THE GAS FIRED POTTERY KILN
DESIGN AND USE FOR SCHOOLS

By

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ABSTRACT

At the time of publication of this thesis little if any reliable technical data was available on the design, construction and operation of gas fired pottery kilns. A few publications have some information but for the most part very little information on the proportional relationships of the various aspects of gas kiln designs are available. If one was to use only the information available in previous publications, inefficient, unsafe and illegally built kilns could easily be manufactured. Students, teachers and various public institutions are finding it necessary to design, build and operate gas kilns to fulfill the education of their students or fully explain the traditional methods of combustion firing and its unique results. It becomes more apparent that guidelines are necessary so that an efficient, safe and inexpensive kiln can be built and utilized without hampering the usefulness of a variety of designs available.

This search for information about kiln design and construction had two main directions, the author consulted authorities having jurisdiction over gas kilns in British Columbia and Alberta and secondly he built and tested kilns using the data collected. These two sources of information were compared in relevant locations to publications available up to publication time. For the most part the investigation into kiln operation comes from informal instruction

from a number of successful kiln builders and operators and provincial gas inspectors.

It has been the researcher's finding that there is a very strong indication that the parameters given are a reliable and useful guide to safe, efficient and pollution controlled kiln design. The main parts of kiln design seem to be dimensional and dynamically interrelated and the parameters of design have shown a very high improvement in efficiency and pollution control which are important benefits.

The dynamics of kiln design are only preliminary and broad in this thesis. Much more could be done with closer testing using more elaborate equipment and controls and with the guidelines used from this paper and further investigation even further improvements in design parameters may improve the efficiency and safety of future kilns.

This thesis is designed to serve as a handbook which is the result of applied research. The thesis is set out in three parts. A brief essay establishing a rational for having a gas kiln, the model for designing a gas fired pottery kiln, and lastly examples of research and kiln firing logs from kilns designed using the model.

Methods of construction, brick laying, application of insulation and arch construction are not covered in this paper as they are well covered in the Olsen and Rhodes books. (see bibliography)

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ACKNOWLEDGEMENT

I should like to thank all the artists, craftsmen, inspectors, and engineers who have assisted me with this paper. Specifically Stan Clarke, and Jim Clachrie, who are so helpful and generous with advice and assistance, Mr. W.R. Montgomery of the Provincial Gas Authority, and the many anonimous kiln owners who submitted their efforts to tests. Lastly, I should like to thank the far sighted, patient, master educator and friend Sam Black for his constant encouragement and assistance, and Graeme Chalmers for his patient understanding and helpful corrections to content and format.

INTRODUCTION

The purpose of this thesis is to show by use of a model a method of designing a safe, efficient and useful gas kiln that will meet the needs of most schools. The model used will also serve to assist in designing any gas or propane fired pottery kiln. Recommended proceedures, authorities and inspectors will be listed for the province of British Columbia up to the time of publication.

It is hoped that this thesis will serve as a guide to those who want to design, build and operate an efficient, safe and pollution controlled gas kiln. Further it is hoped that this thesis will show that gas kilns are a necessary part of a school ceramic education and that in future schools will consider including the use of a gas kiln as an integral part of their education program.

It is not intended in this paper to place all types of kiln information and operation, but rather to restrict the information to modern materials for gas and propane kiln construction and to compliment already published references listed in the Bibliography.

BEFORE EMBARKING ON THIS VENTURE CONSIDER: WHY A GAS KILN?

A gas kiln has many advantages for firing ceramics, but these and the disadvantages must be considered wisely before beginning construction. A gas kiln is a big investment of time, money and responsibility. A gas kiln requires a vast input of energy on the part of the person interested in acquiring it. In most cases there is little if any reliable information as to the requirements, cost and liabilities. Each kiln is an adventure in design and will have its own unique requirements and characteristics. Each requirement must be met with an investment in time and energy to find adequate answers to these problems.

If you plan to use a gas kiln to escape the tedium of firing small electric kilns each day consider that a gas kiln requires much more adjustment and skill to fire than modern electric kilns. In fact only after several firings can results be determinable and controlled.

I believe that it is this very natural phenomenon of not being in full control of results that makes firing a kiln an integral philosophical part of the ceramic process. "To a craftsman it is more important to know what works well than it is to know in precise detail why it works well. Nevertheless it would be absurd for any craftsman today not to take advantage of the results of modern scientific research."[(1)]

The modern artist craftsman should learn to work with the natural process, not to always dominate and impose their will. In art giving up the full control insures the advent of the happy accident that plays such an important part in the generation of new and creative ideas. The loss of such aspects in art would insure dull and monotonous production of works.

"The beauty to which the Sung potters attained was far beyond the highest that from its beginnings in Josiah Wedgewood the English potters ever aimed at."[2]

The beauty Bernard Leach speaks of can be easily contributed to the pursuit of results. The basis upon which artist-craftsmen pursue their goals is for the most part summed up in these lines. Artist-craftsmen and their students should come in contact with the essential experience of working with one of the primary elements of the ceramic process. Fire was and still remains a primary process of the ceramic experience and it is with modern gas that this experience can be easily obtained. The process of firing ceramics can be, and perhaps is, being lost like the craftmanship of the Sung potters to the ease and reliable results of electrical heating.

The organic beauty of fired ceramics cannot be favourably compared to the results of electrical heating. The lusters, reduction spots, colours and toasted look of fired ceramics has that mystical look of having been touched by nature. The essential experiences of a process can be easily denied a generation of learners because of convenience and simplicity and the heritage of generations is lost never to be attained again.

The knowledge of gas firing has also one very strong scientific lesson that cannot be attained without a combustion atmosphere. The chemistry of reduction atmosphere firing cannot be fully experienced or illustrated without a combustion type kiln. The theory can be explained easily but the process must be experienced, learned and practiced before it can be safely or properly done. One of the major concerns of modern gas engineers is the concern that reduction firing be safely and efficiently done so that very little pollution from such firing is generated. Without proper "hands-on" instruction this practice cannot be carried out. There is little if any equipment to control or guage reduction firing and it is far beyond the financial means of most ceramic artists. This situation leads one to the realization that a good number of artist-craftsmen place themselves and others in a high degree of health hazard by reduction firing improperly or in poorly designed kilns. These kilns and operators are polluting the atmosphere far beyond the necessary requirements for a quality reduction firing.

Gas kilns have one final but clear advantage and that is of being able to attain much higher temperatures than electrical kilns. The advantages of higher fired ceramics are many. The main advantage being able to avoid the use of toxic and carcinogenic compounds found in low temperature glazes. These hazardous compounds are almost unavoidable at low temperatures and are certainly key elements in creating a full spectrum of colours in glazes at this temperature. The higher temperature glazes avoid the use of most toxic chemicals because other safer chemicals replace their function in the ceramic glaze formula.

The knowledge and experience of working with high temperatures in clay and glazes insures a strong basic knowledge that is quickly becoming required by modern artist-craftsmen. Gas kilns are the modern tool that allows these essential experiences to be obtained and such experiences should be learned early when the students are easily available and able to learn the processes necessary. Leaving such learning to later ensures that fewer students would learn the important elements and it would insure that more students would go on in ceramics perhaps even with a gas kiln perpetuating the pollution and unsafe firing habits of the unskilled. Such dangers cannot be overlooked in an age when people are turning to gas kilns in ever growing numbers. It is the time to provide the education necessary to insure that the next generation of potters and artist-craftsmen are properly trained in modern techniques and processes.

Those who create art works must make every attempt to generate better standards by setting an example to be compared to, and practised so that students can measure their personal efforts, the efforts of their culture and the efforts of their ancestors so that they can draw conclusions as to their contribution and place in society.

We as artist-craftsmen must show that the ceramic process although complex has very important artistic, scientific and cultural significance and that by ignoring or substituting inadequate systems our society will be the lesser because of it. We must see that safe, reliable and useful systems are made available to students and that research and training provide a continuing responsibility that is earned and rewarded by an ongoing artistically and culturally gifted society.

THE MODEL FOR DESIGNING A KILN.

ADAPTED FROM RESEARCH BY JIM CLACHERIE

BOOKS OF DANIEL RHODES AND FRED OLSEN

AND RESEARCH ON KILNS IN BRITISH COLUMBIA

BY THE AUTHOR.

BASIC DESIGN IN KILN PROPORTIONS.

Studies in both Alberta and British Columbia have shown a strong reliability in the use of design proportions and specifications. These guidelines should be helpful to anyone who wishes to design efficient, safe and useful kilns. The proportionally designed kiln is not the only kiln design that will work. Almost any chamber with sufficient heat could suffice for a kiln. A survey of kilns simply points out proportional guidelines used in efficient, safe and useful kilns. These guidelines should help in serving as starting points for the future.

The concepts of kiln proportion are practically as old as kilns themselves. Kilns designed in the Orient and Europe in very early times were designed proportionally as Rhodes in "Kiln Design and Operation"[3] and Olsen in "The Kiln Book"[4] point out. The relationships and proportions in modern gas kilns are very different from the wood and straw kilns of these ancient designs. The spaces required for combustion are probably the most significantly noticeable difference. In fact the proportions are probably different for each fuel used but for our purposes the proportions for gas and propane shall be the same.

Proportional design is derived at by comparing sizes and relationships in kilns that operate more efficiently and with ease in obtaining most of the desirable effects. Secondly, designs of similar gas fired equipment can give efficiency and proportion information that will make for comparison of the essential requirements. The following guidelines are proportional in nature and should provide a basic starting point for designing a kiln that has been found to be safe, efficient, and economical by the author and many other kiln building enthusiasts. Throughout the guidelines section reference to resources are made to point out the variables and boundaries from which better designs can be adapted.

LOCATING THE KILN.

1. ZONING REGULATIONS AND BY-LAWS FOR THE LOCATION OF YOUR KILN.
2. PROXIMITY AND HEIGHT OF ALL TALL BUILDINGS, TREES OR BARRIERS.
3. ELEVATION AND DRAINAGE OF LAND.
4. PREVAILING WIND DIRECTION.
5. PROXIMITY OF THE CHIMNEY OUTLET TO WINDOWS AND AIR INTAKES INTO NEARBY BUILDINGS.
6. THE GAS SOURCE.
7. A SEPARATE KILN AND WORK AREA.
8. VENTILATION OF KILN AREA.
9. ACCESS FOR SERVICE AND CLEARANCE FOR SAFETY.
10. VANDALISM AND CURIOSITY SEEKER CONTROL AND SAFETY.

The first and final authority having jurisdiction in your kiln building should be the building and gas inspector for gas and the fire marshal for propane. Check and make sure you have all the AUTHORITIES HAVING JURISDICTION listed and checked with before proceeding with any construction.

In any of my kiln building experiences and in the vast majority of research I have found that the inspectors were interested and helpful rather than obstructive and bureaucratic. This is somewhat the case because many inspectors have not seen kilns or have any guidelines or regulations regarding them. This is convenient for the potter who wants room for creativity in his design but this can create problems for that inspector and future gas kiln enthusiasts if the creativity leads to a kiln producing pollution and obvious safety hazards.

Be sure you meet all the requirements for zoning in the area you plan to build. If the kiln will be a hobby you should not have any difficulty in a residential area, if the kiln is part of a business venture or at a school then different requirements will have to be met for workers compensation and fire safety. Remember it is better to meet or surpass requirements and be INSURED for safety's sake. After collecting data like safety codes and by-laws draw up a design using the guidelines provided and submit it for inspection and approval.

INDOOR VS. OUTDOOR.

Kilns have specifications as to outdoor or indoor classifications. An outdoor kiln is defined as a kiln that is exposed to the elements or is installed in an unoccupied building that is used solely for the purpose of its protection from the elements.

Kilns totally exposed to the elements tend to be less useful, less efficient and more costly to operate and maintain. Any kiln that is exposed is difficult to load and fire during rain and snow. This causes delay and can cost both hobbiest and professional a great deal of replanning and expense.

When considering an outdoor kiln the concept of ambient temperature and heat loss due to wind is a very important factor. When a kiln has a roof but is still exposed to wind, the heat loss due to prevailing wind can be an important factor.

WIND VELOCITY IN M.P.H.	HEAT LOSS IN B.T.U. PER SQ. FT.
0	420
10	1040
20	1620

The chart above illustrates the effect that wind has on heat loss from a kiln wall at 40 degrees F. outdoor temperature and with a kiln wall outside temperature of 220 degrees F.

Note that the heat loss at 20 M.P.H. is almost four times as high as that with no wind. It is therefore good economy to protect the outdoor kiln from winds and to insulate the walls of the kiln very well.

One must also consider brick damage due to moisture and frost. Decomposition of brick and insulation not to mention oxidation of metal parts like burners is also substantial on exposed equipment. The cost of maintaining a fully exposed kiln in a climate of strong changes is substantial enough to warrant the cost of enclosing it.

There is one last argument against the exposed kiln. The firing kiln is treated similarly to a swimming pool under the law. They are considered "attractive hazards" and are a liability if not properly protected. Should a child or animal be severely or mortally burned by making contact with your unprotected kiln you may be held responsible for such a misfortune. Kilns are very attractive and extremely hazardous and curiosity seekers can do a great deal of damage to both themselves and the kiln.

Kilns should be housed in a building designed expressly for the purpose and separate from all other buildings. This building or kiln shed should be close to the ceramics studio and source of gas and should meet all requirements of the building inspector. A small metal garden shed makes an excellent kiln shed with only a few minor adjustments needed. Any other building made fire resistant to the required specifications and with proper ventilation would suffice. (see Building Codes in Appendix)

CHOOSING KILN BUILDING MATERIALS.

A kiln is a machine which, like a home, will require more fuel and money to heat the less insulation you have. It is truly false economy to avoid the expense of insulation in kiln building. With modern insulation brick, block insulation and fiber blankets the use of four to nine inces of hard brick is simply out of date and expensive.

Using re-cycled material will slow down building time and on occasion cost you more in time, effort and re-build expense than you will save. Hard fire brick decomposes with each firing and as bricks reach their maturity they will decompose fairly quickly. Used brick will almost surely be mixed in temperature rating and it is almost impossible to find out the rating of used brick. Needless to say it would be disasterous to build a gas kiln designed to fire to 2400 degrees F. and have built in some 1800 degree F. brick that would melt or give way at this temperature.

A gas kiln should be considered as investment from which a reasonable return should be expected. As in all investments your return will be in direct association with what you invest. Kilns should be invested in heavily expecially if you are expecting to get any returns by selling your product to regain the investment. Secondly if you plan to utilize the kiln in a school or teaching situation you must consider that any loss of product by students due to poor kiln design and operation will only show your lack of knowledge and professionalism and that any poor design characteristics and firing habits will be passed on to your students.

When choosing kiln building materials several important factors should be considered. Durability, insulation factor, and heat retention factor. With modern fiber insulations it is possible to build a kiln very light in weight, with good insulation, but with little or not sufficient heat retention.

This type of kiln will cool down much too quickly because although there is sufficient insulation there is no heat retention. That is only the wares are getting heated, the insulation does not absorb heat, it is designed to keep it in, therefore the wares lose their heat as quickly as the insulation will permit. This seems to be much quicker than is good for the wares(4). Kiln designs should be designed for slow cooling. The cooling of fiber type kilns can be slowed by cutting back slowly on the gas during the cooling cycle, but this practice takes more time on the part of the operator and a great deal more money to provide for the gas.

There seems to be a balance of insulation factor, heat retention and heat that makes for an efficient kiln design. The insulation factor is best worked out by comparing various insulation methods to hard brick. This gives the hard brick equivalent. (see H.B.E. page) By comparing various kilns it has been found that efficient kilns have walls of between thirty and forty-five inches of hard brick equivalence in insulation. Heat retention seems to be mostly found in kilns where some insulation brick or hardbrick is used. I would suspect that a design that has materials used in it that absorb the heat like brick will have better heat retention. I suspect that the ratio, although this is more of a guess, is approximately that fifty per cent of the kiln construction by volume should be brick and this brick should be exposed to the flame. When I speak of brick I mean both insulating and hard brick.

To be practical I believe that a kiln should not be built entirely of a thin layer of hard brick or insulating blankets as it will not retain the heat. A balance of both seems to be most efficient and economical. (see Suggested Kiln Wall Combinations page)

THE METHOD OF DETERMINING HARD BRICK EQUIVALENTS (H.B.E.)

The accepted measure of thermal insulating ability is thermal conductivity. Thermal conductivity is the measure of heat flow in BTU (British Thermal Units) through a material per inch of thickness. It can be seen therefore that the thermal conductivity (k) varies as the temperature on the sides increases. Most manufacturers specifications show the (k) by a line at various temperatures up to a maximum recommended temperature for the product. For example, the (k) of hard brick is 10.2 at 2000 degrees, 11.1 at 2400 degrees. From the (k) factors it can be determined that the insulating property of 1" of No. 26 insulating brick is equivalent to 3.7" of hard firebrick. By comparing the "K" factor of the various materials to that of hard brick the hard brick equivalent (H.B.E.) is obtained and is a convenient means of comparing insulating properties. The "K" factor and thus the H.B.E. vary according to the mean or average temperature of the material. It would therefore be impractical in a paper of this size and simplicity, to attempt to list the H.B.E. rating for each material at all possible mean temperatures. For reasons of space and simplicity also; products of similar properties by different manufacturers have been grouped together and their H.B.E. averaged. As all temperatures shown can only be an approximation, we believe the resulting error will be of little significance.

The table marked APPROXIMATE REFRACTORY EQUIVALENTS lists some of the more commonly used refractories and insulations and their approximate average hard brick equivalents (H.B.E.) per inch of thickness. All other required H.B.E. can be determined by using the method described.[5]

APPROXIMATE REFRACTORY EQUIVALENTS

CLASSIFICATION AND SERVICE TEMPERATURE	CANADIAN REFRACTORIES	A.P. GREEN	PLIBRICO	APPROXIMATE HARD BRICK EQUIVALENT PER INCH THICKNESS
3000° INTERMEDIATE HARD BRICK	CLAYBURN	DEFCO	CLAYBURN	1"
2800° INSULATING FIRE BRICK No.28	H W 28	G28	GR28	2.85"
2600° INSULATING FIRE BRICK No.26	H W 26	G26	GR26	3.7"
2400° INSULATING CASTABLE	DUROLITE 24	KAST-O-LITE	PLICAST	3.6"
2300° INSULATING FIRE BRICK No.23	H W 23	G23	GR23	5.5"
2000° INSULATING FIRE BRICK No.20	H W 20	G20	GR20	5.7"
2000°-2200° CASTABLE INSULATION	DUROLITE 22	CAST. INSUL. 20	PLICAST	5.5"
1600°-1800° CASTABLE INSULATION	NOVALITE	CASTABLE BLOCK	VERILITE	8.5"
CLASSIFICATION	A.P. GREEN & PLIBRICO	STEELE BROS. & CANADIAN REF.		
FIBROUS BLANKET 2300°	FIBERFRAX	KAOWOOL		3.4"
CLASSIFICATION	JOHNS MANSVILLE	A.P. GREEN	PLIBRICO	
BLOCK INSULATION	THERMOBESTOUS (1200°)	BLOCK IN. 1900	BLOCK 201	10.5"
CLASSIFICATION	ZONOLITE	CANADIAN REFRACTORIES		
2000°-2200° VERMICULITE LOOSE FILL INSULATION	ZONOLITE VERMICULITE	MICALITE VERMICULITE		6"

The list below gives some of the practical combinations of refractories and insulations from the previous page, and their approximate total H.B.E. shown, has been arrived at by averaging the "K" factor from three manufacturers specific-ations, and therefore, may not agree with the specifications shown by any one manufacturer. The type of refractory must be decided upon according to its temperature use, type of glaz-ing, lenght of life desired, and cost. It is wise in this regard, to ask the advice of instructors, experienced potters and suppliers. This is particularly true when using materials not listed or experimental designs. This is especially true in cases such as salt glazing, where a high duty type of hard brick must be used in order to obtain a reasonable kiln life. Once the refractory and total wall thickness has been decided upon, you are ready to design the wall and roof, or to check the coldface and interface temperature within the limits of the materials menthoned in this paper.

REFRACTORY	H.B.E. PLUS INSULATION		H.B.E.	H.B.E. TOTAL
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	None	0.0"	16.6"
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	1" Block Insul.	10.5"	27.1"
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	2" Block Insul.	21.0"	37.6"
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	$4\frac{1}{2}$" #20 Ins. Brick	25.6"	42.2"
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	3" 1600°-1800°cast. Insulation	25.5"	42.1"
$4\frac{1}{2}$" #26 Insul. Brick	16.6"	$4\frac{1}{2}$" Zonolite	27.0"	43.6"
$4\frac{1}{2}$" #28 Insul. Brick	12.8"	$4\frac{1}{2}$" #20 Insul. Br.	25.6"	38.4"
$4\frac{1}{2}$" Hard Brick	4.5"	$4\frac{1}{2}$" #20 Insul. Br.	25.6"	31.1"
$4\frac{1}{2}$" Hard Brick	4.5"	5" 2000°-2200°cast.	27.5"	32.0"
$4\frac{1}{2}$" Hard Brick	4.5"	$4\frac{1}{2}$" Zono.+4" Com. Brick	4.0"	35.5"
$4\frac{1}{2}$" 2400°-2500° Castable	16.2"	3" 1600°-1800° Castable	25.5"	41.7"

Cold Face Temperatures

A good kiln should have a H.B.E. wall thickness of about 32" or more. The table below gives the approximate coldface or outside temperatures when firing to cone 9 or 2400°F. The temperatures shown are based on manufacturers specifications, although the temperatures may appear high, it is hardly feasable to reduce them further by the use of relatively expensive insulation. By application of foil covered fiberglass, or other low priced insulations, the temperature may be reduced very inexpensively.

APPROXIMATE COLD FACE TEMPERATURES

TOTAL H.B.E.	APPROXIMATE COLD FACE TEMPERATURES
30	292°F.
32	282°F.
34	274°F.
36	266°F.
38	260°F.
40	253°F.
42	246°F.

HOW BIG SHOULD A KILN BE?

When one begins to choose the type of kiln the consideration as to the size becomes very important. What is meant by size is the useable space in a kiln for stacking wares. This space is important for the amount of wares to be loaded, the size of these wares and the type of wares produced. For the individual potter the decision may be easy but when designing a kiln for schools one must take into account the more diversified requirements of such a program. The following is a simple outline to assist in estimating kiln size requirements.

A SIMPLE METHOD OF DETERMINING KILN SIZE REQUIREMENTS

1. Determine max. and min. sizes of product to be fired. Estimate in cu. ft.

2. Determine amount of product between possible firing and re-cycle times. Multiply by cu. ft.

3. Estimate the number of uses of a kiln that are desirable. Example - sculpture, porcelain, temps. etc.

A FEW MODEST SUGGESTIONS:

All too often kilns are designed far too large or small. A kiln that meets the happy medium is one that does not require the potter to labour to fill it or to spend a great deal of time firing to keep up with production. In the vast majority of kilns for the part-time producer the size is in the 18-24 cu. ft. range. For the professional and school the range is much more diversified but seems to be in the above 50 cu. ft. range. Research does not support the theory that

I feel seems to prevail. A kiln needs to be twice or more as big as another if it is to be significantly larger. This in part is due to the longer re-cycle times needed by these intermediate sized kilns.

TAKE INTO CONSIDERATION ALL OF THE FACTORS OF THE PREVIOUS PAGE AND THE SUGGESTIONS OF THIS PAGE BEFORE DESIGNING . . . .

From these estimations calculate the amount of space needed between a weekly, bi-weekly or monthly firing schedule. Consider in your estimation of production bisquing, glazing and trimming times. Plus any marketing or studio management routines. In schools these tasks must not be overlooked.

For most school situations and hobbiests the 18-24 cu. ft. size is sufficient. This size of kiln gives a firing time of 8 hours and a 24-36 hour re-cycle time (meaning cool down, emptying and restacking time). This size is convenient for firing during a work day and also re-cycles quickly enough for 2 or more loads per week. A kiln one-third larger will require up to 100% longer to re-cycle and will therefore not be as useful or provide as much efficiency in the long run. Larger kilns, however, do allow for firing larger products and are useful in firing large amounts of products in production areas where they are designed to fit the kiln space provided.

INTERFACE TEMPERATURES

The interface temperature is the temperature at the point between the outside of the refractory and the inside surface of the insulation. This temperature must be known in order to choose the right insulation for the refractory and the wall thickness to be used. The interface temperature is dependent on several factors, such as:

a) The hot face temperature.
b) The refractory thermal conductivity and thickness.
c) The insulation thermal conductivity and thickness.
d) The ambient temperature and wind velocity.

All of these factors work together to decide both the cold face and interface temperature. The higher the hot face temperature; the higher the interface and cold face temperature. The greater the refractory thickness or the lower the thermal conductivity; the lower the interface and cold face temperature. The greater the insulation thickness or the lower the thermal conductivity; the higher the interface temperature and the lower the cold face temperature. The lower the ambient temperature and the greater the wind velocity; the lower the interface and cold face temperature.

The following table gives the interface temperatures for various H.B.E. wall thicknesses when using hard firebrick, No. 26 or No. 28 insulating firebrick. As the H.B.E. of 2400^{o}-2500^{o} castable refractory and fibrous ceramic blanket is close to that of No. 26, the same column can be used.

INTERFACE TEMPERATURES

TOTAL HARD BRICK EQUIV.	INTERFACE TEMPERATURES		
	4½" HARD BRICK	4½" NO. 26 INSUL.	4½" NO. 28 INSUL.
30	2160°F	1360°F	1625°F
31	2170°F	1440°F	1670°F
32	2175°F	1490°F	1710°F
33	2180°F	1515°F	1740°F
34	2190°F	1530°F	1750°F
35	2195°F	1550°F	1760°F
36	2200°F	1590°F	1725°F
38	2204°F	1630°F	1820°F
40	2210°F	1680°F	1850°F
42	2215°F	1725°F	1875°F

NATURAL GAS OR PROPANE?

There are two types of gas used in most kilns, natural gas that comes piped into the house or studio, and bottled propane. Natural gas has the advantage of convenience and lower price, while propane has less regulation and more flexibility.

Natural gas has two basic distribution systems. In some areas the older low pressure system (4 ounces or 7" water column) is still in use. The main is controlled by a district regulator and the line to your house or studio is sized to handle that load. The line from the main would have to be changed to accommodate the kiln. This would be an expensive venture.

In most areas a system of higher pressure, 10-15 p.s.i., is regulated down to 4 ounces just before the meter. In this case a line can be attached before the regulator and taken to your kiln site for a second meter or a larger meter with a larger gas line can be installed where the existing meter is. Which system you choose becomes a matter of which is more economical for your situation. The gas company will be glad to assist you.

Where no gas lines exist, or where the expense is prohibitive, propane becomes the more economical system. The use of propane also incurs less permanent fixtures and indeed can be fully portable. This convenience makes propane attractive to the studio, or school situation that cannot provide the permanent protection a kiln needs or to those who have only a small kiln and gas requirement.

When you are designing your kiln make sure you consider that natural gas and propane have very different characteristics. The effects manifest themselves in two simple ways.

Gas burners for natural gas must not be placed upside-down due to the fact that natural gas is lighter than air and it causes problems for the proper function of the burner.

NATURAL GAS	PROPANE
- CLEAR ALMOST ODORLESS (Has added odorant for safety)	- CLEAR ALMOST ODORLESS (Has added odorant)
- CONSIDERED NON-TOXIC	- CONSIDERED NON-TOXIC
- B.T.U. PER CU. FT. 1000	- B.T.U. PER CU. FT. OF GAS 2450
-	- B.T.U. PER IMP. GAL. OF LIQUID 110,000
-	- WEIGHT PER IMP. GAL. OF LIQUID 5.1 POUNDS
- SPECIFIC GRAVITY OF GAS .6 (AIR 1.0)	- SPECIFIC GRAVITY OF GAS 1.5 (AIR 1.0)
-	- SPECIFIC GRAVITY OF LIQUID .51 (WATER 1.0)
-	- LOWER AND UPPER LIMITS OF FLAMMABILITY 2.15%-9.5%
-	- BOILING POINT -44°F or -42°C
- 10 CU. FT. OF AIR TO BURN 1 CU. FT. OF GAS	- 24 CU. FT. OF AIR TO BURN 1 CU. FT. OF GAS
-	- 43.6 CU. FT. OF AIR TO BURN 1 IMP. GAL. OF LIQUID
- IGNITION TEMPERATURE 650°C	- IGNITION TEMPERATURE 650°C
- FLAME TEMPERATURE 1879°C	- FLAME TEMPERATURE 1924°C

BEFORE DECIDING ON PROPANE

A propane tank holds liquid propane which boils into a gas form at -44°F. This gas form of propane is drawn off through a pressure regulator to the burners of the kiln. When the gas (which is normally under pressure from the expansion of the gas transformation) is drawn off it is replaced from the liquid in the tank by the boiling process described. This causes the liquid propane to cool slightly. As the demand for propane increases the refridgeration type cooling also increases. If too small a tank is used for the demand required the liquid in the tank may freeze causing a loss of gas pressure and heat required.

NOTE: APPLYING HEAT TO A PROPANE STORAGE TANK BY ANY UNAPPROVED MEANS TO INCREASE VAPOURIZATION, IS A DANGEROUS PRACTISE AND SHOULD NOT BE CARRIED OUT UNDER ANY CIRCUMSTANCES.

To reduce or eliminate the freezing problem proper tank sizes to fit the demand must be considered along with the ambient temperatures of the area in which the tanks will operate. Any propane dealer should be able to solve this problem.

THE CHART LISTED ON THE NEXT PAGE SHOULD HELP YOU IN DETERMINING THE SIZE OF TANK NECESSARY TO FIT YOUR NEEDS.

SUSTAINED AMBIENT TEMP. DEGREES FAHREN.	STANDARD UPRIGHT 100 LBS. ICC CONTAINER	STANDARD UPRIGHT 420 LBS. ICC CONTAINER	AVERAGE HORIZON 499 WATER GAL. CAP. CONTAINER	AVERAGE HORIZON 995 WATER GAL. CAP. CONTAINER
-40	2,300	5,400	27,300	50,200
-30	8,200	19,200	95,700	125,500
-20	14,000	32,900	164,100	201,900
-10	19,900	46,600	232,500	427,600
0	25,800	63,000	300,800	553,600
10	31,700	74,126	369,200	679,400
20	37,500	87,800	437,600	805,200
30	43,400	101,600	506,000	931,100
40	49,300	115,300	574,400	1,056,900
50	55,100	129,000	642,800	1,182,700
60	61,900	142,700	711,200	1,308,622
70	66,900	156,500	779,500	1,434,400
80	72,700	170,200	847,900	1,560,200

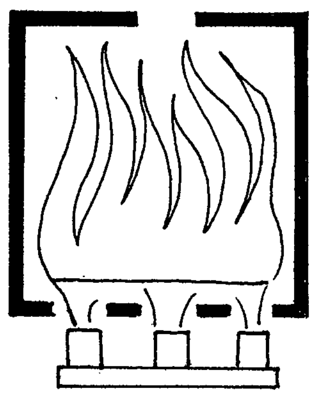
FIND SUSTAINED AMBIENT TEMPERATURE THAT KILN IS LIKELY TO OPERATE IN. FIND B.T.U.s NEEDED TO OPERATE KILN. LOCATE TANK SIZE CONTAINER.

SIZE AND TYPE OF KILN

When one begins to design a kiln several biases and desires seem to arise. The shape and size of kiln and the type of draft. The arguements continue in several areas, but simply put the choice is a matter of differing uses, demands and costs. The following descriptions, comparisons and analysis of kilns is designed to point out some of these biases.

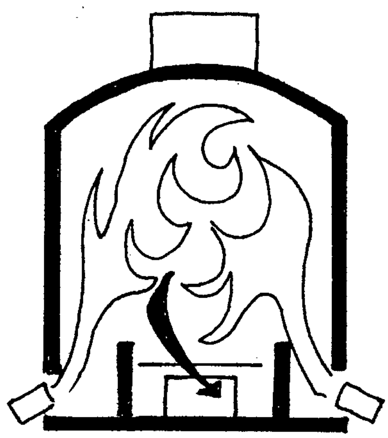
THE UPDRAFT KILN

- ECONOMICAL TO BUILD. HAS A GOOD USABLE SPACE VS. SIZE RATIO.
- REQUIRES A HOOD TO COLLECT HEAT TO DISPURSE OUTSIDE.
- CAN BE DANGEROUS DUE TO CO GETTING INTO KILN SHED.
- TENDENCY TO HEAT UNEVENLY.
- TENDENCY TO HAVE POOR REDUCTION.



THE DOWNDRAFT KILN

- MORE DIFFICULT TO BUILD
- SEEMS TO GET MORE USE OUT OF HEAT INPUT.
- EVEN HEATING.
- STRONGER REDUCTION TENDENCY
- CAN TRAP GAS IN CHAMBER IN A FLAMEOUT AND EXPLODE IF IGNITED.
- COSTLY USABLE SPACE VS. SIZE

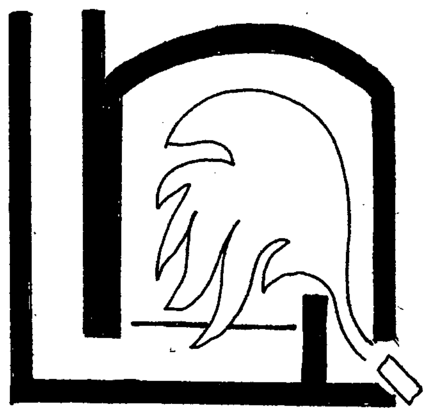


SIZE AND TYPE OF KILN

Although there are many other kiln designs used in kiln construction these are the basic shapes. The use of various arch styles and domes can be obtained, but exotic designs tend to take more time and materials to execute, and little if any advantage is gained. The main advantages of the two types of kilns shown here are economics and space ratio.

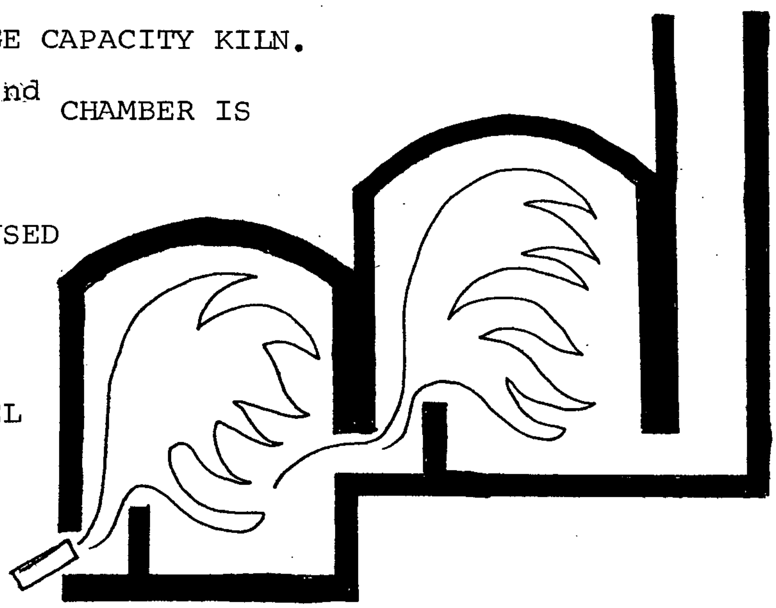
THE CROSS DRAFT KILN

- A GOOD USABLE SPACE VS. TOTAL KILN VOLUMN DESIGN.
- A GOOD DESIGN FOR SMALL KILNS
- TENDS TO FIRE UNEVENLY.



THE CLIMBING CHAMBER KILN

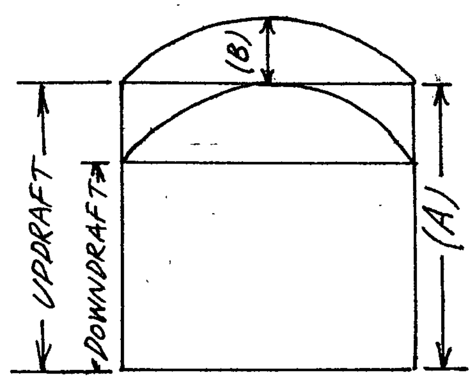
- MOST ECONOMICAL LARGE CAPACITY KILN.
- CAN BE DESIGNED SO 2nd CHAMBER IS UPDRAFT.
- 2nd CHAMBER CAN BE USED FOR BISQUE OR GLAZE.
- FIRES EVENLY.
- GETS GOOD USE OF FUEL DUE TO 2nd CHAMBER.



BASIC DESIGN IN GAS KILNS. CHAMBER SHAPE

On this point almost all designers agree. The most efficient shape to heat is a cube. That is height equals width equals length. There are slight variations to this rule to allow for efficient use of materials shapes and to eliminate needless cutting and waste of refractories. For the most part remain as closely to a cube interior shape as you can.

"A CUBE IS THE BEST ALL ROUND SHAPE FOR A KILN. When thinking of the kiln as a cube shape, the best design for an updraft kiln is with the arch on top of the cube and not contained within. Increasing the height of the cube chamber with a fixed width, decreases the efficiency of firing with an even temperature throughout the kiln. Increasing the length of the cube has no effect on the even firing efficiency of the kiln, hence the developement of tunnel kilns, and other long tube type kilns used commercially.



It is generally accepted that the kiln (inside total) should be roughly a cube in proportion".(6) It is also best to keep all dimensions to functions of 9" or 4½" (1 brick or ½ brick) in width and depth, and in height to functions of 2½".

DETERMINING THE VOLUME WITHIN A SPRUNG ARCH

Since most designs of kilns use a sprung arch for the roof design and since this shape seems to add efficiency to both the directioning of the flame and the transfer of heat, a method of determining the volumn within a sprung arch is necessary if accurate measurement of volumns is to be made. Since the formula for determining the volumn within a sprung arch is quite complicated, Jim Clacherie recommends the following simplified estimate. For the height, take the height to the edge of the arch (A), to this add 2/3 of the rise (B).

(see above chart)

THE CATERNARY ARCH

The caternary arch has many advantages in kiln design. The arch creates a smooth flowing direction that gently directs both flame and heat. This in turn creates a minimum of disturbance, making the firing of a kiln a little more efficient. The arch also seems to create a shape that makes heat and flame rise and transfer more efficient.

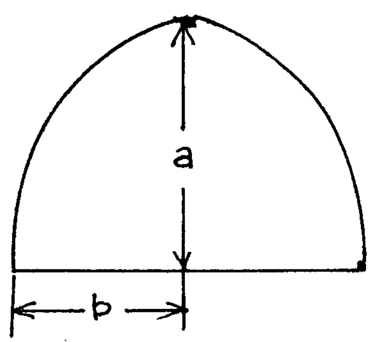
The caternary arch has disadvantages, the main one being the cost of cutting normally square brick into angles to create the arch shape. The cost of cutting the brick in labour, and the loss of the cut off brick makes this construction costly. Kilns with sprung archs rather than Caternary arches create similar advantages in a kiln at minimal costs.

PLANNING THE PROPORTIONS OF A CATERNARY ARCH.

DETERMINING THE VOLUME

AREA = 4/3 x a x b

VOLUME = 4/3 x a x b x depth



BURNER PORT AND EXIT FLUE SIZES

"Inlet flue areas must be equal to exit flue areas for the simple reason of 'what comes in must go out'. If exit flues are restricted, this will slow down the flow and retard combustion efficiency, thereby retarding the temperature".[7]

Unlike Rhodes, who seems to arbitrarily pick sizes for flue, burner port and chimney height[10], and Olsen who at least attempts to balance the equation of input and output as in the above statement, but does not suggest burner capacities or in simpler terms the power of the input. Clacherie in his research compiles an average input in B.T.U. per sq. in. thereby making the flue exit and chimney area equal to the B.T.U.s required to heat the volume of the kiln.

In simple terms, the equasion is the volume of properly insulated space requires X number (15,000) of B.T.U.s to heat. These B.T.U.s are put in through a port which should be 1 sq. in. per every 8,000 B.T.U.s of required input. For every square inch of burner port the kiln must have an equal amount of flue exit and chimney area. The final part of the equasion is the chimney height.

THE BURNER PORTS

An everage burner port size appears to be approximately 8,000 B.T.U. per square inch of burner port.[8] For convenience of construction, most burner ports are 4½" wide (½ brick) by 5" high (2 courses). Kilns will fire well with up to 16,000 B.T.U. per square inch of burner port area. After this discolouration in the flame is visable, which is a sure sign of inefficient combustion. Since 4½" by 5" is usually larger than necessary, they can be reduced later by fitting soft insulation fire brick, watching for flame discolouration.

It is recommended that burner ports be angled upwards an an angle of about 30° off the horizontal so that the flames flow leasurely and unobstructed up the bag wall. This can be accomplished in both side mounted burners and front and rear mounted burners. The purpose of angling the burner is to reduce turbulence and re-directioning of the flame that causes reduced efficiency in the burner's capacity.

Burner ports should be two or more courses below the top of the flue exit to insure that all flue products, including carbon monoxide are vented out the chimney, during reduction firing.

It is an easy rule to remember in design that the key to efficient kilns is in allowing the burner to properly complete combustion including the secondary air entering the burner port before attempting to transfer that heat to the wares. Once a burner can efficiently do its job alterations to the dampers can be made for safe and economical reduction firing.

It is obvious that the more burners or the larger the burner in B.T.U. rating and port the greater volume required in the chimney.

KILN INPUTS & CHIMNEY FLUE SIZES

USABLE VOLUME Cu. Ft.	APPROX. INPUT B.T.U.	INPUT PER CU. FT. B.T.U.	CHIMNEY FLUE SIZE AT 8000 B.T.U. PER SQ. INS.
12	425,000	35,400	53
14	440,000	31,400	55
16	465,000	29,000	58
18	480,000	26,700	60
20	500,000	25,000	62.5
22	520,000	23,600	65
24	535,000	22,300	67
26	555,000	21,300	70
28	575,000	20,500	72
30	590,000	19,700	74
32	615,000	19,200	71
34	625,000	18,400	78
36	650,000	18,000	81

From the above it can be seen that no accurate arbitrary input per cu. ft. can be given that will apply to all sizes. It would be best shown as a curved line on a graph.

Note that a 9 x 9 flue will handle any kiln up to 36 Cu. Ft.

THE CHIMNEY HEIGHT

The chimney or stack as it is xometimes called must be high enough to create draft sufficient to overcome resistance through the burner ports, shelves, wares, setting floor, and damper, and also in a downdraft kiln overcome the fact that hot gasses will naturally rise. It should be sufficient to have it high enough so it will draw in enough air to create an oxidising atmosphere. The stack is not simply a matter of height, but rather a matter of volume. A stack can be bigger in area and less in height and have the same or similar draw as a stack smaller in area but taller.(11)

Because of the many variable in resistance there is no one completely accurate method of determining exactly the right height. The draft of a chimney is determined by its temperature, area and height but and aforementioned resistances all attempt to overcome the chimney draft. Simply the tight or loose stacking of wares will effect the stack by creating resistance.

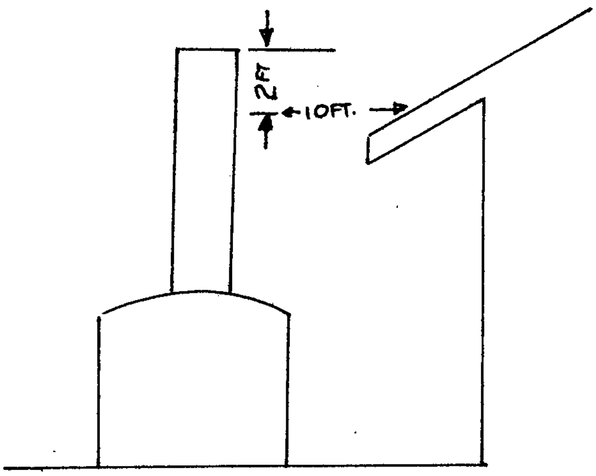
The easiest method of determining stack height is to allow approximately 4" of stack height for each cubic foot of total kiln space.(12) It is interesting to note that this is twice the amount of height as is required for flue and chimney area. It is also 1" of height for every 4,000 B.T.U.s of input.

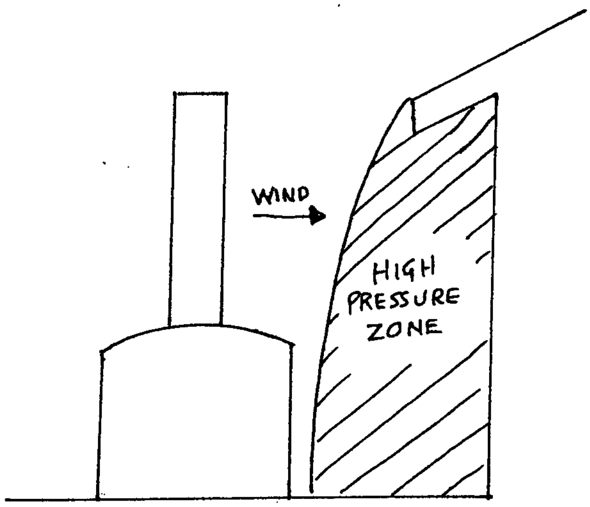
PROXIMITY OF CHIMNEY TO WINDOWS AND AIR INTAKES.

When locating the kiln consider the effluent from the chimney or stack is not always safe to breath. When reduction firing carbon monoxide is formed and escapes into the atmosphere through the stack. This pollution should be kept a substantial distance from windows or air intakes in buildings that are occupied. During oxidation firing only heat and water vapour are formed. Follow the most up to date guide to such buildings as you can obtain. (see Building Codes and Safety Codes in Appendix)

PROXIMITY OF PRESSURE ZONES

The terminus of the chimney should not be located in any area close to a building or large structure where a wind created high pressure zone will prevent proper venting. Generally if you keep the terminus a minimum of 2 ft. above any structure within 10 ft. there should be no venting problem.[(9)]





THE COMBUSTION PROCESS IN THE KILN

Very simply put the process of combustion is the burning of a fuel. This process is a mixture of the fuel, air, and their generation of heat. The one difference between simple combustion and a kiln is the transfer of the generated heat and the required control of the heat. The generation of heat in a gas kiln comes from the burner.

The gas burner mixes the air and the fuel in the proper ratio for optimum generation of heat. This generally requires two sources of air at the burner. Firstly, the mixture of air and gas for primary ignition of the fuel usually in the burner itself, and the secondary air from the burner port used to consume all of the fuel to generate the maximum amount of heat.

The proper mixture of air and fuel for efficient combustion is a major problem in kiln design. For gas inspectors this is an important concern due to the inherent problems of environmental pollution and individual health hazard produced when a kiln design will not allow for complete combustion and thereby generates carbon monoxide.

Once a kiln is designed for efficient combustion and heat flow restriction and adjustments can be made for reduction firing easily, efficiently and at a minimum of damage to the environment.

When considering types of burners and their function the most important design considerations are the space required for combustion both at the burner port and in the chamber space. When considering the burner itself the amount of heat generated by the burner (measured in B.T.U.) and the location of the burners.

Generally speaking in kiln design 2, 4, or 6 burners are better than one large burner. This is due in part to better control on primary heating of the kiln and on even heating throughout the firing.

BURNERS

There are two basic types of burners used in most pottery kilns. The forced air burner is not as common due to the increased cost of the burner itself and the electricity it requires. This usually puts it out of the price range of most potters. This burner does have its advantages, it tends to be more efficient and it has the capacity of being easily controlled by a pyrometer. That is it can be turned up, down or off by electrical impulse control of a pyrometer. This is very handy for schools, colleges and professionals, and should be seriously considered.

The inspirating burner is the most common burner and is probably the most flexible and reliable. The inspirating burner is simply a chamber with gas forced through an orifice collecting air and gas in the venturi and the flame being ignited at the nozel. Many homemade Alfred type burners[13] are built and utilized by potters. They can be efficient and inexpensive, but not as efficient or inexpensive as models on the market that are approved by the authorities.

I do not recommend that schools design and build burners, nor should they encourage their students to do so either. There are several models on the market that will meet every price and need.

Burners are affected by kiln design and the location of the burner is of major importance. A burner should be located in such a way as to allow the flame free passage and a minumum of disturbance. This will insure efficient combustion and safety. Burners can be located opposing each other at the front and rear of the kiln or, as in the designs provided, along the sides.

It is not a matter of which design is best, but rather which one suits the type of flame generated by the burner. Generally speaking, where the flame is longer and requires more space to complete combustion the front and rear configuration seems best. This appears to be in high pressure propane kilns and kilns with the forced air type burners. Where lower pressure natural gas or lower B.T.U. ratings on burners exist a smaller chamber is feasible.

Keeping with the concept of a minimum of disturbance to the flame for more efficient combustion. Burners should be located in such a way as to minimize the redirectioning of the flame. Burners ideally should be located so the flame flows unobstructed up the kiln until combustion is complete. Then flows through the wares. This is possible both in up and down draft kiln design.

Burners can be located so that the flame passes through the floor of the kiln, set at 90^{o} to the vertical, or 60^{o}, whichever allows for the best results for the costs involved.

Different burners will require differing space requirements.

Burners for natural gas should never be installed in an inverted position as this opposes the natural tendency of the gas to rise (being lighter than air) and reduces efficiency and also can be a hazard during ignition. Propane burners may be inverted (propane is heavier than air) if this is to be advantageous in locations where height of a kiln is a problem.

GAS INPUT IN B.T.U. FOR GAS KILNS

The amount of gas and the number of burners required to fire a kiln is a matter of debate and great importance. Simply put, a kiln will reach temperature eventually if enough fuel is used. The excess fuel used in such firing is not only expensive, but also a great contributor to pollution. Kilns using too much fuel require more burners, increasing building costs, and are much harder to control in the early firing stages due to high output design.

The opposite problem is of course even more costly. If too small a gas line or propane tank for the kiln requirements is installed the temperature will not be reached.

There are several guidelines listed in the kiln books suggested in the bibliography, and burner manufacturers can give you detailed burner ratings on various types of burners. (see Burners and Specifications in Appendix) The major problem of kiln design is knowing how much input a kiln will require to meet certain requirements. Given that a kiln is properly insulated, protedted from the elements, and fired properly, the amount of gas in terms of B.T.U. per hour and the number of burners will be a great deal less than one might expect or would find in a kiln not meeting these requirements.

The matter of finding optimum kiln requirements remains a matter of research and under each set of circumstances of kiln construction the needs must be met as are needed. Kiln requirements vary a great deal even under normal conditions, and under extreme conditions the requirements may not be as accurate as is needed.

THE GAS INPUT

Since only a tiny percentage of the gas consumed is used in heating the wares, there is a huge heat loss. As long as the wares receive the required heat, the losses can vary a great amount, and the potter may not know the difference (except for the cost of firing). To illustrate this, below is a gas input (B.T.U.) comparison between two actual kilns and the average of the kilns tested.

	KILN "A"	KILN "B"	AVERAGE
B.T.U. per cu. ft. of usable volume	14,700	32,300	23,000
B.T.U. per cu. ft. of total volume	8,700	25,000	15,500
B.T.U. per sq. in. of chimney area	3,400	6,173	7,100
B.T.U. per sq. ft. of setting floor	52,900	100,100	81,000
B.T.U. per sq. in of burner port	16,600	5,600	8,000

NOTE: The extreme differences between kilns "A" and "B". Both are turning out a good product, yet kiln "A" is doing so with less than ½ of the gas used in kiln "B". Both are indoor kilns.

Some of the factors determining or affecting the gas input required are:

- Size of the kiln
- Co-efficient of heat transfer of the walls and roof
- Weight of the wares
- Ambient temperature (if outdoors)

- Wind velocity (if outdoors)
- Kiln atmosphere (oxidizing or reducing)
- Draft through the kiln (see "Chimney Height")
- Overall combustion efficiency

It is a good idea to use the above as a checklist of the possible variables if a kiln does not function as is expected.

GAS INPUT IN B.T.U. FOR GAS KILNS "CHART"			
The chart shown will give the approximate gas inputs for kilns of about 32" of hard brick equivalent walls. Inputs may be slightly reduced for indoor kilns and kilns of exceptionally high hard brick equivalent wall construction or slightly increased for outdoor kilns.			
USABLE VOLUME	B.T.U. INPUT	USABLE VOLUME	B.T.U. INPUT
12	425,000	24	535,000
14	440,000	26	555,000
16	465,000	28	575,000
18	480,000	30	590,000
20	500,000	32	615,000
22	520,000	34	625,000
		36	650,000

The variety of kiln requirements for kilns not having met the specifications listed are too numerous to list here, and as it is the intention of this paper to give design requirements for efficient kilns these requirements will not be listed.

THE SETTING FLOOR AREA

The amount of space through the floor in both up and down draft kilns is very important, as this area can act as a barrier or damper restricting the proper flow of heat. This problem can be complicated by over stacking of wares in a kiln also. For proper combustion the space in the floor area should at least be equal to the flue exit area or burner port area. If this minimum amount of space is used when wares are closely stacked the kiln may become inefficient due to the dampering effect caused by reduced opening in the floor setting space. Clacherie recommends 8% of the setting floor be left open. This rule seems to hold in most research, but the successful variables can be 6%-10%. Below this amount draft is affected, which can be seen as poor draft through the burner port which is unaffected by the damper adjustment and, above this point, as uneconomical use of kiln space.

KILNS DESIGNED USING THE MODEL

DESIGNED USING THE MODEL PROVIDED

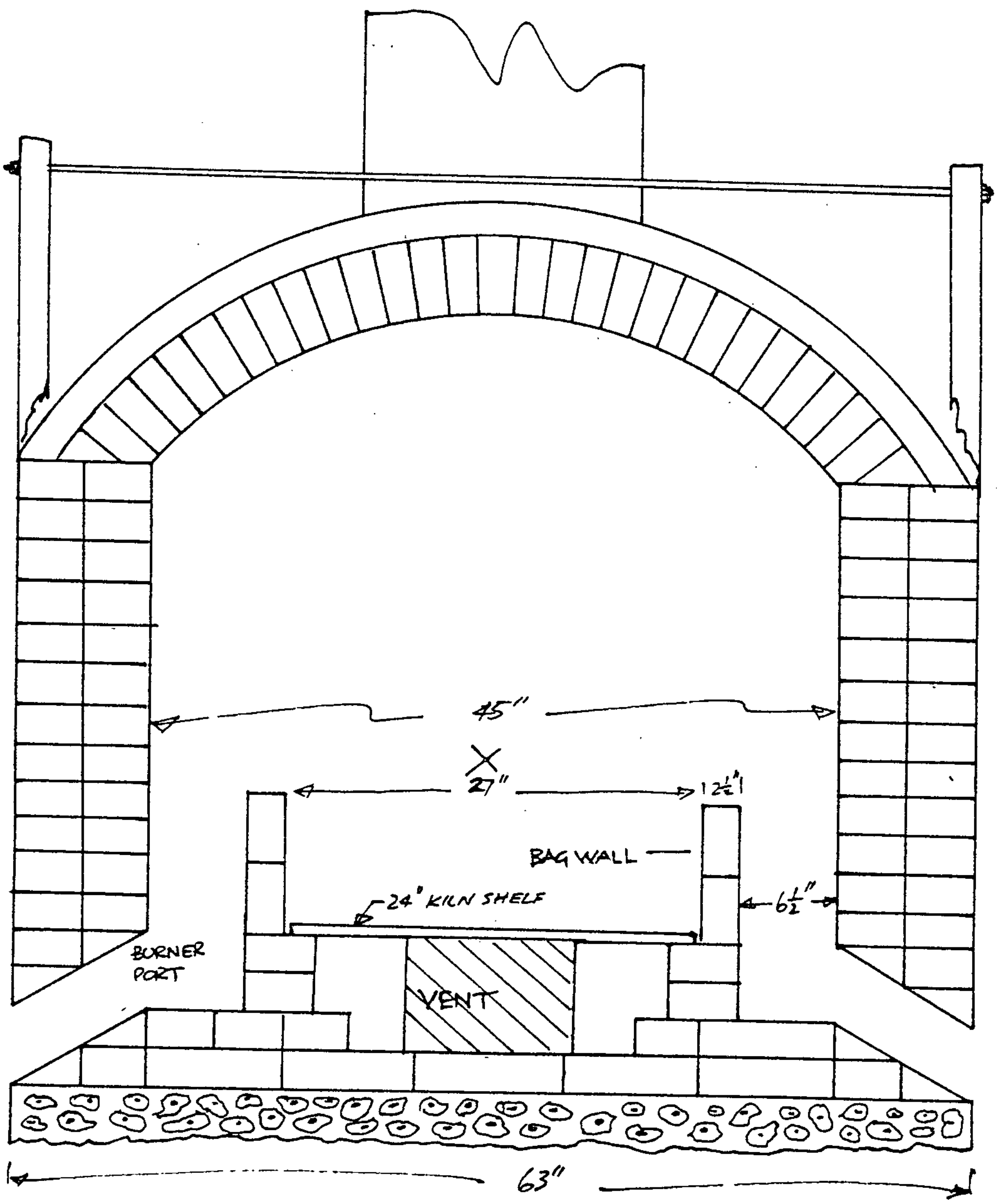
THE WIDTH:

27" usable width is a handy width (3 full or 6 half bricks)	27"
To this add 2 bag walls 2½" each	5"
Outside bag walls the burner space 2/6½"	13"
TOTAL INSIDE WIDTH	45"
The hot face refractory 2/4½"	9"
Insulation fire brick 2/4½"	9"
TOTAL OUTSIDE WIDTH	63"

THE HEIGHT:

SINCE A BRICK IS 2½" THICK EACH COURSE WILL BE FUNCTIONS OF 2½"

floor will be 2 courses 1 hot face 1 insulation	5"
Flue exit should be 3 courses	7½"
TOTAL HEIGHT FOUNDATION TO THE FLOOR	12½



SUMMARY OF DIMENSIONS OF A KILN USING THE MODEL PROVIDED.

Usable Volume

27" W. x Av. Height of 34" x 45" Deep = 41,310 cu. ins.
or 23.9 cu. ft.

Total Volume

Bottom section: 45" W x 30" H x 45" D = 60,760 cu. ins.
Volume within arch: 45" x 6" H (2/3 of 9") x 45" D
= 12,150 cu. ins.
TOTAL = 72,800 cu. ins.
= 42.1 cu. ft.

Setting Floor

27" W x 45" D = 1,215 sq. ins.
= 8.44 sq. ft.

Openings Through the Setting Floor

8% of 1,215 sq. ins. = 97 sq. ins.

Chimney Flue Area

= 81 sq. ins. (9" x 9")

Flue Exit Area

Approximately 81 sq. ins.

Burner Port Size

For convenience 4½" x 5" x 6 ports

Chimney Height

At 3.6" height per total cu. ft. = 3.6 x 42.1 = 12½'
At 4" height per total cu. ft. = 4 x 42.1 = 14'

Gas Input

May vary greatly according to location and construction.

RECOMMEND 23,000 B.T.U. per usable cu. ft.

24 CUBIC FOOT DOWNDRAFT GAS KILN DESIGN

Arch

An average rise for an arch is approximately	9"
From the bottom of the vent to the top of the floor	10"
TOTAL	19"

Since a kiln is 45" total inside width, it should be approximately the same in height, in order to maintain the cube design required. 45" - 19" = 26". This is not a function of 2½", so 27" would be better and would make the side wall 11 courses in height above the floor.

Summary of Height

	INCHES	COURSES
INSULATING COURSE ON FOUNDATION	2½"	1
HEIGHT OF VENT OUTLET	7½"	3
SETTING FLOOR IF BRICK	2½"	1
SETTING FLOOR MAY BE A ½" - 1" KILN SHELF		
FROM THE TOP OF SETTING FLOOR TO THE TOP OF THE SIDE WALL	27½"	11
FROM FOUNDATION TO TOP OF SIDE WALL	40"	16
USABLE HEIGHT ABOVE SETTING FLOOR	36½"	
HEIGHT FROM TOP OF FLUE EXIT TO TOP OF SIDE WALL	30"	12

The Depth

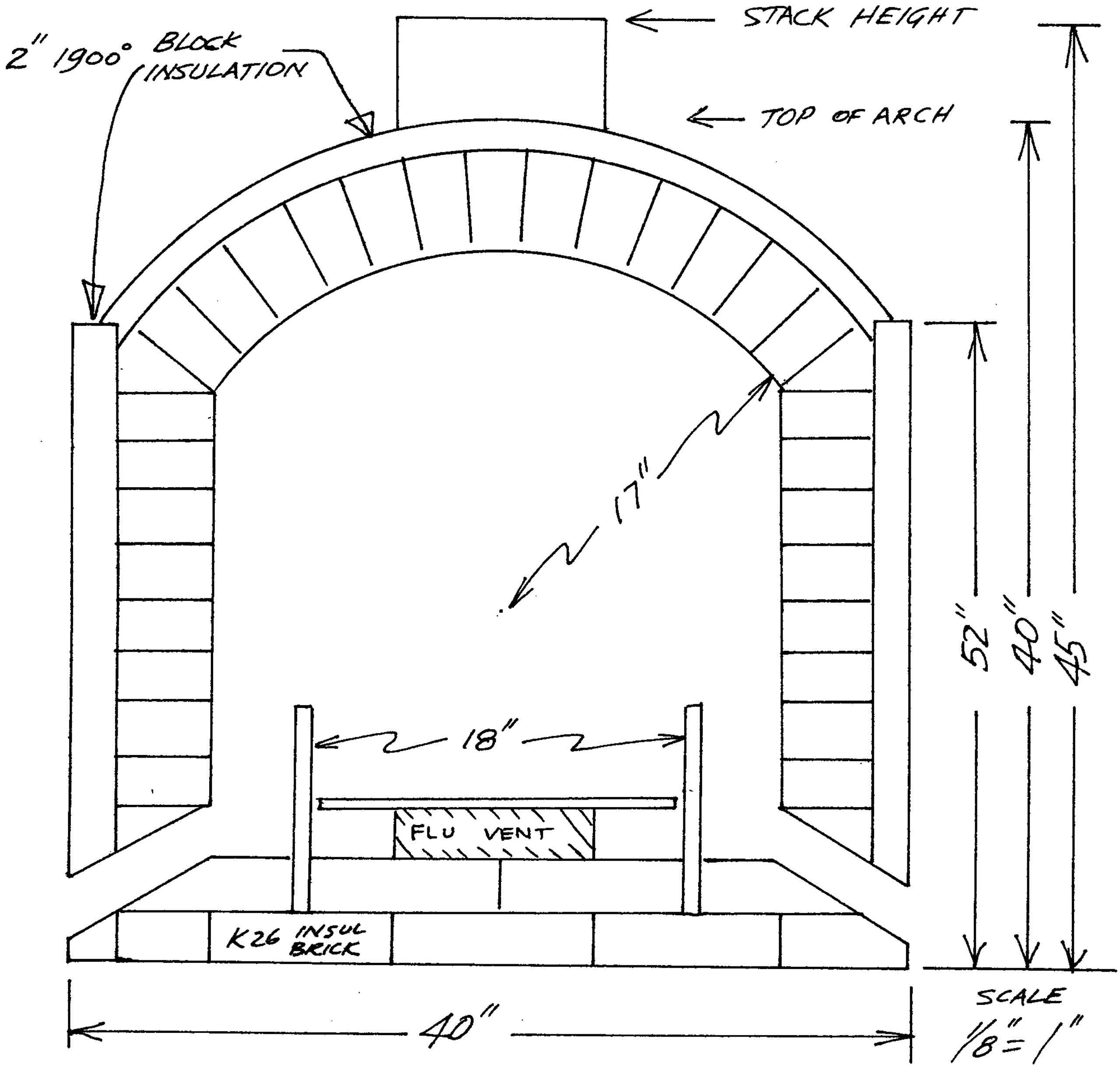
In order to keep the total inside design as a cube the depth from the inside of the door to the inside rear should be approximately 45" (5 bricks) or 40½" (4½ bricks).

Given that the 45" thickness is utilized and that the door is bricked in 2 thicknesses, the outside depth will be 45" + 9" (rear wall) + 9" (door) = 63" total

KILNS LARGER THAN THIS MODEL ARE DIFFICULT TO LOAD CONSIDERATION TO CAR OR SHUTTLE KILNS IS A DESIGN IDEA. worth consider

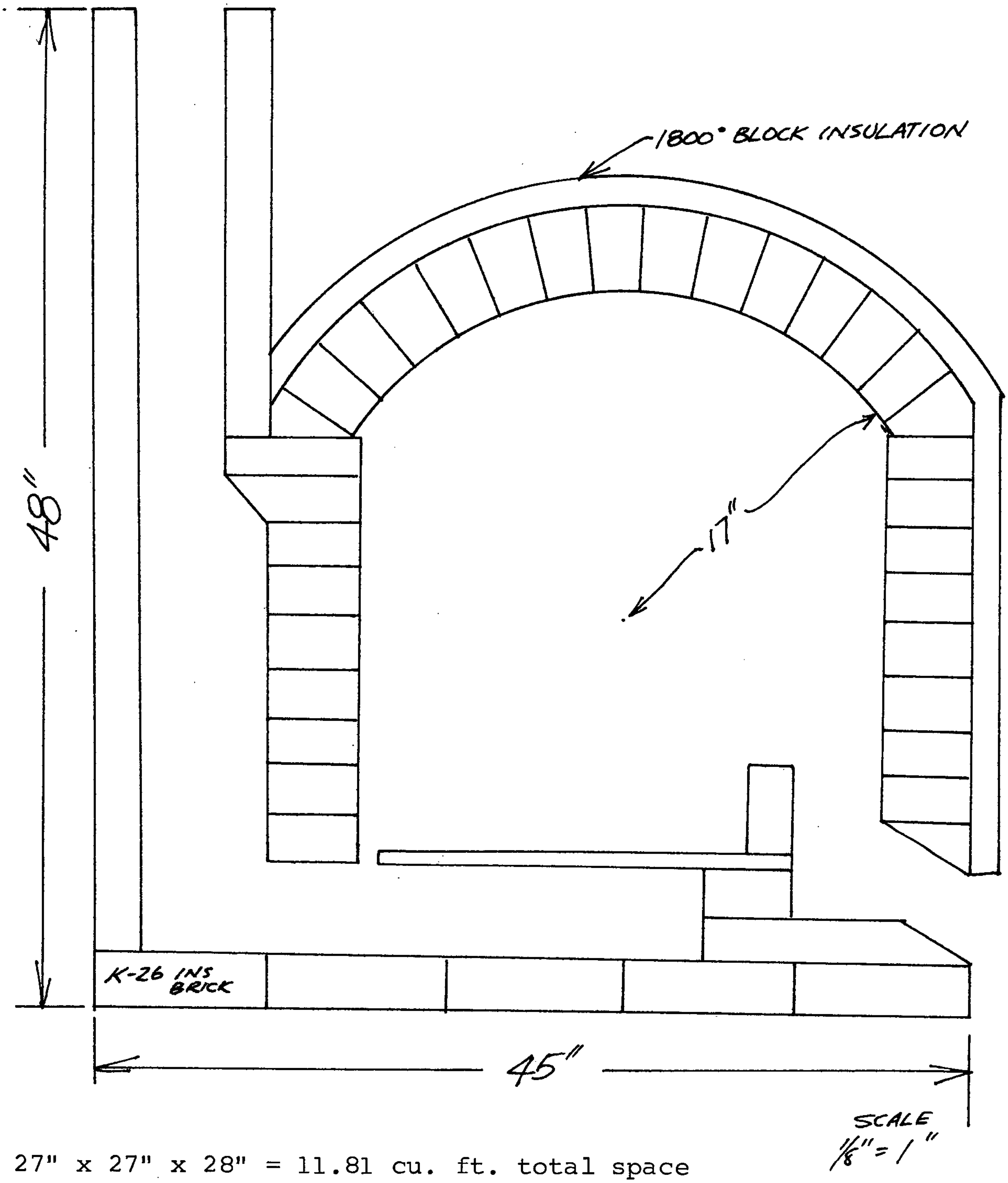
SMALL DOWN DRAFT KILN DESIGN

- CUBIC FEET OF USABLE SPACE 6.38
- B.T.U. MAX. 150,000
- SETTING FLOOR AREA 3.375 sq. ft. or 486 sq. in.
- CHIMNEY FLUE 22.5 sq. in.
- CHIMNEY HEIGHT 40.5 in. @ 4"/cu.ft.
- USABLE SPACE 18 x 27 x 22.5 = 10,935 ÷ 1728 = 6.328 cu.ft.
- TOTAL VOLUME 27 x 27 x 22.5 = 16,402.5 ÷ 1728
= 9.492 cu.ft.
- BRICK SIZE 4.5" x 9" x 2.5"
- BRICK TYPE K 26 insulating firebrick INSULATION 1900° block



SMALL CROSS DRAFT KILN

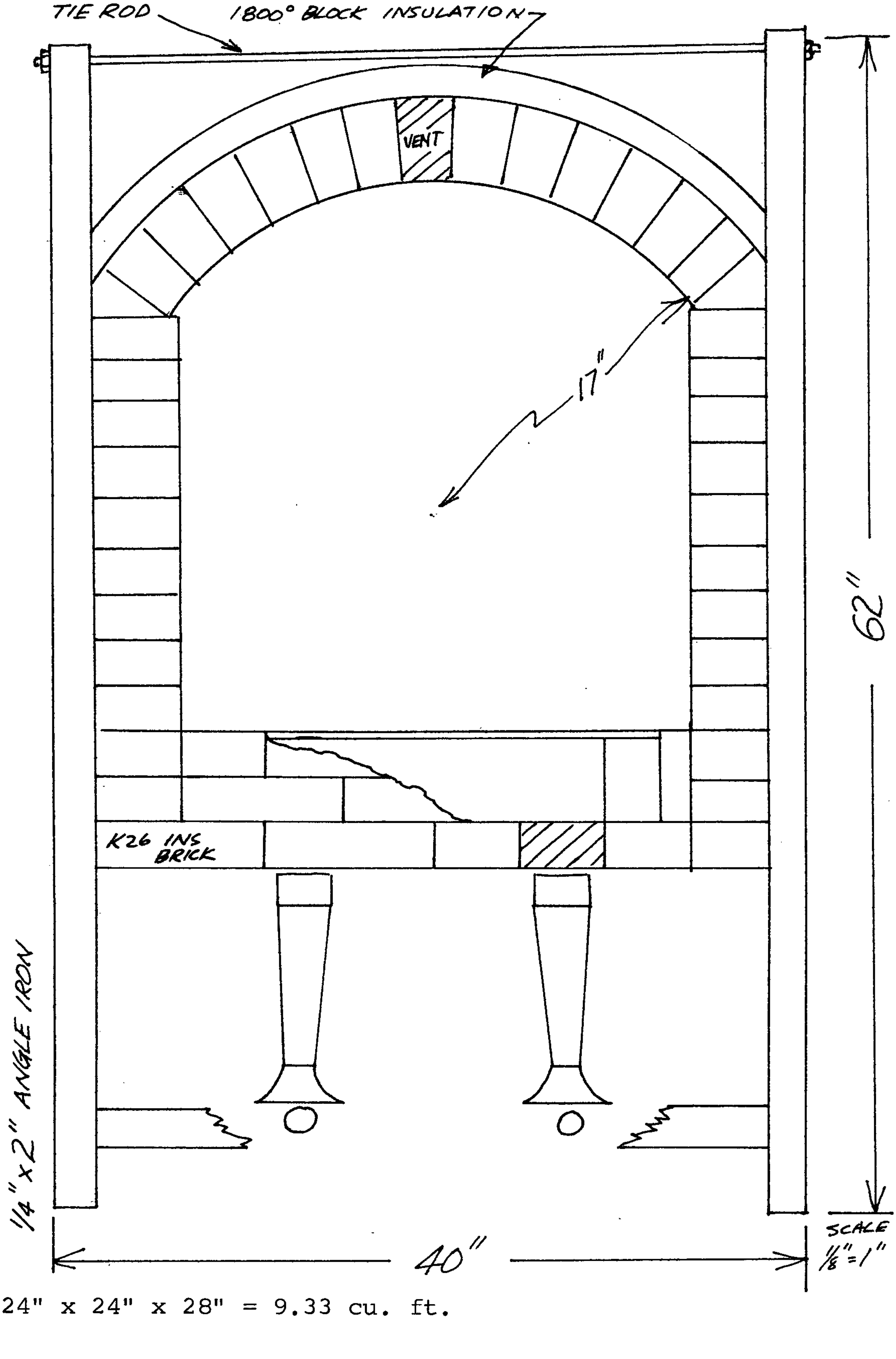
Approx. 10 cu. ft. of usable space.



27" x 27" x 28" = 11.81 cu. ft. total space

22" x 27" x 28" = 9.625 cu. ft. usable space

Approx. 10 cu. ft. of usable space



24" x 24" x 28" = 9.33 cu. ft.

APPENDIX

The following pages are designed to assist in firing a gas or propane kiln. They are intended to assist an operator who has had previous experience or training with gas kilns. If the operator has had no prior experience with kilns it is strongly recommended that Ritchie's book on Gas Kiln Firing and professional help be obtained and followed for the first few firings.

BEFORE FIRING YOUR KILN THE FIRST TIME

1. Make sure all tests, recommendations and inspections have been carried out.

2. Make sure fire extinguishers and safety proceedures are readied.

3. Test each shut off, pilot light and burner individually for minimum and maximum operation and auto safety shut off.

4. Test each shut off pilot light and burner in a group operation for minimum and maximum operation. Make sure burners will not backfire, and if they do how to correct and avoid the situation.

5. Test automatic shut offs to make sure they will perform in an emergency.

SAFE KILN OPERATING PROCEEDURES

PLOT ALL INFORMATION ON THE KILN FIRING LOG.

1. Make sure all burners are in off position before turning on gas at the meter.

2. Make sure all burners are ready to light, ports open etc. Make sure gas main at meter is on, and then the main next
t to the kiln

3. Make sure damper on the stack is open.

4. Ignite a pilot light by holding the switch at the solinoid valve and touching the burner with a lighted match.

5. Light all pilot lights.

6. Warm the kiln from the pilot lights 15 min. to ½ hr.

7. Turn on the burners to the lowest setting at which a steady flame will hold. Make sure the primary air at the base of the burner is adjusted to allow for minimum air flow.

8. Turn up gas as temperature rise indicates, and turn up the primary air flow with the gas as needed.

9. When the kiln reaches $1000^{\circ}C$, or where a good red heat is visable, reduction firing may be implimented. A simple methoed of reduction firing is to use the last ½ hour of the firing cycle to reduce.

To impliment reduction firing close off the damper at the stack until flame is visable in the stack. Back off until it disappears. Now adjust so that the flame is noticable. Test the reduction by opening a spy hole in the kiln, if flame appears a good reduction is underway. If black smoke or soot is building up on the spy holes or damper you are over reducing the firing. If a stronger reduction is necissary close off primary air at the burner.

<u>NOTE</u> REDUCTION FIRING CAUSES POLLUTION USE IT DISCRIMINATLY.

WHEN THE KILN REACHES THE DESIRED TEMPERATURE IT IS TIME FOR THE SHUT DOWN PROCEEDURE.

SHUT DOWN PROCEDURE

1. Shut off the burner valves.
2. Close the damper on the stack.
3. Shut off the gas mains.
4. Close the burner ports.
5. Log the pyrometer temperature.
6. Kiln must be below 250°C before opening.

NOTE: THE SURFACE TEMPERATURE OF THE KILN WILL CONTINUE TO RISE FOR 3-4 MORE HOURS. MAKE SURE NO COMBUSTABLES ARE LEFT NEAR THE KILN.

DO's AND DON'Ts OF KILN FIRING

Ignite the pilot light before turning on the gas burner. DO NOT turn on the gas at the main without making sure the burners are shut off.

Always make sure the kiln door is open when igniting burners without pilot lights - so that gas will not build up in the kiln chamber.

DO NOT leave kiln door closed when not in use. (To avoid gas build up if leaks occur.)

DO use kiln wash on shelves <u>often</u>.

DO NOT allow unknown clay or glaze to be stacked in the kiln.

Train all persons associated with the kiln in its safe operation and post procedures where they are easily accessable, in case you are unavoidable called away.

DO NOT allow a kiln to go unattended for prolonged periods without the operator checking.

DO NOT allow open access to your kiln - it can burn an "unaware" public.

RECOMMENDED SAFETY EQUIPMENT FOR SCHOOL USE

NO KILN SHOULD BE BUILT IN A SCHOOL, OR WHERE IT WILL GO UNATTENDED, WITHOUT THE FOLLOWING EQUIPMENT:

1. Thermocouple shut offs and pilot lights on every burner.

2. A damper that will only close 90-95% of the chimney.

3. A pyrometer designed to shut off the burner at maximum temperatures, with thermocouple of platinum and platinum-rhodium shielded in porcelain.

4. A lockable gas main shut off easily accessable and away from the kiln.

5. A lockable door to kiln and shed.

I do not recommend additional equipment because the kiln must function without too many false shut downs if it is to be useful and reliable. Secondly the operator of the kiln must make the operation and function of the kiln as their prime responsibility.

Kilns where the operator is in full attendance, and where no other persons shall have access, can be operated easily without pilot lights, thermocouples and pyrometers.

KILN SITTER

A kiln sitter can be used to shut off a gas kiln, but the kiln sitter is not designed to work in reduction atmosphere or at high temperatures. They can fail more often because of this and their function can be replaced by a good quality platinum-platinum rhodium thermocouple attached to an industrial pyrometer with auto. shut off or hold capabilities. I strongly recommend the pyrometer type of control.

THERMOCOUPLE AUTO. SHUT OFF

A thermocouple is a device that senses heat and sends a small electrical current to a device that controls the gas flow to both pilot lights and main burners. This device will shut off the gas if for any reason the flame goes out, this prevents any possible build up of gasses in the chamber or shed that could be ignited accidently causing rapid combustion or explosion.

HERITAGE KILN BURNERS

NATURAL GAS BURNER INSTALLATION INSTRUCTIONS

IMPORTANT NOTICE: THESE BURNERS MUST BE INSTALLED IN ACCORDANCE WITH THE REGULATIONS OF THE AUTHORITY HAVING JURISDICTION IN YOUR AREA.

BURNERS SHOULD BE INSTALLED BY A LICENSED GAS FITTER ON A PERMIT FROM THE ENFORCING AUTHORITY.

1. These burners are designed and orificed to be operated at the accepted natural gas pressure of 7 ins. Water Column.

2. All lines should be sized in accordance with local regulations to supply the correct 7 ins. Water Column pressure. (See Table 1)

3. Natural Gas burners may be installed with the burner venturi facing upwards, or horizontal but never with the port downwards.

4. Be sure that the valve, orifice and burner are in a true straight line as in Fig. 1.

5. Because kilns vary so much in shape, size, and design, suitable burner brackets cannot be supplied by the burner manufacturer. Burner brackets as shown in Fig. 2 must be provided which will securely hold the burners in the proper position in a fixed relation to the kiln port as shown in Fig. 3.

6. Burner orifices are supplied drilled No. 18 W.G. for approximately 125,000 BTU , or if kiln information was supplied to the manufacturer may be drilled to the minimum that may be required.

   If you do not reach temperature do not assume that the gas input is too low since there are several other factors which may also affect the temperatures such as:

   (a) Bag wall too high or too low.
   (b) Wares stacked too closely.
   (c) Insufficient combustion space from wall to bag wall.
   (d) Over reduction (high percentage of unburned gas).
   (e) Over oxidation (too much air cooling the kiln).
   (f) Insufficient insulation.
   (g) Too high a gas input for the combustion space.

   When all factors have been considered and if you still suspect the gas input is too low, increase the size one wire gauge size. (See Table 2). If the temperature goes up you may be on the right course. If possible use a pyrometer for your first few firings. If the temperature goes down you are probably passing more gas than there is combustion space for or than can be properly vented due to various restrictions as mentioned above.

7. It is the responsibility of the installer to apply for an inspection or test to the authority having jurisdiction in your area. This is for your protection.

NATURAL GAS
GAS LINES TO KILNS

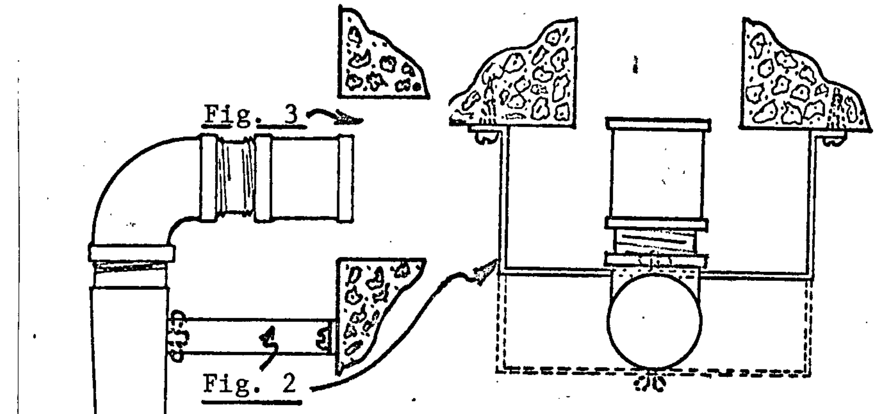
(at 7" W. C. with not over .5" W. C. drop)

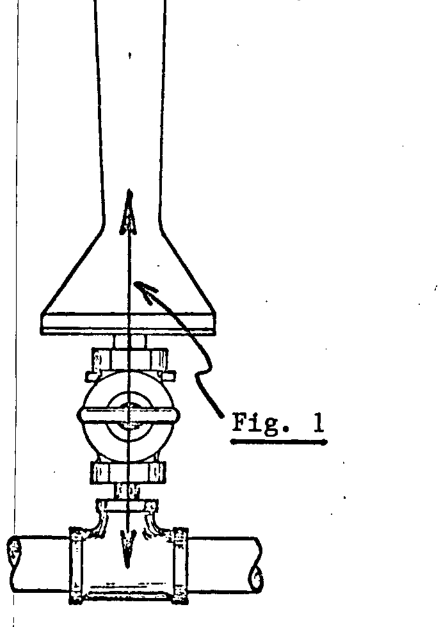
LENGTH OF LINE	KILN VOLUME → / GAS INPUT →		3	5	6	6	10	14	18	18	20	24	28		35			40
		200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000	1200
↓ 10		3/4	3/4	3/4	1	1	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½
15		3/4	3/4	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½
20		3/4	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½
25		3/4	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½
30		1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	2	2
35		1	1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	2	2
40		1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	2	2
50		1	1	1	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	2	2	2
60		1	1	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	2	2	2	2	2
80		1	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	2	2	2	2	2	2	2
100		1	1¼	1¼	1¼	1½	1½	1½	1½	2	2	2	2	2	2	2	2	2

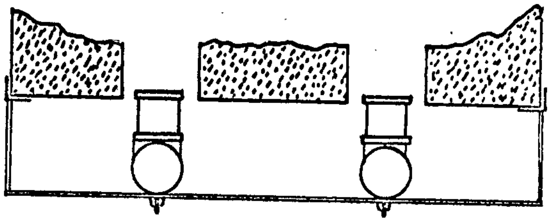
Table 1

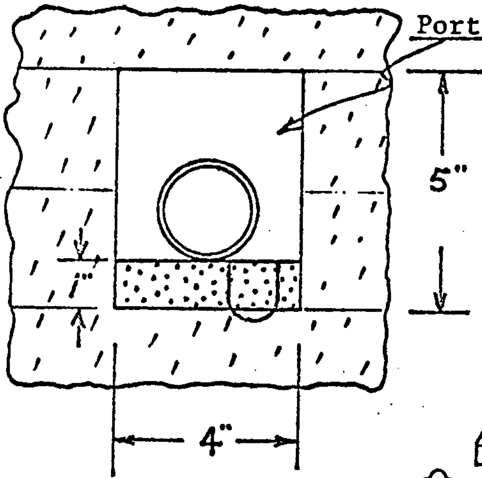
NATURAL GAS	
Flow through an orifice at 7 Ins. Water Column Press. (4 Oz.)	
Orifice Size D.M.S. Wire Gauge	Thousands of B.T.U.
27	90
26	94.5
25	98
24	101
23	104
5/32"	107
22	108
21	111
20	113
19	121
18	125
11/64"	129
17	131
16	137
15	142
14	145
13	150
3/16"	154
12	156
11	160
10	164
9	168
8	173

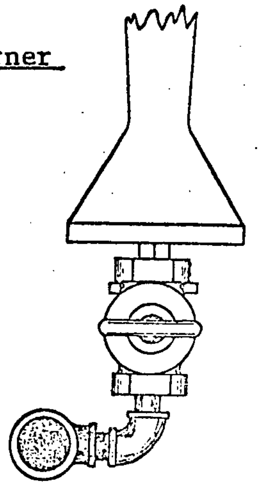
Table 2

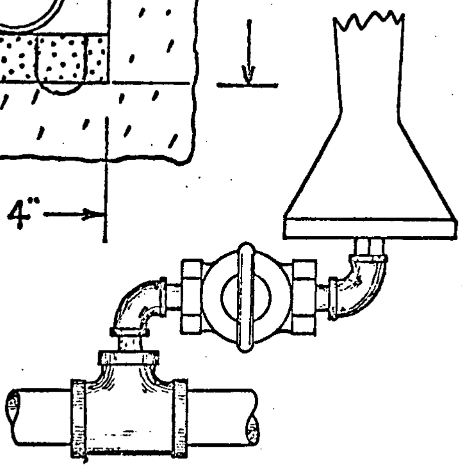












PROPANE BURNER INSTALLATION INSTRUCTIONS

IMPORTANT NOTICE: THESE BURNERS MUST BE INSTALLED IN ACCORDANCE WITH THE REGULATIONS OF THE AUTHORITY HAVING JURISDICTION IN YOUR AREA.

BURNERS SHOULD BE INSTALLED BY A LICENSED GAS FITTER ON A PERMIT FROM THE ENFORCING AUTHORITY.

1. These burners are designed and orificed to be operated at the accepted propane pressure of 11 ins. Water Column.

2. Tank size should be as shown in Table 1 to ensure proper supply pressure at the lowest temperature at which you wish to fire.

3. All lines should be sized in accordance with local regulations to supply the correct 11 ins. Water Column pressure. (See Table 2)

4. Propane burners may be installed with the burner venturi facing upwards, downwards or horizontal.

5. Be sure that the valve, orifice and burner are in a true straight line as in Fig. 1.

6. Because kilns vary so much in shape, size, and design, suitable burner brackets cannot be supplied by the burner manufacturer. Burner brackets as shown in Fig. 2 must be provided which will securely hold the burners in the proper position in a fixed relation to the kiln port as shown in Fig. 3.

7. Burner orifices are supplied drilled No. 30 W. G. for approximately 115,000 BTU of propane, or if kiln information was supplied to the manufacturer may be drilled to the minimum that may be required.

   If you do not reach temperature there are several other factors which may also affect the temperatures such as:

   (a) Bag wall too high or too low.
   (b) Wares stacked too closely.
   (c) Insufficient combustion space from wall to bag wall.
   (d) Over reduction
   (e) Over oxidation (too much air cooling the kiln).
   (f) Insufficient insulation
   (g) Too high a gas input for the combustion space.

   When all factors have been considered and if you still suspect the gas input is too low, increase the size one wire gauge size. (See Table 3) If the temperature goes up you may be on the right course. If possible use a pyrometer for your first few firings. If the temperature goes down you are probably passing more gas than there is combustion space for or than can be properly vented due to various restrictions as mentioned above.

8. It is the responsibility of the installer to apply for an inspection or test to the authority having jurisdiction in your area. This is for your protection.

Input in Thds. BTU	Kiln Usable Cu. Ft.	Distance from Last Stage Regulator to Burners							
		10'	20'	30'	40'	50'	60'	80'	100'
250	4	½	3/4	3/4	3/4	3/4	1	1	1
300	6	3/4	3/4	3/4	1	1	1	1	1
350	8	3/4	3/4	1	1	1	1	1	1¼
400	12	3/4	1	1	1	1	1	1¼	1¼
450	15	3/4	1	1	1	1	1¼	1¼	1¼
500	18	3/4	1	1	1	1¼	1¼	1¼	1¼
625	2	1	1	1¼	1¼	1¼	1¼	1¼	1¼
750	32	1	1¼	1¼	1¼	1¼	1¼	1¼	1½
875	35	1	1¼	1¼	1¼	1¼	1¼	1¼	1½
1000		1	1¼	1¼	1¼	1½	1½	1½	1½
1250		1¼	1¼	1½	1½	1½	1½	2	2

Table 2

Sustained Ambient Temp. Degrees Fahren.	Standard Upright 100 lb. ICC Container.	Standard Upright 420 lb. ICC Container.	Average Horizon. 499 Water Gallons Capacity Container.	Average Horizon. 995 Water Gallons Capacity Container.
-40	2,300	5,400	27,300	50,200
-30	8,200	19,200	95,700	125,500
-20	14,000	32,900	164,100	201,900
-10	19,900	46,600	232,500	427,800
0	25,800	60,300	300,800	553,600
10	31,700	74,126	369,200	679,400
20	37,500	87,800	437,600	805,200
30	43,400	101,600	506,000	931,100
40	49,300	115,300	574,400	1,056,900
50	55,100	129,000	642,800	1,182,700
60	61,900	142,700	711,200	1,308,622
70	66,900	156,500	779,500	1,434,400
80	72,700	170,200	847,900	1,560,200

Table 1

PROPANE INPUT

at 11" Water Column Pressure

Wire Gauge Drill	Input B.T.U./Hr.
38	77,400
37	81,125
36	85,170
35	90,800
34	92,500
33	96,000
32	101,000
31	108,070
30	123,875
29	138,840
28	148,000
27	155,650

Table 3

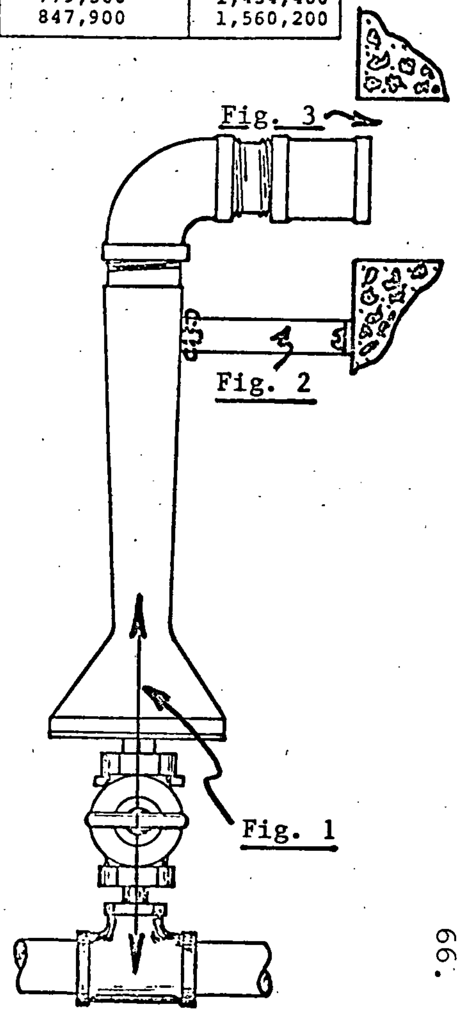


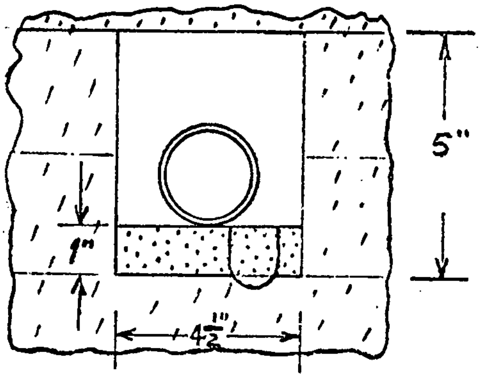
Fig. 3

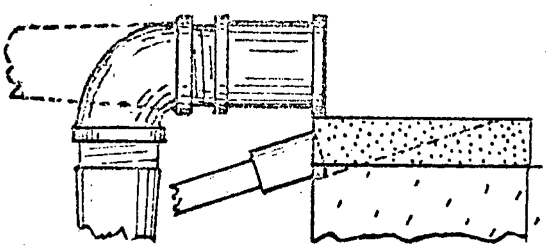
Fig. 2

Fig. 1

SAFETY PILOT MOUNTING INSTRUCTIONS

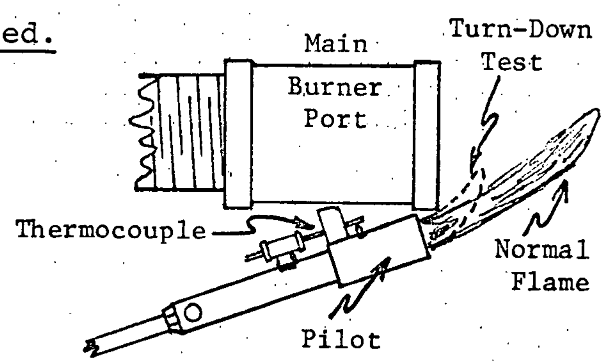
For proper pilot operation, it is imperative that these instructions be carefully followed by competent licensed personnel and with the approval of the authority having jurisdiction in your area.





A convenient burner opening size is 4½" wide by 5" (2 courses high). At the bottom, place a piece of No. 26 or 28 insulating brick 1" thick. In this, cut a tapered groove 1" wide x 1" deep as shown. Place the pilot in this groove about ½" back from the burner port and angled upwards approximately 30° off horizontal. Bracket pilot securely in this position.

PILOT TURN-DOWN TEST: No safety pilot application is complete unless this test is carried out and passed.



1. Slowly close the pilot valve until the flame on the thermocouple is just barely touching the thermocouple.
2. At this point, the pilot flame should still be intersecting the course of the main burner flame. If not, relocate pilot to accomplish this.
3. If visually sat. in 2; open main burner firing valve to check for proper ignition.

WHEN COMPLETED, REQUEST AN INSPECTION BY THE ENFORCING AUTHORITY HAVING JURISDICTION IN YOUR AREA.

Recommended Kiln Construction and Installation Requirements

1. Installation of Kilns

   (a) A gas kiln shall not be installed within the living area of a residence.

   (b) When a gas kiln is installed in a building or a room attached to an occupied building the common wall or walls shall have a 1 hour fire resistance rating.

   (c) Where a gas kiln is installed in a room adjacent to a work area; means shall be provided to screen or partition the kiln area from the work area by means acceptable to the enforcing authority.

2. Construction

   Indoor kilns shall be constructed with walls and roof equivalent in insulating properties to 26" of hard firebrick.

3. Safety Controls

   (a) Safety shut-off controls shall be provided on indoor kilns for all burners which are not under constant supervision. This requirement shall not apply to kilns installed outdoors or in an unoccupied building used solely to protect the kiln from the elements.

   (b) Kilns having on-off automatic temperature controlled burners shall be provided with safety shut off controls on all burners.

   (c) Kilns fired with L. P. gases shall have safety controls which cut off both main and pilot burners when required as in (a) and (b) above.

4. Combustion Air & Ventilation

   The kiln room or kiln area as in 1 (b) or (c) shall be provided with a combustion air inlet close to floor level and a ventilation outlet at ceiling to be 50% greater than that required by Clause 4.2.1 of C. S. A. B149.1 (1974).

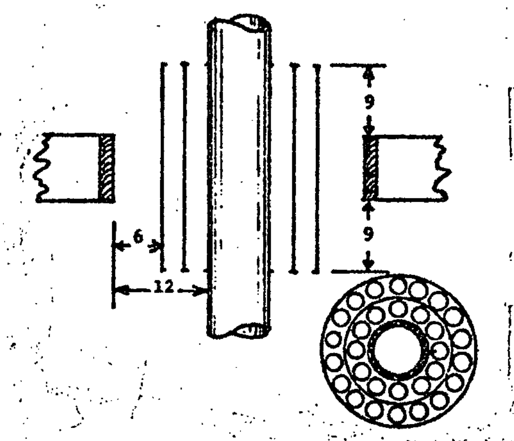
5. Clearances and Venting of Indoor Kilns

   (a) The minimum clearance from the top, sides and rear to combustible material shall be 48". This distance may be reduced when insulation acceptable to the enforcing authority is provided but in no case may be less than 24".

   (b) Clause 6.2.8.6 (7) of the National Building Code states (in brief) every metal chimney designed for use at over 538°C (1000°F) shall be lined with at least 4½" of firebrick or other material providing equivalent temperature protection.

   Since 2½" of a 2500°F castable insulating refractory would be equal in insulating properties to 8" of hard firebrick, it would be considered acceptable.

   (c) Clause 6.2.8.6 (9) of the National Building Code states: "Except as provided in sentence (10), every interior metal chimney shall have a clearance of at least 3 ft. (915 MM) to combustible material within the storey in which the heating appliance is contained". Sentence (10) states: "Where a metal chimney passes through a combustible roof assembly, the clearance between the chimney and the nearest combustible material may be reduced to 12 in. (305 MM) provided the metal chimney is guarded by a metal thimble extending at least 9" (229 MM) above and 9" (229 MM) below the roof construction. Such thimbles shall have double cylindrical walls with a ventilated space between the walls and between the metal chimney and thimble, and the clearance between the metal thimble and the combustible material shall be at least 6 in. (152 MM)". The sketch may make this a little clearer.



(d) Where an updraft type kiln is vented by means of a canopy and single wall metal vent, the clearance shall be 18". This clearance may be reduced when protection is provided in accordance with Table 4.3.8.2. of C. S. A. B149.1 (1974) or if provided with an insulating thimble as in (c).

(e) Clause 9.21.6.1 of the same code states "The clearance between concrete or mansonry chimneys and combustible framing shall be not less than 2" for interior and ½" for exteriors. Since this clause does not take the temperature into consideration, 6" would be a more realistic distance. In any case, it is generally accepted throughout the gas industry that no combustible material should be permitted to reach a temperature in excess of 45°C (117°F).

TABLE 4.3.8.2
Clearance* With Specified Forms of Protection†

Type of Protection	Where the Required Clearance With No Protection Is: 36 Inches			18 Inches			12 Inches		9 In.	6 Inches	
	Above	Sides and Rear	Flue Pipe	Above	Sides and Rear	Flue Pipe	Above	Sides and Rear	Flue Pipe	Above	Sides and Rear
a) ¼-in asbestos millboard spaced out 1 in	30	18	30	15	9	12	9	6	6	3	2
b) 0.013-in (No. 28 MSG) sheet metal on ¼-in asbestos millboard	24	18	24	12	9	12	9	6	4	3	2
c) 0.013-in (No. 28 MSG) sheet metal spaced out 1 in	18	12	18	9	6	9	6	4	4	2	2
d) 0.013-in (No. 28 MSG) sheet metal on ⅛-in asbestos millboard spaced out 1 in	18	12	18	9	6	9	6	4	4	2	2
e) 1½-in asbestos cement covering on heating appliance	18	12	36	9	6	18	6	4	9	2	1
f) ¼-in asbestos millboard on 1-in mineral wool batts reinforced with wire mesh or equivalent	18	12	18	6	6	6	4	4	4	2	2
g) 0.026-in (No. 22 MSG) sheet metal on 1-in mineral wool batts reinforced with wire mesh or equivalent	18	12	12	4	3	3	2	2	2	2	2
h) ¼-in asbestos cement board or ¼-in asbestos millboard	36	36	36	18	18	18	12	12	9	4	4
i) ¼-in cellular asbestos	36	36	36	18	18	18	12	12	9	3	3

* All clearances given in inches.
† Except for the protection indicated in (e) above, all clearances shall be measured from the outer surface of the appliance to the combustible material disregarding any intervening protection applied to the combustible material, but in no case shall the clearance be such as to interfere with the requirements for combustion air and for accessibility.
‡ Applied to the combustible material unless otherwise specified and covering all surfaces within the distance specified as the required clearance with no protection. Thicknesses are minimum.

NOTE: Spacers shall be of non-combustible material.

our file : D-02-02

your file :

GOVERNMENT OF BRITISH COLUMBIA
DEPARTMENT OF PUBLIC WORKS

Safety Engineering Services Division

November 1975

TO ALL INSPECTORS AND CONTRACTORS

GAS FIRED POTTERY KILNS

An increasing number of gas fired kilns are being installed throughout the Province and it has become necessary to set out the following guidelines for their installation.

1. A gas fired kiln shall not be installed within the living area of a residence.

2. Where a gas fired kiln is installed in a room adjacent to a work area the kiln area shall be partitioned or screened from the work area in a manner acceptable to the enforcing authority.

3. Safety shut-off controls shall be provided on indoor kilns for all burners which are not under constant supervision. This requirement shall not apply to kilns installed outdoors or in an unoccupied building used solely to protect the kiln from the elements.

4. Kilns having on-off automatic temperature controlled burners shall be provided with safety shut-off controls on all burners.

5. The minimum clearance from the top, sides and rear of a kiln to combustible construction shall be 48", except that this distance may be reduced when insulation acceptable to this Branch is provided. In no case shall the clearance be less than 24".

TABLE 9.21.6.A.

NATIONAL BUILDING CODE

Forming Part of Article 9.21.6.5.

CLEARANCE BETWEEN A FLUE PIPE AND PROTECTED COMBUSTIBLE MATERIAL	
Type of protection applied to the combustible material unless otherwise specified and covering all surfaces within 18 in. of the flue pipe.	Clearance between flue pipe and combustible material. in.
¼" asbestos millboard spaced out 1" by noncombustible material	12
0.0129" sheet metal on ¼" asbestos millboard	12
0.0129" sheet metal spaced out 1" by noncombustible material	9
0.0129" sheet metal on 1/8" asbestos millboard spaced out 1" by noncombustible material	9
1½" asbestos cement covering on flue pipe	9
0.0259" sheet metal on 1" mineral wool batts reinforced with wire mesh or equivalent	3

C.S.A. B149.1 - 1971

TABLE 25

(See Clause 4.3.8.2.)

CLEARANCE WITH SPECIFIED FORMS OF PROTECTION

Type of Protection	Where the Required Clearance With No Protection Is:					
	36 Inches			18 Inches		
	Above	Sides and Rear	Flue Pipe	Above	Sides and Rear	Flue Pipe
a) ¼" asbestos millboard spaced out 1"	30	18	30	15	9	12
b) 0.0129" (No.28 MSG) sheet metal on ¼" asbestos millboard	24	18	24	12	9	12
c) 0.0129" (No.28 MSG) sheet metal spaced out 1"	18	12	18	9	6	9
d) 0.0129" (No.28 MSG) sheet metal on 1/8" asbestos millboard spaced out 1"	18	12	18	9	6	9
e) 1½" asbestos cement covering on heating appliance	18	12	36	9	6	18
f) ¼" asbestos millboard on 1" mineral wool batts reinforced with wire mesh or equivalent	18	12	18	6	6	6
g) 0.0259" (No.22 MSG) sheet metal on 1" mineral wool batts reinforced with wire mesh or equiv.	18	12	12	4	3	3
h) ¼" asbestos cement board or ¼" asbestos millboard	36	36	36	18	18	18
i) ¼" cellular asbestos	36	36	36	18	18	18

KILN TEST REPORTS

PLEASE INDICATE ALL OF THE ABLE INFORMATION ABOUT YOUR KILN THAT YOU CAN. MAKE THE INFORMATION AS ACCURATE AS YOU CAN. IF SOMETHING CANNOT BE REMEMBERED OR RECALLED PLEASE GUESS AND MARK IT ACCORDINGLY.

1. YOUR NAME ______

   ADDRESS ______

   PHONE ______

2. HAS YOUR KILN BEEN INSPECTED BY THE FIRE MARSHALL Yes

   GAS INSPECTOR ______

3. HAVE YOU CONSULTED ANY ONE REGUARDING THE CONSTRUCTION AND DESIGN OF YOUR KILN? IF SO PLEASE INDICATE THE NAMES AND ADDRESSES IF POSSIBLE.

   Jim Clacherie. Stan Clarke.

4. PLEASE LIST BOOKS,PAMPHLETS,THESIS OR OTHER PUBLICATIONS IN WHICH YOU FOUND HELPFUL INFORMATION.

   Rhodes - "Kilns, Designs & Operation"

   Olsen - "The Kiln Book"

5. IF YOUR GAS KILN WAS PURCHASED PLEASE INDICATE THE MANUFACTURERS

   NAME ______

   ADDRESS ______

   AND ANY INFORMATION YOU FEEL IS HELPFUL REGUARDING THE EFFICIENCY OF THIS KILN.

   Very Good

6. PLEASE INDICATE DATE THE KILN WAS INSTALLED OR FIRST FIRED.

   DAY 17 MONTH Aug. YEAR '74

7. PLEASE STATE THE NUMBER OF FIRINGS THE KILN HAS MADE 50 approx.

   INDICATE THE APPROXIMATE COST OF A FIRING $7.00

   INDICATE THE AMOUNT OF FUEL USED IN A TYPICAL FIRING ______

IS YOUR KILN UPDRAFT

DOWNDRAFT

CROSSDRAFT

IF OTHER PLEASE SPECIFY...........

SPRUNG ARCH

CATERNARY ARCH

CUBE

ROUND

IF OTHER PLEASE SPECIFY............

IF YOUR KILN IS MULTI-CHAMBERED PLEASE INDICATE THE INFORMATION FOR EACH CHAMBER BY NUMBERING THE CHAMBERS 1, 2, 3, AND SO ON. INCLUDE A SKETCH SO THAT THE CHAMBERS CAN BE IDENTIFIED.

PROPORTIONS OF THE KILN EXTERNAL.

WIDTH. THE OUTER EXTREMITY ACROSS THE FRONT 63" ~~x~~= ______.

HEIGHT. FROM BASE TO TOP OF KILN. 120".

DEPTH. FROM FRONT TO BACK 63".

PROPORTIONS OF KILN INTERNAL.

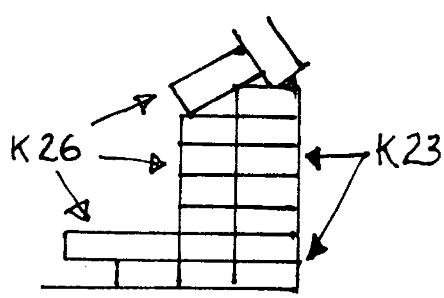
WIDTH. MAXIMUM INTERNAL WIDTH HOT FACE TO HOT FACE. 45".

HEIGHT. FROM TOP OF VENT O
FROM TOP OF LOWER MOST SHELF TO TOP OF INSIDE. 49".

DEPTH. FROM INSIDE OF CLOSED DOOR TO INSIDE REAR. 37".

ON THE REVERSE SIDE OF THIS PAGE PLEASE SKETCH THE KILN FLOOR, WALL, AND ROOF INCLUDE THICKNESS, MAKE, TYPE OF MATERIALS USED.

EXAMPLE.



BRICKS FROM
FAIREY & CO.
NO MORTAR

USABLE KILN SPACE- TH.. SPACE FOR SETTING 'ARES.

WIDTH - THE DISTANCE BETWEEN BAG WALLS. IF NO BAG WALLS DIST. OF SET WARES 27"

HEIGHT- THE DISTANCE FROM THE TOPOF THE USABLE FLOOR TO THE INSIDE TOP OF THE KILN 48"

DEPTH - THE DISTANCE FROM THE INSIDE OF THE DOOR TO THE INSIDE REAR OF THE KILN. 36"

SIZE OF FLUE OPENING - THE EXHAUST VENT

SIZE OF OPENING AT EXIT FROM CHAMBER 7.5"

HORIZONTAL DISTANCE FROM INSIDE FLUE OPENING TO THE VERTICAL SHAFT OF THE CHIMNEY. 18"

VERTICAL RISE IF ANY -

SIZE OF VERTCAL SHAFT 9" X 9"

HEIGHT OF VERTICAL SHAFT (CHIMNEY) 14'

DAMPER

PLEASE SKETCH IN LOCATION IF POSSIBLE

POSITIONS DURING FIRING
PLEASE INDICATE % CLOSED FOR HOURS INDICATED

0		6		12
1		7	50	13
2		8	50	14
3		9	50	15
4		10	50	16
5		11	100*	17

* shut down

BURNERS

TYPE- IF PURCHASED STATE MAKE Clacherie
MODEL
MANUFACTURER
ADDRESS

IF HOME MADE A SKETCH WOULD BE HELPFUL

INDICATE SIZE OF ORIFICE WGS 18

JUMBER OF BURNERS 6

INCLUDE LOCATION OF BURNERS ON THE KILN SKETCH

B.T.U.RATING OF 1 BURNER PER HOUR FULL OPEN 90,000 B. T. U.

DO YOU HAVE.....CIRCLE IF YES

PILOT LITES AUTO-SAFETY SHUT OFF

KILN SITTER ELECTRONIC KILN CONTROL

PYROMETER PLEASE INDICATE ANY OTHER CONTROLS NO

BURNER PORTS

SIZE OF BURNER PORT(SIZE OF OPENING BURNER TO KILN) 4" x 5"

SIZE OF ANY SECONDARY AIR SOURCES ~~x~~

FUEL CIRCLE THE CORRECT ONE

NATURAL GAS WOOD

PROPANE OTHER PLEASE SPECIFY

OIL

TIME

AMOUNT OF TIME USED IN A TYPICAL FIRING 14 hrs.

TEMPERATURE REACHED $^{\circ}C$ 10

TIME TO REACH TEMPERATURE 12 HOURS ____ MIN.

LENGTH OF SOAK 2 HOURS ____ MIN.

TOTAL FIRING TIME START TO SHUT DOWN 14 HOURS ____ MIN.

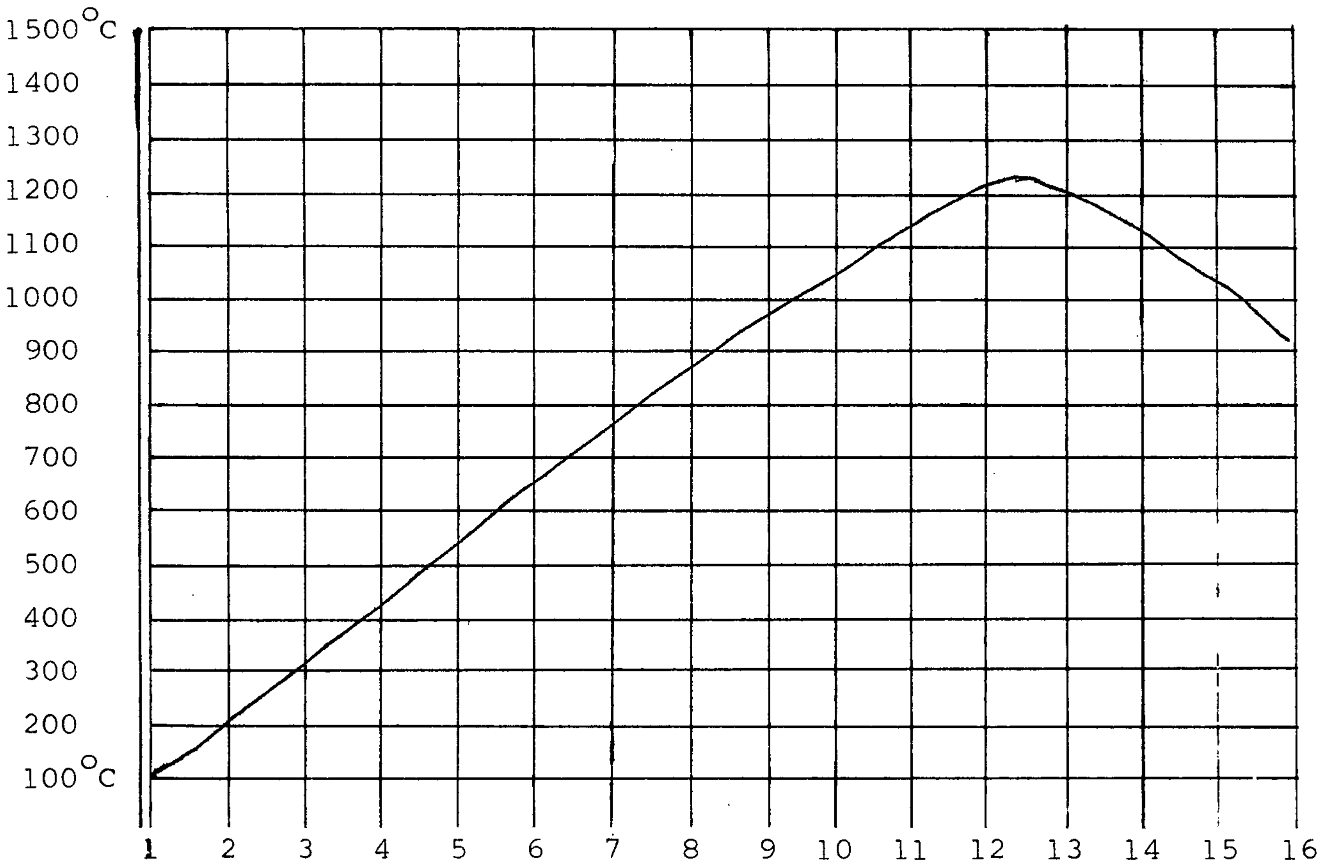
COOL DOWN TIME 20 HOURS ____ MIN.

TOTAL TIME FROM START UP TO TEMPERATURE & BACK DOWN TO UNLOADING TEMPERATURE. 36 HOURS ____ MIN.

ARE YOU FAMILIAR WITH THE DANGERS OF REDUCTION FIRING ?
IF SO STATE THE DANGERS.

CO + Explosion if reignition

PLEASE PLOT ON THIS GRAPH A TYPICAL FIRING.



INDICATE ANY PROBLEMS CREATED DURING FIRING BY:

WIND	RAIN steam	PROPANE TANK FREEZING
OUTSIDE TEMP.	FUEL (PRESSURE)	COOL SPOTS IN KILN
HUMIDITY	GAS SERVICE	REDUCTION

PLEASE WRITE A BRIEF PARAGRAPH INDICATING HOW YOUR KILN HAS FUNCTIONED UP TO THIS POINT.

A Honey.

PLEASE MAKE A SKETCH OF YOUR KILN OR INCLUDE A COPY (PHOTO) OF ANY PLANS YOU MADE. MAKE SURE YOU INCLUDE ANY CHANGES YOU MADE SINCE TO IMPROVE THE OPERATION.

see 24 cu. ft. kiln in Appendix.

PLEASE SKETCH A LOCATION DRAWING OF YOUR KILN ON YOUR PROPERTY INCLUDE USUAL WIND DIRECTION, TALL TREES, BUILDINGS, ETC. IF KILN IS EXPOSED OR IF IT IS INCLOSED, THE DISTANCE FROM YOUR HOUSE OR STUDIO, VENTILATION, IF APPLICABLE AND FLUE ARE HELPFUL.

Ishould like to thank you for your effort. It is my hope to visit as many kiln sites as possible in the near future. If you would not mind having your kiln photographed please indicate by filling out the area below. Indicate a map if you think it might be necessary.

NAME____

ADDRESS______________________________________

PHONE_______________________________________

MAP:

IF YOU DO NOT MIND HAVING ME REFER TO YOUR KILN IN A THESIS PUBLICATION OR TO OTHER ARTISTS PLEASE INDICATE THIS BY SIGNING THE SPACE PROVIDED

____

THANK YOU....

PLEASE INDICATE ALL OF THE ABLE INFORMATION ABOUT YOUR KILN THAT YOU CAN. MAKE THE INFORMATION AS ACCURATE AS YOU CAN. IF SOMETHING CANNOT BE REMEMBERED OR RECALLED PLEASE GUESS AND MARK IT ACCORDINGLY.

1. YOUR NAME ______

   ADDRESS ______

   PHONE ______

2. HAS YOUR KILN BEEN INSPECTED BY THE FIRE MARSHALL ______

   GAS INSPECTOR ______

3. HAVE YOU CONSULTED ANY ONE REGUARDING THE CONSTRUCTION AND DESIGN OF YOUR KILN? IF SO PLEASE INDICATE THE NAMES AND ADDRESSES IF POSSIBLE. ______

4. PLEASE LIST BOOKS, PAMPHLETS, THESIS OR OTHER PUBLICATIONS IN WHICH YOU FOUND HELPFUL INFORMATION.

   Rhodes - "Kilns, Design & Operation"

5. IF YOUR GAS KILN WAS PURCHASED PLEASE INDICATE THE MANUFACTURERS

   NAME ______

   ADDRESS ______

   AND ANY INFORMATION YOU FEEL IS HELPFUL REGUARDING THE EFFICIENCY OF THIS KILN.

   Expensive to operate

6. PLEASE INDICATE DATE THE KILN WAS INSTALLED OR FIRST FIRED.

   DAY ____ MONTH July YEAR '70

7. PLEASE STATE THE NUMBER OF FIRINGS THE KILN HAS MADE 100's

   INDICATE THE APPROXIMATE COST OF A FIRING $35

   INDICATE THE AMOUNT OF FUEL USED IN A TYPICAL FIRING ______

KILN DESIGN

IS YOUR KILN

UPDRAFT

DOWNDRAFT

CROSSDRAFT

IF OTHER PLEASE SPECIFY...........

SPRUNG ARCH

CATERNARY ARCH

CUBE

ROUND

IF OTHER PLEASE SPECIFY...........

IF YOUR KILN IS MULTI-CHAMBERED PLEASE INDICATE THE INFORMATION FOR EACH CHAMBER BY NUMBERING THE CHAMBERS 1, 2, 3, AND SO ON. INCLUDE A SKETCH SO THAT THE CHAMBERS CAN BE IDENTIFIED.

PROPORTIONS OF THE KILN EXTERNAL.

WIDTH. THE OUTER EXTREMITY ACROSS THE FRONT 5' X ______.

HEIGHT. FROM BASE TO TOP OF KILN. 5'2".

DEPTH. FROM FRONT TO BACK 6'.

PROPORTIONS OF KILN INTERNAL.

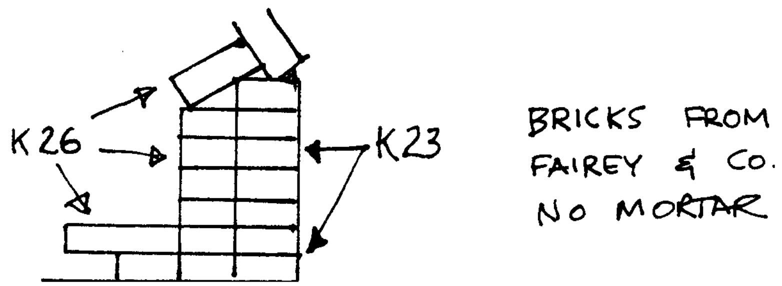
WIDTH. MAXIMUM INTERNAL WIDTH HOT FACE TO HOT FACE. 3.5'.

HEIGHT. FROM TOP OF VENT O
FROM TOP OF LOWER MOST SHELF TO TOP OF INSIDE. 3.9'.

DEPTH. FROM INSIDE OF CLOSED DOOR TO INSIDE REAR. 4'.

ON THE REVERSE SIDE OF THIS PAGE PLEASE SKETCH THE KILN FLOOR, WALL, AND ROOF INCLUDE THICKNESS, MAKE, TYPE OF MATERIALS USED.

EXAMPLE.



USABLE KILN SPACE- TH. SPACE FOR SETTING 'ARES.

WIDTH - THE DISTANCE BETWEEN BAG WALLS. IF NO BAG WALLS DIST. OF SET WARES 2'

HEIGHT- THE DISTANCE FROM THE TOPOF THE USABLE FLOOR TO THE INSIDE TOP OF THE KILN 3.9'

DEPTH - THE DISTANCE FROM THE INSIDE OF THE DOOR TO THE INSIDE REAR OF THE KILN. 4'

SIZE OF FLUE OPENING - THE EXHAUST VENT

SIZE OF OPENING AT EXIT FROM CHAMBER 7' x 9'

HORIZONTAL DISTANCE FROM INSIDE FLUE OPENING TO THE VERTICAL SHAFT OF THE CHIMNEY. 3'

VERTICAL RISE IF ANY ______

SIZE OF VERTCAL SHAFT 9' X 9'

HEIGHT OF VERTICAL SHAFT (CHIMNEY) 10'

DAMPER

PLEASE SKETCH IN LOCATION IF POSSIBLE

POSITIONS DURING FIRING
PLEASE INDICATE % CLOSED FOR HOURS INDICATED

0		6		12	
1		7		13	
2		8		14	
3		9	50	15	50
4		10	50	16	50
5		11	50	17	

BURNERS

TYPE- IF PURCHASED STATE MAKE

MODEL
MANUFACTURER
ADDRESS

IF HOME MADE A SKETCH WOULD BE HELPFUL

INDICATE SIZE OF ORIFICE ______

NUMBER OF BURNERS 4

INCLUDE LOCATION OF BURNERS ON THE KILN SKETCH

B.T.U.RATING OF 1 BURNER PER HOUR FULL OPEN 120,000 B. T. U.

DO YOU HAVE.....CIRCLE IF YES

PILOT LITES	AUTO-SAFETY SHUT OFF
KILN SITTER	ELECTRONIC KILN CONTROL
PYROMETER	PLEASE INDICATE ANY OTHER CONTROLS

BURNER PORTS

SIZE OF BURNER PORT(SIZE OF OPENING BURNER TO KILN) 2.5X 3"

SIZE OF ANY SECONDARY AIR SOURCES ___X___

FUEL CIRCLE THE CORRECT ONE

NATURAL GAS	WOOD
PROPANE	OTHER PLEASE SPECIFY
OIL	

TIME

AMOUNT OF TIME USED IN A TYPICAL FIRING 20

TEMPERATURE REACHED 10 °C

TIME TO REACH TEMPERATURE 20 HOURS ___ MIN.

LENGTH OF SOAK ___ HOURS ___ MIN.

TOTAL FIRING TIME START TO SHUT DOWN 21 HOURS ___ MIN.

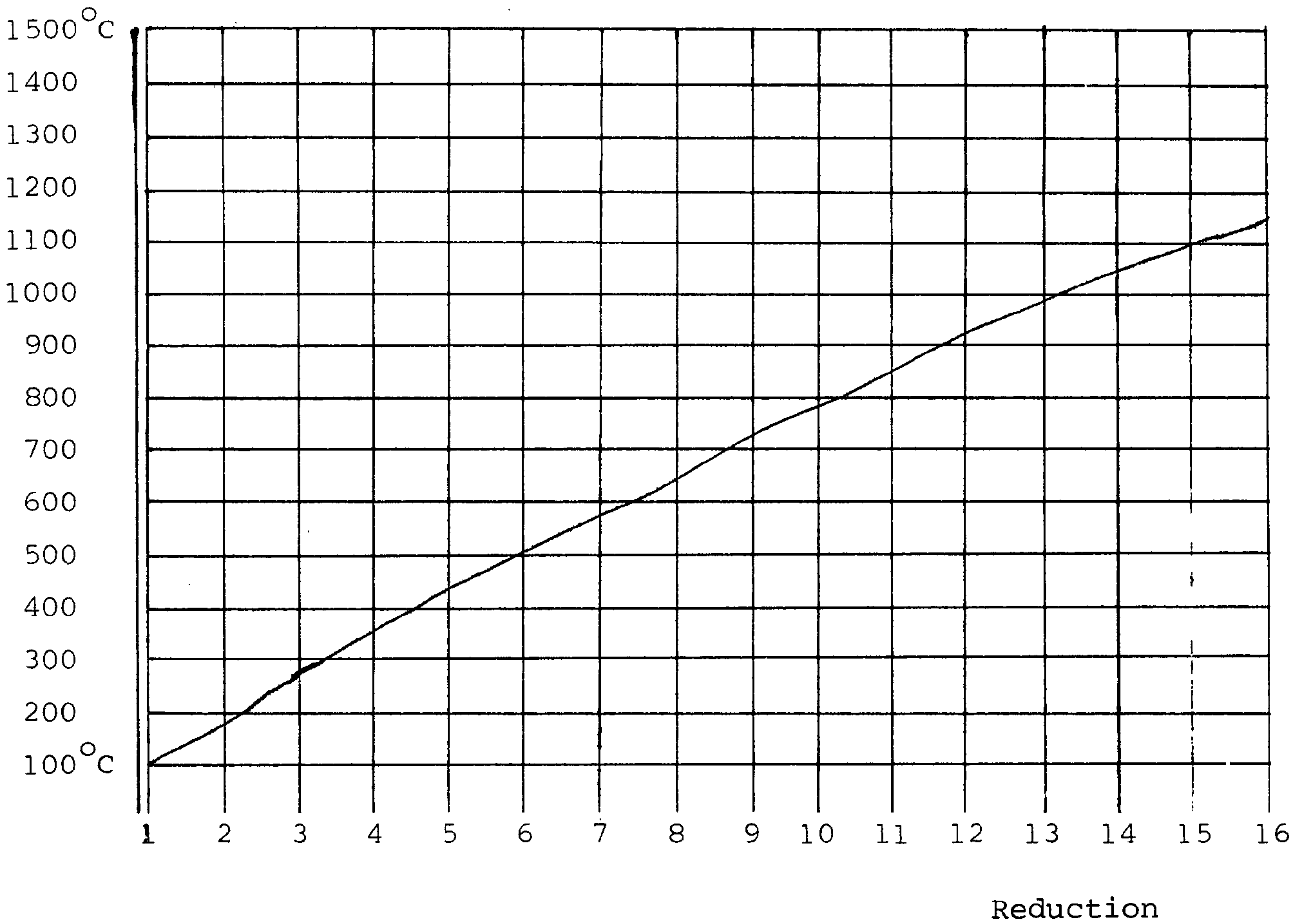
COOL DOWN TIME 24 HOURS ___ MIN.

TOTAL TIME FROM START UP TO TEMPERATURE & BACK DOWN TO UNLOADING TEMPERATURE. 48 HOURS ___ MIN.

ARE YOU FAMILIAR WITH THE DANGERS OF REDUCTION FIRING ?

IF SO STATE THE DANGERS.

PLEASE PLOT ON THIS GRAPH A TYPICAL FIRING.



INDICATE ANY PROBLEMS CREATED DURING FIRING BY:

WIND	RAIN	PROPANE TANK FREEZING
OUTSIDE TEMP.	FUEL (PRESSURE)	COOL SPOTS IN KILN
HUMIDITY	GAS SERVICE	REDUCTION

PLEASE WRITE A BRIEF PARAGRAPH INDICATING HOW YOUR KILN HAS FUNCTIONED UP TO THIS POINT.

PLEASE MAKE A SKETCH OF YOUR KILN OR INCLUDE A COPY (PHOTO) OF ANY PLANS YOU MADE. MAKE SURE YOU INCLUDE ANY CHANGES YOU MADE SINCE TO IMPROVE THE OPERATION.

PLEASE SKETCH A LOCATION DRAWING OF YOUR KILN ON YOUR PROPERTY INCLUDE USUAL WIND DIRECTION, TALL TREES, BUILDINGS, ETC. IF KILN IS EXPOSED OR IF IT IS INCLOSED, THE DISTANCE FROM YOUR HOUSE OR STUDIO, VENTILATION, IF APPLICABLE AND FLUE ARE HELPFUL.

Ishould like to thank you for your effort. It is my hope to visit as many kiln sites as possible in the near future. If you would not mind having your kiln photographed please indicate by filling out the area below. Indicate a map if you think it might be necessary.

NAME________________________________

ADDRESS______________________________

PHONE________________________________

MAP:

IF YOU DO NOT MIND HAVING ME REFER TO YOUR KILN IN A THESIS PUBLICATION OR TO OTHER ARTISTS PLEASE INDICATE THIS BY SIGNING THE SPACE PROVIDED

____

THANK YOU....

ABLE

PLEASE INDICATE ALL OF THE INFORMATION ABOUT YOUR KILN THAT YOU CAN. MAKE THE INFORMATION AS ACCURATE AS YOU CAN. IF SOMETHING CANNOT BE REMEMBERED OR RECALLED PLEASE GUESS AND MARK IT ACCORDINGLY.

1. YOUR NAME ____________________

   ADDRESS ____________________

   PHONE ____________________

2. HAS YOUR KILN BEEN INSPECTED BY THE FIRE MARSHALL ________

   GAS INSPECTOR ________

3. HAVE YOU CONSULTED ANY ONE REGUARDING THE CONSTRUCTION AND DESIGN OF YOUR KILN? IF SO PLEASE INDICATE THE NAMES AND ADDRESSES IF POSSIBLE. ____________________

   ____

4. PLEASE LIST BOOKS, PAMPHLETS, THESIS OR OTHER PUBLICATIONS IN WHICH YOU FOUND HELPFUL INFORMATION.

   ____

   ____

   ____

5. IF YOUR GAS KILN WAS PURCHASED PLEASE INDICATE THE MANU FACTURERS

   NAME ____________________

   ADDRESS ____________________

   ____

   AND ANY INFORMATION YOU FEEL IS HELPFUL REGUARDING THE EFFICIENCY OF THIS KILN.

   ____

   ____

   ____

   ____

   ____

   ____

6. PLEASE INDICATE DATE THE KILN WAS INSTALLED OR FIRST FIRED.

   DAY____ MONTH ________ YEAR ________

7. PLEASE STATE THE NUMBER OF FIRINGS THE KILN HAS MADE ________

   INDICATE THE APPROXIMATE COST OF A FIRING ________

   INDICATE THE AMOUNT OF FUEL USED IN A TYPICAL FIRING ________

IS YOUR KILN

UPDRAFT

DOWNDRAFT

CROSSDRAFT

IF OTHER PLEASE SPECIFY...........

SPRUNG ARCH

CATERNARY ARCH

CUBE

ROUND

IF OTHER PLEASE SPECIFY............

IF YOUR KILN IS MULTI-CHAMBERED PLEASE INDICATE THE INFORMATION FOR EACH CHAMBER BY NUMBERING THE CHAMBERS 1, 2, 3, AND SO ON. INCLUDE A SKETCH SO THAT THE CHAMBERS CAN BE IDENTIFIED.

PROPORTIONS OF THE KILN EXTERNAL.

WIDTH. THE OUTER EXTREMITY ACROSS THE FRONT ______X______.

HEIGHT. FROM BASE TO TOP OF KILN. ________.

DEPTH. FROM FRONT TO BACK ________.

PROPORTIONS OF KILN INTERNAL.

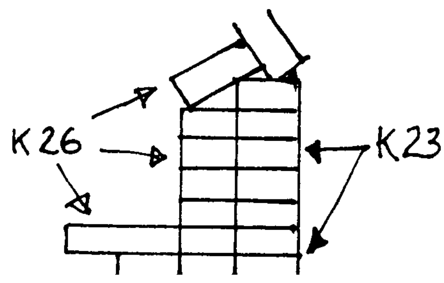
WIDTH. MAXIMUM INTERNAL WIDTH HOT FACE TO HOT FACE. ______.

HEIGHT. FROM TOP OF VENT O
FROM TOP OF LOWER MOST SHELF TO TOP OF INSIDE.______.

DEPTH. FROM INSIDE OF CLOSED DOOR TO INSIDE REAR. ______.

ON THE REVERSE SIDE OF THIS PAGE PLEASE SKETCH THE KILN FLOOR, WALL, AND ROOF INCLUDE THICKNESS, MAKE, TYPE OF MATERIALS USED.

EXAMPLE.



BRICKS FROM
FAIREY & CO.
NO MORTAR

USABLE KILN SPACE- TH. SPACE FOR SETTING 'ARES.

WIDTH - THE DISTANCE BETWEEN BAG WALLS. IF NO BAG WALLS DIST. OF SET WARES ___2'___

HEIGHT- THE DISTANCE FROM THE TOPOF THE USABLE FLOOR TO THE INSIDE TOP OF THE KILN ___3.75'___

DEPTH - THE DISTANCE FROM THE INSIDE OF THE DOOR TO THE INSIDE REAR OF THE KILN. ___3.25'___

SIZE OF FLUE OPENING - THE EXHAUST VENT

SIZE OF OPENING AT EXIT FROM CHAMBER ___35 sq.___ in.

HORIZONTAL DISTANCE FROM INSIDE FLUE OPENING TO THE VERTICAL SHAFT OF THE CHIMNEY. ___3'___

VERTICAL RISE IF ANY ______

SIZE OF VERTCAL SHAFT ___9 X 9___

HEIGHT OF VERTICAL SHAFT (CHIMNEY) ___14'___

DAMPER

PLEASE SKETCH IN LOCATION IF POSSIBLE

POSITIONS DURING FIRING
PLEASE INDICATE % CLOSED FOR HOURS INDICATED

0		6	25	12	50
1		7	25	13	50
2	25	8	50	14	75
3	25	9	50	15	75
4	25	10	50	16	
5	25	11	25	17	

BURNERS

TYPE- IF PURCHASED STATE MAKE Homemade
MODEL
MANUFACTURER
ADDRESS

IF HOME MADE A SKETCH WOULD BE HELPFUL — Alfred Burner from Rhodes book

INDICATE SIZE OF ORIFICE ___WGS 10___

NUMBER OF BURNERS ______

INCLUDE LOCATION OF BURNERS ON THE KILN SKETCH

B.T.U.RATING OF 1 BURNER PER HOUR FULL OPEN Approx. 200,000 B. T. U.

DO YOU HAVE.....CIRCLE IF YES

PILOT LITES AUTO-SAFETY SHUT OFF

KILN SITTER ELECTRONIC KILN CONTROL

PYROMETER PLEASE INDICATE ANY OTHER CONTROLS

BURNER PORTS

SIZE OF BURNER PORT(SIZE OF OPENING BURNER TO KILN) 5" X 6.5"

SIZE OF ANY SECONDARY AIR SOURCES ____ X ____

FUEL CIRCLE THE CORRECT ONE

NATURAL GAS WOOD

PROPANE OTHER PLEASE SPECIFY

OIL

TIME

AMOUNT OF TIME USED IN A TYPICAL FIRING ______

TEMPERATURE REACHED ______ °C

TIME TO REACH TEMPERATURE ______ HOURS ______ MIN.

LENGTH OF SOAK ______ HOURS ______ MIN.

TOTAL FIRING TIME START TO SHUT DOWN ______ HOURS ______ MIN.

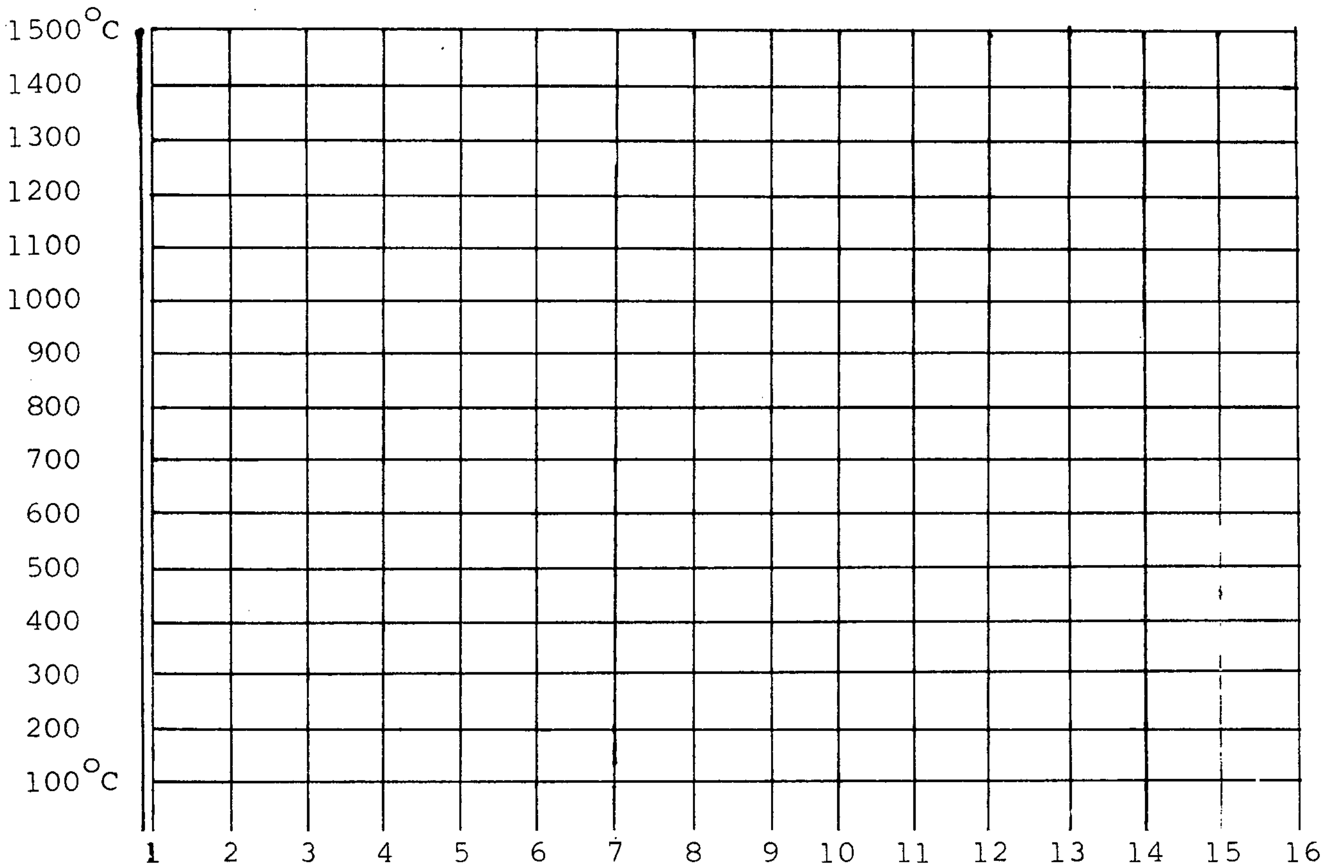
COOL DOWN TIME ______ HOURS ______ MIN.

TOTAL TIME FROM START UP TO TEMPERATURE & BACK DOWN TO UNLOADING TEMPERATURE. ______ HOURS ______ MIN.

ARE YOU FAMILIAR WITH THE DANGERS OF REDUCTION FIRING ?
IF SO STATE THE DANGERS.

Explosion.

PLEASE PLOT ON THIS GRAPH A TYPICAL FIRING.



INDICATE ANY PROBLEMS CREATED DURING FIRING BY:

WIND	RAIN	PROPANE TANK FREEZING
OUTSIDE TEMP.	FUEL (PRESSURE)	COOL SPOTS IN KILN
HUMIDITY	GAS SERVICE	REDUCTION

PLEASE WRITE A BRIEF PARAGRAPH INDICATING HOW YOUR KILN HAS FUNCTIONED UP TO THIS POINT.

Loses pressure at end of some firings.

Uneven temp. front to rear, and sides.

PLEASE MAKE A SKETCH OF YOUR KILN OR INCLUDE A COPY (PHOTO) OF ANY PLANS YOU MADE. MAKE SURE YOU INCLUDE ANY CHANGES YOU MADE SINCE TO IMPROVE THE OPERATION.

PLEASE SKETCH A LOCATION DRAWING OF YOUR KILN ON YOUR PROPERTY INCLUDE USUAL WIND DIRECTION,TALL TREES,BUILDINGS, ETC. IF KILN IS EXPOSED OR IF IT IS INCLOSED, THE DISTANCE FROM YOUR HOUSE OR STUDIO,VENTILATION,IF APPLICABLE AND FLUE ARE HELPFUL.

Ishould like to thank you for your effort. It is my hope to visit as many kiln sites as possible in the near future. If you would not mind having your kiln photographed please indicate by filling out the area below. Indicate a map if you think it might be necessary.

NAME____

ADDRESS______________________________________

PHONE_______________________________________

MAP:

IF YOU DO NOT MIND HAVING ME REFER TO YOUR KILN IN A THESIS PUBLICATION OR TO OTHER ARTISTS PLEASE INDICATE THIS BY SIGNING THE SPACE PROVIDED

____

THANK YOU....

KILN FIRING LOG FOR

18 CU.FT. GAS KILN BUILT BY AUTHOR

USING MODEL PROVIDED.

10 - 1260°

Firing No. 1

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: Sat. Nov. 20, 1976

1.
2.
3.
4.
5.
6.
7.

8. - Begin reducing ports 30%, Damper 50%, Spyholes show small flame, Top & Bottom 6 down.
9.
10.
11.
12.

KILN SMOKING DUE TO INSULATION BURN OFF.

11:30 a.m.

TYPE OF DAY

Sunny (Warm)

Cloudy

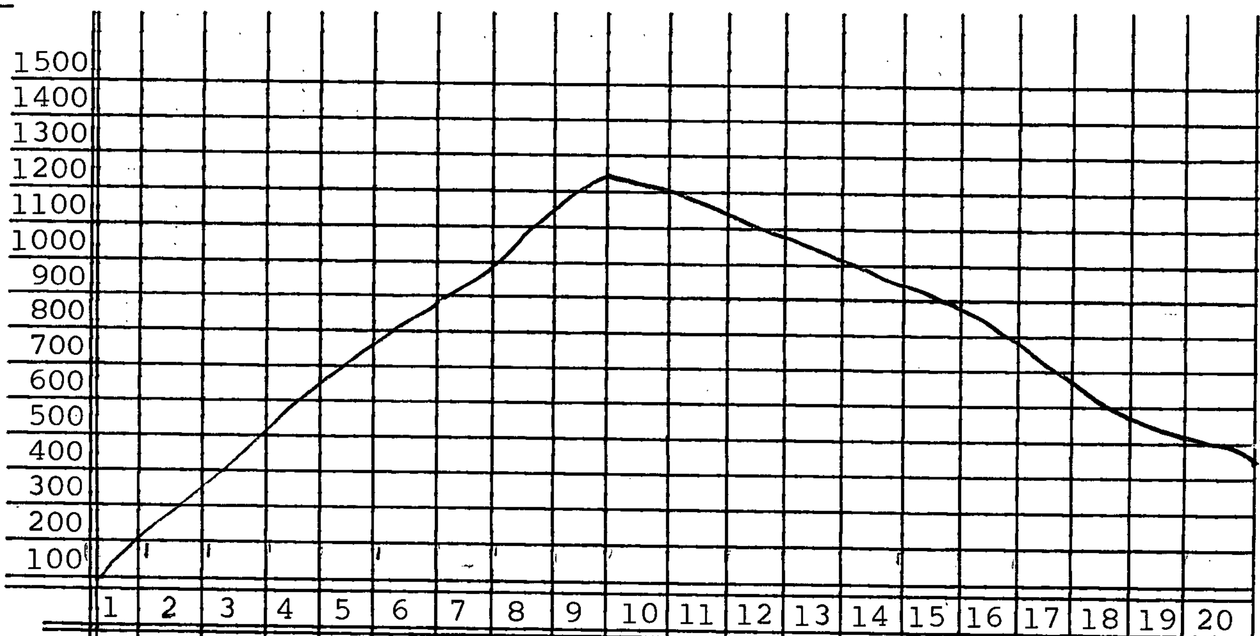
Dull

Rain

Wind Direction NONE

Speed

GRAPH



BURNERS % OPEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2																				
3																				
4																				

DAMPER % OPEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

10 -

Firing No. 2

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: Fri. Nov. 26, 1976

4 All 4 burners low as possible - 12 noon, open damper & ports

5 Damper heat good

3 - 2:00 open door

8 turned all 4 to 50%

11:30 reduction cycle

9:30 a.m. remove plugs, create draft

4:00 p.m.

TYPE OF DAY

Sunny (Cold)

Rain

Cloudy

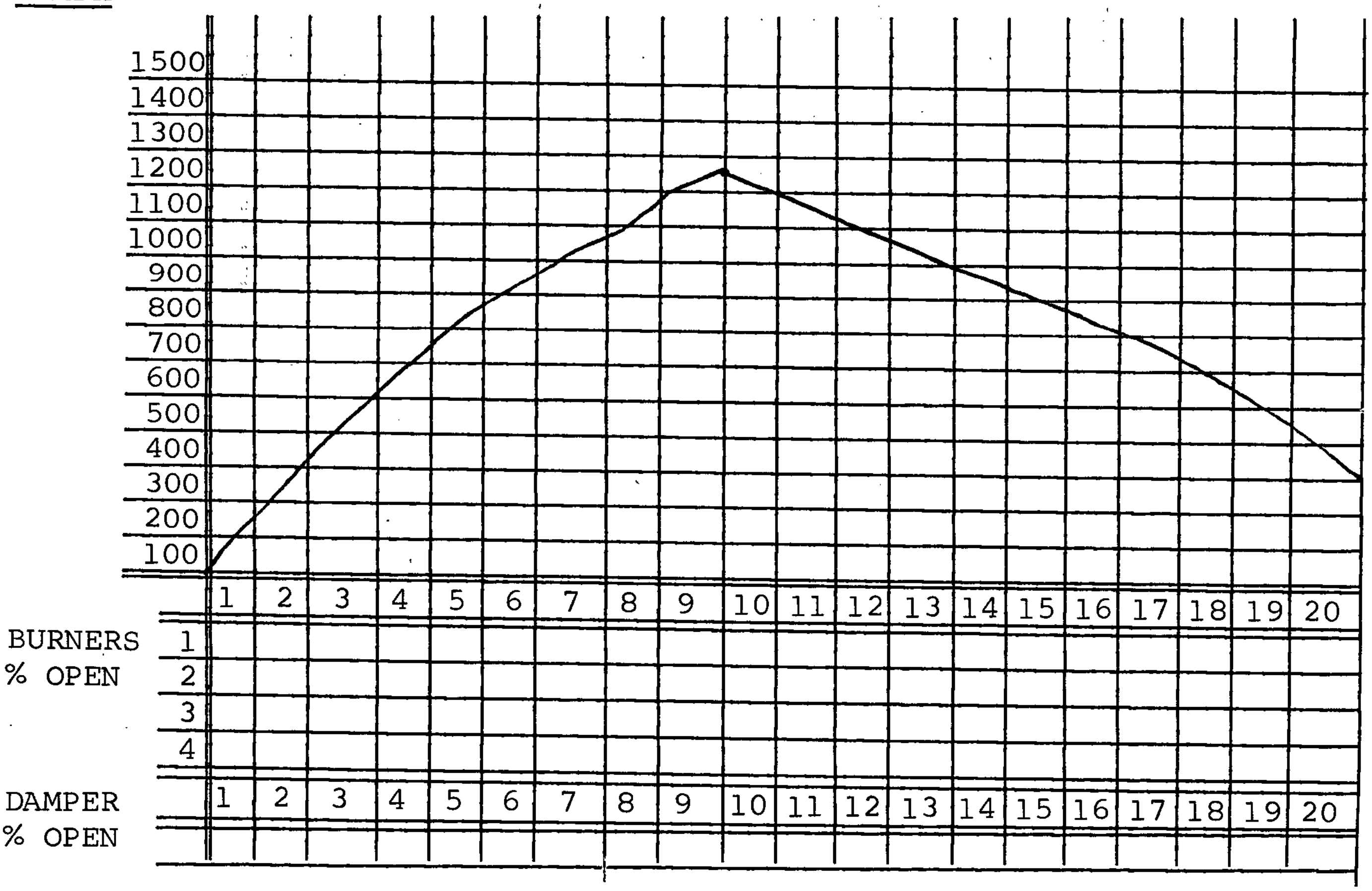
Wind Direction

NONE

Dull

Speed

GRAPH



10 -

Firing No. 3

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: Nov. 27/77

3:45 p.m. ON 85 pieces loaded

10-1045° 1:40 a.m. OFF - soak for 30 min.

10:00 a.m. Open all dampers, plugs & ports.

12 noon OPENING -- EXCELLENT FIRING

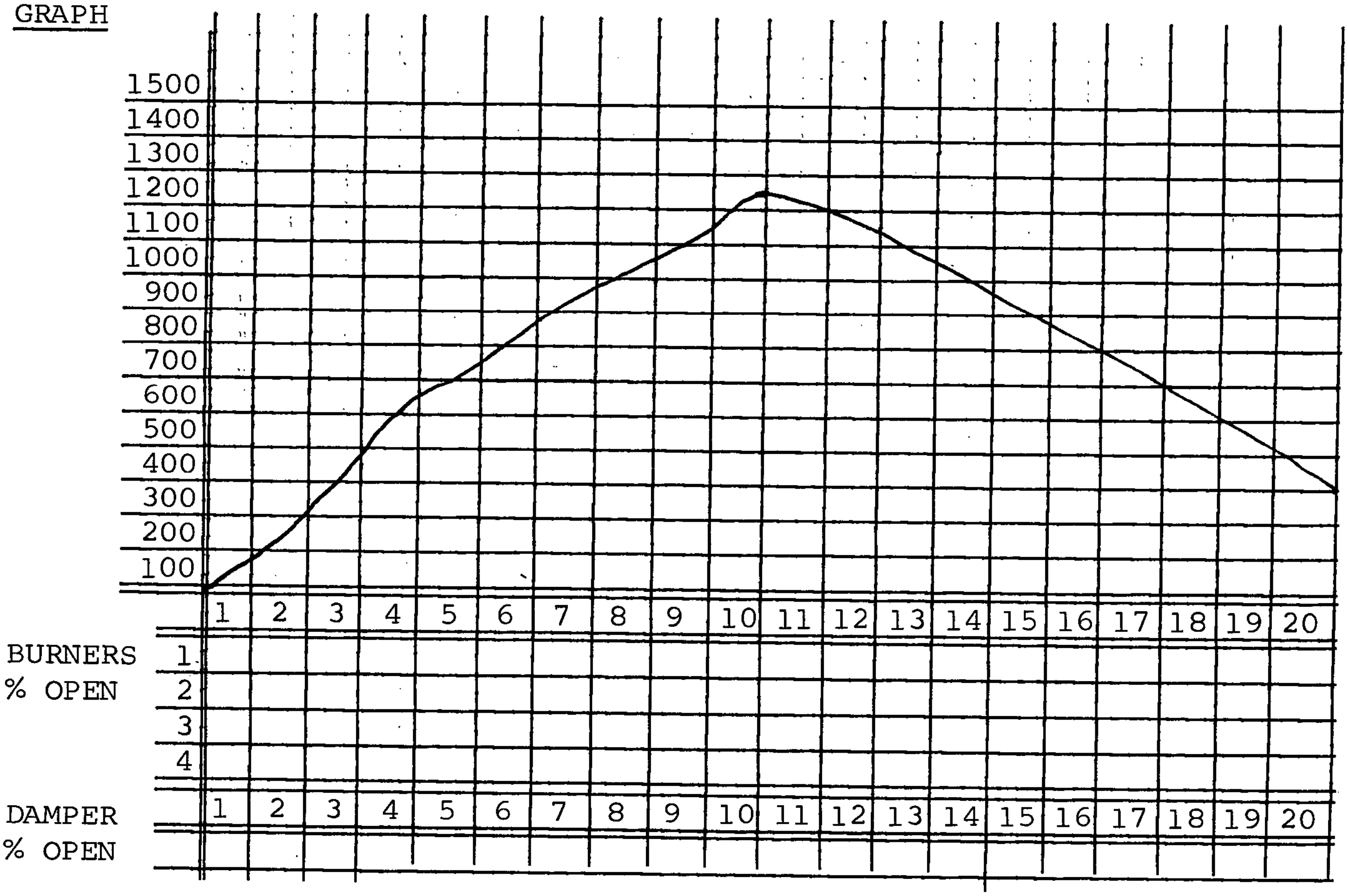
TYPE OF DAY

Sunny (Clear + Cold) Rain

Cloudy Wind Direction

Dull Speed 20 mph, Gusting South & West

GRAPH



10 -

Firing No. 4

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: Dec. 22/76

12 NOON

- Could have fired much quicker
- some warping of wares

TYPE OF DAY

Sunny (Clear)

Cloudy

Dull

Rain

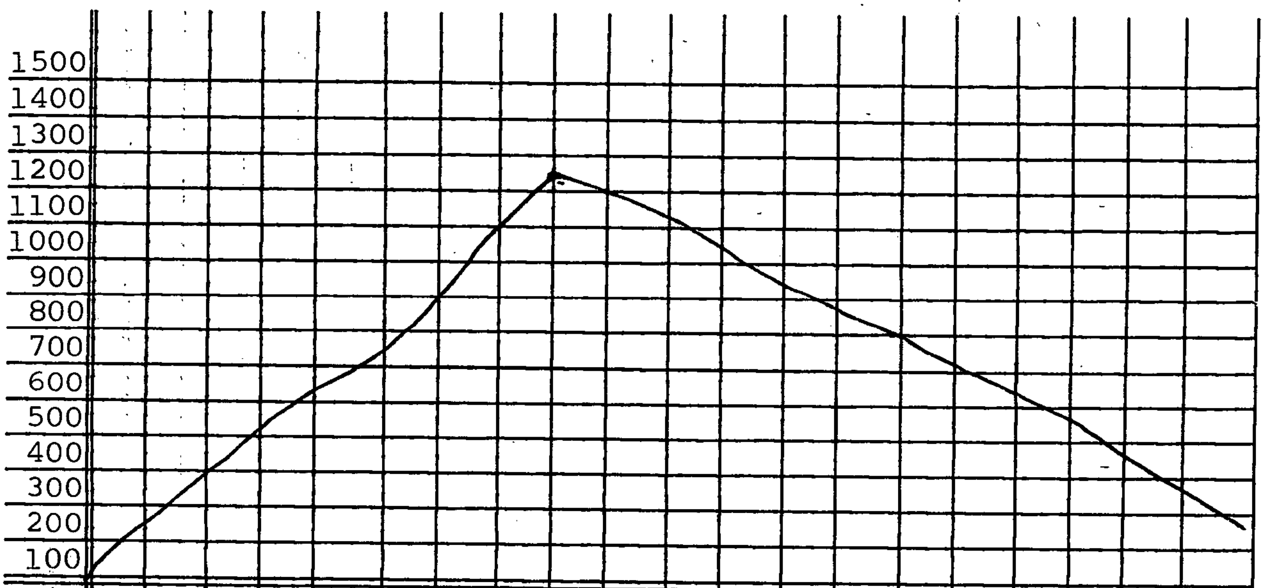
Wind Direction

NONE

Speed

(SE 15 mph - end of firing)

GRAPH



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BURNERS % OPEN	1																				
	2																				
	3																				
	4																				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DAMPER % OPEN																				

10 -

Firing No. 5

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: May 29, 1977

11 A.M.

- 4 coilbuilt vases for G. Hanis
- 3 large bowls
- Porcelain Sculpture
- Stoneware "

Gas Meter 147.5

TYPE OF DAY

Sunny

Rain

Cloudy

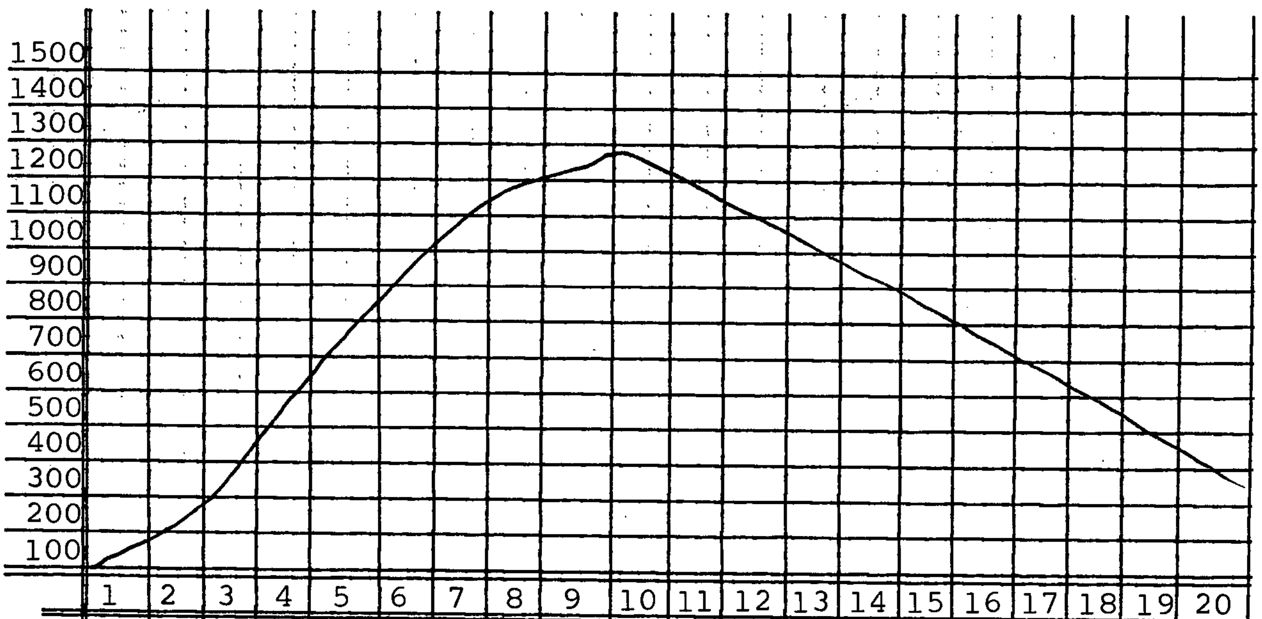
Wind Direction

NIL

Dull

Speed

GRAPH



BURNERS % OPEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2																				
3																				
4																				

DAMPER % OPEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

10 -

Firing No. 6

KILN FIRING LOG

KILN LOAD DISCRIPTION

DATE: Apr. 11/77

Large Vases

21 mugs for B.C.T.F. Eng. Teach. Assoc.

4 large bowls

Beads

Sculpture

TYPE OF DAY

Sunny
+
Cloudy

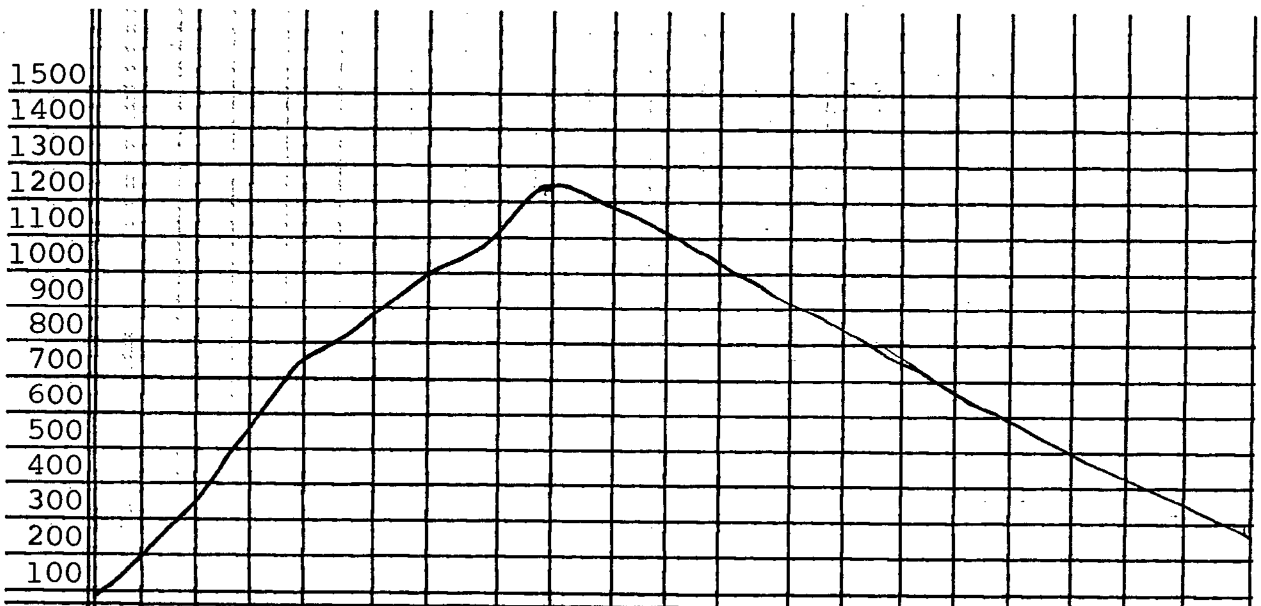
Rain

Wind Direction
SW + SE

Dull

Speed 5-15 mph

GRAPH



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BURNERS % OPEN	1																				
	2																				
	3																				
	4																				
DAMPER % OPEN		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

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