate matter into the environment.

Creosote burns as hot as coal, so its escape from the firebox is a loss of potential heat for the house. In the top-burn fire, all creosote burns up in the stove or fireplace.

Fred Schukal, long-time sweep and owner-manager of Sleepy Hollow Chimney Supply in Brentwood, New York, quickly adopted the top-burn method for all types of fireplaces. He says, "We should teach it to our customers and preach it like the gospel!"

He and Chris Prior demonstrate it untiringly at chimney sweep gatherings: Place the largest pieces of wood at the bottom. For the best coalbed, use dense hardwoods--this is the perfect place for those impossible gnarled pieces and crotches. Graduate to layers of smaller, softer wood in criss-cross crib fashion as you build it higher. The last layer should be the smallest possible diameter kindling. Place a few crumples of newspaper on top, or, better still, use a handful of cedar shavings.

Chris, a mason and chimney sweep by trade, buys a bundle of cedar shakes each season and with his jackknife works up a little pile of shavings for each fire he builds.

Refueling is not as critical a process as the initial laying of the fire. Add more wood when the crib of glowing coals falls in on itself. As long as you have a good bed of coals, the firebox will be hot enough to heat up and ignite fresh fuel.

This makes a dramatic difference in conventional fireplaces, producing a long, clean burn and usually solving any start-up smoking problems.

Everett, Washington mason Jerry Frisch lays a top-burn fire in the masonry heaters he designs and builds. His is a more casual approach, but it works. He starts with big chunks of seasoned Douglas Fir and places small strips of newspaper strategically here and there. Then he stacks on smaller pieces of wood, topping it all off with kindling and more pieces of paper.

Early on in my own top-burn education, I carefully constructed one in a friend's fireplace insert. Flames traveled dutifully downward and the fire burned long into the night without further ado. (My friend was mightily impressed.)

Look, no smoke!

A top-burn fire produces little or no smoke. Presto, there is a drastic reduction of particulate matter released into the air and virtually no creosote builds up on flue walls to pose a fire hazard.

Masonry heaters, already noted for their clean burn, now emit almost no smoke at all in that once-smoky initial 10 minutes or so of firing.

I found I had been doing a variation of the top burn for years in my old Fisher stove, but I have refined my technique of late. The fire takes longer to build, but it burns better and needs less attention. Jeff, my sweep, annually brushes down no more than a cupful of creosote.

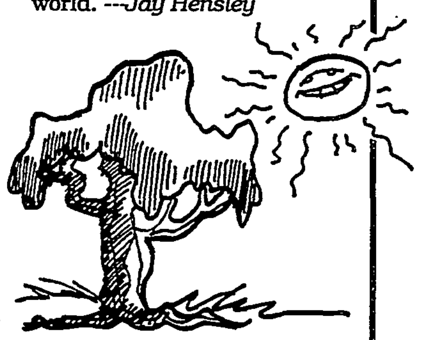
A top-burn bonfire

Chris built a glorious top-burn bonfire at his state chimney sweep guild's summer '93 workshop. Four feet square at the base and five feet high, it burned all night. (An item for the *Guiness Book of Records?)*

As the word spreads, we may soon find Cub Scout and Brownie leaders teaching this skill to their young recruits.

Hopefully, all conscientious woodburners will eventually up-grade to masonry heaters, refractory fireplaces and hi-tech EPA-certified stoves . . . and *always* do a top burn.

In the meantime, building top-burn fires in those old-generation conventional fireplaces and stoves will produce cleaner, more efficient burns, helping us safeguard our families and do our part to renew this weary and abused old world. ---*Jay Hensley*



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