Rocket Mass Heater Permitting

What's the official status of an earthen masonry stove?
As of 2012, they have a 1-week approval process in Portland, Oregon! See below for details on applicable building codes.
If you don't live in Portland, there are still some good resources out there. A rocket mass heater
- may be exempt from EPA regulation (by weight, as a site-built masonry heater it is not a woodstove);
- may be insurable or permittable in other locations if 'supervised or build by an experienced masonry heater builder' (ASTM standard 1602-03). Local code references follow for several states.

Related links:

Shop for Plans

Upcoming Workshops

Our Fire Science and Rocket Stove pages

Rocket Mass Heater books and info: www.rocketstoves.com

Building the test case: Dana Annex Rocket Mass Heater: picasaweb.google.com/earwister

Earthen building experts and links: www.cobcottage.com www.nbnetwork.org

Building code regarding Masonry Heaters: Oregon

Here's the story of our quest to try this out for ourselves, which started in 2009.

We've been working with officials from the city of Portland to make it possible to get an official permit for a Rocket Mass Heater. As of summer 2012, there is a document approved through the Alternative Technology Advisory Committee (ATAC) that specifies the detailing for this 1-week approval process.

If you're wondering what is a Rocket Mass Heater in the first place, I suggest starting with this page: http://www.ernieanderica.info/rocketstoves

And for how it's going for testing and permits, I describe our experiences on my journal, here's a link to start with: http://www.journalscape.com/ecca (February 26, 2009)

The officials we worked with have been consistently friendly and informative. The process of

Interpretive Ruling No. 93-47

Residential Specialty Code, Chapter 9 & 10. Cf Section 925: "Masonry stoves shall be constructed in accordance with the *Building Code*."

Oregon Structural Specialty Code, Chapter 10: Chimneys and Fireplaces, section R1002: Masonry Heaters (link)

Not a woodstove per DEQ: Woodstoves are under 800KG (1800 lbs) - OAR 340-262-0020

Here's the DEQ document in full:

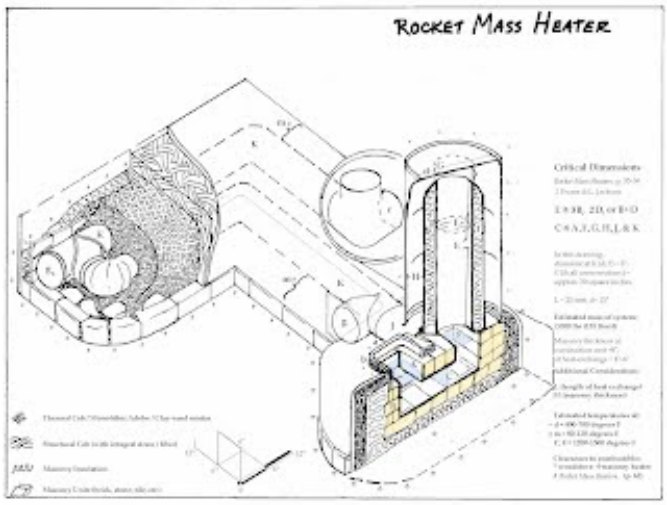
http://arcweb.sos.state.or.us/rules/

Among other things, it says that a stove that's the main source of heat, a cookstove, or in a house whose income is below 125% of federal poverty levels, can be exempted from some (but not all) of the requirements.

The testing requirements for woodstoves (which a rocket mass heater isn't, by definition) and wood heaters (which are also supposed to be under 800 kilos, these are wood-fueled furnaces

sharing information and working out the details has taken some time. Chances are in your area, nobody may know quite what to make of the whole thing, but there are several options on the table.

In Portland, we helped write some building-code-style descriptions, using clearances that are consistent with fireplace, woodstove, and masonry heater code, to establish a clearer set of guidelines for permit officials and builders.
Relevant code sections include Section 1000 for Masonry Chimneys and Fireplaces (and especially R1002 for Masonry Heaters, here's the California version of R1002)



(Update: This process is now complete, and the finished code and drawings will be available at Portland's Building Design Services website in summer 2012, under ATAC (Alternative Technologies Advisory Committtee). These guidelines can be used to design and apply for permits through the usual Alternative Appeals Process in Portland, and may be helpful in other locations. A big thank you to Joshua Klyber, Bernhard Masterson, Melora Golden, and all the other ReCode Portland and ATAC members who made this happen. Www.portlandonline.com/BDS/ATAC.)

We also want to get some EPA / UL testing done, to prove the claims about fuel efficiency, air quality, and heat delivery, and safety.

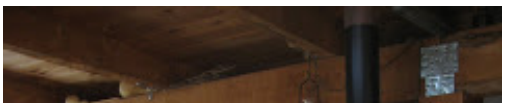
We are currently raising funds to pay testing fees for a prototype Rocket Mass Heater, either on-site or lab testing depending on the city's desired level of proof, and our budget. RMH's don't consume enough fuel to undergo woodstove testing, so some custom variation of testing may be needed. The local testing lab (OMNI-Labs, near the Portland Airport) charges about $5,000 for standard woodstove testing.

If you are interested in contributing, you can make a donation via PayPal to **eawisner@gmail.com**. Please specify whether the donation is for TESTING FEES (to be set aside for fees only) or for GENERAL RESEARCH (can be used for materials and supplies to support concurrent research projects, like refractory materials, temperature probes, travel and printing, or prototype fabrication).

So what if I want one this winter?

The biggest recommendation I would make to someone thinking about trying to get a permit for their own rocket mass heater:

If you go with "masonry heater" as the category (and there are good reasons to do so) you are likely to need a reinforced foundation. Ideally, you will want to get your design approved (under the mechanical permitting process) before building it. But this may be tricky, since the person making the decision probably won't have any idea what you're talking about.



and boilers for the most part) ...

http://www.epa.gov/

These standards are clearly designed to apply to manufacturers of retail stoves. They require testing "not to exceed 1 in 10,000 units," and in some cases as little as 1 in 100,000 units (if the manufacturer has consistently been successful in previous tests of this model).

There is no mention of site-built or masonry devices in these testing requirements.

Rocket Mass Heaters are not primarily a cookstove - there is another kind of "rocket stove" designed for cooking; the common feature is a short 'heat riser' that encourages hot burn and directs that heat to where it's wanted.

That's why we are not too disappointed that we got the wrong permit by mistake. (We went ahead and built it as a result). At least this way, the inspectors get to actually see a working example while they try to make their decisions.

As a result of this, and the combined efforts of the citizen-led ReCode initiative and a city-approved Alternative Technologies Advisory Committee to support sustainable building alternatives, we now have a precedent for a permittable rocket mass heater in Portland, OR.

Alternatives that might work for other situations:

1) Start the conversation with a tangible example. Build a prototype mock-up outdoors, and invite local officials to look at it (and sit on it, and feed it, and pet it) while they consider your permit application. Then make whatever design changes might be required to build your indoor version. (Try the changes on the mock-up first, if you doubt their benefit; some well-intentioned changes can seriously affect performance.)

2) Submit designs, and use experts. Create a design, or get proven plans from someone experienced, and have an engineer or architect sign off on these drawings. Local officials are much happier approving something when a licensed professional has put their license on the line to guarantee it. Likewise, some insurers will approve a masonry heater installation if you have an experienced masonry heater builder supervise or build the system. If your local experts are still not sure about it, send them to a workshop or put them in touch with us for questions. We like having engineers and architects in workshops - but we have to admit, we like having old experienced masons and builders in there even more. Fire marshalls and EPA inspectors can be fun too.

3) Build a non-permitted or exempt version. This is what most owners to date have done - and the reason why some back-to-the-landers deliberately seek out a location with minimal permitting requirements. Off-the-radar installations should still be constructed according to the best practice you can research. Try to build it so as to qualify for a permit, or for an exemption, or both, in case of official inspection. Exemptions from EPA requirements may be made for antique woodstoves, wood-heat devices that are a household's only way to heat, or the only way to cook, and for devices that are over 900 KG (1870 lbs or so) and not causing any pollution complaints.

You may have better luck if you are in an area that has already accepted cob or earthen building as acceptable masonry practice, or if you have like-minded neighbors who are happy to live and let live.

More facts of interest are below.

The most useful references to date:

ASTM standard for Masonry Heaters: 1602-03

Oregon Interpretive Ruling 93-47

Residential Specialty Code Section R1002 for Masonry Heaters
(a subsection of the Residential Specialty Code, Chapter 10: Fireplaces and Chimneys; a sample text is provided below with links to two states' free online versions.)

and the soon-to-be-released Rocket Mass Heater building code for Portland, Oregon: Www.portlandonline.com/BDS/ATAC.

Yours,

Erica and Ernie Wisner

questions@ErnieAndErica.info

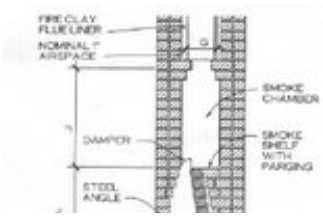
Act II: The Building Codes and Legal Combustion of Solid Fuels

There were a great many horrific fires in historic cities - Rome, London, Chicago and San Francisco notoriously burned to the ground on several occasions, and these fires increased in frequency with the introduction of coal-fired home furnaces. Most pioneer towns had at least one close call.

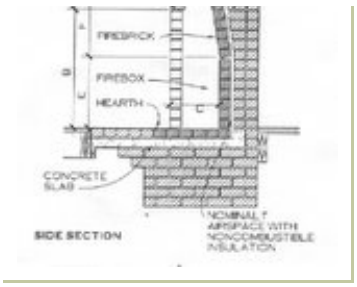
Modern building codes require permits for installation of most combustion devices, to ensure their prior approval for occupant and building safety. Since 1970, approved devices also need to past tests specified by the EPA to diminish widespread air pollution. These codes are an interesting historic phenonenon: they combine centuries of experience-driven 'best practices,' with modern, mostly commercially-driven technical amendments. Unfortunately, many of the more recent and efficient European masonry heater techniques were not yet common knowledge in the US when the codes were first adopted, and only with much effort on the part of volunteer masons have the masonry heaters at last achieved a modicum of recognition. Testing of 'kits' still allows a much easier approval path than site-built heaters, at the cost of some flexibility for master masons to design heaters that may better meet a household's particular needs.

The cost of altering building codes is substantial, giving a tremendous advantage to industries which can spread the cost of testing and lobbying over thousands of retail units. Masonry does not retail well - much easier to ship a glorified metal barbecue grill, than a more efficient brick heater. So site-built technologies must be approved individually, at a significant disadvantage in cost and time delays. Categorical exemptions have already been made by the EPA for masonry heaters, but local building officials can be reluctant to accept such an exemption without a signed letter from... someone ... on EPA letterhead.

So where does that leave our traditional, earthy, masonry fireplaces?



- Rumford fireplaces are already in code - in many parts of the US they are approved under the same EPA categories as a certified insert or woodstove, based on their much lower contribution to local smog compared to cruder square fireplaces. In Portland, you can even build a Rumford fireplace



with cob (monolithic adobe) under a local code variance that was just created through Portland's Alternative Technologies Advisory process. (Rumford diagram from www.HJMasonry.com, Maryland)

- Masonry heaters have been permitted in the US for at least 15 years, and exempted from EPA regulation by weight (each is site-built of tons of masonry, and can't effectively be transported to a testing lab. But they are known to be cleaner-burning than most commercial alternatives. (They have been a proven, high-end combustion technology for home heating in Europe for several centuries, and larger versions have been approved for some commercial buildings.)

So what about Rocket Mass Heaters?

Are they ready to 'come out' into mainstream built environments?

It is possible to build a Rocket Mass Heater completely according to masonry heater code. And, though more expensive than the junkyard variety, it would still be one of the least expensive masonry heaters and the easiest for an ordinary owner-builder to do with mostly their own labor. (The ASTM specifies that masonry heaters are complex and should be built, or supervised, by an experienced masonry heater builder. None of the builders currently listed on the masonry heater guild websites are conversant with rocket mass heaters. But the standard does not restrict the term 'experienced' to members of these guilds. Arguably, we would qualify as experienced builders under this standard.)

However, the process is complicated by the fact that few jurisdictions understand what codes and standards even apply to the European-style masonry heaters, let alone something with earthen masonry and a metal bell.

Here's the story of our attempt to build a Rocket Mass Heater, legally, under City of Portland building codes. (Journal entry at www.Journalscape.com/Ecca

So, we have this ... thing ... in our living room. Pictures of The Thing

We built it out of recycled bricks, metal, sand, dirt, and a little bit of fancy stovepipe, tile, and plaster.

It burns wood. But it weighs over 6000 lbs, so officially it does not qualify as a woodstove. We gave it a factory-built chimney suitable for a woodstove, and some heat shielding and insulation from the walls like a woodstove, anyhow.

At that weight, and given that it's mostly made of masonry, it might be a masonry heater. (These are exempt from UL testing according to the testing companies and masonry heater guys. Oregon building code finding 93-47.pdf describes a type of European masonry stove, and it seems to apply pretty well to what we have here. Except for the shape.).

Our Thing is spread out around the room, about 18 inches high, and has a

factory-built chimney instead of a masonry chimney. (A masonry heater is usually a giant stone or brick chimney, which puts the smoke from a fireplace or woodstove through some baffles to slow it down and collect more heat from it. Masonry Heaters Association, http://mha-net.org)

Does it need a reinforced foundation, if there's no possible way it could fall on anybody or bring the house down with it?

It can boil water. But it's not our sole cooking device; we use it occasionally for making tea/soup, for fun or in power outages. (A cookstove that is your only way to cook is exempt from EPA even if it smokes like a demon.)

It can heat the house pretty well - it was able to bring the thermostat to 61 degrees, in 13-degree weather. We have a furnace in the house, but we don't use it when The Thing is working.

And it's really comfy to sit on. (Part of it is a heat-exchanger, where the flue gas runs through a cob bench, so it makes a full-body heating pad or heated sofa/bed.)

The flue gas doesn't smell like woodsmoke, or like much of anything. It's basically steam and CO2. On warm days, it makes no visible smoke. Just clear flue gas. On cool days, it puts out clear steam that immediately condenses into white clouds, and then dissolves again as it drifts away.

We've had friends over with small children, and lit it for them, and they felt comfortable and safe.

We just had two inspectors from Portland's building code team, and one from DEQ, out to have a look at it. They didn't give it a permit, but they didn't deny it, either.

It doesn't fit into any existing box.

Here's the long version of the story:

Ernie was part of the research team for the 2005 edition of the book, *Rocket Mass Heaters: Superefficient Woodstoves You Can Build (and cuddle up to!).* When he got hurt, we did a workshop as a fund-raiser and built one outdoors at Tryon Life Community Farmwww.tryonfarm.org). It went over well, and one of the participants had us do another workshop the following year at his house - to heat an outdoor bench and small outbuilding.

There's a lot of interest from folks in being able to build one indoors, in a "normal" house. (We have friends and mentors on Oregon's south coast, who have installed these in small cob houses where they *are* the only cooking and heating device, and they work great. We also know of a few people in various places who have installed them, up-to-code or otherwise, as owner-builders in conventional and/or log houses, and they work well there, too.)

We've helped people build a couple of them outdoors for a "warming fire," and they work pretty good - but outdoors is not necessarily where most people want to stay warm. The "Rocket Rocket" was developed for people

people want to stay warm. The "Pocket Rocket" was developed for people who have no indoors to go to, and need a warming fire - but it's kinda bulky for most people. Ernie knows a guy who has one on his boat.

We can help someone learn how to build a clean fire, and how to clean out their Rumford fireplace so it works better(or refit an "ox-cooker" fireplace to a more Rumford-like configuration for better heat efficiency). And we can show people how to build a Thing as a fancy outdoor cooking or heating device. www.ErnieAndErica.InfoWe think these Things are an improvement over what's out there for home solid-fuel heating, in a lot of ways.

For example, they put out way less visible smoke that the currently available UL-certified woodstoves, even when the latter are run by competent fire-makers with properly cured wood. (With inexperienced people or wet wood, there's no comparison.)

They use about 1/5 to 1/10 the wood for heating that a conventional woodstove would use in the same place. This means a normal, suburban family could get the heat they need without quitting their day job to split wood.

They provide an extraordinarily comfortable, direct body-heating option, which means that you can have a variety of people in the house and maintain a temperature gradient that keeps everybody happy.

So we'd like to be able to tell people, "Get a permit, and you can put one of these in your home; here's how you do it to code so you don't invalidate your insurance."

But nobody's done that yet, at least in Oregon. So we don't know how it would work.

So we decided to try it ourselves.

The place we're currently renting is part of the Dana property in the Sylvan hills. It's an attached cottage, known as the Annex or "Little House," next door to "the Big House."

The family has been thinking about developing this two-family residential property into a sort of ecological retreat or B&B, to preserve its rural character in an increasingly suburban area. (Recent infill has contributed to stormwater and other problems, and the owners are not excited about the idea of seeing their childhood home replaced by 5 or 6 big-footprint McMansions.)

So Emily Dana was in favor of installing an efficient wood-burner in the rental house. She paid for the permit application and the parts required for code, as a "capitol investment," and got her hands dirty mixing cob, laying masonry, and cobbing-in the heat-exchange ducting.

We got the permit application in September, and we had the stove mostly built by the end of October. We had to wait a while between layers, because of damp (the little house is pretty damp to begin with).

Our final work-party to finish the exterior plaster was the weekend after

Chinese New Year. The 180-day deadline for our first inspection was still a month or two out, and we thought about calling around to get advice ... but we decided that we'd rather hear it from the officials in charge, than try to please everybody and then hear it from the officials anyway.

So we called the Bureau of Development Services, and scheduled an inspection.

We were all excited about it, and tidied up the living room, and rescheduled our tax appointment when the inspector needed to come earlier in the day.

Inspector John came out, and said, "Wow." Or maybe, "Whoa." He looked in both ends, we lit it off for him, he asked to see the plans, we pulled out the Rocket Stove Book and our photo show, and hunted around for the original design drawings.

He said, "This is very cool - but I can't inspect it. I have no idea what to inspect it *for*. Let me put you in touch with my supervisor."

So we called his supervisor, Joe. The first thing he asked when he called back is whether it was a "cooking rocket," or a "rocket mass heater." Good researching!
(Cooking rockets were developed for third-world families as an improvement over a 3-brick indoor hearth; they have an L-shaped burn chamber, and are not designed to heat a home.bioenergylists.org or aprovecho.net)

We had an interesting phone conversation about whether we had a woodstove, a fireplace, or a cookstove. We said, "None of the above." He told us if it heats the house or cooks food it's an appliance (not the term I would have used for a fireplace or chimney, but apparently that's the building code language). And would need EPA approval and UL ratings. We pointed him toward Finding 93-47, which describes "masonry heaters" as an alternative category of solid-fueled device, hand-built, and not considered a UL-testable woodstove on account of the weight.

(We had already asked about this by calling OMNI-Test Labs. They certify woodstoves and other fuel-burning products. They said it sounds like we have a masonry stove, which is exempt; and also, the UL tests are run at three wood-consumption burn rates, all of which are faster than our Thing can swallow wood.)

After doing some research, Joe called back and set an appointment for the following Thursday morning, to come see it and bring a DEQ inspector along. We invited him to bring anybody else who wanted to see it, too.

Once again, we tidied up and prepared. I got all our design drawings and notes collected into a file, and drafted a new, larger drawing on official-looking architectural vellum.

Our inspectors arrived on time (Joe from BSA, Robert from DEQ, and later John stopped back by as well). We showed them what we have, and they asked to see it work, and we discussed options.

They could see the value in a "poor man's masonry stove," and Robert from DEQ seemed relieved to find himself among people who knew how to make fire without smoke.

But they couldn't pass it, based on the existing code categories.

One issue was the permit we'd gotten: it was for a woodstove installation, which means UL-approved or antique woodstoves. For a masonry heater we should have submitted the plans first for a mechanical permit, instead. (The office didn't know this, and they were between issues of the code at the time, so neither did we.)
Joe decided to keep our original permit open, meaning we'd have another 180 days to get it inspected again. We could submit the plans for a mechanical permit, and if they needed changes (like a reinforced slab footing suitable for a massive chimney) we could tear out the existing work and re-do it. Um....

Another option would be to submit the plans and information to "OMOA" (another division of BDS), and see if we could get it passed as an "approved alternative." (To my mind, this might be necessary anyway, because of the earthen masonry.)

Or it could go through testing at OMNI-Labs and get approved as a heating device, we could put a sticker on it, and they could pass it as an appliance, like a woodstove but different.

If we didn't have an electric range, it could be exempted under DEQ as a cookstove. But I kind of like having a kitchen. (My thoughts: Maybe there's an exception for emergency cooking / heating, like the woodstove Grandma used to have in her basement?)

So that's where we stand at the moment. Joe, John, and Robert are going to keep talking to their office mates, and showing pictures. We gave them Ernie's card with our website, and hopefully they can find the pictures.

We'll give Karl in OMOA a call in a little while once Joe has had a chance to mention this to him, and see what the process is for "approved alternative."

It may be a lengthy process, but hopefully we can get a prescriptive, or ideally descriptive, option worked out. That would allow a homeowner to

build this "poor man's masonry stove," and burn less fuel with less smoke than any other option we know.

<u>The Thing's good points:</u>

- Clean
- Efficient: low-fuel, lots of heat
- Local biofuel alternative energy
- Low-cost
- Low-maintenence (yearly inspection/cleanout, daily ash cleanout and one or two 2-hour firings per day during cold season)
- Safety: Lower temperatures on exposed surfaces than most heaters, fewer toxic components, fire is mostly recessed away from curious hands

hands.

Points of concern:

- Foundations and reinforcement: Seems like overkill to pour a concrete slab with enough rebar to support a 10- or 20-foot chimney, when this stove is basically a slab with a center of mass under a foot from the ground. But existing slab-on-grade may not be enough.
- Unusual materials: Earthen masonry, recycled metal barrel, and ducting/stovepipe installation specs:
  These are substantially different from approved Masonry Stove construction methods. (Masonry chimney, high-heat ceramic flues, rebar and concrete footing, hearth or vertical burn chamber door, etc.)
  We think they're better in many ways (better thermal contact between flues and mass, solid monolithic masonry with integrated tensile reinforcement instead of linear rebar, lower environmental impact and materials costs). And there's some evidence that concrete and rebar are not compatible with earthen masonry in certain applications. But it's not up to us entirely: somebody official needs to agree with us about that.

Other observations from the inspectors:
Robert wondered if a child could "fall into" or against the barrel and be burned.
The barrel is a substantially lower temperature than the woodstove we had in my home growing up, or the modern ones I've seen in other homes and meeting spaces since 2005. And we've built a fairly substantial cob structure around the stove core. It's ergonomically not that easy to get your body in position to fall into the barrel unless you actually climb onto the sloping cob mass. The kids we've had in the house seemed to get the picture quite easily, and sat happily on the bench or ran around in the other parts of the house. But it could happen; kids do run around and climb on things, and it might one day suffer the same fate as many a family sofa.

Proposed solution: John described a screen they'd built from square metal bars, three rails, that served as a "kid fence" without interrupting the radiant heat from their stove. I've been looking for decorative options anyway, and a wrought-iron lattice or sleek modern rail could add something nice to the stove's appearance. (And, Emily observes, it would be somewhere nice to dry mittens, socks, and warm towels for luxuriant showers.)

The option that Tryon Farm used for kid-safety (they host school groups, and have toddlers in residence) was
a) Ernie designed the stove so the barrel wouldn't overheat easily, and
b) they cobbed a sculptural motif around the main part of the barrel in addition, making it difficult to accidentally touch the metal but still possible to cook on it.

While thinking about safety, Joe liked the downdraft setup. It's not hot above the wood feed, and it avoids a lot of the problems associated with a "hearth" where fire can fall out onto the floor.

From our friends' experience, you'd have to do something really silly like perch a 4-foot long crooked stick of firewood in the stove (more than twice the design length), and then leave it unattended, leaning precariously at odd angles, in order to get it to fall out.

One of my favorite aspects is that we can actually burn a single log (of 4" to 5" diameter) and it self-feeds and self-regulates the air. Smokeless, just like the other fuel options.

Another speculative option that one of our inspectors suggested in a humorous mood ... would the fact that it's made of local dirt, as old as dinosaurs, and in a traditional manner, possibly qualify it as antique?

Woodstove and Wood Heater testing requirements:

(for devices which meet the definition of a woodstove): Average particulate emissions less than 4.1 g/hour, as proven by tests on not more than 1 in 10,000 of any given model of stove produced. (One in 5,000 if they were within 30% of the allowable limit on their last test.)

§ 60.532 Standards for particulate matter.

(i) At burn rates less than or equal to

2.82 kg/hr (6.2 lb/hr),

C = K

1BR + K2

Where:

BR = Burn rate in kg/hr (lb/hr) K

1 = 3.55 g/kg (0.00355 lb/lb)

K

2 = 4.98 g/hr (0.0.011 lb/hr)

(ii) At burn rates greater than 2.82 kg/hr (6.2 lb/hr), C = 15 g/hr (0.033 lb/hr).

(2) An affected facility not equipped with a catalytic combustor shall not discharge into the atmosphere any gases which contain particulate matter in excess of a weighted average of 7.5 g/

400 **Environmental Protection Agency**

hr (0.017 lb/hr). Particulate emissions shall not exceed 15 g/hr (0.033 lb/hr) during any test run at a burn rate less than or equal to 1.5 kg/hr (3.3 lb/hr) that is required to be used in the weighted average and particulate emissions shall not exceed 18 g/hr (0.040 lb/ hr) during any test run at a burn rate greater than 1.5 kg/hr (3.3 lb/hr) that is required to be used in the weighted average.

[53 FR 5873, Feb. 26, 1988, as amended at 60 FR 33925, June 29, 1995; 65 FR 61764, Oct. 17, 2000]

(3)(i) Except as provided in paragraph (o)(3)(iii) or (o)(5) of this section, the manufacturer or his authorized representative shall conduct an emission test on a randomly selected affected facility produced within a model line certified under § 60.533 (e) or (h), on the following schedule: If weighted aver-age certification test results were— If yearly production per model is— <2500 >2500 70% or less of std When directed by EPA, not to ex-ceed once every 10,000 stoves. Every 10,000 stoves or triennially (which-ever is more frequent). Within 30% of std Every 5,000 stoves Every 5,000 stoves or annually (whichever is more frequent). ...

Exciting - a snippet of emissions testing data from a rocket mass heater researcher in the Netherlands: Peter tests Rinchen's 8" equivalent Rocket Mass Heater
This may not be very representative of all rocket mass heaters, but it's the first emissions data I've seen.

Building Codes related to Masonry Heaters

SECTION R1002 MASONRY HEATERS

R1002.1 Definition. A masonry heater is a heating *appliance* constructed of concrete or *solid masonry*, hereinafter referred to as masonry, which is designed to absorb and store heat from a solid-fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox may include flow in a horizontal or downward direction before entering the chimney and which delivers heat by radiation from the masonry surface of the heater.

R1002.2 Installation. Masonry heaters shall be installed in accordance with this section and comply with one of the following:

1. Masonry heaters shall comply with the requirements of ASTM E 1602; or
2. Masonry heaters shall be *listed* and *labeled* in accordance with UL 1482 and installed in accordance with the manufacturer's installation instructions.

R1002.3 Footings and foundation. The firebox floor of a masonry heater shall be a minimum thickness of 4 inches (102 mm) of noncombustible material and be supported on a noncombustible footing and foundation in accordance with Section R1003.2.

R1002.4 Seismic reinforcing. In Seismic Design Categories D_0, D_1 and D_2, masonry heaters shall be anchored to the masonry foundation in accordance with Section R1003.3. Seismic reinforcing shall not be required within the body of a masonry heater whose height is equal to or less than 3.5 times it's body width and where the masonry chimney serving the

heater is not supported by the body of the heater. Where the masonry chimney shares a common wall with the facing of the masonry heater, the chimney portion of the structure shall be reinforced in accordance with Section R1003.

R1002.5 Masonry heater clearance. Combustible materials shall not be placed within 36 inches (914 mm) of the outside surface of a masonry heater in accordance with NFPA 211 Section 8-7 (clearances for solid-fuel-burning *appliances*), and the required space between the heater and combustible material shall be fully vented to permit the free flow of air around all heater surfaces.

Exceptions:

1. When the masonry heater wall is at least 8 inches (203 mm) thick of *solid masonry* and the wall of the heat exchange channels is at least 5 inches (127 mm) thick of *solid masonry*, combustible materials shall not be placed within 4 inches (102 mm) of the outside surface of a masonry heater. A clearance of at least 8 inches (203 mm) shall be

outside surface of a masonry heater. A clearance of at least 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.

2. Masonry heaters tested and listed by an American National Standards Association (ANSI)-accredited laboratory to the requirements of UL1482 may be installed in accordance with the listing specifications and the manufacturer's written instructions.

(The above is from the CyberRegs site for the California Residential Code, Title 24, 2011)
Similar language for Oregon can be found here: www.cbs.state.or.us (PDF)
Many other states use similar text, based on the International Building Codes. Some areas may have more restrictive regulations (such as bans on wood heat for air stagnation zones or fire season; and peculiar restrictions within certain cities or communities). Other areas are more permissive, allow local exceptions, and many have not adopted any residential building code requirements at all (e.g. most of Vermont, certain counties in Wyoming).
Check with your local building office, or local building professionals, before planning your project - you can be cagey if you like, but it's much easier to build a few extra inches into the original design than to move a wall or foundation after it's in place.

Draft 2 of Rocket Mass Heater code: (historic interest - see current version July 2012)

1. Scope:

1.1 This guide covers the design and construction of Rocket Mass Heaters, a subset of solid fuel burning masonry heaters. It provides dimensions for site constructed rocket mass heaters and clearances that have been derived by experience and found to be consistent with safe installation of those rocket mass heaters.

1.2 Values given are in English measurements, and are regarded to be standard. All dimensions are nominal unless specifically stated otherwise. All clearances listed in this guide are actual dimensions.

2. Definitions:

2.1 Combustion unit: The area where fuel is consumed and clean exhaust produced; comprising the fuel feed, burn tunnel, heat riser, barrel, and the manifold.

2.2 Combustion unit base: Area composed of the fuel feed, burn tunnel, insulation and casing.

2.3 Fuel/air feed: Area where fire is lit and fuel is added. This is the sole air intake.

2.4 Burn tunnel: Horizontal area where initial combustion occurs.

2.5 Heat riser: Internal chimney, insulated for high-temperature combustion and draft.

2.6 Barrel: Metal or masonry envelope around the heat riser that radiates heat.

2.7 Manifold: The connection between the combustion unit and the heat-exchange ducting.

2.8 Heat-exchanger: The area that absorbs heat from the heat exchange ducting and re-radiates it over an extended period of time. Comprised of the heat exchange ducting, thermal core and casing.

2.9 Heat exchange ducting: The flues that carry hot exhaust gas through the thermal mass.

2.10 Thermal core: Area directly around heat exchange ducting.

~~**2.11** Thermal earthen masonry:~~

2.~~13~~ 11 Casing: Durable external layers to protect thermal core, provide additional thermal mass, maintain desired surface temperature, and allow decorative expression.

2.12 Flue exhaust: The portion of the ducting after it leaves the thermal core.

2.~~14~~ 13 Cleanout: Capped opening for maintenance access.

3. Significance and use:

3.1 This guide can be used by code officials, architects and other interested parties to evaluate the design and construction of rocket mass heaters. It is not restricted to a specific method of construction, nor does it provide the principles to be followed for the safe construction of rocket mass heaters.

3.2 This guide is not intended as a complete set of directions for construction of rocket mass heaters.

3.3 Construction of rocket mass heaters is complex, and in order to

ensure their safety and performance, construction shall be done by or under the supervision of a skilled and experienced rocket mass heater builder.

4. Requirements:

4.1 Sizing:

4.1.1 6" flue rocket mass heaters can be installed for any heated space 1000 sq. ft. or less.

4.1.2 8" flue rocket mass heaters are typical and appropriate for any installation.

4.1.3 Cross sectional area shall remain consistent throughout the system except in the barrel and manifold, where it may be larger.

4.1.4 Ducting may be tapered to reduce diameter by 1" in the final third of its length to improve gas flow.

4.1.5 Total ducting length from manifold to exhaust outlet may be up to 60 feet, with 30 to 50 feet being typical. NOTE: Some configurations within this range may require special design consideration to ensure proper exhaust.

4.2 Dampers: Shall have no dampers installed that can obstruct free flow of exhaust gas. **Exception:** A two-way flap or valve which maintains >100% flow may be used between alternate exhaust paths.

4.3 Foundation: The combustion unit base, heat exchanger (no more than 36" in height from foundation), and bench back (no greater than 48" in height from foundation) shall be supported by a 4" concrete slab or equivalent. All other configurations shall have an engineered footing.

4.4 Combustion unit: Shall be constructed in either earthen masonry or refractory materials. If refractory materials are used, an expansion joint shall be included between combustion unit and earthen masonry.

4.4.1 Mortars, when used, shall be clay-sand, fire clay or suitable refractory mortar. Mortars may be omitted if using monolithic earthen masonry as an external seal.

4.4.2 Fuel feed:

4.4.2.1 Shall be constructed of fire brick, clay brick or equivalent refractory material rated for over 2200° F.

refractory material rated for over 2200° F.

4.4.2.2 Shall have an emergency shut down lid.

4.4.2.3 Shall be the sole air intake.

4.4.3 Burn tunnel:

4.4.3.1 Shall be constructed of fire brick, clay brick or equivalent refractory material rated for over 2200° F.

4.4.3.2 Shall be insulated with 2" of clay-perlite insulation or equivalent underneath, above, and on all sides except the fuel feed and heat riser openings.

4.4.4 Heat riser:

4.4.4.1 Shall have a minimum height of twice the burn tunnel length.

4.4.4.2 Shall be at least three times the height of the fuel feed.

4.4.4.3 Shall be constructed of firebrick, clay brick, metal flue or equivalent refractory material rated for over 2200° F.

4.4.4.4 If constructed of metal flue, it shall be free from holes, wrinkles, burrs, jagged edges or other obstructions. Metal shall be high-temperature stovepipe or steel.

4.4.4.5 Shall be insulated with minimum of 2" of clay-perlite insulation or equivalent.

4.4.5 Barrel:

4.4.5.1 Shall be free from holes, wrinkles, burrs, jagged edges or other defects.

4.4.5.2 Any existing paint or surface coatings shall be removed. High-temperature coatings rated for woodstove application such as stove enamel, cast-iron seasoning oils may be used.

4.4.5.3 A cleanout shall be located near the base of the barrel that allows access to the manifold and initial ducting, or the barrel shall be configured for removal.

4.5 Heat exchanger:

4.5.1 The heat exchanger rests on 4 inches of dry stack masonry, above or including the foundation.

4.5.2 Ducting:

4.5.2.1 Shall be metal flue, ceramic flue liner, or well pointed brick. Metal flue shall be free from holes, wrinkles, burrs, jagged edges or other defects.

4.5.2.2 Shall be embedded in a continuous layer of earthen mortar for both thermal contact and gas seal.

4.5.2.3 The length of ducting encased within the heat exchanger is typically 15 to 40 feet.

4.5.3 Cleanouts:

4.5.3.1 Shall have a sufficient number of cleanouts such that all sections of the ducting shall be accessible.

4.5.3.2 Cleanouts shall be the same minimum size as system: ~~e.g.~~ 6" diameter for a 6" flue rocket mass heater and 8" for an 8" flue rocket mass heater.

4.5.4 Thermal core shall be ~~encased with a minimum of 2" thermal earthen masonry around the ducting.~~ a minimum 2" of heat-tolerant masonry in thermal contact with ducting. Earthen masonry for thermal core shall be dense and without organic fibers or air pockets.

4.5.5 Casing:

4.5.5.1 Total thickness from ducting to surface ~~from ducting~~, for a 6" system shall be at least 4" depth around the first 10 feet of ducting, and 3 inches around the remainder.

4.5.5.2 Total thickness from ducting to surface ~~to surface from ducting~~, for a 8" system shall be at least 6" depth around the first 10 feet of ducting, and 4 inches around the remainder.

4.5.5.3 Casing shall be compatible with thermal core, such as earthen masonry finishes over an earthen masonry core. Portland cement casings are not compatible with an earthen masonry core.

4.6 Flue exhaust:

4.6.1 Flue exhaust may be a manufactured chimney, lined masonry chimney, or horizontal exhaust.

4.6.1.1 Manufactured chimney exhausts shall be installed

according to manufacturer's instructions and local building codes.

4.6.1.2 Lined masonry chimneys or horizontal exhausts shall be suitable for ~~low-temperature~~ flue-gas exhaust from combustion appliances, such as a furnace or gas-powered dryer. Exhaust temperatures can be designed to reach from 70F to over 350F within the scope of this code, so temperature-appropriate exhaust treatment is at discretion of builder.

~~**4.6.1.3** Horizontal exhaust shall be constructed similar to a dryer vent or other low-temperature flue gas exhaust.~~

4.6.2 Exterior sections of exhaust shall be located away from building air intakes and occupied areas, and protected from wind, rain, and vermin.

4.7 Clearances:

4.7.1 Fuel feed: A minimum clearance of 18" shall be maintained from combustible materials to fuel feed.

4.7.2 Combustion base: A minimum clearance of 4" shall be maintained from combustible materials to all surfaces.

4.7.3 Barrel: A minimum clearance of 36" shall be maintained from combustible materials to all surfaces, if installed without a heat shield. A minimum clearance of 18" shall be maintained from combustible materials to all surfaces, if installed with a heat shield including 1" air gap.

4.7.4 Heat exchanger:

4.7.4.1 Minimum distance between ducting and combustible wall shall be 6".

4.7.4.2 ~~Heat tolerant fabric shall be used for all seating surfaces.~~ Any fabric used for seating surfaces shall be heat tolerant.

5 Inspections

5.1 Inspection Points for Rocket Mass Heater Installation:

The main inspection should be performed after combustion unit, ducting, and exhaust have been installed, and while ducting is still exposed.

5.1.1 Confirm measurements:

Ratio of heat riser to burn tunnel and heat riser:

____Heat riser is about twice the length of the burn tunnel, or taller

____Heat riser is about three times the height of the feed tube, or taller

Cross sectional areas:

____Consistent cross sectional area throughout system except barrel, manifold, and possible 1" decrease in final third of flue.

5.1.2 Confirm clearances:

____*EITHER* ____36" from all barrel surfaces to combustibles.
OR: ____18" from all barrel surfaces to heat shields with a 1" air gap.

____4" from combustion base to all combustibles

____Room for sufficient masonry thickness around ducting.

5.1.3 Confirm maintenance elements:

____Cleanouts provide access to manifold, ducting, and exhaust.

____Exhaust outlet is properly installed, AND
____ protected from elements and vermin.

____Maintenance and operation manual is in good order, with accurate as-built drawing(s).

5.1.4 Confirm structural elements:

____Foundation appears sufficient to support final installation (4" slab or engineered footing).

____Suitable earthen and/or refractory materials are being used.

5.1.5 *Inspector may request that Rocket Mass Heater be fired. If so:*

____Confirm proper drafting.

5.2 Inspection Points for Completed Rocket Mass Heater

For a previously completed or engineered installation, the following may be used:

5.2.1

____Confirm measurements, clearances, maintenance and structural elements, as above.

5.2.2 Confirm masonry integrity:

____Masonry thickness around ducting conforms to minimum standards (3-6" or more).

____No cracks apparent in casing or visible masonry.

____Casing materials are compatible with thermal core. (No cement stucco over earthen masonry).

5.2.3 Request that Rocket Mass Heater be fired. *If possible, have applicants fire their heater the day before inspection, and then again in the presence of the inspector, to simulate normal operations.*

5.2.4 Confirm performance:

____Draft and seals function properly; no indoor smoke observed.

____Exterior exhaust appears clean (white or transparent)

____Surface temperatures are within tolerances (Safe to touch, except barrel and fuel feed).

5.2.5 Check any special features:

Installations may include __Heat shield(s), __Exhaust chimney, ____Bypass valve, __Gaskets/expansion joints, __Structural reinforcements, or ____Other features.

Confirm that features

Confirm that features

____Conform to as-built drawings.

____Appear to be properly installed and functional.

~~Inspection Points:~~

~~An inspection should be performed after ducting has been installed and while it is still exposed~~

~~Confirm measurements:~~

~~1. Proper ratio of heat riser to burn tunnel and heat riser.~~

~~2. heat riser is twice the length of the burn tunnel~~

~~3. heat riser is three times the height of the feed tube~~

~~4. Confirm proper cross sectional areas.~~

~~5. Consistent cross sectional area throughout system except barrel, manifold, and possible 1" decrease in final third of flue~~

~~6. Confirm clearances~~

~~7. 36" from all barrel surfaces to combustibles.~~

~~8. 18" from all barrel surfaces to heat shields with a 1" air gap.~~

~~9. 4" from combustion base to all combustibles~~

~~10. Room for sufficient masonry thickness around ducting.~~

~~11. Confirm suitable footing and foundation.~~

~~12. Confirm appropriate cleanouts.~~

~~13. Confirm exhaust flue is protected from elements and vermin.~~

~~14. Confirm existence and orderliness of maintenance and operation manual.~~

~~Inspector may request that Rocket mass heater be fired.~~

~~If so: Confirm proper drafting.~~

www.ErnieAndErica.info