

NAR MAZZETTI
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NAR MAZZETTI



REFRACTORIES

- SUPER SILICA BRICK
- SILICA BRICK
- FIRECLAY BRICK
- INSULATING FIREBRICK
- SUPER DUTY BRICK
- HIGH ALUMINA BRICK
- HI TEMPERATURE MORTARS
- PLASTIC REFRACTORIES
- CASTABLE REFRACTORIES
- FIRECLAYS

NORTH AMERICAN REFRACTORIES CO.
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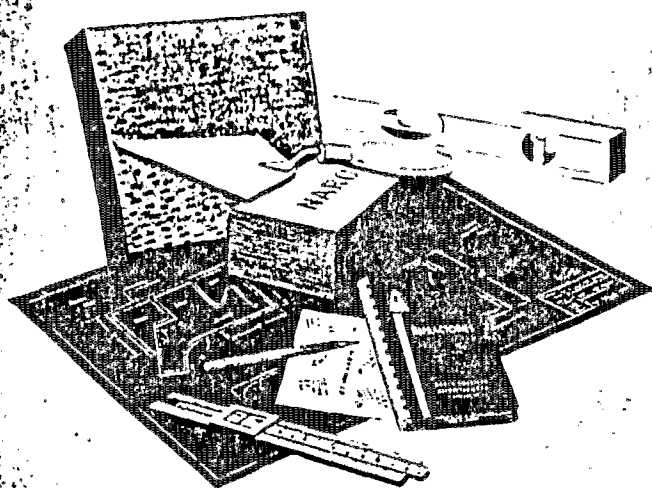
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NAR-59



REFRACTORIES

"The Backbone of Industry"

FOREWORD



This pocket-sized booklet is intended to be a handbook for the user of refractories as well as a catalogue. The tables are designed to give complete coverage of all necessary information for the design and application of refractory materials. They have been thoroughly revised to give a maximum of data with emphasis on clearness and easy usage. This is a workaday booklet outlined for convenient reference in solving everyday problems.

The refractory products covered are highly diversified. They range from high alumina and super duty silica to low duty firebrick. For use in conjunction with these various types of brick, there is offered a complete series of high temperature mortars and ground fire clays. The proper one is available for any type of installation. Similarly, a wide variety of plastic refractories and castable refractories is described. The proper selection of these materials is quite important as service life is often determined as much by the mortar used or the refractory specialties employed as it is by the fire brick. The properties of these materials are tabulated for conciseness and clarity.

The products described are backed by ample, proven resources which insure uniformity and availability for years to come. In each major producing district all of the important manufacturing processes are employed to produce refractories that will successfully meet the exacting service conditions of present day furnaces. All mining and manufacturing procedures are under regular laboratory control to insure the consistent, high quality of NARCO products.



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BRANDS OF FIRECLAY BRICK

A.S.T.M. Class	Brand	Process
PENNSYLVANIA BRANDS		
Super Duty.....	NARCO 71.....	D.P.
High Duty.....	CRESCENT.....	D.P., S.P., H.M.
	-CRESCENT-.....	D.P.
	CRESCENT Bung..	D.P.
	Q.R. GLASS.....	D.P.
	RELIANCE.....	D.P.
Intermediate Duty..	KING.....	D.P.
Low Duty.....	ELK STEEL.....	H.M.
	KEYSTONE.....	D.P.
KENTUCKY BRANDS		
High Duty.....	ASHLAND CROWN	S.P.
	ASHLAND EMPIRE	
	CROWN.....	H.M.
	ASHLAND	
	HIGRADE.....	D.P.
Blast Furnace.....	ASHLAND BF.....	S.P.
	ASHLAND BF TOP	S.P.
	ASHLAND Bottom	
	Blocks.....	D.P., S.P.
Intermediate Duty..	ASHCO.....	D.P., S.P.
MISSOURI BRANDS		
Super Duty.....	NARCO 68.....	D.P., S.P.
High Duty.....	FARBER.....	D.P.
	-FARBER-.....	S.P.
	FARBER Bung.....	D.P.
	FARBER C.....	D.P.
	FARBER F.....	D.P.
Intermediate Duty..	FFB.....	D.P.
OHIO BRANDS		
Intermediate Duty..	DOVER.....	D.P.
Low Duty.....	BUCKEYE.....	D.P., S.P.
	WIRE CUTS.....	Extruded
D.P. = Dry Press H.M. = Hand Made S.P. = Steam Press		



TYPES OF FIRECLAY BRICK

Fireclay brick are the industry's most important product because their wide range of properties fits them for use in a great variety of refractory applications. NARCO fireclay brick plants are located in Pennsylvania, Ohio, Kentucky and Missouri where a wide variety of high-grade flint, semi-flint and plastic bond clays are available in the highest quality. In each district NARCO produces a series of brands with various combinations of properties, so that there is always available a brand to meet successfully any service condition where fireclay brick are applicable.

The properties of fireclay brick are dependent primarily upon the types of clays used, the proportions of the various clays employed and the process of manufacture. The grain structure, moisture content during forming, as well as firing temperatures and procedures also influence the final product.

Brick produced by the dry press method are suitable for a wide variety of service applications. The brick are formed under high pressures by sturdy mechanical presses which gives an excellent balance in the properties of the end product. The brick have good spalling and abrasion resistance and at the same time have reasonable resistance to slag attack. They possess adequate strength and good load-bearing ability at high temperatures.

The steam press method of manufacture gives a strong, dense product with a resulting low porosity. This tight, dense structure is highly resistant to abrasion and to the penetration of slags as well as chemical attack or solution by fluxes.

The hand made process of manufacture has the special characteristic of high versatility. Small quantities can be made most economically by this process and tile of unusual size or complicated shape can be produced.

All products are fired under strict control to give desirable physical and mineral changes thereby producing strong, well-bonded brick. All NARCO brands of fireclay refractories possess uniformity of physical properties, workmanship and size of the finished product.



SUPER DUTY FIRECLAY BRICK

Increased severity of service conditions in many modern furnaces has made it more economical to use super duty refractories rather than even the best high duty brick. With their greater refractoriness, outstanding spalling resistance, high strength, constancy of volume at high temperatures and ability to withstand many types of corrosive slags, super duty brick offer



the furnace builder a material for use under extreme conditions.

Through extensive research, NARCO has developed super duty brands with many desirable properties to resist a combination of destructive forces. In some furnaces super duty brick are used to line only the hot spots while in others the entire hot zone is lined with super duty refractories. The decision is based on, (a) cost per unit of product treated, (b) seriousness of possible failure from use of lower quality brick, (c) cost of interruption in operation, (d) reduction in operating costs because of better process control and (e) insurance against unexpected interruptions.

NARCO 68 and 71 are supplied in standard dry press sizes which method of manufacture insures uniform quality and workmanship. Hand made shapes and tile are available of equally refractory material thus making possible complete super duty installations. NARCO super duty brick are made of a blend of several of the purest and most carefully selected fireclays to insure a super product. In the process of manufacture, the clays are properly proportioned, ground to a definite grain sizing, formed, dried and fired by the most advanced, controlled methods.

NARCO 68 is a Missouri product of medium grain structure. The high spalling resistance and slag resistance, together with high strength, makes NARCO 68 suitable for a wide variety of service conditions.

SUPER DUTY FIRECLAY BRICK



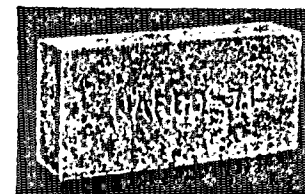
This brand is especially valuable where there is a combination of high temperatures, active slag attack and spalling action. Such conditions occur in oil-fired or coal-fired boilers operating at high ratings, glass tank port necks and uptakes, upper checker chamber walls and upper courses of checker brick, heating furnace roofs, enameling furnaces, and malleable iron air furnace walls and bottoms.

NARCO 68 products are well known wherever super duty brick are used and have established many outstanding service records under extremely severe operating conditions. This wide spread use testifies to the excellent physical and chemical properties of this product which results in increased service life.

NARCO 71 is a Pennsylvania super duty product quite similar to NARCO 68 in grain structure and also in its fields of greater usefulness. The excellent service records for NARCO 71 under adverse conditions were possible because of the high quality of this product. These records were compiled through many years of continued use by satisfied customers.

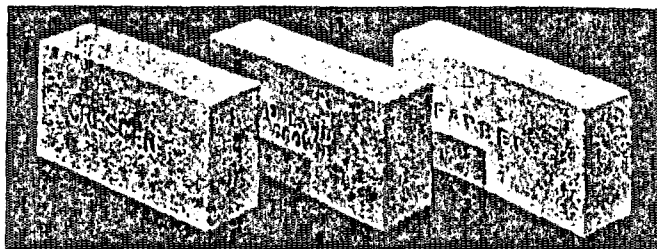
NARCO 71 possesses a remarkable freedom from shrinkage at high operating temperatures which enables tight masonry construction to be maintained throughout the life of the furnace. This brand has found wide application throughout the east since its early development for lining pulverized coal fired boilers, and especially in oil fired furnaces, many of which have been rebuilt from designs intended for coal firing. In this type of service NARCO 71 has not only proved to be decidedly economical, but has also given excellent, uniform operating conditions. Other applications correspond in general to those where the prevailing conditions are too severe for high duty fireclay brick.

In most instances where super duty brick are used, the selection of a proper mortar plays an important part in the construction of the furnace. NARCO has developed several types of mortars as well as super duty fireclay mixtures to meet the demands of the different conditions that may be encountered.





HIGH DUTY FIRECLAY BRICK



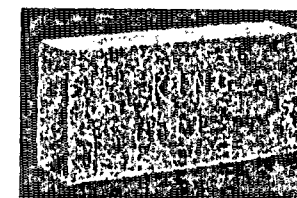
NARCO produces brick of high duty quality in all the major producing districts thus enabling the furnace operator to obtain just the brick for his needs, in a minimum amount of time and at a minimum cost to him. This is possible through the scientific combining of numerous types of clay and variations in the processing methods whereby a series of brands is produced in each district possessing a range of physical properties to combat various combinations of destructive forces present in installations.

Fireclay brick are required to have properties such as high refractoriness, high density, constancy of volume at high temperatures and resistance to thermal shock, slag penetration, erosion, corrosion and abrasion. In one instance the spalling resistance may be of prime importance in one part of a furnace while in another part of the same furnace slag penetration may be dominant. Proper selection of the various types of high duty refractories can materially lengthen the service life of such an installation. It is not unusual to use a high duty brick to withstand certain destructive forces present even when operating temperatures indicate the use of intermediate or low duty brick. Each of our brands possesses to the highest degree the particular properties desired. This high quality was developed by long years of close cooperation with the users of fire brick and the adjusting of the brick properties to suit exactly the service conditions to be encountered.

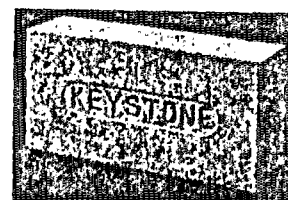
INTERMEDIATE AND LOW DUTY FIRECLAY BRICK



In general, when refractory structures are subjected to relatively moderate or low temperatures, brick of the intermediate or low duty class give excellent service. They are strong, tough, dense and are especially resistant to abrasion and slag action at moderate temperatures. Thus they find use in cooler sections of boilers, upper parts of cupolas, cooler sections of both vertical and rotary lime kilns and portland cement kilns, heating and annealing furnaces and many similar furnaces or portions of furnaces operated at moderate temperatures.



Of course, both intermediate and low duty brick are used extensively as back-up materials for high and super duty fire brick in a wide variety of furnaces. The toughness and abrasion resistance of these brick enable them to successfully withstand all types of mechanical abuse from causes outside the furnace and thereby protect the weaker but more refractory inner walls.



Low duty and many intermediate duty fire brick are resistant to damage by continued exposure to moisture and freezing conditions. Because of these characteristics they are used widely for underground flues and foundations which are exposed to

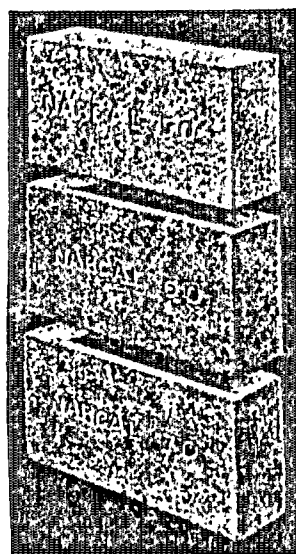
ground water, and for the outside of furnaces, kilns and chimneys exposed to the weather.

In many industrial furnaces, operating temperatures often call for the use of low or intermediate duty brick but high or even super duty brick must be used to combat the other destructive forces present which shorten the life of the refractories.



HIGH ALUMINA BRICK

Increased temperatures and other severe operating conditions in many modern furnaces have made it necessary to develop a material of higher refractoriness than super duty brick. Refractories of the high alumina class can meet these more rigid requirements as they are progressively more refractory than fire-clay brick in proportion to their alumina content. In addition to temperature resistance, high-alumina refractories have excellent load bearing characteristics and an unusual resistance at alkaline slags. They also retain good spalling resistance at higher temperatures than do high duty or super duty refractories. These outstanding properties enable high alumina brick to withstand the conditions present



in the more vulnerable parts of furnaces. NARCO supplies four standard grades of high alumina brick with 50%, 60%, 70% and 80% alumina content. Each one possesses balanced properties which they retain under increasingly severe service conditions.

NARCAL 50, with an alumina content of 50%, has a P.C.E. value of 34-35 which is more refractory than super duty brick. Other important properties are high resistance to spalling and slag attack, high mechanical strength and excellent volume stability at operating temperatures. NARCAL 50 is used extensively in lime kilns of both the vertical and rotary types and in rotary cement kilns. They are also used in boiler furnaces, heating furnaces and forge furnaces where brick are exposed to rapid temperature fluctuations and as top checker brick in glass tank regenerators where alkali attack is severe because of the high temperatures encountered.

HIGH ALUMINA BRICK



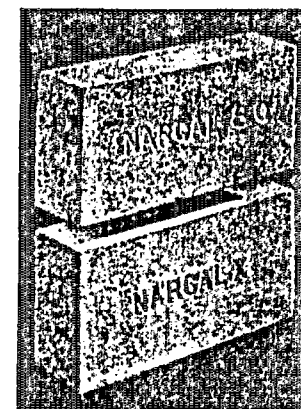
NARCAL 60 brick carry these valuable properties to a higher temperature level. They have high volume stability in the presence of lime and alkali fluxes.

These properties dictate use of NARCAL 60 brick in various types of oil-fired furnaces, lime kilns, cement kilns, and at the slag line of metallurgical furnaces, as well as in port walls, uptakes and upper checker courses of glass tanks. Many burner blocks for high temperature furnaces are supplied in NARCAL 60 quality.

NARCAL 70 is furnished with still more refractory qualities to meet extremely severe conditions. Containing 70% alumina, this brick finds its widest application in the hot zones of rotary kilns producing lime, cement and dolomite. The texture is such that there is a relatively low penetration by molten slags and softened clinker, yet it takes on and holds a satisfactory coating in cement kilns.

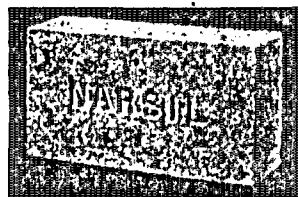
To complete the line of high-alumina brick, NARCAL 80 is produced to meet the most extreme conditions that can be met by diaspore-base materials. It has extreme refractoriness and resistance to shrinkage and to fluxing action.

NARCAL X brick are manufactured by a special process using a considerable amount of fused alumina as their base material. This combination yields excellent resistance to abrasion with high refractoriness, high strength and excellent volume stability. These brick are well suited for numerous applications such as hearths of various types of heating furnaces, forge furnace hearths, slag lines and areas of mechanical abuse in soaking pits, and the various parts of glass tanks where the attack from volatile alkalis is severe.





The properties which make silica refractories so desirable are excellent load bearing ability, freedom from shrinkage at high temperatures, high mechanical strength, high refractoriness and rigidity almost up to the melting point.



NARSIL is a super duty silica brick developed to meet the demand for a silica refractory that would permit higher furnace temperatures, and longer service life. NARSIL is of maximum purity and runs from 60° to 100° F. higher in refractoriness under load at elevated temperatures than regular silica brick. NARSIL brick are used largely in roofs of open hearth furnaces where there is an overall reduction both in the number of brick per net ton of steel and a reduction in refractories cost.

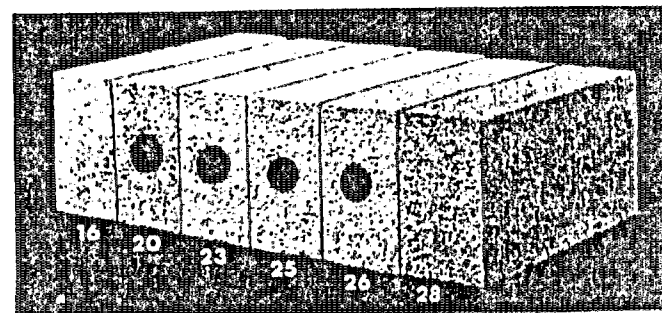
Mr U silica brick are well known wherever silica brick are used due to their excellent service records. They are made from carefully selected raw materials and manufactured under strict control to insure the highest quality silica brick. The firing is carried out at extra high temperatures which are held several days to secure thorough conversion. The extra heat treatment is costly but it insures volume stability under operating conditions.



Some typical applications are open hearth furnace walls and roofs, electric arc steel furnaces and by-product coke ovens. Silica is also used in glass tank superstructure walls and caps, copper reverberatory and refining furnaces, and gas retorts. NARCO's silica Ticknor checkers are giving unusually good service in glass melting furnaces.



INSULATING FIRE BRICK



NARCO, acting as distributors for a leading manufacturer, offers six types of insulating fire brick for furnace construction. This complete line is designed for temperatures from 1600° F. to 2800° F. The selection of any one type depends mainly upon the maximum temperature to be encountered in service.

All types can be used directly exposed in equipment fired with gas, oil, electricity, or powdered fuel. However, insulating fire brick should not be used where they are exposed to molten metal and slags or severe mechanical abrasion. When these conditions prevail, insulating fire brick should be used as back-up insulation.

Insulating fire brick improve furnace operation by:

1. Reducing fuel costs
2. Speeding production
3. Insuring more accurate temperature control
4. Simplifying furnace design
5. Reducing construction costs
6. Quieting furnace noises

The brands A-16, A-20 and A-25 are used where maximum service temperatures reach 1600° F., 2000° F., and 2500° F. respectively. Known as light duty brands, they are most effective where lightness of weight and high insulating value are of prime importance.

The three brands A-23, A-26 and A-28 are used where maximum operating temperatures are 2300° F., 2600° F. and 2800° F. These heavy duty brands are capable of withstanding heavy loads and are particularly suited for any type of exposed face service where slagging and abrasion are not paramount.

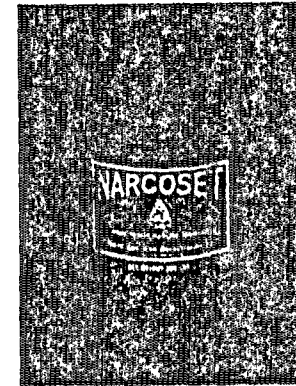
HIGH TEMPERATURE BONDING MORTARS

BRAND	PRINCIPAL USES	General Characteristics		Temperature of Use		Containers
		Type of Set	Form As Shipped	Minimum	Maximum	
NARCOSET	With all types of clay fire brick (including super duty and insulating particularly on walls cooled on one side.	Air Set	Wet	Room	3000°F.	50-, 100- and 200-lb. drums
NARCO No. 101	With all types of clay fire brick, particularly on walls cooled on one side.	Air Set	Dry	Room	3000°F.	100-lb. bags
NARCOBOND-S	With high duty and low duty clay fire brick and silica brick, where fast set is desired.	Air Set	Dry	Room	2600°F.	100-lb. bags
NARCO No. 99	With high duty, super duty and high alumina brick, particularly for division walls or in contact with highly alkaline slags.	Heat Set	Dry	2200°F.	3100°F.	100-lb. bags
NARCAL HIGH ALUMINA MORTAR	With 50, 60 and 70 per cent alumina brick.	Heat Set	Dry	2200°F.	3200°F.	100-lb. bags
NARCO-SIL	With all types of silica brick and clay fire brick where acidic slags, molten metals or gases attack the lining.	Heat set	Dry	2300°F.	3100°F.	100-lb. bags
NARCOBOND-L	Flues, foundations of furnaces and chimneys, where water may be encountered.	Set	Dry	Room	2400°F.	100-lb. bags
FIRECLAY MIXTURES AND FIRE CLAYS	With all types of clay fire brick.	Heat set	Dry	1400°F.	3100°F.	Bulk or 100-lb. bags

NARCOSET



NARCOSET is an air-setting high temperature bonding mortar which is shipped in wet form. It bonds brickwork securely from normal room temperature to 3000° F. and is recommended for laying fireclay, super-duty fireclay, high alumina and insulating fire brick. NARCOSET is composed of the highest grade clays and calcines which enables it to withstand high temperatures without shrinking, cracking, softening or overfiring. Comparatively thick joints may be used without difficulty because of these properties.



NARCOSET is ready mixed and is supplied in a uniform consistency that is perfect for the average troweled joint. If dipped joints are desired, it may be thinned with water to the proper consistency. Its ability to retain moisture, even in contact with very porous materials such as insulating fire brick, is an invaluable aid to proper bricklaying.

NARCOSET is designed to meet severe service conditions, combat spalling, hold a wall in place under extreme temperature conditions, keep joints tight, hold heat in and cold air out. Every property that has a bearing on furnace life has been developed to an extremely high degree in harmony with all others.

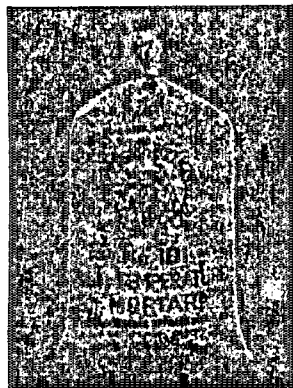
NARCOSET is manufactured under the most modern methods known. All ingredients are proportioned by modern devices and milled in equipment designed especially for this particular manufacturing operation. These procedures coupled with rigid control testing insure that every shipment arrives on the job, in excellent condition and ready for use.

NARCOSET, the finest of air-setting bonding mortars, is shipped in all-metal, air-tight drums in 50-, 100- and 200-pound sizes.



NARCO NO. 101

NARCO No. 101 is a dry, air-setting high temperature bonding mortar which, when mixed with water, is similar to NARCOSET except for a slightly modified dry strength. It is manufactured from similar high grade materials and, therefore, is similar in refractoriness, workability, freedom from shrinkage and resistance to slagging. It is used widely for laying fire brick wherever a dry mortar is preferred. NARCO No. 101 is shipped dry but comes as close to possessing the desired properties of a wet air-setting mortar as it is possible to secure.



NARCO No. 101 is shipped in 100-lb. burlap bags with waterproof paper linings to insure arrival on the job in excellent condition. To use, it is only necessary to mix the dry mortar thoroughly in a tight mortar box, and add sufficient clean water for the desired consistency.

NARCO No. 101 is easily applied and begins to set very soon after it is applied, forming a strong bond between the brick. This bond is maintained at industrial furnace temperatures.

NARCOBOND S

NARCOBOND S is a dry, air-setting mortar with a silica base, suitable for use with silica or fireclay brick. It possesses air-setting properties similar to NARCO No. 101 except that the air set is secured somewhat faster and the strength developed slightly greater. It has high resistance to abrasion and to some fluxes and so finds exceptional use under certain special conditions.

NARCOBOND S is shipped in 100-lb. burlap bags with waterproof paper linings.

NARCO NO. 99



NARCO No. 99 is a dry, heat-setting mortar of the highest quality with the maximum of refractoriness. A blend of selected raw and calcined clays plus correct grain sizing gives the mortar a desirable balance of properties.

NARCO No. 99 possesses negligible shrinkage, has excellent workability and great resistance to solution and attack by slags. It develops a satisfactory bond above 2200° F. and finds its greatest use between that temperature and 3100° F. which is the practical limit of most fuel-fired industrial furnaces.

It finds special application in piers, division walls of boilers and furnaces, baffles, division arches and target walls where soaking heats are encountered and extreme refractoriness is demanded. It is also used widely in furnaces where alkali attack is severe.

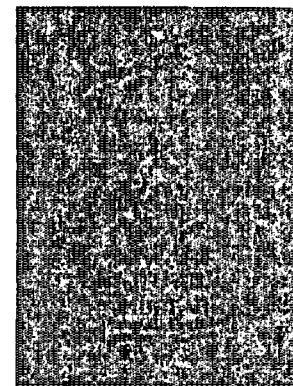
NARCO No. 99 is shipped in 100-pound, waterproof, paper-lined, burlap bags to insure safe arrival on the job. Since it contains no air-setting ingredients, it may be stored indefinitely without change. To use, it is necessary only to mix it with clean water and permit a short time for slaking of the plastic clay.

NARCOBOND L

NARCOBOND L is a hydraulic-setting mortar for use up to 2400° F., and is well suited for use in flues, stacks, foundations and similar parts of furnace structures, especially where water may be present during emergency conditions.

NARCOBOND L is shipped in burlap, paper-lined bags, ready for use after mixing with water. In order to develop the full strength of the mortar joint the brick should be soaked in water for a short time before use.

NARCOBOND L should be stored in a dry location and kept free from moisture and high storage temperatures.





NARCO-SIL

NARCO-SIL is a super silica mortar used in conjunction with regular M_T U silica brick or NARSIL super duty silica brick wherever furnace conditions are very severe. It has unusual balanced properties such as maximum refractoriness, excellent workability, high resistance to slag erosion, negligible shrinkage, good bonding characteristics and high load-bearing ability. It contains no fire clay or siliceous clay whatever, but makes use of other special ingredients to give it outstanding plasticity and bonding power.

NARCO-SIL possesses excellent workability shown by a very satisfactory water retention period and at the same time excellent body and freedom from stickiness. These properties plus good bonding characteristics and resistance to erosion make NARCO-SIL well suited for service in open-hearth furnaces operating at the highest rates. These same properties, plus a chemical composition practically identical to that of the best silica brick, give longer life to caps and upper structure of glass tanks.

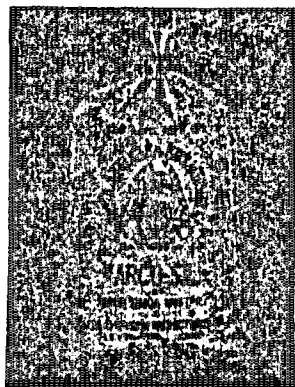
NARCO-SIL is shipped in 100-lb. burlap, paper-lined bags. To use, it is only necessary to mix with clean water to the desired consistency.

M_T U SILICA CEMENT

M_T U SILICA CEMENT is produced in two grades, coke oven and open hearth, which are standard mortars for laying silica brick. M_T U Coke Oven Cement is also used in glass tanks as well as in coke ovens. Both grades possess high refractoriness and good working properties.

These products can be troweled easily, and are also used satisfactorily for dipped joints. They develop a strong ceramic bond when heated to furnace operating temperatures.

They are supplied in bulk or multi-wall paper bags of 100-lb. capacity.



NARCO FIRECLAY MIXTURES **FIRECLAYS AND CALCINES**



FIRECLAY MIXTURES: When service conditions in furnaces are not severe, fireclay mixtures offer the most economical mortars with a balance in properties to give good furnace construction. They are highly refractory, reasonably low in shrinkage, possess good bonding characteristics at high temperatures and have good workability.

These mixtures are available in multi-wall paper bags although, if desired, mixtures can be shipped in bulk.

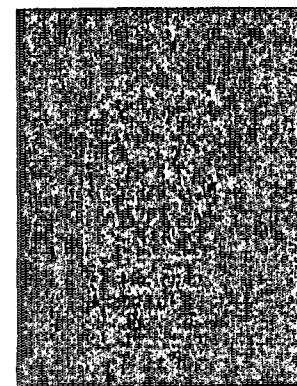
NARCAL HIGH ALUMINA MORTAR MIX is designed for use with 50%, 60%, and 70% alumina-diapore fireclay brick. It is the lowest priced material recommended for use with high alumina refractories.

NARCO SUPER FIRECLAY MIXTURES are prepared for use with super duty fireclay brick as the most reasonably priced mortar that can be recommended for this type of brick.

There are special **PLASTIC CLAY-FLINT CLAY MIXTURES** for use with high duty fire brick to avoid the shrinkages encountered with straight plastic fire clay and yet have a mortar of excellent plasticity and body.

RAW FIRE CLAYS: NARCO offers a wide variety of raw, ground fire clays which may be used for mortar. The diversity of clays available permits the selection of those with the desired properties of refractoriness, dry and fired strength, and bonding characteristics.

CALCINED CLAYS: Various calcined fire clays are available for furnace work and for preparing ceramic bodies. These may consist of ground and screened high duty fire brick or of calcined virgin flint clay of high quality. They are shipped in heavy multi-wall paper bags or, if desired, may be shipped in bulk where extreme economy is necessary.



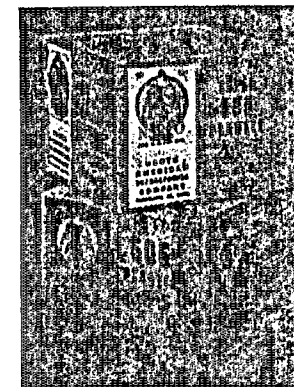
PLASTIC AND CASTABLE REFRACTORIES

BRAND	PRINCIPAL USES	General Characteristics			Temperature of Use		Containers
		Type	Condition As Shipped	Pounds per cu. ft.	Minimum	Maximum	
NARCO SUPER 505 PLASTIC	Patching and new monolithic construction where service is unusually severe.	Plastic	Wet	145	2000°F.	3100°F.	100-lb. water-tight cartons
NARCO 505 PLASTIC	Patching and new monolithic construction heated over 2000°F. on hot face.	Plastic	Wet	135	2000°F.	3000°F.	100-lb. water-tight cartons
NARCOLINE	Patching and new monolithic linings where slag resistance is imperative.	Plastic	Wet	145	2000°F.	3100°F.	100-lb. water-tight cartons
NARCO HEARTH	Patching and new monolithic construction in thick sections heated up to 2700°F. on hot face.	Castable	Dry	120	Room	2700°F.	100-lb. bags
NARCO BAFFLEMIX	Patching and new monolithic construction in thin sections heated up to 2700°F. on hot face.	Castable	Dry	115	Room	2700°F.	100-lb. bags
NARCOCRETE	Patching and new monolithic construction where light weight and insulating value are important.	Castable	Dry	70	Room	2450°F.	50-lb. bags
NARCOLITE	Patching and new monolithic construction where light weight and high insulating values are essential.	Castable	Dry	50	Room	2000°F.	50-lb. bags

NARCO PLASTIC REFRACTORIES



NARCO plastic refractories are available in two grades: NARCO 505 for moderate and high duty service, and NARCO SUPER 505 for more severe operating conditions. Both grades are ready-to-use refractory materials in plastic form suitable for repairing furnace walls and for building monolithic linings in boiler settings, heating and annealing furnaces, forge furnaces, ladles and forming burner blocks or other special shapes. Both NARCO 505 and NARCO SUPER 505 are composed of the best grades of raw and calcined clays obtainable and are compounded to give maximum service and ease of installation.



NARCO 505 is intended for use in those places where high duty fire brick would ordinarily be adequate. The plastic form of this material makes it adaptable for economical patching and lining construction where it is not practical or convenient to use standard fire brick.

NARCO SUPER 505 can be used under the most severe furnace conditions. It has a refractoriness and composition similar to that of super duty fire brick and thus is designed for use in applications beyond the limits of NARCO 505 PLASTIC. It serves the purpose of patching and repairing installations where appreciably higher refractoriness is necessary.

These products are shipped in easy-to-handle, 100-lb. cartons and sealed in newly-developed, moisture-proof plastic envelopes to retain the special workability incorporated at the plant. Before packing, the plastic refractory is cut in convenient slabs two inches thick.

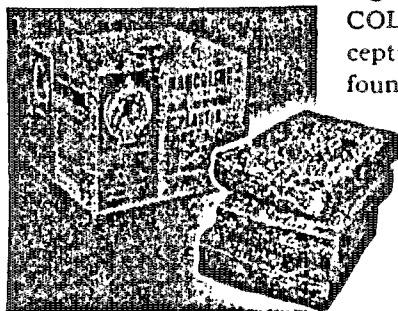
Estimate 135 pounds of NARCO 505 or 145 pounds of NARCO SUPER 505 PLASTIC to form a cubic foot.



NARCOLINE

Slag resistant plastic refractory

NARCOLINE is a slag-resistant plastic refractory which is at its best when in contact with molten metal or in applications where reducing conditions exist. NARCOLINE has proven exceptional when used in foundry ladles, spouts and blast furnace runners or wherever high resistance to solution from many types of slags is necessary.



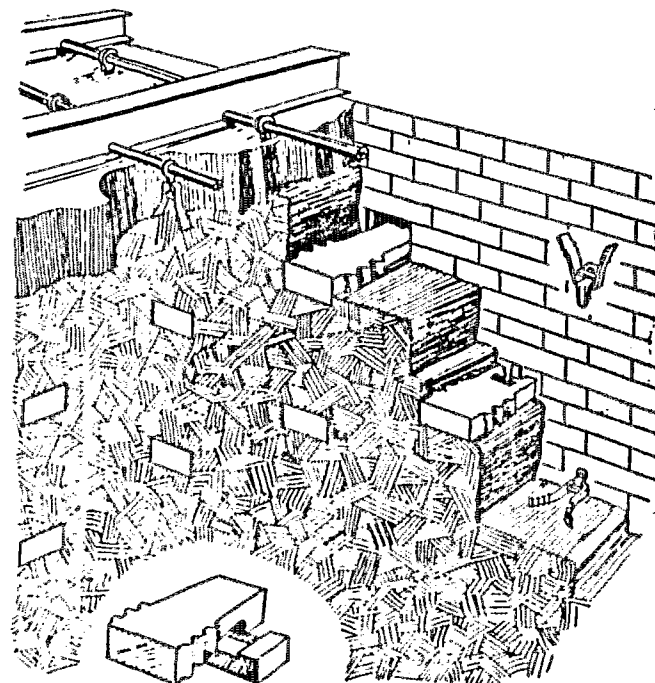
NARCOLINE is composed of super duty materials and possesses balanced properties which insure excellent service life. Only the very best raw materials are selected for this product and are combined in such a manner as to insure ease of installation and close packing to produce maximum density. This product is manufactured under strict plant control and a workability range can be provided from very stiff for air hammer installation to very soft for hand placing.

Although NARCOLINE gives its best results in a reducing atmosphere, when it is exposed to strongly oxidizing conditions the properties of this slag-resistant plastic are those of super duty plastic with all of the high refractoriness and excellent resistance to slag attack and spalling of the best of that class of product.

NARCOLINE is shipped in easy-to-handle 100-lb. cartons. The plastic is cut into 2-inch slices which facilitates installation. NARCOLINE is sealed in newly-developed, moisture-proof plastic envelopes which retain the special workability incorporated at the plant.

For estimating purposes, allow 145 pounds of NARCOLINE for each cubic foot of lining.

ANCHORS FOR INSTALLATION OF PLASTIC AND CASTABLE REFRACTORIES



Shown in the above illustration are various types of anchors and how they are used in a typical wall and flat arch.

The refractory anchors shown are designed for high temperatures and severe service conditions. The anchor tile may be installed using either the refractory box mounted in the wall or metal clips. Both methods allow flexibility of movement in service and also allow the anchor tile to be readily replaced.

The metal anchors shown are flexible in application, easily installed and free to move during expansion and contraction of the walls or arches. Their use in monolithic furnace walls insures safe, strong construction.



NARCO CASTABLE REFRACTORIES

NARCO produces four types of castable refractories for a wide variety of applications. These are mixtures that are shipped dry and are to be mixed with clean water, cast in place and cured for approximately eighteen hours to develop strength. They may then be dried and fired similar to any other refractory.



NARCO HEARTH is a medium-grained product developed for wide use under severe service conditions up to 2700°F. Raw materials for this product are carefully blended to give ample refractoriness, negligible shrinkage in service, good strength and

reasonable resistance to spalling and abrasion. It is designed for use in large sections such as floors, sidewalls, arches and doors of large furnaces. At the same time, it is equally suitable for construction of smaller furnaces, ash pits, car slabs for tunnel kilns or heat treating furnaces or for the repair of worn spots in furnaces operated up to 2700°F.

NARCO HEARTH is shipped dry in 100 lb. waterproof bags. Allow 120 pounds of NARCO HEARTH for each cubic foot of construction.

NARCO BAFFLEMIX is a similar product with a top operating temperature of 2700°F. but is furnished in a finer grain size so that thin sections may be cast easily. NARCO BAFFLEMIX is especially suited for casting baffles around boiler tubes, for forming thin door linings, for dental furnaces and other small heating devices. It is also convenient for forming complicated shapes and tile for emergency repairs or special construction.

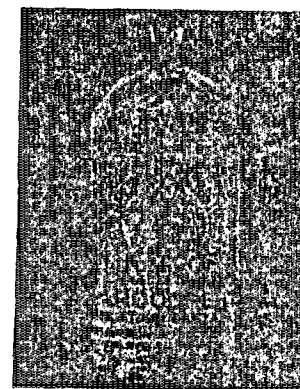
NARCO BAFFLEMIX is also shipped in 100-pound waterproof bags and requires 116 pounds per cubic foot of construction.



NARCO CASTABLE REFRACTORIES



NARCOCRETE is an insulating castable with a hydraulic-setting action which permits rapid utilization after casting in position. Composed of an insulating aggregate, this castable when fired in place has two outstanding advantages in insulating value and light weight. When these considerations are important in service, NARCOCRETE is recommended and may be used up to operating temperatures of 2450°F.



NARCOCRETE is especially valuable for heat-retaining doors and for providing a smooth insulating layer for foundations of furnaces, tunnel kiln cars and annealing furnace cars. In such cases heat losses are reduced and uniform temperature conditions promoted.

NARCOCRETE is shipped in 50-lb. waterproof burlap bags. For estimating purposes, allow 70 pounds of NARCOCRETE as shipped for each cubic foot of furnace wall.

NARCOLITE is a lightweight castable refractory with a density of 50 lbs. per cubic foot. Some typical applications are lining hot air flues, upper walls, arches and doors of annealing and tempering furnaces, glass lehrs, domestic heating furnaces, air preheaters, oil refining units and waste heat boilers. In each of the above installations NARCOLITE is valuable because of (a) its good insulating value, (b) its low density thus requiring only small supporting members, (c) its low heat capacity and quick heat-up to operating temperatures, (d) its volume stability and (e) its excellent workability and ease of placing.

This material is used wherever the top temperature does not exceed 2000°F. and abrasion or serious fluxing action is absent. It is shipped in 50-pound bags and can be installed by molding, casting, troweling or spraying.



CHROME SPECIALTIES

NARCHROME MORTAR (Air-Set)

NARCHROME MORTAR (Air-Set) is an air-setting, high temperature bonding mortar with a chrome ore base. The only preparation necessary is mixing with clean water to the consistency desired, thereby obtaining a mortar excellent for laying or coating all types of basic brick, as well as clay and high alumina, when these are in contact with highly corrosive slags or oxides.



NARCHROME MORTAR (Air-Set) has excellent workability and suspension characteristics along with a high refractoriness and good bonding strength which properties are

desirable for numerous applications over a wide temperature range. The air-setting ingredients, after drying, form a strong bond until a ceramic bond is developed at higher temperatures.

NARCHROME MORTAR is supplied in dry form and is shipped in 100-lb. bags.

NARCHROME MORTAR (Heat-Set)

NARCHROME MORTAR (Heat-Set), with chrome ore as its base, is a chemically neutral high temperature mortar of maximum refractoriness. This high refractoriness imparts maximum resistance to basic and ferrous slags. It possesses a small amount of air-set but depends chiefly on high temperatures to obtain its permanent set in service.

NARCHROME MORTAR (Heat-Set) has high water retention and good plasticity which makes it ideal for all types of troweled joints. It is also widely used for patching small holes in furnaces or in NARCHROME PLASTIC. Strong adhesive characteristics make this mortar very suitable for bonding and spray-coating all kinds of refractories.

Furnished dry in 100-lb. bags, it requires only the addition of water before using.

CHROME SPECIALTIES

NARCHROME PLASTIC REFRACTORY



NARCHROME PLASTIC REFRACTORY is a neutral chrome product supplied in the plastic condition, ready to use. Strength and hardness are developed upon air drying with strength being further increased when the plastic is heated to high temperatures. This plastic possesses good grain sizing for maximum density and the required plasticity to be rammed into place.

The hard, dense, finished surface is highly resistant to a wide variety of slags and mechanical abrasion and thus finds wide usage in installations such as rammed bottoms of soaking pits, heating furnaces, heat-treating and forging furnaces, and walls and bottoms of pulverized coal-fired boilers.

NARCHROME PLASTIC REFRACTORY is furnished in 200-lb. steel drums. Approximately 195 pounds are required to ram a cubic foot.



NARCHROME CASTABLE REFRACTORY

NARCHROME CASTABLE REFRACTORY is a chrome ore base, hydraulic-setting material which is recommended for temperatures up to 2850°F. To use, mix with clean water to the desired consistency and then pour like concrete.

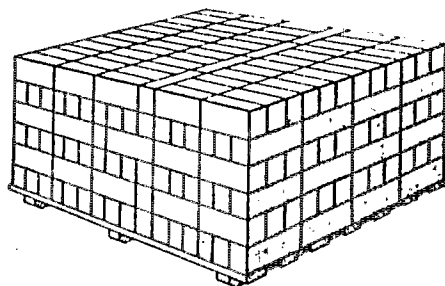
Like NARCHROME PLASTIC REFRACTORY, it has excellent resistance to chemical attack by fluxes, basic slags and molten metals and may be used for patching walls and floors of NARCHROME PLASTIC.

It may be used for walls and floors of water-cooled boiler furnaces and lower walls and hearths of heating furnaces where high iron oxide slags normally cause severe erosion and abrasion.

NARCHROME CASTABLE REFRACTORY is supplied dry in 100-lb. bags and about 185 lbs. of material is required to cast one cubic foot of lining.



PALLETIZING



NARCO is equipped to furnish refractories on pallets to users who desire such shipments in order to facilitate the unloading and handling of refractories by mechanical means.

Loaded pallets are shipped in box cars employing either of the two carloading systems in general use. Under the floating load system the pallet loads are secured in units by means of wood end gates bound with heavy steel strapping to provide the utmost stability of the load while in transit. Where the fixed load system is employed the wood end gates are dispensed with and the pallet loads are compactly placed in the box car with loose (unpalletized) brick packed in the open space in the doorway of the car to stabilize and prevent shifting of the load enroute. Pallets and gates are returnable and a full credit allowed when they are returned in usable condition.

The standard pallets are 36" x 48" in size and have three 2" x 2 1/2" runners. The capacity of such a pallet ranges from approximately 450 to 500 -- 9" equivalent in fire clay and silica refractories, depending on the weight factor of the type of refractory involved.

GUARANTEES



NARCO uses extreme care throughout every phase of production and distribution of its refractories in order to furnish only high quality materials which in its judgment is best suited for the purposes for which they are intended.

The consumer will find it advantageous to seek and select the material which will give him the best results and to exercise care and discretion in the use of the material which he receives.

In the sale of refractories, no performance guarantees are made, since the manufacturer has no control over the conditions to which his products are subjected in service.

SIZE DEVIATIONS

When tested in accordance with Standard Method C-134 of the American Society for Testing Materials, nine-inch series brick shall not show a size variation of more than plus or minus two per cent. Tile or shapes shall not show a size variation of more than plus or minus two per cent on dimensions of four inches or over, and plus or minus three per cent on dimensions smaller than four inches.

WARPAGE

Ninety-five per cent of the tile or shapes shall not show a warpage of greater than one per cent of the diagonal measured when tested in accordance with A.S.T.M. Standard Method C-154.

OVERSHIPMENTS

The following overages shall be allowable on all shipments of shapes that are not standard:

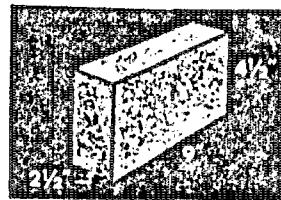
Quantity Specified	Overages
1 to 100.....	10%*
101-1,000.....	7%
1,001-5,000.....	3%
5,001-10,000.....	2%
Over 10,000.....	1%

* Not less than one shape. If in sets, 1 complete set.

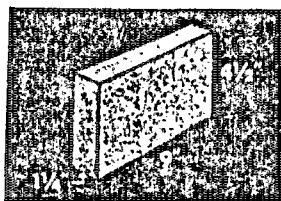


STANDARD FIRECLAY BRICK SIZES ★

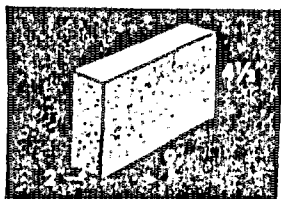
9" x 4 1/2" x 2 1/2" SERIES



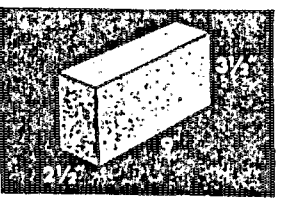
9" STRAIGHT
9" x 4 1/2" x 2 1/2"



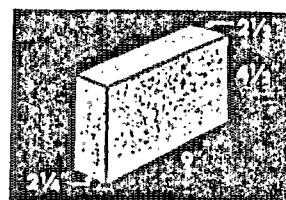
SPLIT BRICK
9" x 4 1/2" x 1 1/4"



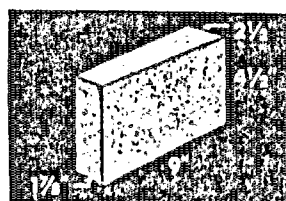
2 INCH BRICK
9" x 4 1/2" x 2"



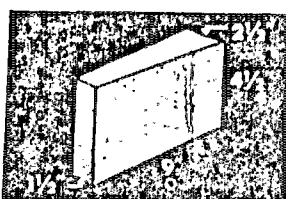
SMALL 9" BRICK
9" x 3 1/2" x 2 1/2"



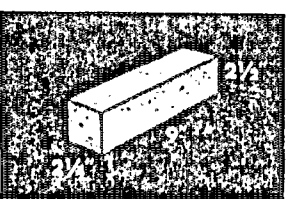
No. 1-X WEDGE
9" x 4 1/2" x (2 1/2"-2 1/4")
6'-9" Inside Radius



No. 1 WEDGE
9" x 4 1/2" x (2 1/2"-1 7/8")
2'-3" Inside Radius



No. 2 WEDGE
9" x 4 1/2" x (2 1/2"-1 1/2")
1'-11 1/2" Inside Radius

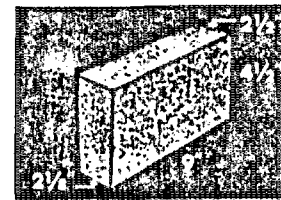


SOAP BRICK
9" x 2 1/2" x 2 1/4"

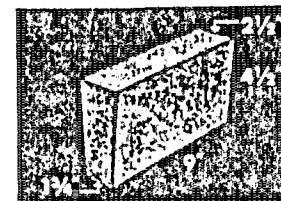
* Also standard in silica brick

STANDARD FIRECLAY BRICK SIZES ★

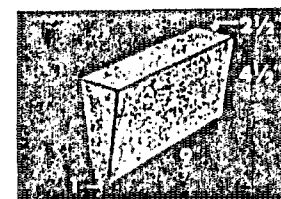
9" x 4 1/2" x 2 1/2" SERIES



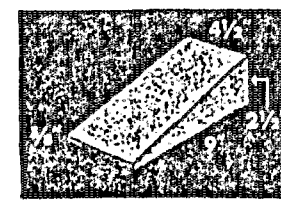
No. 1 ARCH
9" x 4 1/2" x (2 1/2"-2 1/8")
2'-1 1/2" Inside Radius



No. 2 ARCH
9" x 4 1/2" x (2 1/2"-1 3/4")
10 1/2" Inside Radius

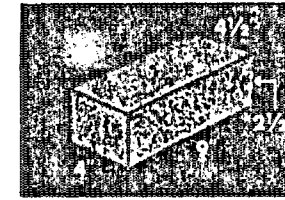


No. 3 ARCH
9" x 4 1/2" x (2 1/2"-1")
3" Inside Radius

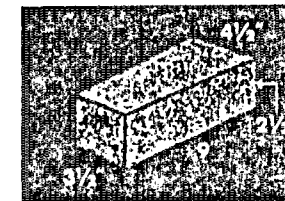


NECK BRICK
9" x 4 1/2" x (2 1/2"-5/8")

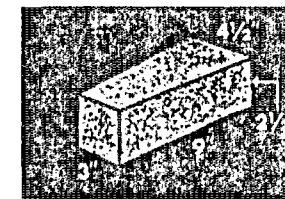
* Also standard in silica brick



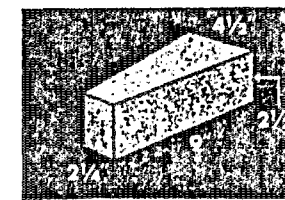
No. 1 KEY
9" x (4 1/2"-4") x 2 1/2"
6'-0" Inside Radius



No. 2 KEY
9" x (4 1/2"-3 1/2") x 2 1/2"
2'-7 1/2" Inside Radius



No. 3 KEY
9" x (4 1/2"-3") x 2 1/2"
1'-6" Inside Radius



No. 4 KEY
9" x (4 1/2"-2 1/4") x 2 1/2"
9" Inside Radius



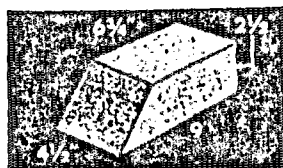
STANDARD FIRECLAY BRICK SIZES

9" x 4 1/2" x 2 1/2" SERIES



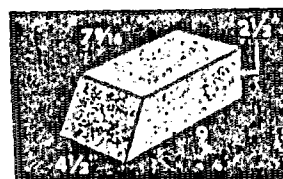
JAMB BRICK*

9" x 4 1/2" x 2 1/2"



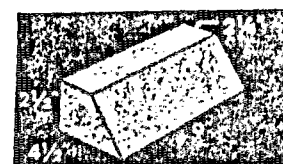
48° END SKEW*

(9"-6 3/4") x 4 1/2" x 2 1/2"



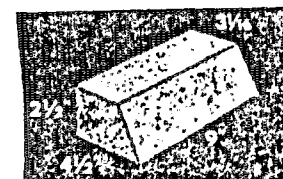
60° END SKEW*

(9"-7 7/16") x 4 1/2" x 2 1/2"



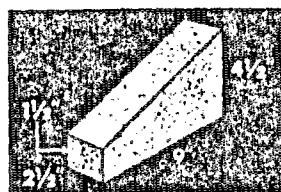
48° SIDE SKEW*

9" x (4 1/2"-2 1/4") x 2 1/2"



60° SIDE SKEW*

9" x (4 1/2"-3 1/16") x 2 1/2"



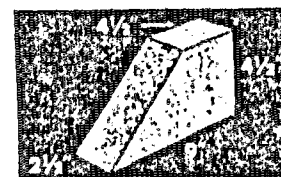
EDGE SKEW*

9" x (4 1/2"-1 1/2") x 2 1/2"



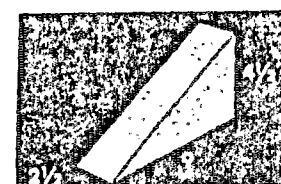
FEATHEREDGE*

9" x 4 1/2" x (2 1/2"-1 1/8")



ANGLE "A" SKEW

(9"-4 1/2") x 4 1/2" x 2 1/2"



ANGLE "B" SKEW

(9"-0") x 4 1/2" x 2 1/2"



ANGLE "C" SKEW

(9"-4 1/2") x 4 1/2" x 2 1/2"

* Also standard in silica brick

STANDARD FIRECLAY BRICK SIZES *

9" x 4 1/2" x 3" SERIES



Name of Brick	Dimensions	Inside Radius
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9" Straight - 3" Series	9" x 4 1/2" x 3"	—
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Small 9" Brick - 3" Series	9" x 3 1/2" x 3"	—
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9" Soap - 3" Series	9" x 2 1/4" x 3"	—
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9" Split Brick - 3" Series	9" x 4 1/2" x 1 1/2"	—
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9" No. 1 Arch - 3" Series	9" x 4 1/2" x (3"-2 3/4")	4'-1 1/2"
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9" No. 2 Arch - 3" Series	9" x 4 1/2" x (3"-2 1/2")	1'-10 1/2"
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9" No. 3 Arch - 3" Series	9" x 4 1/2" x (3"-2")	9"
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9" No. 4 Arch - 3" Series	9" x 4 1/2" x (3"-1")	2 1/4"
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9" No. 1 Wedge - 3" Series	9" x 4 1/2" x (3"-2 3/4")	8'-3"
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9" No. 2 Wedge - 3" Series	9" x 4 1/2" x (3"-2 1/2")	3'-9"
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9" No. 3 Wedge - 3" Series	9" x 4 1/2" x (3"-2")	1'-6"
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9" No. 1 Key - 3" Series	9" x (4 1/2"-4") x 3"	6'-0"
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9" No. 2 Key - 3" Series	9" x (4 1/2"-3 1/2") x 3"	2'-7 1/2"
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9" No. 3 Key - 3" Series	9" x (4 1/2"-3") x 3"	1'-6"
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9" No. 4 Key - 3" Series	9" x (4 1/2"-2 1/4") x 3"	9"
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9" Feather Edge - 3" Series	9" x 4 1/2" x (3"-1 1/8")	—
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9" Neck Brick - 3" Series	9" x 4 1/2" x (3"-5/8")	—
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9" Edge Skew - 3" Series	9" x (4 1/2"-1 1/2") x 3"	—
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9" -48° End Skew - 3" Series	(9"-6 3/16") x 4 1/2" x 3"	—
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9" -48° Side Skew - 3" Series	9" x (4 1/2"-1 13/16") x 3"	—
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9" 60° End Skew - 3" Series	(9"-7 1/4") x 4 1/2" x 3"	—
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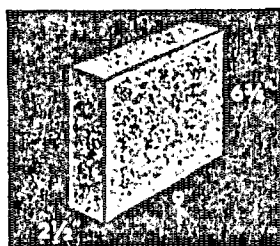
9" 60° Side Skew - 3" Series	9" x (4 1/2"-2 3/4") x 3"	—
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9" Jamb Brick - 3" Series	9" x 4 1/2" x 3"	—
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* Also standard in silica brick.

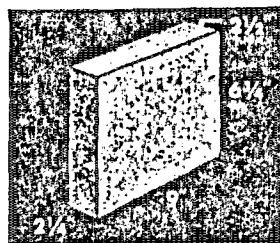


STANDARD FIRECLAY BRICK SIZES



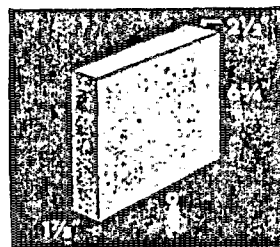
LARGE 9" STRAIGHT*

9"x 6 $\frac{3}{4}$ "x 2 $\frac{1}{2}$ "
9"x 6 $\frac{3}{4}$ "x 3"



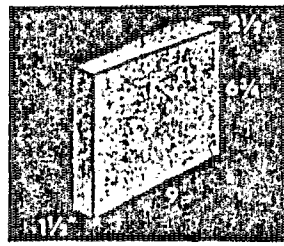
LARGE 9" No. 1-X WEDGE*

9"x 6 $\frac{3}{4}$ "x (2 $\frac{1}{2}$ "-2 $\frac{1}{4}$ ")
6'-9" Inside Radius



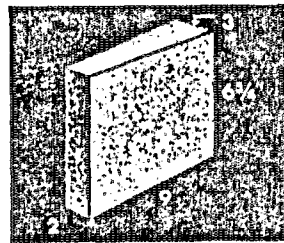
LARGE 9" No. 1 WEDGE*

9"x 6 $\frac{3}{4}$ "x (2 $\frac{1}{2}$ "-1 $\frac{7}{8}$ ")
2'-3" Inside Radius
9"x 6 $\frac{3}{4}$ "x (3"-2 $\frac{1}{4}$ ")
8'-3" Inside Radius



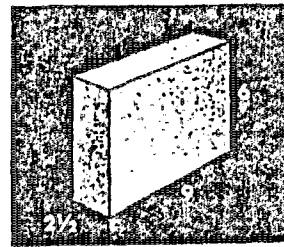
LARGE 9" No. 2 WEDGE*

9"x 6 $\frac{3}{4}$ "x (2 $\frac{1}{2}$ "-1 $\frac{1}{2}$ ")
1'-1 $\frac{1}{2}$ " Inside Radius
9"x 6 $\frac{3}{4}$ "x (3"-2 $\frac{1}{2}$ ")
3'-9" Inside Radius



LARGE 9" No. 3 WEDGE*

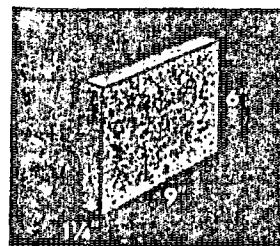
9"x 6 $\frac{3}{4}$ "x (3"-2")
1'-6" Inside Radius



FLAT BACK STRAIGHT

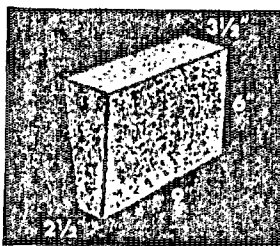
9"x 6"x 2 $\frac{1}{2}$ "

STANDARD FIRECLAY BRICK SIZES



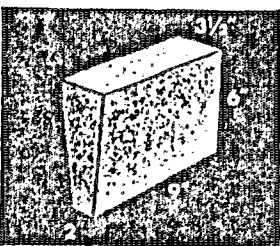
FLAT BACK SPLIT

9"x 6"x 1 $\frac{1}{4}$ "



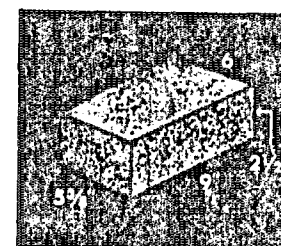
No. 1 FLAT BACK ARCH

9"x 6"x (3 $\frac{1}{2}$ "-2 $\frac{1}{2}$ ")
1'-3" Inside Radius



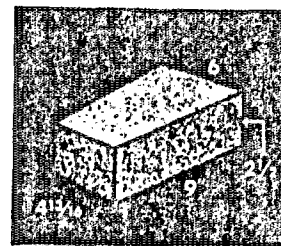
No. 2 FLAT BACK ARCH

9"x 6"x (3 $\frac{1}{2}$ "-2")
8" Inside Radius



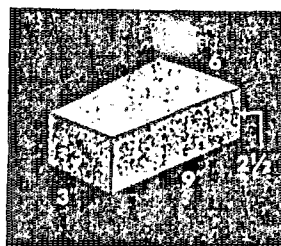
9"x 6" No. 1 KEY

9"x (6"-5 $\frac{3}{8}$ ") x 2 $\frac{1}{2}$ "
9"x (6"-5 $\frac{3}{8}$ ") x 3"
6'-6" Inside Radius



9"x 6" No. 2 KEY

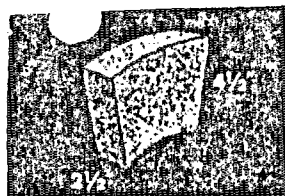
9"x (6"-4 $\frac{13}{16}$ ") x 2 $\frac{1}{4}$ "
9"x (6"-4 $\frac{13}{16}$ ") x 3"
3'-0" Inside Radius



9"x 6" No. 3 KEY

9"x (6"-3") x 2 $\frac{1}{2}$ "
9"x (6"-3") x 3"
9" Inside Radius

* Also standard in silica brick



STANDARD 9" CIRCLE BRICK

Fireclay

Dimensions of all Circle Brick
Outside Chord approx 9 inches
Radial Dimension 4½ inches
Thickness 2½ inches

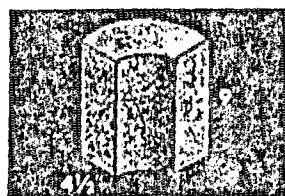
Name 2½" Series	Inside Chord in Inches	Outside Chord in Inches	Diameter in Inches		Number of Brick Per Ring
			Inside	Outside	
24-33	6 7/32	8 17/32	24	33	12
36-45	7 1/32	8 25/32	36	45	16
48-57	7 1/2	8 29/32	48	57	20
60-69	7 27/32	9	60	69	24
72-81	8 1/16	9 1/16	72	81	28
84-93	8 7/32	9 1/8	84	93	32
96-105	8 5/32	8 21/32	96	105	37
108-117	8 9/32	8 31/32	108	117	41
120-129	8 3/8	9	120	129	45

Circle brick of 3 inch thickness are furnished when desired. They are specified by adding the suffix 3 to the Name, thus, 24 33 3.

STANDARD 9" CUPOLA BLOCKS

Fireclay

Dimensions of all Blocks
Outside Chord approx 9 inches
Radial Dimension 4½ inches
Height 9 inches



Name of Block	Inside Chord in Inches	Outside Chord in Inches	Diameter in Inches		Number of Blocks Per Ring
			Inside	Outside	
A	5 15/32	8 9/16	16	25	9
B	5 29/32	8 7/16	21	30	11
C	6 15/32	8 5/8	27	36	13
D	6 11/16	8 11/16	30	39	14
E	7 11/32	9	40	49	17
F	7 19/32	8 15/16	51	60	21
G	7 27/32	9	60	69	24
H	7 29/32	8 7/8	73	82	29



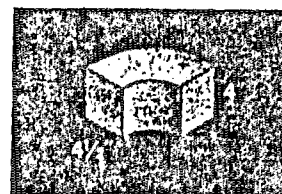
STANDARD 6" CUPOLA BLOCK and STANDARD 6" ROTARY KILN BLOCKS

Fireclay

Dimensions of all Blocks
Outside Chord approx 9 inches
Radial Dimension 6 inches
Thickness 4 inches

Name of Block	Inside Chord in Inches	Outside Chord in Inches	Diameter in Inches		Number of Blocks Per Ring
			Inside	Outside	
30-42	6 1/4	8 23/32	30	42	15
36-48	6 5/8	8 13/16	36	48	17
42-54	6 9/32	8 7/8	42	54	19
48-60	7 5/32	8 15/16	48	60	21
54-66	7 11/32	9	54	66	23
60-72	7 17/32	9 1/32	60	72	25
66-78	7 21/32	9 1/16	66	78	27
72-84	7 25/32	9 3/32	72	84	29
78-90	7 29/32	9 1/2	78	90	31
84-96	8	9 1/8	84	96	33
90-102	7 27/32	8 7/8	90	102	36
96-108	7 17/16	8 29/32	96	108	38
102-114	8	8 15/16	102	114	40
108-120	8 1/16	8 11/32	108	120	42
114-126	8 1/8	9	114	126	44
120-132	8 3/16	9	120	132	46
123-135	8 7/32	9 1/32	123	135	47
126-138	8 1/4	9 1/2	126	138	48

NOTE: Although cupola blocks and rotary kiln blocks are manufactured in duplicate sizes they are not interchangeable in most cases. Service conditions dictate variations in physical and chemical properties.



STANDARD 4½" CUPOLA BLOCKS

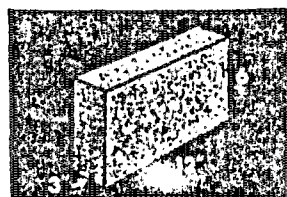
Fireclay

Dimensions of all Blocks
Outside Chord approx 9 inches
Radial Dimension 4½ inches
Height 4 inches

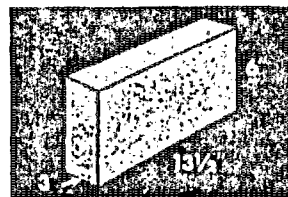
Name of Block	Inside Chord in Inches	Outside Chord in Inches	Diameter in Inches		Number of Blocks Per Ring
			Inside	Outside	
27-36	6 15/32	8 5/8	27	36	13
32-41	7 1/8	9 1/8	32	41	14



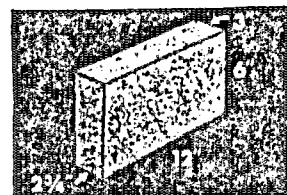
STANDARD FIRECLAY BRICK SIZES



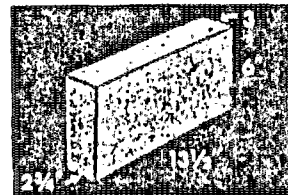
12'' x 6'' STRAIGHT*
12'' x 6'' x 3''



13 1/2'' x 6'' STRAIGHT*
13 1/2'' x 6'' x 2 1/2''
13 1/2'' x 6'' x 3''



12'' x 6'' No. 1 WEDGE*
12'' x 6'' x (3''-2 3/4'')
11'-0'' Inside Radius



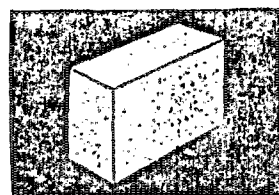
13 1/2'' x 6'' No. 1 WEDGE*
13 1/2'' x 6'' x (3''-2 3/4'')
12'-4 1/2'' Inside Radius

12'' x 6'' No. 2 WEDGE*
12'' x 6'' x (3''-2 1/2'')
5'-0'' Inside Radius

13 1/2'' x 6'' No. 2 WEDGE*
13 1/2'' x 6'' x (3''-2 1/2'')
5'-7 1/2'' Inside Radius

12'' x 6'' No. 3 WEDGE*
12'' x 6'' x (3''-2'')
2'-0'' Inside Radius

13 1/2'' x 6'' No. 3 WEDGE*
13 1/2'' x 6'' x (3''-2'')
2'-3'' Inside Radius



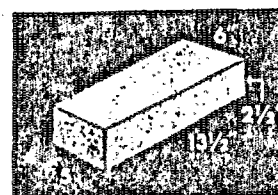
OPEN HEARTH CHECKERS

9'' x 6'' x 3'' 10 1/2'' x 4 1/2'' x 4 1/2'' 13 1/2'' x 4 1/2'' x 4 1/2''
10 1/2'' x 4 1/2'' x 3'' 13 1/2'' x 4 1/2'' x 3'' 13 1/2'' x 6'' x 2 1/2''
13 1/2'' x 6'' x 3''

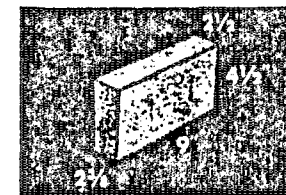
* Also standard in silica brick



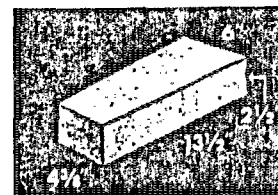
STANDARD FIRECLAY BRICK SIZES



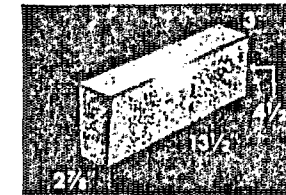
13 1/2'' x 6'' No. 1 KEY
13 1/2'' x (6''-5'') x 2 1/2''
13 1/2'' x (6''-5'') x 3''*
5'-7 1/2'' Inside Radius



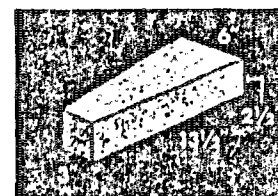
9'' BUNG ARCH
9'' x 4 1/2'' x (2 1/2''-2 3/8'')
7'-1 1/2'' Inside Radius



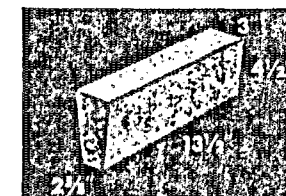
13 1/2'' x 6'' No. 2 KEY
13 1/2'' x (6''-4 3/8'') x 2 1/2''
13 1/2'' x (6''-4 3/8'') x 3''*
3'-0'' Inside Radius



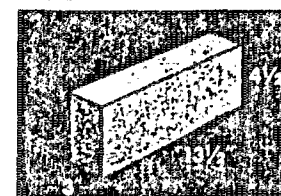
No. 105 BUNG ARCH
13 1/2'' x 4 1/2'' x (3''-2 7/8'')
9'' x 4 1/2'' x (3''-2 7/8'')
8'-7 1/2'' Inside Radius



13 1/2'' x 6'' No. 3 KEY
13 1/2'' x (6''-3'') x 2 1/2''
13 1/2'' x (6''-3'') x 3''*
1'-1 1/2'' Inside Radius

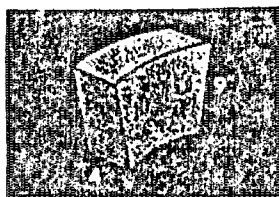


No. 103 BUNG ARCH
13 1/2'' x 4 1/2'' x (3''-2 5/8'')
2'-7 1/2'' Inside Radius



No. 101 SQUARE BUNG
13 1/2'' x 4 1/2'' x 3''
9'' x 4 1/2'' x 3''

* Also standard in silica brick



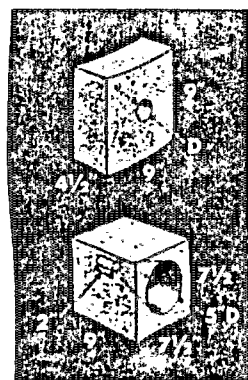
STANDARD 9" ROTARY KILN BLOCKS

Fireclay

Dimensions of all Blocks

Outside Chord approx. 9 inches
Radial Dimension 9 inches
Thickness 4 inches

Name of Block	Inside Chord in Inches	Outside Chord in Inches	Diameter in Inches		Number of Blocks Per Ring
			Inside	Outside	
48-66	6 $\frac{17}{32}$	9	48	66	23
54-72	6 $\frac{25}{32}$	9 $\frac{1}{32}$	54	72	25
60-78	6 $\frac{31}{32}$	9 $\frac{1}{16}$	60	78	27
66-84	7 $\frac{1}{8}$	9 $\frac{3}{16}$	66	84	29
72-90	7 $\frac{9}{16}$	9 $\frac{1}{2}$	72	90	31
78-96	7 $\frac{13}{16}$	9 $\frac{5}{8}$	78	96	33
84-102	7 $\frac{5}{8}$	8 $\frac{7}{8}$	84	102	36
90-108	7 $\frac{7}{8}$	8 $\frac{31}{32}$	90	108	38
96-114	7 $\frac{15}{16}$	8 $\frac{15}{16}$	96	114	40
102-120	7 $\frac{5}{8}$	8 $\frac{31}{32}$	102	120	42
108-126	7 $\frac{23}{32}$	9	108	126	44
114-132	7 $\frac{25}{32}$	9	114	132	46
117-135	7 $\frac{13}{16}$	9 $\frac{1}{16}$	117	135	47
120-138	7 $\frac{1}{2}$	9 $\frac{1}{8}$	120	138	48
123-141	7 $\frac{7}{8}$	9 $\frac{1}{4}$	123	141	49
126-144	7 $\frac{3}{4}$	8 $\frac{7}{8}$	126	144	51
132-150	7 $\frac{11}{16}$	8 $\frac{7}{8}$	132	150	53
138-156	7 $\frac{7}{8}$	8 $\frac{15}{16}$	138	156	55
144-162	7 $\frac{15}{16}$	8 $\frac{15}{16}$	144	162	57
150-168	7 $\frac{1}{2}$	8 $\frac{1}{2}$	150	168	59



CUPOLA SLAG HOLE BLOCK

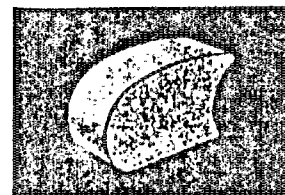
Name of Block	D in Inches	Inside Dia. Inches	Outside Dia. Inches
S-1-A	1 $\frac{1}{2}$	51	60
S-1-B	2	51	60

MALLEABLE FURNACE TAP-OUT BLOCK

9" x 7 $\frac{1}{2}$ " x 7 $\frac{1}{2}$ "

Tap Out-1 with $\frac{3}{4}$ " Tap Hole for Hand Ladles

Tap Out-2 with 1" Tap Hole for Bull Ladles



CURVEX CUPOLA BLOCKS 6" LINING

Fireclay

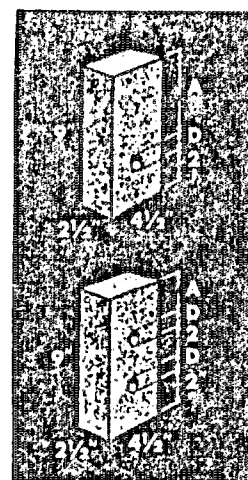
approx. 9" x 6" x 4"

Number of Pieces Required Per Ring

Diameter Inside Brickwork	No. per Ring	Diameter Inside Brickwork	No. per Ring	Diameter Inside Brickwork	No. per Ring
		4'-0"	18	6'-0"	26
		4'-3"	19	6'-3"	27
2'-6"	12	4'-6"	20	6'-6"	28
2'-9"	13	4'-9"	21	6'-9"	29
3'-0"	14	5'-0"	22	7'-0"	30
3'-3"	15	5'-3"	23	7'-3"	31
3'-6"	16	5'-6"	24	7'-6"	32
3'-9"	17	5'-9"	25	8'-0"	34

CUPOLA TAP-OUT BLOCKS

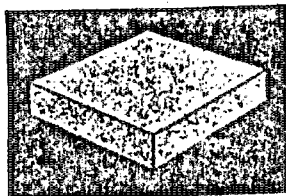
(One and Two-Hole Types)



Name of Block	A in Inches	D in Inches
One Hole Type		
T-1-A	6 $\frac{1}{2}$	$\frac{1}{2}$
T-1-B	6 $\frac{1}{4}$	$\frac{3}{4}$
T-1-C	6	1
T-1-D	5 $\frac{3}{4}$	1 $\frac{1}{4}$
T-1-E	5 $\frac{1}{2}$	1 $\frac{1}{2}$
T-1-F	5 $\frac{7}{8}$	1 $\frac{1}{8}$
Two Hole Type		
T-2-A	4	$\frac{1}{2}$
T-2-B	3 $\frac{1}{2}$	$\frac{3}{4}$
T-2-C	3	1
T-2-D	2 $\frac{1}{2}$	1 $\frac{1}{4}$
T-2-E	2	1 $\frac{1}{2}$
T-2-F	3 $\frac{3}{4}$	$\frac{5}{8}$

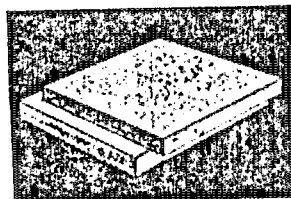


TYPICAL FIRECLAY TILE AND SHAPES



SQUARE EDGE TILE

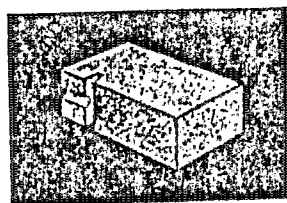
These are made in various lengths, widths and thicknesses.



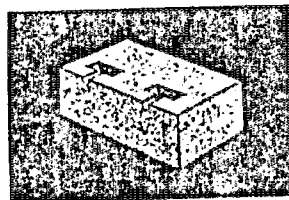
SHIPLAP TILE

Made in various sizes with two sides lapped or as shown four sides lapped.

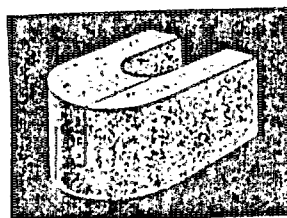
MARINE BOILER TILE



1 BOLT TYPE



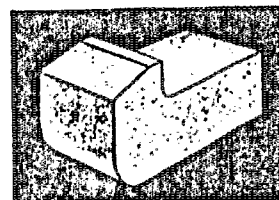
2 BOLT TYPE



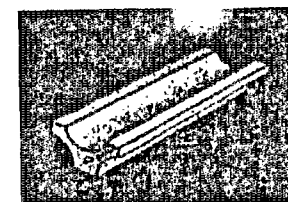
BLOW OFF PROTECTOR
TILE

(2 to set)

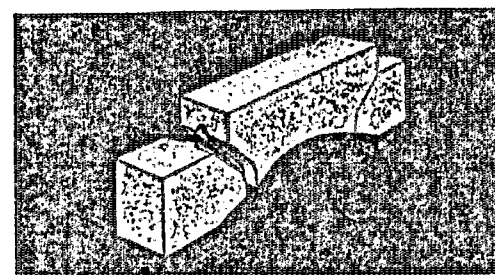
TYPICAL FIRECLAY TILE AND SHAPES



SOOT BLOWER TILE

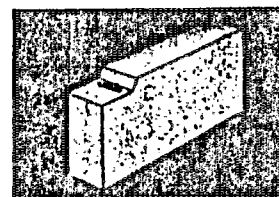


BOILER BAFFLE TILE

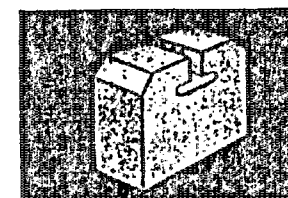


BOILER DOOR ARCH TILE
AND SKEWBLOCKS

(3 pieces to set for 16", 18"
and 20" doors)



BOILER ANCHOR TILE OR
HOLDING TILE



SUSPENDED REAR ARCH TILE



STANDARD SILICA BRICK SIZES

Silica brick are produced in 9"x4 1/2"x2 1/2" series and 9"x4 1/2"x3" series as shown in detail for fireclay brick on pages 32, 33, 34 and 35 indicated by asterisks (*). They are also standard in 9"x6 3/4"x2 1/2" series and 9"x6 3/4"x3" series, page 36, and some other sizes as shown on pages 38 and 39 which are marked by asterisks (*) and listed below.

Name	Dimensions	Number Per Ring	Diameter of Ring	
			Inside	Outside

STANDARD 12" x 4 1/2" x 3" SIZES

Straight	12"x4 1/2"x3"			
No. 1 X Wedge	12"x4 1/2"x(3"-2 7/8")	604	46'-0"	48'-0"
No. 1 Wedge	12"x4 1/2"x(3"-2 1/4")	302	22'-0"	24'-0"
No. 2 Wedge	12"x4 1/2"x(3"-2 1/2")	151	10'-0"	12'-0"
No. 3 Wedge	12"x4 1/2"x(3"-2")	76	4'-0"	6'-0"

STANDARD 12" x 6" x 3" SIZES

Straight	12"x6"x3"			
No. 1 Arch	12"x6"x(3"-2 1/4")	151	11'-0"	12'-0"
No. 2 Arch	12"x6"x(3"-2 1/2")	76	5'-0"	6'-0"
No. 3 Arch	12"x6"x(3"-2")	38	2'-0"	3'-0"
No. 1 X Wedge	12"x6"x(3"-2 7/8")	604	46'-0"	48'-0"
No. 1 Wedge	12"x6"x(3"-2 1/4")	302	22'-0"	24'-0"
No. 2 Wedge	12"x6"x(3"-2 1/2")	151	10'-0"	12'-0"
No. 3 Wedge	12"x6"x(3"-2")	76	4'-0"	6'-0"
No. 1 Key	12"x(6"-5 1/2")x3"	151	22'-0"	24'-0"
No. 2 Key	12"x(6"-5")x3"	76	10'-0"	12'-0"

STANDARD 12" x 9" x 3" SIZES

Straight	12"x9"x3"			
No. 1 X Wedge	12"x9"x(3"-2 7/8")	604	46'-0"	48'-0"
No. 1 Wedge	12"x9"x(3"-2 1/4")	302	22'-0"	24'-0"
No. 2 Wedge	12"x9"x(3"-2 1/2")	151	10'-0"	12'-0"
No. 3 Wedge	12"x9"x(3"-2")	76	4'-0"	6'-0"

STANDARD 13 1/2" x 4 1/2" x 3" SIZES

Straight	13 1/2"x4 1/2"x3"			
No. 1 Arch	13 1/2"x4 1/2"x(3"-2 1/4")	113	8'-3"	9'-0"
No. 2 Arch	13 1/2"x4 1/2"x(3"-2 1/2")	57	3'-9"	4'-6"
No. 3 Arch	13 1/2"x4 1/2"x(3"-2")	29	1'-6"	2'-3"
No. 4 Arch	13 1/2"x4 1/2"x(3"-1")	15	0'-4 1/2"	1'-1 1/2"

STANDARD SILICA BRICK SIZES

(Continued)



Name	Dimensions	Number Per Ring	Diameter of Ring	
			Inside	Outside

STANDARD 13 1/2" x 6" x 3" SIZES

Straight	13 1/2"x6"x3"			
No. 1 Arch	13 1/2"x6"x(3"-2 1/4")	151	11'-0"	12'-0"
No. 2 Arch	13 1/2"x6"x(3"-2 1/2")	76	5'-0"	6'-0"
No. 3 Arch	13 1/2"x6"x(3"-2")	38	2'-0"	3'-0"
No. 1 X Wedge	13 1/2"x6"x(3"-2 7/8")	679	51'-9"	54'-0"
No. 1 Wedge	13 1/2"x6"x(3"-2 1/4")	340	24'-9"	27'-0"
No. 2 Wedge	13 1/2"x6"x(3"-2 1/2")	170	11'-3"	13'-6"
No. 3 Wedge	13 1/2"x6"x(3"-2")	85	4'-6"	6'-9"
No. 1 Key	13 1/2"x(6"-5")x3"	85	11'-3"	13'-6"
No. 2 Key	13 1/2"x(6"-4 1/8")x3"	52	6'-0"	8'-3"
No. 3 Key	13 1/2"x(6"-3")x3"	29	2'-3"	4'-6"

STANDARD 13 1/2" x 9" x 3" SIZES

Straight	13 1/2"x9"x3"			
No. 1 Arch	13 1/2"x9"x(3"-2 1/4")	227	16'-6"	18'-0"
No. 2 Arch	13 1/2"x9"x(3"-2 1/2")	113	7'-6"	9'-0"
No. 3 Arch	13 1/2"x9"x(3"-2")	57	3'-0"	4'-6"
No. 1 X Wedge	13 1/2"x9"x(3"-2 7/8")	679	51'-9"	54'-0"
No. 1 Wedge	13 1/2"x9"x(3"-2 1/4")	340	24'-9"	27'-0"
No. 2 Wedge	13 1/2"x9"x(3"-2 1/2")	170	11'-3"	13'-6"
No. 3 Wedge	13 1/2"x9"x(3"-2")	85	4'-6"	6'-9"

STANDARD 15" x 6" x 3" SIZES

Straight	15"x6"x3"			
No. 1 X Wedge	15"x6"x(3"-2 7/8")	754	57'-6"	60'-0"
No. 1 Wedge	15"x6"x(3"-2 1/4")	377	27'-6"	30'-0"
No. 2 Wedge	15"x6"x(3"-2 1/2")	189	12'-6"	15'-0"
No. 3 Wedge	15"x6"x(3"-2")	95	5'-0"	7'-6"

STANDARD 15" x 9" x 3" SIZES

Straight	15"x9"x3"			
No. 1 X Wedge	15"x9"x(3"-2 7/8")	754	57'-6"	60'-0"
No. 1 Wedge	15"x9"x(3"-2 1/4")	377	27'-6"	30'-0"
No. 2 Wedge	15"x9"x(3"-2 1/2")	189	12'-6"	15'-0"
No. 3 Wedge	15"x9"x(3"-2")	95	5'-0"	7'-6"

STANDARD 18" x 6" x 3" SIZES

Straight	18"x6"x3"			
No. 1 X Wedge	18"x6"x(3"-2 7/8")	905	69'-0"	72'-0"
No. 1 Wedge	18"x6"x(3"-2 1/4")	453	33'-0"	36'-0"
No. 2 Wedge	18"x6"x(3"-2 1/2")	227	15'-0"	18'-0"
No. 3 Wedge	18"x6"x(3"-2")	113	6'-0"	9'-0"

STANDARD 18" x 9" x 3" SIZES

Straight	18"x9"x3"			
No. 1 X Wedge	18"x9"x(3"-2 7/8")	905	69'-0"	72'-0"
No. 1 Wedge	18"x9"x(3"-2 1/4")	453	33'-0"	36'-0"
No. 2 Wedge	18"x9"x(3"-2 1/2")	227	15'-0"	18'-0"
No. 3 Wedge	18"x9"x(3"-2")	113	6'-0"	9'-0"



OTHER COMMON SILICA BRICK SIZES

Name	Dimensions	Number Per Ring	Diameter of Ring	
			Outside	Inside
9" x 9" x 2 1/2" SIZES				
Straight	9"x9"x2 1/2"			
No. 1-X Wedge	9"x9"x(2 1/2"-2 1/4")	227	13'-6"	15'-0"
No. 1 Wedge	9"x9"x(2 1/2"-1 7/8")	91	4'-6"	6'-0"
No. 2 Wedge	9"x9"x(2 1/2"-1 1/2")	57	2'-3"	3'-9"
9" x 9" x 3" SIZES				
Straight	9"x9"x3"			
No. 1 Wedge	9"x9"x(3"-2 1/4")	227	16'-6"	18'-0"
No. 2 Wedge	9"x9"x(3"-2 1/2")	113	7'-6"	9'-0"
No. 3 Wedge	9"x9"x(3"-2")	57	3'-0"	4'-6"
13 1/2" x 4 1/2" x 2 1/2" SIZES				
Straight	13 1/2"x4 1/2"x2 1/2"			
No. 1 Arch	13 1/2"x4 1/2"x(2 1/2"-2 1/8")	76	4'-3"	5'-0"
No. 2 Arch	13 1/2"x4 1/2"x(2 1/2"-1 3/4")	38	1'-9"	2'-6"
No. 3 Arch	13 1/2"x4 1/2"x(2 1/2"-1")	19	0'-6"	1'-3"
13 1/2" x 4 1/2" x 3" SIZES				
No. 1-X Wedge	13 1/2"x4 1/2"x(3"-2 7/8")	679	51'-9"	54'-0"
No. 1 Wedge	13 1/2"x4 1/2"x(3"-2 3/4")	340	24'-9"	27'-0"
No. 2 Wedge	13 1/2"x4 1/2"x(3"-2 1/2")	170	11'-3"	13'-6"
No. 3 Wedge	13 1/2"x4 1/2"x(3"-2")	85	4'-6"	6'-9"
21" x 6" x 3" SIZES				
Straight	21"x6"x3"			
No. 1-X Wedge	21"x6"x(3"-2 7/8")	1056	80'-6"	84'-0"
No. 1 Wedge	21"x6"x(3"-2 3/4")	528	38'-6"	42'-0"
No. 2 Wedge	21"x6"x(3"-2 1/2")	264	17'-6"	21'-0"
No. 3 Wedge	21"x6"x(3"-2")	132	7'-0"	10'-6"
21" x 9" x 3" SIZES				
Straight	21"x9"x3"			
No. 1-X Wedge	21"x9"x(3"-2 7/8")	1056	80'-6"	84'-0"
No. 1 Wedge	21"x9"x(3"-2 3/4")	528	38'-6"	42'-0"
No. 2 Wedge	21"x9"x(3"-2 1/2")	264	17'-6"	21'-0"
No. 3 Wedge	21"x9"x(3"-2")	132	7'-0"	10'-6"

REFRACTORY CONSTRUCTION DATA



ESTIMATING REFRACTORY MATERIALS

In estimating brick quantities for refractory construction using standard brick the following net amounts will be useful. Added allowances should be made for expansion joints, breakage, cutting, and mortar joints.

	Thickness of Wall	Required Number of Brick	
		9"x4 1/2"x2 1/2"	9"x4 1/2"x3"
1 sq. ft. of wall	2 1/2"	3 6	
1 sq. ft. of wall	3"		3 6
1 sq. ft. of wall	4 1/2"	6 4	5 3
1 sq. ft. of wall	9"	12 8	10 7
1 sq. ft. of wall	13 1/2"	19 2	16 0
1 cu. ft. of wall		17 1	14 2
Volume of 1000 standard brick		58 6 cu. ft.	70 3 cu. ft.

1 cu. ft. of fireclay brick weighs 120-140 pounds.

1 cu. ft. of silica brick weighs 105-120 pounds.

To allow a sufficient number of extra brick of standard sizes for speedy and sound construction it is suggested that the following quantities be ordered along with the net amount.

FOR BREAKAGE AND CUTTING

Net Amounts	Extra Pieces
Up to 250	10%
251-1,500	5%
1,501-5,000	3%
Over 5,000	2%

WEIGHT OF SPECIALTIES

Name	Type	Condition As Shipped	Pounds per Cu. Ft.
NARCO SUPER 505	Plastic	Wet	145
NARCO 505	Plastic	Wet	135
NARCOLINE	Plastic	Wet	145
NARCHROME PLASTIC REFRACTORY	Plastic	Wet	195
NARCHROME CAST-ABLE REFRACTORY	Castable	Dry	185
NARCO HEARTH	Castable	Dry	120
NARCO BAFFLEMIX	Castable	Dry	116
NARCOCRETE	Castable	Dry	70
NARCOLITE	Castable	Dry	50

From 300 to 450 pounds of air-set high temperature mortar is sufficient to lay 1000 standard 9-inch brick.

From 250 to 400 pounds of heat-set high temperature mortar is sufficient to lay 1000 standard 9-inch brick.

From 250 to 450 pounds of fire clay is sufficient to lay 1000 standard 9-inch brick.



BRICKWORK CONSTRUCTION

Furnace structures requiring a refractory lining are designed and constructed for the most efficient service. To utilize good design, careful attention to refractory construction is required. Such construction is a highly specialized and skilled trade and should be entrusted only to experienced FIRE BRICK masons.

To operate efficiently, a furnace wall should be constructed to meet the following somewhat conflicting requirements as far as is practical:

1. The strongest possible bond or tie across joints and through the wall,
2. A construction as airtight as possible,
3. Provision for removing and rebuilding the inside brick courses on the hot face as easily as possible and with the least disturbance to the rest of the wall, and
4. Provision for relieving the fluctuating expansion strains by allowing proper expansion joints.

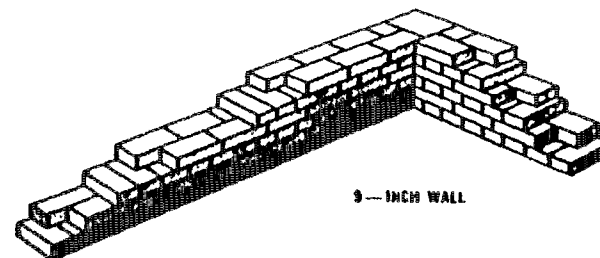
The determining factor in meeting the first three requirements is the type of bond used and the soundness of the brick laying. The type of expansion joint is not dependent on the kind of bond used.

MASONRY BONDS

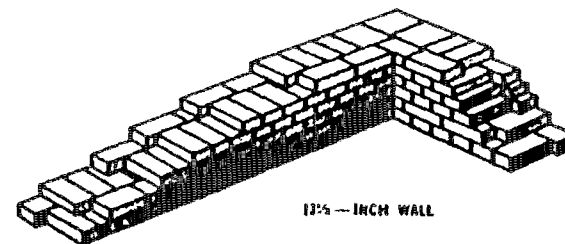
On the opposite page are illustrations of some standard masonry bonds. The wall thickness and type of bond is determined by service conditions present and load due to the height of the wall. To achieve maximum strength plus an airtight or gastight wall, it is important to stagger vertical joints.

The alternate header and stretcher bond is good practice and probably the most common. The only reason for departing from such a bond is to reduce the difficulty of repairing some portions of the furnace walls that require attention previous to the remainder of the furnace. Under such circumstances a compromise is advisable using three, four or five headers to one stretcher course. Once the arrangement of headers to stretchers on the furnace face is established, the same cross bond carries systematically through the wall for walls of any thickness and repeats itself at regular intervals.

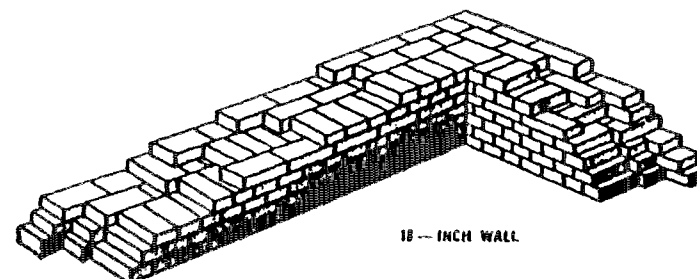
TYPICAL MASONRY BONDS



9 -- INCH WALL



12 1/2 -- INCH WALL



18 -- INCH WALL



BRICKWORK CONSTRUCTION (Continued)

EXPANSION JOINTS

One of the important considerations in designing and constructing furnaces is that the brickwork expands and contracts due to heating and cooling. Severe fluctuating stresses are often developed as the temperature inside the furnace rises and falls. This is supplemented by the steep temperature gradient usually present in furnaces whereby the hot face expands more than the cooler parts of the brickwork. It should be noted that this expansion takes place both horizontally and vertically.

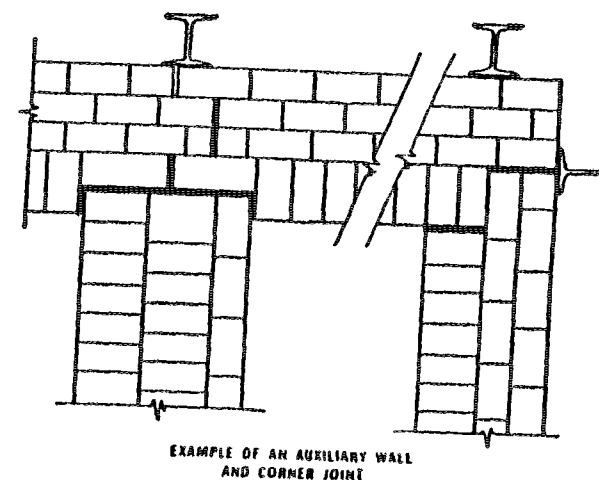
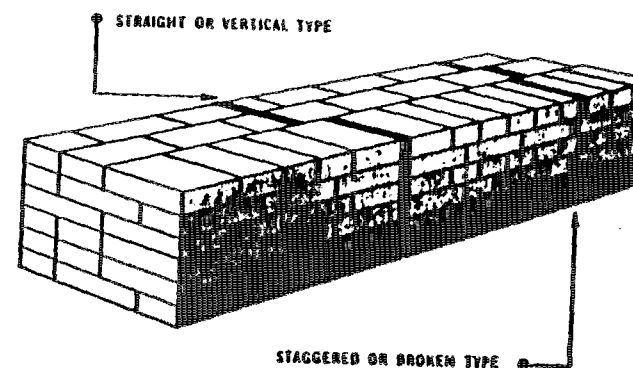
Provision for vertical expansion, except in high walls, is easily made by leaving the wall free to expand upward without encountering boiler drums, piping or other structural members. Vertical contraction during subsequent cooling takes care of itself when the wall settles.

There are two common types of expansion joints for horizontal movement as shown on the opposite page. The "Staggered" or "Broken" type has the open joints staggered at adjoining courses. This type is perhaps simpler and easier to construct as it requires no large 9 inch straights or cutting and fitting. This type also results in a minimum weakening of the wall at the expansion joints. The "Straight" or "Vertical" type with no overlapping headers, allows the wall sections to expand and contract with a greater freedom which results in a minimum of buckling on the inside brick courses. As the ability to open and close easily is the expansion joint's main requisite, the free movement of the "Straight" type probably outweighs any disadvantages.

In practice, expansion joints are usually constructed to provide for double the expansion that will occur on the first heating. This allows for any accidental filling of the expansion joints by mortar, dust, or materials charged into the furnace during operation. To keep joints clean, they are usually packed with a combustible or compressible filler during construction.

There is a large variety of expansion joints used for corners, joining auxiliary walls and separating zones of different temperatures. Shown are examples that are generally considered good practice.

TYPICAL EXPANSION JOINTS

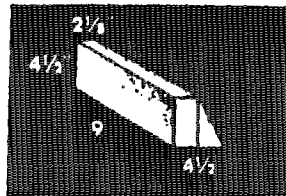


EXAMPLE OF AN AUXILIARY WALL
AND CORNER JOINT

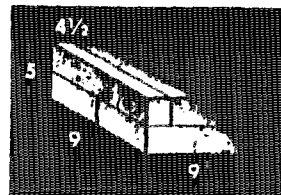


STANDARD SKEWBACKS

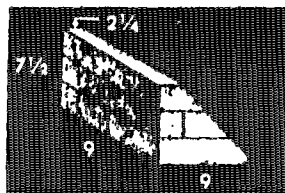
SKEWS BUILT WITH STANDARD BRICK



for
ARCH 4 1/2" THICK
Rise 1 1/2" per ft. of span
Skew consists of
1 9" 2-Inch Brick (2 1/2" Series)
1 9" Featheredge / Series

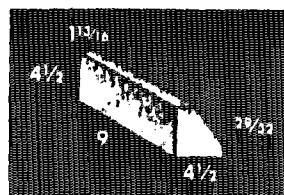


for
ARCH 4 1/2" THICK
Rise 2 1/16" per ft. of span
Skew consists of
1 9" 48" Side Skew (2 1/2" Series)
2 9" 48" End Skews
1 9" Soap Brick

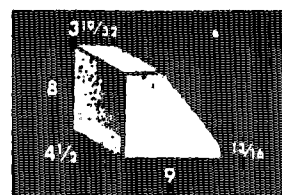


for
ARCH 9" THICK
Rise 2 1/16" per ft. of span
Skew consists of
2 9" 48" End Skews (2 1/2" Series)
2 9" 48" Side Skews
1 9" Soap Brick

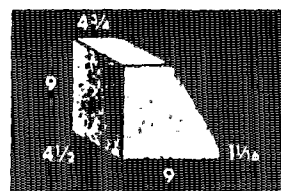
SPECIAL SKEWBACKS



for
ARCH 4 1/2" THICK
Rise 2" per ft. of span



for
ARCH 9" THICK
Rise 2" per ft. of span

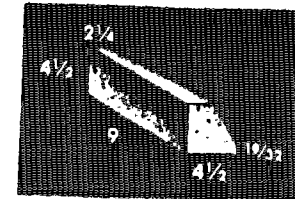


for
ARCH 9" THICK
Rise 1 1/2" per ft. of span

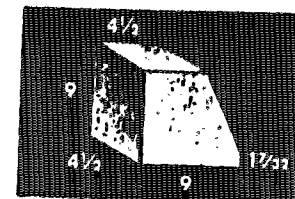


SPECIAL SKEWBACKS

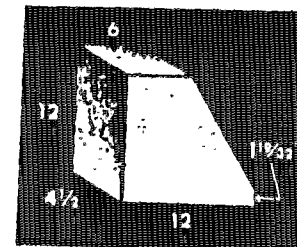
For Arches with Included Angle of 60 Degrees



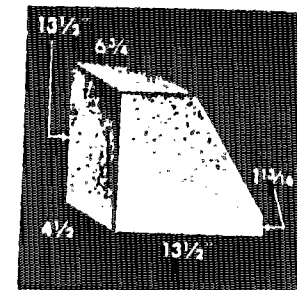
for
ARCH 4 1/2" THICK
Rise 1.608" per ft. of span



for
ARCH 9" THICK
Rise 1.608" per ft. of span



for
ARCH 12" THICK
Rise 1.608" per ft. of span



for
ARCH 13 1/2" THICK
Rise 1.608" per ft. of span



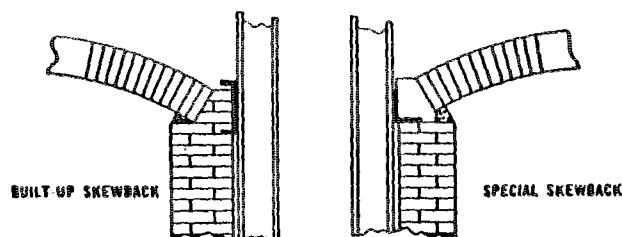
SKEWBACKS IN FURNACES

Skewbacks are masonry units with an inclined face from which an arch is sprung. As illustrated, a single special shape may be used, or a combination of standard brick sizes may be laid up to form the skewback. The one-piece skewbacks are stronger and are generally used for arches of longer spans. The important requirements for skewbacks are high strength and good bearing on the sidewalls.

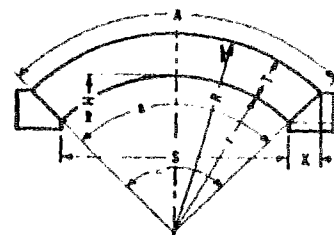
The skewback receives the full thrust of the arch which includes a downward thrust exerted by the weight of the arch as well as an outward thrust on the sidewall. Support of the arch is usually made by steelwork consisting of angles or channels on which the skews rest. These angles and channels are held in place by buckstays generally connected by tie-rods with provisions for adjustment as the furnace temperature rises and falls. If structural steel is not used, the sidewall must be constructed to receive the entire thrust of the arch.

When steelwork is used, the line of thrust should fall within the channel or angle to promote stability of the arch. Skewbacks should be placed so they are protected as much as possible from the destructive forces of the furnace, a precaution which usually lengthens the life of the skewback. To further protect the skewback, a stretcher course should never be used directly below the skewback.

Shown are two commonly used methods which are considered good practice for holding skewbacks.



ELEMENTS OF ARCHES



KEY TO SYMBOLS

- S Span of arch
- H Rise of arch
- R Outside radius of arch
- r Inside radius of arch
- T Thickness of arch
- A Outer arc length
- a Inner arc length
- θ Central Angle

FORMULAS:

To find the rise when the radius and span are given:

$$H = r - \frac{1}{2} \sqrt{4r^2 - S^2}$$

To find the inside radius when the rise and span are given:

$$r = \frac{S^2 + 4H^2}{8H}$$

To find the angle θ when the radius and span are given:

$$\text{Sine } \frac{1}{2} \theta = \frac{S}{2r}$$

To find the arc lengths when the radius and central angle are given:

$$\begin{aligned} \text{Outer arc: } A &= \frac{2\pi R \theta}{360} & \text{Inner arc: } a &= \frac{2\pi r \theta}{360} \end{aligned}$$

VALUES FOR GIVEN RISES PER FOOT OF SPAN

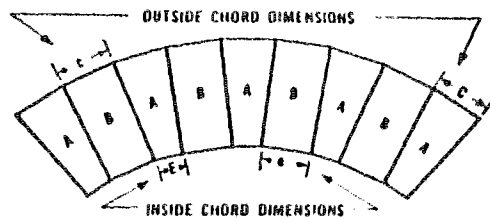
Rise in Inches Per Foot of Span	Inside* Radius in Factor x S	Central Angle θ		Inside* Arc in Factor x S	Diff. of* Outer and Inner Arcs Factor x T	Skewback	
		Degree	Part of Circle			X* is Factor x T	Y* is Factor x T
1	1.5417	37°50.9'	0.1051	1.0184	0.6606	0.3243	0.9460
1 1/4	1.2521	47°4.4'	0.1308	1.0287	0.8216	0.3993	0.9168
1 1/2	1.0625	56°8.7'	0.1560	1.0412	0.9799	0.4706	0.8824
1.608	1.0000	60°0.0'	0.1667	1.0472	0.0472	0.5000	0.8660
1 3/4	0.9301	65°2.5'	0.1807	1.0558	1.1352	0.5376	0.8432
2	0.8333	73°44.4'	0.2048	1.0725	1.2870	0.6000	0.8000
2 1/4	0.7604	82°13.4'	0.2284	1.0913	1.4351	0.6575	0.7534
2.302	0.7474	83°58.5'	0.2333	1.0954	1.4656	0.6690	0.7433
2 1/2	0.7042	90°28.8'	0.2513	1.1120	1.5792	0.7101	0.7041
2 3/4	0.6600	98°29.7'	0.2736	1.1346	1.7191	0.7575	0.6528
3	0.6250	106°15.6'	0.2952	1.1591	1.8546	0.8000	0.6000

*Inside radius, inside arc, difference of outer and inner arcs, x and y are obtained by multiplying the factor in each respective column with S or T, whichever applies.

For typical skewbacks refer pages 54, 55 and 56



COMBINATIONS TO FORM A RING WITH TWO SIZES OF BRICK



- A A radial brick used with a straight or another radial brick B, which turns a larger circle than A.
- B A straight brick or a radial brick which turns a larger circle than A, both A and B forming the same thickness of arch T.
- T The thickness of the arch formed by A and B.
- C The outside chord of brick A.
- c The outside chord of brick B.
- E The inside chord of brick A.
- e The inside chord of brick B.
- D Given outside diameter of desired ring.
- d Given inside diameter of desired ring.
- G Outside diameter of ring formed by radial brick A alone.
- J Number of brick A to form a ring of outside diameter G.
- g Outside diameter of ring formed by brick B alone if it is radial.
- j Number of brick B to form a ring of outside diameter g.
- x Number of pieces of brick A, used with brick B to form a ring of outside diameter D.
- y Number of pieces of brick B, used with brick A to form a ring of outside diameter D.
- S Total number of pieces of brick A and brick B to form a ring of outside diameter D.



COMBINATIONS TO FORM A RING WITH TWO SIZES OF BRICK

- I. When both brick A and B are radial and outside chords are equal ($C = c$) but inside chords are unequal,

$$(1) \quad S = \frac{\pi D}{C} - \frac{\pi D}{c}$$

$$(2) \quad y = \frac{\pi d}{c} - \frac{SE}{E}$$

- II. When brick B is a straight brick and brick A is radial, $c = e$ and

$$(3) \quad x = \frac{2\pi T}{C E} = \frac{6.2832T}{C E}$$

$$(4) \quad y = \frac{\pi D}{c} - xC$$

- III. When both brick A and B are radial and both chord dimensions of A differ from those of B,

$$(5) \quad Cx + cy = \pi D$$

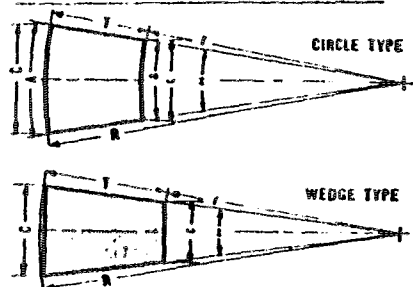
$$(6) \quad Ex + ey = \pi d$$

- IV. When calculating a series of combinations the following formulas are convenient:

$$(7) \quad x = \frac{J(g-D)}{g G}$$

$$(8) \quad y = \frac{j(D-G)}{g G}$$

RADIAL BRICK FORMULAS



KEY TO SYMBOLS:

- a Inside arc of circle type brick
- A Outside arc of circle type brick
- c Inside chord of circle or wedge type brick
- C Outside chord of circle or wedge type brick
- r Inside radius of radial brick
- R Outside radius of radial brick
- d Inside diameter of ring formed by radial brick
- T Radial dimension of brick
- theta Theta, the included angle of brick
- Pi- 3.1416
- S Total number of a given radial brick required to form a ring

FORMULAS:

$$c = \frac{r C}{r + T} = \frac{R c}{R + T} = \frac{2 \pi T}{C} = \frac{\pi D}{C} = \frac{\pi d}{C}$$

$$C = \frac{(r + T) c}{r} = \frac{R c}{r} = \frac{C}{\text{Sine } \frac{1}{2} \theta} = \frac{c}{2 R} \text{ or } \frac{c}{2 r}$$

$$\theta = \frac{360^\circ}{S}$$

TABLE FOR USE IN DESIGNING RADIAL TYPE BRICK

If the outside chord of a radial brick is desired for a given number of pieces per ring, find the number of pieces in column 1 and multiply the corresponding sine of the half angle in column 2 by the outside diameter of the ring.

If brick with an outside chord of approximately 9" is desired, find the diameter in column 3 that comes closest to the desired outside diameter. Then multiply the corresponding sine of the half angle in column 2 by the desired outside diameter to obtain the actual chord. The number of pieces to form a ring will be found in column 1.

No. of Brick to Circle (1)	Sine of Half Angle (2)	Dia. for 9" Chord in Inches (3)	No. of Brick to Circle (1)	Sine of Half Angle (2)	Dia. for 9" Chord in Inches (3)
5	.58779	15.312	9	.34202	26.314
6	.50000	18.000	10	.30902	29.124
7	.43388	20.743	11	.28173	31.945
8	.38268	23.518	12	.25882	34.773

TABLE FOR USE IN DESIGNING RADIAL TYPE BRICK (Concluded)



No. of Brick to Circle (1)	Sine of Half Angle (2)	Dia. for 9" Chord in Inches (3)	No. of Brick to Circle (1)	Sine of Half Angle (2)	Dia. for 9" Chord in Inches (3)
13	.23932	37.607	57	.05508	163.399
14	.22252	40.446	58	.05414	166.236
15	.20791	43.288	59	.05322	169.109
16	.19509	46.133	60	.05234	171.953
17	.18375	48.980	61	.05147	174.859
18	.17365	51.828	62	.05065	177.690
19	.16459	54.681	63	.04985	180.542
20	.15643	57.534	64	.04907	183.411
21	.14904	60.386	65	.04832	186.258
22	.14231	63.242	66	.04758	189.155
23	.13616	66.099	67	.04687	192.020
24	.13053	68.950	68	.04618	194.890
25	.12533	71.810	69	.04552	197.715
26	.12054	74.664	70	.04486	200.624
27	.11609	77.526	71	.04423	203.482
28	.11197	80.379	72	.04362	206.327
29	.10812	83.241	73	.04302	209.205
30	.10453	86.100	74	.04244	212.064
31	.10117	88.959	75	.04188	214.900
32	.09802	91.818	76	.04132	217.812
33	.09506	94.677	77	.04079	220.642
34	.09227	97.540	78	.04027	223.491
35	.08964	100.402	79	.03975	226.415
36	.08716	103.258	80	.03926	229.241
37	.08481	106.120	81	.03878	232.078
38	.08258	108.985	82	.03830	234.987
39	.08047	111.843	83	.03784	237.844
40	.07846	114.708	84	.03739	240.706
41	.07655	117.570	85	.03695	243.572
42	.07473	120.434	86	.03652	246.440
43	.07299	123.305	87	.03610	249.307
44	.07134	126.156	88	.03569	252.171
45	.06976	129.014	89	.03529	255.030
46	.06825	131.868	90	.03490	257.880
47	.06680	134.731	91	.03452	260.718
48	.06540	137.615	92	.03414	263.620
49	.06407	140.471	93	.03377	266.509
50	.06279	143.335	94	.03341	269.380
51	.06156	146.199	95	.03306	272.232
52	.06038	149.056	96	.03272	275.061
53	.05924	151.924	97	.03238	277.949
54	.05815	154.772	98	.03205	280.811
55	.05709	157.646	99	.03173	283.643
56	.05607	160.514	100	.03141	286.533



4 1/2" LINING—ARCH BRICK
 9" x 4 1/2" x 2 1/2" or 13 1/2" x 4 1/2" x 2 1/2"

Diameter Inside Brickwork	Number Required Per Ring				
	No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight	Total
0'- 6"	19				19
0'- 7"	18	3			21
0'- 8"	17	5			22
0'- 9"	15	8			23
0'-10"	14	10			24
0'-11"	13	13			26
1'- 0"	12	15			27
1'- 1"	10	18			28
1'- 2"	9	20			29
1'- 3"	8	23			31
1'- 4"	7	25			32
1'- 5"	5	28			33
1'- 6"	4	30			34
1'- 7"	3	33			36
1'- 8"	2	35			37
1'- 9"		38			38
1'-10"		36	3		39
1'-11"		36	5		41
2'- 0"		34	8		42
2'- 3"		31	15		46
2'- 6"		26	23		49
2'- 9"		23	30		53
3'- 0"		19	38		57
3'- 3"		15	46		61
3'- 6"		11	53		64
3'- 9"		8	60		68
4'- 0"		4	68		72
4'- 3"			76		76
4'- 6"			76	4	80
5'- 0"			76	11	87
5'- 6"			76	19	95
6'- 0"			76	26	102
6'- 6"			76	34	110
7'- 0"			76	41	117
7'- 6"			76	49	125
8'- 0"			76	56	132
8'- 6"			76	64	140
9'- 0"			76	71	147
9'- 6"			76	79	155
10'- 0"			76	87	163
10'- 6"			76	94	170
11'- 0"			76	102	178
11'- 6"			76	109	185
12'- 0"			76	117	193
12'- 6"			76	124	200
13'- 0"			76	132	208
13'- 6"			76	139	215
14'- 0"			76	147	223



4 1/2" LINING—ARCH BRICK
 9" x 4 1/2" x 3" or 13 1/2" x 4 1/2" x 3"

Diameter Inside Brickwork	Number Required Per Ring				
	No. 4 Arch	No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight
0'- 4 1/2"	15				15
0'- 5"	14	1			15
0'- 6"	13	3			16
0'- 7"	12	5			17
0'- 8"	11	7			18
0'- 9"	10	9			19
0'-10"	8	12			20
0'-11"	7	14			21
1'- 0"	6	16			22
1'- 1"	5	18			23
1'- 2"	4	20			24
1'- 3"	4	22			26
1'- 4"	3	24			27
1'- 5"	1	27			28
1'- 6"		29			29
1'- 9"		25	7		32
2'- 0"		22	13		35
2'- 3"		19	19		38
2'- 6"		16	25		41
2'- 9"		13	31		44
3'- 0"		10	38		48
3'- 3"		7	44		51
3'- 6"		3	51		54
3'- 9"			57		57
4'- 0"			54	6	60
4'- 3"			50	13	63
4'- 6"			47	19	66
4'- 9"			44	26	70
5'- 0"			41	32	73
5'- 3"			38	38	76
5'- 6"			35	44	79
5'- 9"			32	50	82
6'- 0"			28	57	85
6'- 6"			22	70	92
7'- 0"			16	82	98
7'- 6"			10	94	104
8'- 0"			3	107	110
8'- 3"				113	113
8'- 6"				113	117
9'- 0"				113	123
9'- 6"				113	129
10'- 0"				113	135
10'- 6"				113	142
11'- 0"				113	148
11'- 6"				113	154
12'- 0"				113	161
12'- 6"				113	167
13'- 0"				113	173
13'- 6"				113	179
14'- 0"				113	186



4 1/2" LINING—CIRCLE BRICK
 9" x 4 1/2" x 2 1/2" or 9" x 4 1/2" x 3"

Diameter Inside Brickwork	Number Required Per Ring					Total
	24 33 Circle	36 45 Circle	48 57 Circle	60 69 Circle	72 81 Circle	
2' 0"	12					12
2' 1"	11	2				13
2' 2"	10	3				13
2' 3"	9	4				13
2' 4"	8	6				14
2' 5"	7	7				14
2' 6"	6	8				14
2' 7"	6	9				15
2' 8"	4	11				15
2' 9"	3	12				15
2' 10"	3	13				16
2' 11"	1	15				16
3' 0"		16				16
3' 1"		15	2			17
3' 2"		13	4			17
3' 3"		12	5			17
3' 4"		11	7			18
3' 5"		9	9			18
3' 6"		8	10			18
3' 7"		7	12			19
3' 8"		6	13			19
3' 9"		4	15			19
3' 10"		4	16			20
3' 11"		2	18			20
4' 0"			20			20
4' 1"			20	1		21
4' 2"			18	3		21
4' 3"			16	5		21
4' 4"			14	8		22
4' 5"			12	10		22
4' 6"			10	12		22
4' 7"			8	15		23
4' 8"			6	17		23
4' 9"			4	19		23
4' 10"			3	21		24
4' 11"			1	23		24
5' 0"				24		24
5' 1"				21	4	25
5' 2"				19	6	25
5' 3"				17	9	26
5' 4"				15	11	26
5' 5"				13	13	26
5' 6"				12	15	27
5' 7"				10	17	27
5' 8"				8	19	27
5' 9"				6	22	28
5' 10"				4	24	28
5' 11"				2	26	28



4 1/2" LINING—CIRCLE BRICK
 9" x 4 1/2" x 2 1/2" or 9" x 4 1/2" x 3" — Concluded

Diameter Inside Brickwork	Number Required Per Ring					Total
	72 81 Circle	84 93 Circle	96 105 Circle	108 117 Circle	120 129 Circle	
6' 0"	28					28
6' 1"	26	3				29
6' 2"	23	6				29
6' 3"	21	9				30
6' 4"	19	11				30
6' 5"	16	14				30
6' 6"	14	17				31
6' 7"	11	20				31
6' 8"	9	22				31
6' 9"	7	25				32
6' 10"	4	28				32
6' 11"	2	30				32
7' 0"		32				32
7' 1"		28	5			33
7' 2"		26	7			33
7' 3"		23	11			34
7' 4"		20	14			34
7' 5"		17	18			35
7' 6"		14	21			35
7' 7"		11	24			35
7' 8"		8	28			36
7' 9"		5	31			36
7' 10"		2	34			36
7' 11"			37			37
8' 0"			37			37
8' 1"			30	7		37
8' 2"			28	10		38
8' 3"			25	13		38
8' 4"			24	15		39
8' 5"			20	19		39
8' 6"			18	21		39
8' 7"			16	24		40
8' 8"			13	27		40
8' 9"			10	30		40
8' 10"			8	33		41
8' 11"			5	36		41
9' 0"				41		41
9' 1"				41	1	42
9' 2"				37	5	42
9' 3"				34	8	42
9' 4"				30	13	43
9' 5"				27	16	43
9' 6"				23	20	43
9' 7"				20	24	44
9' 8"				16	28	44
9' 9"				13	31	44
9' 10"				9	36	45
10' 0"					45	45



4 1/2" LINING—9-INCH CUPOLA BLOCKS

Diameter Inside Brickwork	Number Required Per Ring								Total
	A	B	C	D	E	F	G	H	
1'-4"	9								9
1'-6"	6	4							10
1'-9"		11							11
2'-0"		6	6						12
2'-3"			13						13
2'-6"				14					14
3'-0"				6	10				16
3'-4"					17				17
3'-6"					14	4			18
4'-0"					5	15			20
4'-3"						21			21
4'-6"						14	8		22
5'-0"							24		24
5'-6"							12	15	27
6'-0"								29	29
6'-1"								29	29



6" LINING—ARCH BRICK

12" x 6" x 3" or 13 1/2" x 6" x 3"



Diameter Inside Brickwork	Number Required Per Ring				Total
	No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight	
2'-0"	38				38
2'-3"	35	6			41
2'-6"	31	13			44
2'-9"	29	19			48
3'-0"	26	25			51
3'-3"	22	32			54
3'-6"	19	38			57
3'-9"	16	44			60
4'-0"	13	50			63
4'-3"	9	57			66
4'-6"	7	63			70
4'-9"	4	69			73
5'-0"		76			76
5'-3"		72	7		79
5'-6"		69	13		82
5'-9"		66	19		85
6'-0"		63	25		88
6'-3"		60	32		92
6'-6"		57	38		95
6'-9"		54	44		98
7'-0"		51	50		101
7'-3"		47	57		104
7'-6"		44	63		107
7'-9"		41	69		111
8'-0"		38	75		113
8'-3"		35	82		117
8'-6"		32	88		120
8'-9"		29	94		123
9'-0"		25	101		126
9'-3"		22	107		129
9'-6"		19	113		132
9'-9"		16	119		135
10'-0"		13	126		139
10'-3"		10	132		142
10'-6"		7	138		145
10'-9"		4	145		148
11'-0"			151		151
11'-6"			151	6	157
12'-0"			151	13	164
12'-6"			151	19	170



6" LINING ROTARY KILN OR CUPOLA BLOCKS 9" x 6" x 4"

Diameter Inside Brickwork	Number Required Per Ring								Total
	30-42	36-48	42-54	48-60	54-66	60-72	66-78		
2'-0"	15							15	
2'-9"	8	8						16	
3'-0"		17						17	
3'-3"		8	10					18	
3'-6"			19					19	
3'-9"			9	11				20	
4'-0"				21				21	
4'-3"				10	12			22	
4'-6"					23			23	
4'-9"					13	11		24	
5'-0"						25		25	
5'-3"						14	12	26	
5'-6"							27	27	
	66-78	72-84	78-90	84-96	90-102	96-108	102-114		
5'-9"	16	12						28	
6'-0"		29						29	
6'-3"		18	12					30	
6'-6"			31					31	
6'-9"			19	13				32	
7'-0"				33				33	
7'-3"				16	19			35	
7'-6"					36			36	
7'-9"					17	20		37	
8'-0"						38		38	
8'-3"						22	17	39	
8'-6"							40	40	
	102-114	108-120	114-126	120-132	123-135	126-138			
8'-9"	22	19						41	
9'-0"		42						42	
9'-3"		24	19					43	
9'-6"			44					44	
9'-9"			36	9				45	
10'-0"				46				46	
10'-3"					47			47	
10'-6"						48		48	



6" LINING—FLAT BACK ARCH BRICK

Diameter Inside Brickwork	Number Required Per Ring			Total
	No. 2 F.B.A. 9"x6"x(3 1/2" x 2")	No. 1 F.B.A. 9"x6"x(3 1/2" x 2 1/2")	F.B. Straight 9"x6"x2 1/2"	
1'-4"	26			26
1'-6"	22	5		27
1'-9"	16	14		30
2'-0"	11	22		33
2'-3"	5	30		35
2'-6"		38		38
3'-0"		38	8	46
3'-6"		38	15	53
4'-0"		38	23	61
4'-6"		38	30	68
5'-0"		38	38	76
5'-6"		38	45	83
6'-0"		38	53	91
6'-6"		38	60	98
7'-0"		38	68	106
7'-6"		38	75	113
8'-0"		38	83	121
8'-6"		38	91	129
9'-0"		38	98	136
9'-6"		38	106	144
10'-0"		38	113	151
10'-6"		38	121	159
11'-0"		38	128	166
11'-6"		38	136	174
12'-0"		38	143	181
12'-6"		38	151	189
13'-0"		38	158	196



9" LINING—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"

Diameter Inside Brickwork	Number Required Per Ring				Total
	No. 2 Wedge	No. 1 Wedge	No. 1 X Wedge	Straight	
2'-3"	57				57
2'-6"	51	10			61
2'-9"	44	20			64
3'-0"	38	30			68
3'-3"	32	40			72
3'-6"	25	51			76
3'-9"	19	61			80
4'-0"	13	70			83
4'-3"	6	81			87
4'-6"		91			91
4'-9"		88	7		95
5'-0"		85	13		98
5'-3"		83	19		102
5'-6"		81	25		106
5'-9"		78	32		110
6'-0"		75	38		113
6'-3"		73	44		117
6'-6"		71	50		121
6'-9"		68	57		125
7'-0"		66	63		129
7'-3"		63	69		132
7'-6"		60	76		136
7'-9"		58	82		140
8'-0"		56	88		144
8'-3"		53	94		147
8'-6"		50	101		151
8'-9"		48	107		155
9'-0"		46	113		159
9'-3"		43	120		163
9'-6"		40	126		166
9'-9"		38	132		170
10'-0"		35	139		174
10'-6"		30	151		181
11'-0"		25	164		189
11'-6"		20	176		196
12'-0"		15	189		204
12'-6"		10	202		212
13'-0"		5	214		219
13'-6"			227		227
14'-0"			227	7	234
15'-0"			227	22	249
16'-0"			227	37	264
17'-0"			227	52	279
18'-0"			227	67	294
19'-0"			227	83	310
20'-0"			227	98	325
21'-0"			227	113	340
22'-0"			227	128	355



9" LINING—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or
9" x 9" x 3"

This table can be used also for 13 1/4" x 9" x 3" arch brick by substituting
No. 1, 2, and 3 arch brick for the corresponding wedge brick

Diameter Inside Brickwork	Number Required Per Ring				Total
	No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	Straight	
3'-0"	57				57
3'-3"	54	6			60
3'-6"	50	13			63
3'-9"	47	19			66
4'-0"	44	26			70
4'-3"	41	32			73
4'-6"	38	38			76
4'-9"	35	44			79
5'-0"	32	50			82
5'-3"	28	57			85
5'-6"	25	63			88
5'-9"	22	70			92
6'-0"	19	76			95
6'-3"	16	82			98
6'-6"	13	88			101
6'-9"	10	94			104
7'-0"	6	101			107
7'-3"	3	107			110
7'-6"		113			113
7'-9"		110	7		117
8'-0"		107	13		120
8'-3"		104	19		123
8'-6"		101	25		126
8'-9"		97	32		129
9'-0"		94	38		132
9'-3"		91	44		135
9'-6"		88	51		139
9'-9"		85	57		142
10'-0"		82	63		145
10'-6"		76	75		151
11'-0"		69	88		157
11'-6"		63	101		164
12'-0"		57	113		170
12'-6"		50	126		176
13'-0"		44	139		183
13'-6"		38	151		189
14'-0"		32	163		195
14'-6"		25	176		201
15'-0"		19	189		208
15'-6"		13	201		214
16'-0"		6	214		220
16'-6"			226		226
17'-0"			226	7	233
17'-6"			226	13	239
18'-0"			226	19	245



9" LINING—KEY BRICK

9" x 4 1/2" x 2 1/2" or 9" x 4 1/2" x 3"

Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 4 Key	No. 3 Key	No. 2 Key	No. 1 Key	Straight	
1' 6"	26					26
2' 0"	17	13				30
2' 6"	9	25				34
3' 0"		38				38
3' 6"		29	13			42
4' 0"		21	25			46
4' 6"		13	38			51
5' 0"		4	51			55
5' 3"			57			57
5' 6"			55	4		59
6' 0"			50	13		63
6' 6"			46	21		67
7' 0"			42	30		72
7' 6"			38	38		76
8' 0"			34	46		80
8' 6"			29	55		84
9' 0"			25	63		88
9' 6"			21	72		93
10' 0"			17	80		97
10' 6"			13	88		101
11' 0"			9	96		105
11' 6"			4	105		109
12' 0"				113		113
12' 6"				113	5	118
13' 0"				113	9	122
13' 6"				113	13	126
14' 0"				113	17	130
14' 6"				113	21	134
15' 0"				113	26	139
15' 6"				113	30	143
16' 0"				113	34	147
16' 6"				113	38	151
17' 0"				113	42	155
17' 6"				113	47	160
18' 0"				113	51	164
18' 6"				113	55	168
19' 0"				113	59	172
19' 6"				113	63	176
20' 0"				113	68	181
20' 6"				113	72	185
21' 0"				113	76	189
21' 6"				113	80	193
22' 0"				113	84	197
22' 6"				113	88	201
23' 0"				113	93	206
23' 6"				113	97	210
24' 0"				113	101	214
24' 6"				113	105	218
25' 0"				113	109	222



9" LINING—KEY BRICK

9" x 6" x 2 1/2" or 9" x 6" x 3"

Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 3 Key	No. 2 Key	No. 1 Key	Straight		
1' 6"	19					19
2' 0"	17	5				22
2' 6"	15	11				26
3' 0"	13	16				29
3' 6"	11	21				32
4' 0"	9	26				35
4' 6"	7	31				38
5' 0"	5	36				41
5' 6"	2	42				44
6' 0"		48				48
6' 6"		45	6			51
7' 0"		41	13			54
7' 6"		38	19			57
8' 0"		34	26			60
8' 6"		31	32			63
9' 0"		27	39			66
9' 6"		24	46			70
10' 0"		21	52			73
10' 6"		17	59			76
11' 0"		13	66			79
11' 6"		10	72			82
12' 0"		6	79			85
12' 6"		3	85			88
12' 10"			90			90
13' 0"			91			91
13' 6"			91	4		95
14' 0"			91	7		98
14' 6"			91	10		101
15' 0"			91	13		104
15' 6"			91	16		107
16' 0"			91	19		110
16' 6"			91	22		113
17' 0"			91	26		117
17' 6"			91	29		120
18' 0"			91	32		123
18' 6"			91	35		126
19' 0"			91	38		129
19' 6"			91	41		132
20' 0"			91	44		135
20' 6"			91	48		139
21' 0"			91	51		142
21' 6"			91	54		145
22' 0"			91	57		148
22' 6"			91	60		151
23' 0"			91	63		154
23' 6"			91	66		157
24' 0"			91	70		161
24' 6"			91	73		164
25' 0"			91	76		167



9" LINING ROTARY KILN BLOCKS 9" x 9" x 4"

Diameter Inside Brickwork	Number Required Per Ring										Total
	48-66	54-72	60-78	66-84	72-90	78-96	84-102				
4'-0"	23									23	
4'-3"	11	13								24	
4'-6"		25								25	
4'-9"		14	12							26	
5'-0"			27							27	
5'-3"			15	13						28	
5'-6"				29						29	
5'-9"				12	18					30	
6'-0"					31					31	
6'-3"					14	18				32	
6'-6"						33				33	
6'-9"						16	19			35	
7'-0"							36			36	

	84-102	96-114	108-126	117-135			
	90-108	102-120	114-132				
7'-3"	17	20			37		
7'-6"		38			38		
7'-9"		22	17		39		
8'-0"			40		40		
8'-3"			27	14	41		
8'-6"				42	42		
8'-9"				25	18	43	
9'-0"				44		44	
9'-3"				27	18	45	
9'-6"					46	46	
9'-9"						47	47

	120-138	126-144	138-156	150-168				
	123-141	132-150	144-162					
10'-0"	48				48			
10'-3"		49			49			
10'-6"			51		51			
10'-9"			14	38	52			
11'-0"				53	53			
11'-3"				24	30	54		
11'-6"					55	55		
11'-9"					34	22	56	
12'-0"						57	57	
12'-3"						24	34	58
12'-6"							59	59



12" LINING — WEDGE BRICK 12" x 4 1/2" x 3", 12" x 6" x 3" or 12" x 9" x 3"

Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	No. 1-X* Wedge	Straight	
4'- 0"	76					76
4'- 6"	69	13				82
5'- 0"	63	25				88
5'- 6"	57	38				95
6'- 0"	51	50				101
6'- 6"	44	63				107
7'- 0"	38	75				113
7'- 6"	32	88				120
8'- 0"	25	101				126
8'- 6"	19	113				132
9'- 0"	13	126				139
9'- 6"	7	138				145
10'- 0"		151				151
10'- 6"		144	13			157
11'- 0"		139	25			164
11'- 6"		132	38			170
12'- 0"		126	50			176
12'- 6"		120	63			183
13'- 0"		113	76			189
13'- 6"		107	88			195
14'- 0"		101	100			201
14'- 6"		95	113			208
15'- 0"		88	126			214
15'- 6"		82	138			220
16'- 0"		76	151			227
16'- 6"		69	164			233
17'- 0"		63	176			239
17'- 6"		57	188			245
18'- 0"		51	201			252
18'- 6"		44	214			258
19'- 0"		38	226			264
19'- 6"		32	239			271
20'- 0"		25	252			277
20'- 6"		19	264			283
21'- 0"		13	276			289
21'- 6"		7	289			296
22'- 0"			302			302
22'- 6"			295	13		308
23'- 0"			289	26		315
23'- 6"			283	38		321
24'- 0"			277	50		327
24'- 6"			270	63		333
25'- 0"			264	76		340
25'- 6"			258	88		346
26'- 0"			251	101		352
26'- 6"			245	114		359



12" LINING — WEDGE BRICK 12" x 4 1/2" x 3", 12" x 6" x 3" or 12" x 9" x 3" — Concluded

Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	No. 1-X* Wedge	Straight	
27'- 0"			239	126		365
27'- 6"			233	138		371
28'- 0"			226	151		377
28'- 6"			220	164		384
29'- 0"			214	176		390
29'- 6"			207	189		396
30'- 0"			202	201		403
30'- 6"			195	214		409
31'- 0"			189	226		415
31'- 6"			182	239		421
32'- 0"			176	252		428
32'- 6"			170	264		434
33'- 0"			163	277		440
33'- 6"			158	289		447
34'- 0"			151	302		453
34'- 6"			145	314		459
35'- 0"			138	327		465
35'- 6"			132	340		472
36'- 0"			126	352		478
36'- 6"			119	365		484
37'- 0"			113	377		490
37'- 6"			107	390		497
38'- 0"			101	402		503
38'- 6"			94	415		509
39'- 0"			88	428		516
39'- 6"			82	440		522
40'- 0"			76	452		528
40'- 6"			69	465		534
41'- 0"			63	478		541
41'- 6"			57	490		547
42'- 0"			50	503		553
42'- 6"			44	516		560
43'- 0"			38	528		566
43'- 6"			32	540		572
44'- 0"			25	553		578
44'- 6"			19	566		585
45'- 0"			13	578		591
45'- 6"			6	591		597
46'- 0"				604		604
46'- 6"				604	6	610
47'- 0"				604	12	616
47'- 6"				604	18	622
48'- 0"				604	25	629
48'- 6"				604	31	635

*NOTE: The No. 1-X Wedge is standard in Silica Materials only. For Fireclay Material, in the case of diameters 22' 0", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 302. The quantity of Straight brick is determined by subtracting 302 from the quantity given in the column "Total."



13 1/2" LINING—WEDGE BRICK

13 1/2" x 4 1/2" x 3", 13 1/2" x 6" x 3" or
13 1/2" x 9" x 3"

Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	No. 1 X* Wedge	Straight	
4'-6"	85					85
5'-0"	79	13				92
5'-6"	73	25				98
6'-0"	66	38				104
6'-6"	60	50				110
7'-0"	54	63				117
7'-6"	47	76				123
8'-0"	41	88				129
8'-6"	35	100				135
9'-0"	29	113				142
9'-6"	22	126				148
10'-0"	16	138				154
10'-6"	10	151				161
11'-0"	3	164				167
11'-3"		170				170
11'-6"		167	6			173
12'-0"		160	19			179
12'-6"		154	32			186
13'-0"		148	44			192
13'-6"		141	57			198
14'-0"		135	70			205
14'-6"		129	82			211
15'-0"		123	94			217
15'-6"		116	107			223
16'-0"		110	120			230
16'-6"		104	132			236
17'-0"		97	145			242
17'-6"		92	157			249
18'-0"		85	170			255
18'-6"		79	182			261
19'-0"		72	195			267
19'-6"		66	208			274
20'-0"		60	220			280
20'-6"		53	233			286
21'-0"		48	245			293
21'-6"		41	258			299
22'-0"		35	270			305
22'-6"		28	283			311
23'-0"		22	296			318
23'-6"		16	308			324
24'-0"		9	321			330
24'-6"		4	333			337
24'-9"			340			340
25'-0"			336	7		343
25'-6"			330	19		349
26'-0"			324	31		355
26'-6"			318	44		362
27'-0"			311	57		368
27'-6"			305	69		374



Diameter Inside Brickwork	Number Required Per Ring					Total
	No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	No. 1 X* Wedge	Straight	
28'-0"			299	82		381
28'-6"			292	95		387
29'-0"			286	107		393
29'-6"			280	119		399
30'-0"			274	132		406
30'-6"			267	145		412
31'-0"			261	157		418
31'-6"			255	170		425
32'-0"			248	183		431
32'-6"			242	195		437
33'-0"			236	207		443
33'-6"			230	220		450
34'-0"			223	233		456
34'-6"			217	245		462
35'-0"			210	258		468
35'-6"			205	270		475
36'-0"			198	283		481
36'-6"			192	295		487
37'-0"			186	308		494
37'-6"			179	321		500
38'-0"			173	333		506
38'-6"			166	346		512
39'-0"			161	358		519
39'-6"			154	371		525
40'-0"			148	383		531
40'-6"			142	396		538
41'-0"			135	409		544
41'-6"			129	421		550
42'-0"			122	434		556
42'-6"			117	446		563
43'-0"			110	459		569
43'-6"			104	471		575
44'-0"			98	484		582
44'-6"			91	497		588
45'-0"			85	509		594
45'-6"			79	521		600
46'-0"			73	534		607
46'-6"			66	547		613
47'-0"			60	559		619
47'-6"			54	572		626
48'-0"			47	585		632
48'-6"			41	597		638
49'-0"			35	609		644
49'-6"			29	622		651
50'-0"			22	635		657
50'-6"			16	647		663
51'-0"			10	660		670
51'-6"			3	673		676
51'-9"				679		679
52'-0"				679	3	682
52'-6"				679	9	688

*NOTE: The No. 1 X Wedge is standard in Silca Material only. For Fireclay material, in the case of diameters over 24' 9", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 340. The quantity of Straight brick is determined by subtracting 340 from the quantity given in the column "Total"



13½" LINING—KEY BRICK
13½" x 6" x 2½" or 13½" x 6" x 3"

Diameter Inside Brickwork	Number Required Per Ring				Total
	No. 3 Key	No. 2 Key	No. 1 Key	Straight	
2'-3"	29				29
2'-6"	26	4			30
2'-9"	25	7			32
3'-0"	23	10			33
3'-3"	21	14			35
3'-6"	19	18			37
3'-9"	18	21			39
4'-0"	16	24			40
4'-3"	14	28			42
4'-6"	12	31			43
4'-9"	10	34			44
5'-0"	8	38			46
5'-3"	7	41			48
5'-6"	4	45			49
5'-9"	3	48			51
6'-0"		52			52
6'-3"		51	3		54
6'-6"		48	7		55
6'-9"		46	11		57
7'-0"		43	16		59
7'-3"		41	20		61
7'-6"		38	24		62
7'-9"		36	28		64
8'-0"		33	32		65
8'-3"		31	36		67
8'-6"		28	40		68
8'-9"		26	44		70
9'-0"		23	48		71
9'-3"		21	52		73
9'-6"		18	56		74
9'-9"		16	60		76
10'-0"		13	64		77
10'-3"		11	68		79
10'-6"		8	73		81
10'-9"		5	77		82
11'-0"		3	81		84
11'-3"			85		85
11'-6"			85	2	87
11'-9"			85	3	88
12'-0"			85	5	90
12'-6"			85	8	93
13'-0"			85	11	96
13'-6"			85	14	99
14'-0"			85	18	103
14'-6"			85	21	106
15'-0"			85	24	109
15'-6"			85	27	112



13½" LINING—KEY BRICK
13½" x 6" x 2½" or 13½" x 6" x 3"—Concluded

Diameter Inside Brickwork	Number Required Per Ring				Total
	No. 3 Key	No. 2 Key	No. 1 Key	Straight	
16'-0"			85	30	115
16'-6"			85	33	118
17'-0"			85	36	121
17'-6"			85	39	124
18'-0"			85	43	128
18'-6"			85	46	131
19'-0"			85	49	134
19'-6"			85	52	137
20'-0"			85	55	140
20'-6"			85	58	143
21'-0"			85	61	146
21'-6"			85	65	150
22'-0"			85	68	153
22'-6"			85	71	156
23'-0"			85	74	159
23'-6"			85	77	162
24'-0"			85	80	165
24'-6"			85	83	168
25'-0"			85	87	172
25'-6"			85	90	175
26'-0"			85	93	178
26'-6"			85	96	181
27'-0"			85	99	184
27'-6"			85	102	187
28'-0"			85	105	190
28'-6"			85	109	194
29'-0"			85	112	197
29'-6"			85	115	200
30'-0"			85	118	201
30'-6"			85	121	206
31'-0"			85	124	209
31'-6"			85	127	212
32'-0"			85	131	216
32'-6"			85	134	219
33'-0"			85	137	222
33'-6"			85	140	225
34'-0"			85	143	228
34'-6"			85	146	231
35'-0"			85	149	234
35'-6"			85	153	238
36'-0"			85	156	241
36'-6"			85	159	244
37'-0"			85	162	247
37'-6"			85	165	250
38'-0"			85	168	253
38'-6"			85	171	256
39'-0"			85	175	260
39'-6"			85	178	263
40'-0"			85	181	266



4 1/2" ARCH THICKNESS — ARCH BRICK

9" x 4 1/2" x 2 1/2" or 13 1/2" x 4 1/2" x 2 1/2"

1 1/2" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course			
			No. 3 Arch	No. 1 Arch	Straight	Total
1'-0"	1 1/2"	1'-0 1/4"	5	2		7
1'-1"	1 5/8"	1'-1 11/16"	5	3		8
1'-2"	1 3/4"	1'-2 7/8"	4	4		8
1'-3"	1 7/8"	1'-3 5/16"	4	4		8
1'-4"	2"	1'-5"	4	5		9
1'-5"	2 1/8"	1'-6 1/16"	3	6		9
1'-6"	2 1/4"	1'-7 1/8"	3	7		10
1'-7"	2 3/8"	1'-8 3/16"	2	8		10
1'-8"	2 1/2"	1'-9 1/4"	2	8		10
1'-9"	2 5/8"	1'-10 5/16"	1	10		11
1'-10"	2 3/4"	1'-11 3/8"	1	10		11
1'-11"	2 7/8"	2'-0 7/16"	1	11		12
2'-0"	3"	2'-1 1/2"		12		12
2'-3"	3 3/8"	2'-4 11/16"		12	1	13
2'-6"	3 1/4"	2'-7 7/8"		12	3	15
2'-9"	4 1/8"	2'-11 1/16"		12	4	16
3'-0"	4 1/2"	3'-2 1/4"		12	5	17
3'-3"	4 7/8"	3'-5 7/16"		12	6	18
3'-6"	5 1/4"	3'-8 5/8"		12	8	20
3'-9"	5 5/8"	3'-11 3/16"		12	9	21
4'-0"	6"	4'-3"		12	10	22
4'-3"	6 3/8"	4'-6 3/16"		12	11	23
4'-6"	6 3/4"	4'-9 5/8"		12	13	25
4'-9"	7 1/8"	5'-0 9/16"		12	14	26
5'-0"	7 1/2"	5'-3 1/4"		12	15	27
5'-3"	7 7/8"	5'-6 5/16"		12	16	28
5'-6"	8 1/4"	5'-10 1/8"		12	18	30
5'-9"	8 5/8"	6'-1 5/16"		12	19	31
6'-0"	9"	6'-4 1/2"		12	20	32
6'-3"	9 3/8"	6'-7 11/16"		12	21	33
6'-6"	9 3/4"	6'-10 7/8"		12	23	35

4 1/2" ARCH THICKNESS — ARCH BRICK

9" x 4 1/2" x 3" or 13 1/2" x 4 1/2" x 3"

1 1/2" Rise Per Foot of Span



Span	Rise	Inside Radius	Number Required Per Course			
			No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight Total
1'-0"	1 1/2"	1'-0 1/4"	3	3		6
1'-1"	1 5/8"	1'-1 11/16"	3	3		6
1'-2"	1 3/4"	1'-2 7/8"	3	4		7
1'-3"	1 7/8"	1'-3 5/16"	2	5		7
1'-4"	2"	1'-5"	2	5		7
1'-5"	2 1/8"	1'-6 1/16"	2	6		8
1'-6"	2 1/4"	1'-7 1/8"	1	7		8
1'-7"	2 3/8"	1'-8 3/16"	1	7		8
1'-8"	2 1/2"	1'-9 1/4"	1	8		9
1'-9"	2 5/8"	1'-10 5/16"		9		9
1'-10"	2 3/4"	1'-11 3/8"		9	1	10
1'-11"	2 7/8"	2'-0 7/16"		8	2	10
2'-0"	3"	2'-1 1/2"		8	2	10
2'-1"	3 1/8"	2'-2 9/16"		8	3	11
2'-2"	3 1/4"	2'-3 5/8"		7	4	11
2'-3"	3 3/8"	2'-4 11/16"		7	4	11
2'-4"	3 1/2"	2'-5 3/4"		7	5	12
2'-5"	3 5/8"	2'-6 13/16"		6	6	12
2'-6"	3 3/4"	2'-7 7/8"		6	6	12
2'-7"	3 7/8"	2'-8 5/16"		6	7	13
2'-8"	4"	2'-10"		5	8	13
2'-9"	4 1/8"	2'-11 1/16"		5	8	13
2'-10"	4 1/4"	3'-0 1/8"		5	9	14
2'-11"	4 3/8"	3'-1 1/16"		4	10	14
3'-0"	4 1/2"	3'-2 1/4"		4	10	14
3'-1"	4 5/8"	3'-3 5/16"		1	11	15
3'-2"	4 3/4"	3'-4 3/8"		3	12	15
3'-3"	4 7/8"	3'-5 7/16"		3	12	15
3'-4"	5"	3'-6 1/2"		3	13	16
3'-5"	5 1/8"	3'-7 9/16"		2	14	16
3'-6"	5 1/4"	3'-8 5/8"		2	14	16
3'-7"	5 3/8"	3'-9 11/16"		2	15	17
3'-8"	5 1/2"	3'-10 3/4"		1	16	17
3'-9"	5 5/8"	3'-11 11/16"			17	17
3'-10"	5 1/4"	4'-0 7/8"			18	18
3'-11"	5 3/8"	4'-1 15/16"			18	18
4'-0"	6"	4'-3"			18	1
4'-3"	6 3/8"	4'-6 3/16"			18	2
4'-6"	6 3/4"	4'-9 5/8"			18	3
4'-9"	7 1/8"	5'-0 9/16"			18	4
5'-0"	7 1/2"	5'-3 1/4"			18	5
5'-3"	7 7/8"	5'-6 5/16"			18	6
5'-6"	8 1/4"	5'-10 1/8"			18	7
5'-9"	8 5/8"	6'-1 5/16"			18	8
6'-0"	9"	6'-4 1/2"			18	9



4 1/2" ARCH THICKNESS — ARCH BRICK

9" x 4 1/2" x 2 1/2" or 13 1/2" x 4 1/2" x 2 1/2"
1.608" Rise Per Foot of Span
(60° Central Angle)

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Arch	No. 1 Arch	Straight	Total
1'-0"	1 19/32"	1'-0"	6	1		7
1'-1"	1 1/4"	1'-1"	6	2		8
1'-2"	1 7/8"	1'-2"	5	3		8
1'-3"	2"	1'-3"	5	4		9
1'-4"	2 5/32"	1'-4"	4	5		9
1'-5"	2 9/32"	1'-5"	4	5		9
1'-6"	2 13/32"	1'-6"	3	7		10
1'-7"	2 17/32"	1'-7"	3	7		10
1'-8"	2 11/16"	1'-8"	3	8		11
1'-9"	2 15/16"	1'-9"	2	9		11
1'-10"	2 19/16"	1'-10"	2	10		12
1'-11"	3 3/32"	1'-11"	1	11		12
2'-0"	3 7/32"	2'-0"	1	11		12
2'-1"	3 11/32"	2'-1"	1	12		13
2'-2"	3 15/32"	2'-2"		13		13
2'-3"	3 5/8"	2'-3"		13	1	14
2'-6"	4 1/32"	2'-6"		13	2	15
2'-9"	4 7/16"	2'-9"		13	3	16
3'-0"	4 11/16"	3'-0"		13	4	17
3'-3"	5 1/32"	3'-3"		13	6	19
3'-6"	5 5/8"	3'-6"		13	7	20
3'-9"	6 1/32"	3'-9"		13	8	21
4'-0"	6 7/16"	4'-0"		13	9	22
4'-3"	6 21/32"	4'-3"		13	11	24
4'-6"	7 1/4"	4'-6"		13	12	25
4'-9"	7 5/8"	4'-9"		13	13	26
5'-0"	8 1/32"	5'-0"		13	14	27
5'-3"	8 1/16"	5'-3"		13	16	29
5'-6"	8 17/32"	5'-6"		13	17	30
5'-9"	9 1/4"	5'-9"		13	18	31
6'-0"	9 21/32"	6'-0"		13	19	32
6'-3"	10 1/16"	6'-3"		13	21	34
6'-6"	10 7/16"	6'-6"		13	22	35

4 1/2" ARCH THICKNESS — ARCH BRICK

9" x 4 1/2" x 3" or 13 1/2" x 4 1/2" x 3"
1.608 Rise Per Foot of Span
(60° Central Angle)



Span	Rise	Inside Radius	Number Required Per Course				
			No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight	Total
1'-0"	1 19/32"	1'-0"	4	2			6
1'-1"	1 3/4"	1'-1"	4	3			7
1'-2"	1 7/8"	1'-2"	3	4			7
1'-3"	2"	1'-3"	3	4			7
1'-4"	2 5/32"	1'-4"	3	5			8
1'-5"	2 9/32"	1'-5"	2	6			8
1'-6"	2 13/32"	1'-6"	2	6			8
1'-7"	2 17/32"	1'-7"	2	7			9
1'-8"	2 11/16"	1'-8"	1	8			9
1'-9"	2 15/16"	1'-9"	1	8			9
1'-10"	2 19/16"	1'-10"	1	9			10
1'-11"	3 3/32"	1'-11"		9	1		10
2'-0"	3 7/32"	2'-0"		9	1		10
2'-1"	3 11/32"	2'-1"		9	2		11
2'-2"	3 15/32"	2'-2"		8	3		11
2'-3"	3 5/8"	2'-3"		8	3		11
2'-4"	3 9/16"	2'-4"		8	4		12
2'-5"	3 7/8"	2'-5"		7	5		12
2'-6"	4 1/32"	2'-6"		7	5		12
2'-7"	4 5/32"	2'-7"		7	6		13
2'-8"	4 9/32"	2'-8"		6	7		13
2'-9"	4 13/16"	2'-9"		6	7		13
2'-10"	4 17/16"	2'-10"		6	8		14
2'-11"	4 11/16"	2'-11"		5	9		14
3'-0"	4 15/16"	3'-0"		5	10		15
3'-1"	4 19/32"	3'-1"		5	10		15
3'-2"	5 1/32"	3'-2"		4	11		15
3'-3"	5 5/32"	3'-3"		4	12		16
3'-4"	5 9/32"	3'-4"		4	12		16
3'-5"	5 13/32"	3'-5"		3	13		16
3'-6"	5 17/32"	3'-6"		3	14		17
3'-7"	5 21/32"	3'-7"		2	15		17
3'-8"	5 25/32"	3'-8"		2	15		17
3'-9"	6 1/32"	3'-9"		2	16		18
3'-10"	6 5/32"	3'-10"		1	17		18
3'-11"	6 9/32"	3'-11"		1	17		18
4'-0"	6 13/16"	4'-0"		1	18		19
4'-1"	6 17/16"	4'-1"			19		19
4'-2"	6 21/16"	4'-2"			19		19
4'-3"	6 25/16"	4'-3"			19	1	20
4'-6"	7 1/4"	4'-6"			19	2	21
5'-0"	8 1/32"	5'-0"			19	4	23
5'-6"	8 21/32"	5'-6"			19	6	25
6'-0"	9 11/32"	6'-0"			19	8	27
6'-6"	10 7/16"	6'-6"			19	10	29



4 1/2" ARCH THICKNESS — ARCH BRICK
 9" x 4 1/2" x 2 1/2" or 13 1/2" x 4 1/2" x 2 1/2"
 2" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Arch	No. 1 Arch	Straight	Total
1'-0"	2"	10"	8			8
1'-1"	2 5/16"	10 1/16"	8			8
1'-2"	2 11/32"	11 1/32"	7	2		9
1'-3"	2 1/2"	1' 0 1/2"	7	2		9
1'-4"	2 21/32"	1' 1 11/32"	7	3		10
1'-5"	2 27/32"	1' 2 5/32"	6	4		10
1'-6"	3"	1' 3"	5	5		10
1'-7"	3 5/16"	1' 3 1/16"	5	6		11
1'-8"	3 11/32"	1' 4 1/32"	5	6		11
1'-9"	3 1/2"	1' 5 1/2"	4	8		12
1'-10"	3 21/32"	1' 6 11/32"	4	8		12
1'-11"	3 27/32"	1' 7 5/32"	4	9		13
2'-0"	4"	1' 8"	3	10		13
2'-1"	4 5/16"	1' 8 1/16"	2	11		13
2'-2"	4 11/32"	1' 9 1/32"	2	12		14
2'-3"	4 1/2"	1' 10 1/2"	2	12		14
2'-4"	4 21/32"	1' 11 11/32"	1	14		15
2'-5"	4 27/32"	2' 0 5/32"	1	14		15
2'-6"	5"	2' 1"	1	15		16
2'-9"	5 1/2"	2' 3 1/2"		16	1	17
3'-0"	6"	2' 6"		16	2	18
3'-3"	6 1/2"	2' 8 1/2"		16	3	19
3'-6"	7"	2' 11"		16	5	21
3'-9"	7 1/2"	3' 1 1/2"		16	6	22
4'-0"	8"	3' 4"		16	7	23
4'-3"	8 1/2"	3' 6 1/2"		16	9	25
4'-6"	9"	3' 9"		16	10	26
4'-9"	9 1/2"	3' 11 1/2"		16	11	27
5'-0"	10"	4' 2"		16	12	28
5'-3"	10 1/2"	4' 4 1/2"		16	14	30
5'-6"	11"	4' 7"		16	15	31
5'-9"	11 1/2"	4' 9 1/2"		16	16	32
6'-0"	1' 0"	5' 0"		16	18	34
6'-3"	1' 0 1/2"	5' 2 1/2"		16	19	35
6'-6"	1'-1"	5' 5"		16	20	36



4 1/2" ARCH THICKNESS — ARCH BRICK
 9" x 4 1/2" x 3" or 13 1/2" x 4 1/2" x 3"
 1 2" Rise Per Foot of Span



Span	Rise	Inside Radius	Number Required Per Course				
			No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight Total	
1'- 0"	2"	10"	6	1		7	
1'- 1"	2 $\frac{5}{32}$ "	10 $\frac{27}{32}$ "	5	2		7	
1'- 2"	2 $\frac{11}{32}$ "	11 $\frac{41}{32}$ "	5	2		7	
1'- 3"	2 $\frac{1}{2}$ "	1'- 0 $\frac{1}{2}$ "	5	3		8	
1'- 4"	2 $\frac{21}{32}$ "	1'- 1 $\frac{11}{32}$ "	4	4		8	
1'- 5"	2 $\frac{27}{32}$ "	1'- 2 $\frac{5}{32}$ "	4	4		8	
1'- 6"	3"	1'- 3"	4	5		9	
1'- 7"	3 $\frac{5}{32}$ "	1'- 3 $\frac{27}{32}$ "	3	6		9	
1'- 8"	3 $\frac{11}{32}$ "	1'- 4 $\frac{41}{32}$ "	2	7		9	
1'- 9"	3 $\frac{1}{2}$ "	1'- 5 $\frac{1}{2}$ "	2	8		10	
1'-10"	3 $\frac{21}{32}$ "	1'- 6 $\frac{11}{32}$ "	2	8		10	
1'-11"	3 $\frac{27}{32}$ "	1'- 7 $\frac{5}{32}$ "	2	9		11	
2'- 0"	4"	1'- 8"	1	10		11	
2'- 1"	4 $\frac{5}{32}$ "	1'- 8 $\frac{27}{32}$ "	1	10		11	
2'- 2"	4 $\frac{11}{32}$ "	1'- 9 $\frac{41}{32}$ "	1	11		12	
2'- 3"	4 $\frac{1}{2}$ "	1'-10 $\frac{1}{2}$ "		12		12	
2'- 4"	4 $\frac{21}{32}$ "	1'-11 $\frac{11}{32}$ "		11	1	12	
2'- 5"	4 $\frac{27}{32}$ "	2'- 0 $\frac{5}{32}$ "		11	2	13	
2'- 6"	5"	2'- 1"		11	2	13	
2'- 7"	5 $\frac{5}{32}$ "	2'- 1 $\frac{27}{32}$ "		10	3	13	
2'- 8"	5 $\frac{11}{32}$ "	2'- 2 $\frac{41}{32}$ "		10	4	14	
2'- 9"	5 $\frac{1}{2}$ "	2'- 3 $\frac{1}{2}$ "		10	4	14	
2'-10"	5 $\frac{21}{32}$ "	2'- 4 $\frac{11}{32}$ "		9	5	14	
2'-11"	5 $\frac{27}{32}$ "	2'- 5 $\frac{5}{32}$ "		9	6	15	
3'- 0"	6"	2'- 6"		8	7	15	
3'- 2"	6 $\frac{11}{32}$ "	2'- 7 $\frac{27}{32}$ "		8	8	16	
3'- 4"	6 $\frac{21}{32}$ "	2'- 9 $\frac{41}{32}$ "		7	10	17	
3'- 6"	7"	2'-11"		6	11	17	
3'- 8"	7 $\frac{11}{32}$ "	3'- 0 $\frac{11}{32}$ "		6	12	18	
3'-10"	7 $\frac{21}{32}$ "	3'- 2 $\frac{11}{32}$ "		5	14	19	
4'- 0"	8"	3'- 4"		4	15	19	
4'- 2"	8 $\frac{11}{32}$ "	3'- 5 $\frac{27}{32}$ "		3	17	20	
4'- 4"	8 $\frac{21}{32}$ "	3'- 7 $\frac{41}{32}$ "		3	18	21	
4'- 6"	9"	3'- 9"		2	20	22	
4'- 8"	9 $\frac{11}{32}$ "	3'-10 $\frac{11}{32}$ "		1	21	22	
4'-10"	9 $\frac{21}{32}$ "	4'- 0 $\frac{11}{32}$ "		1	22	23	
4'-11"	9 $\frac{27}{32}$ "	4'- 1 $\frac{5}{32}$ "			23	23	
5'- 0"	10"	4'- 2"			23	1	24
5'- 6"	11"	4'- 7"			23	3	26
6'- 0"	1'- 0"	5'- 0"			23	5	28
6'- 6"	1'- 1"	5'- 5"			23	7	30



4 1/2" ARCH THICKNESS—ARCH BRICK
 9" x 4 1/2" x 2 1/2" or 13 1/2" x 4 1/2" x 2 1/2"
 2 3/16" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course				
			No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight Total	
0'- 6"	1 $\frac{5}{16}$ "	4 $\frac{1}{2}$ "	4	2		6	
0'- 7"	1 $\frac{11}{32}$ "	5 $\frac{7}{16}$ "	3	3		6	
0'- 8"	1 $\frac{17}{32}$ "	5 $\frac{11}{16}$ "	3	4		7	
0'- 9"	1 $\frac{23}{32}$ "	6 $\frac{1}{16}$ "	2	5		7	
0'-10"	1 $\frac{29}{32}$ "	7 $\frac{1}{16}$ "	2	5		7	
0'-11"	2 $\frac{1}{8}$ "	8 $\frac{1}{16}$ "	2	6		8	
1'- 0"	2 $\frac{5}{16}$ "	8 $\frac{3}{4}$ "	1	7		8	
1'- 1"	2 $\frac{1}{2}$ "	9 $\frac{1}{4}$ "	1	8		9	
1'- 2"	2 $\frac{11}{16}$ "	10 $\frac{1}{2}$ "		9		9	
1'- 3"	2 $\frac{7}{8}$ "	11 $\frac{1}{4}$ "		9	1	10	
1'- 4"	3 $\frac{1}{16}$ "	11 $\frac{11}{16}$ "		8	2	10	
1'- 5"	3 $\frac{1}{4}$ "	1'- 0 $\frac{23}{32}$ "		7	3	10	
1'- 6"	3 $\frac{5}{16}$ "	1'- 1 $\frac{15}{16}$ "		7	4	11	
1'- 7"	3 $\frac{21}{32}$ "	1'- 2 $\frac{7}{16}$ "		7	4	11	
1'- 8"	3 $\frac{27}{32}$ "	1'- 2 $\frac{15}{16}$ "		6	6	12	
1'- 9"	4 $\frac{1}{16}$ "	1'- 3 $\frac{11}{16}$ "		6	6	12	
1'-10"	4 $\frac{7}{32}$ "	1'- 4 $\frac{7}{16}$ "		6	7	13	
1'-11"	4 $\frac{13}{32}$ "	1'- 5 $\frac{5}{16}$ "		5	8	13	
2'- 0"	4 $\frac{19}{32}$ "	1'- 5 $\frac{51}{16}$ "		5	9	14	
2'- 1"	4 $\frac{25}{32}$ "	1'- 6 $\frac{11}{16}$ "		4	10	14	
2'- 2"	5"	1'- 7 $\frac{7}{16}$ "		4	10	14	
2'- 3"	5 $\frac{3}{16}$ "	1'- 8 $\frac{3}{16}$ "		3	12	15	
2'- 4"	5 $\frac{1}{8}$ "	1'- 8 $\frac{15}{16}$ "		3	12	15	
2'- 5"	5 $\frac{1}{16}$ "	1'- 9 $\frac{1}{16}$ "		3	13	16	
2'- 6"	5 $\frac{3}{4}$ "	1'-10 $\frac{7}{16}$ "		2	14	16	
2'- 7"	5 $\frac{15}{16}$ "	1'-11 $\frac{5}{16}$ "		2	15	17	
2'- 8"	6 $\frac{1}{8}$ "	1'-11 $\frac{19}{32}$ "		1	16	17	
2'- 9"	6 $\frac{1}{16}$ "	2'- 0 $\frac{21}{32}$ "			17	17	
2'-10"	6 $\frac{17}{32}$ "	2'- 1 $\frac{13}{32}$ "			18	18	
2'-11"	6 $\frac{23}{32}$ "	2'- 2 $\frac{5}{32}$ "			18	18	
3'- 0"	6 $\frac{29}{32}$ "	2'- 2 $\frac{29}{32}$ "			18	1	19
3'- 1"	7 $\frac{3}{32}$ "	2'- 3 $\frac{11}{32}$ "			18	1	19
3'- 2"	7 $\frac{9}{32}$ "	2'- 4 $\frac{13}{32}$ "			18	2	20
3'- 3"	7 $\frac{15}{32}$ "	2'- 5 $\frac{5}{32}$ "			18	2	20
3'- 4"	7 $\frac{21}{16}$ "	2'- 5 $\frac{29}{32}$ "			18	3	21
3'- 5"	7 $\frac{7}{8}$ "	2'- 6 $\frac{11}{32}$ "			18	3	21
3'- 6"	8 $\frac{1}{16}$ "	2'- 7 $\frac{13}{32}$ "			18	3	21
4'- 0"	9 $\frac{3}{32}$ "	2'-11 $\frac{7}{8}$ "			18	6	24
4'- 6"	10 $\frac{3}{8}$ "	3'- 4 $\frac{3}{8}$ "			18	9	27
5'- 0"	11 $\frac{1}{2}$ "	3'- 8 $\frac{7}{8}$ "			18	11	29
5'- 6"	1'-0 $\frac{1}{32}$ "	4'- 1 $\frac{11}{32}$ "			18	14	32
6'- 0"	1'-1 $\frac{13}{16}$ "	4'- 5 $\frac{5}{16}$ "			18	17	35
6'- 6"	1'-2 $\frac{11}{32}$ "	4'-10 $\frac{5}{16}$ "			18	19	37

* More exactly 2.302".



4 1/2" ARCH THICKNESS—ARCH BRICK
 9" x 4 1/2" x 3" or 13 1/2" x 4 1/2" x 3"
 2 3/16" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course				
			No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight Total	
1'-0"	2 5/16"	8 11/32"	7			7	
1'-1"	2 1/2"	9 23/32"	6	1		7	
1'-2"	2 11/16"	10 15/32"	6	2		8	
1'-3"	2 7/8"	11 7/32"	6	2		8	
1'-4"	3 1/16"	11 11/32"	5	3		8	
1'-5"	3 1/4"	1'-0 23/32"	5	4		9	
1'-6"	3 5/16"	1'-1 15/16"	5	4		9	
1'-7"	3 21/32"	1'-2 7/16"	4	6		10	
1'-8"	3 27/32"	1'-2 15/16"	4	6		10	
1'-9"	4 1/16"	1'-3 11/16"	3	7		10	
1'-10"	4 7/32"	1'-4 7/16"	3	8		11	
1'-11"	4 13/32"	1'-5 5/16"	3	8		11	
2'-0"	4 19/32"	1'-5 51/16"	2	9		11	
2'-1"	4 25/32"	1'-6 11/16"	2	10		12	
2'-2"	5"	1'-7 7/16"	2	10		12	
2'-3"	5 3/16"	1'-8 3/16"	1	11		12	
2'-4"	5 1/8"	1'-8 15/16"	1	12		13	
2'-5"	5 1/16"	1'-9 1/16"	1	12		13	
2'-6"	5 3/4"	1'-10 7/16"		14		14	
2'-7"	5 15/16"	1'-11 5/16"		13	1	14	
2'-8"	6 1/8"	1'-11 29/32"		13	1	14	
2'-10"	6 17/32"	2'-1 13/32"		12	3	15	
3'-0"	6 29/32"	2'-2 29/32"		11	5	16	
3'-2"	7 3/32"	2'-4 13/32"		10	6	16	
3'-4"	7 11/32"	2'-5 5/32"		10	7	17	
3'-6"	8 1/16"	2'-7 13/32"		9	9	18	
3'-8"	8 7/16"	2'-8 7/8"		8	11	19	
3'-10"	8 11/16"	2'-10 3/8"		7	12	19	
4'-0"	9 7/32"	2'-11 7/8"		7	13	20	
4'-2"	9 19/32"	3'-1 15/16"		6	15	21	
4'-4"	9 25/32"	3'-2 7/8"		6	16	22	
4'-6"	10 3/8"	3'-4 3/8"		5	17	22	
4'-8"	10 3/16"	3'-5 27/32"		4	19	23	
4'-10"	11 1/8"	3'-7 11/32"		3	21	24	
5'-0"	11 1/2"	3'-8 7/8"		3	22	25	
5'-2"	11 29/32"	3'-10 11/32"		2	23	25	
5'-4"	1'-0 9/32"	3'-11 27/32"		1	25	26	
5'-6"	1'-0 21/32"	4'-1 11/32"			27	27	
5'-8"	1'-1 1/16"	4'-2 15/16"			27	27	
5'-10"	1'-1 7/16"	4'-4 5/16"			27	1	28
6'-0"	1'-1 11/16"	4'-5 13/16"			27	2	29
6'-6"	1'-2 13/32"	4'-10 5/16"			27	4	31

* More exactly 2.302".



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"
1 1/2" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course				Total
			No. 2 Wedge	No. 1 Wedge	No. 1-X Wedge	Straight	
1'-6"	2 1/4"	1'-7 1/8"	5	6			11
1'-7"	2 3/8"	1'-8 1/16"	5	7			12
1'-8"	2 1/2"	1'-9 1/4"	4	8			12
1'-9"	2 5/8"	1'-10 3/16"	3	10			13
1'-10"	2 3/4"	1'-11 5/8"	3	10			13
1'-11"	2 7/8"	2'-0 7/16"	2	12			14
2'-0"	3"	2'-1 1/2"	1	13			14
2'-1"	3 1/8"	2'-2 3/16"		14			14
2'-2"	3 1/4"	2'-3 3/8"		14	1		15
2'-3"	3 3/8"	2'-4 11/16"		14	1		15
2'-4"	3 1/2"	2'-5 3/4"		14	2		16
2'-5"	3 5/8"	2'-6 13/16"		13	3		16
2'-6"	3 3/4"	2'-7 7/8"		13	3		16
2'-7"	3 7/8"	2'-8 13/16"		13	4		17
2'-8"	4"	2'-10"		12	5		17
2'-9"	4 1/8"	2'-11 1/16"		12	6		18
2'-10"	4 1/4"	3'-0 1/8"		12	6		18
2'-11"	4 3/8"	3'-1 7/16"		12	7		19
3'-0"	4 1/2"	3'-2 1/4"		11	8		19
3'-1"	4 5/8"	3'-3 3/16"		11	8		19
3'-2"	4 3/4"	3'-4 3/8"		11	9		20
3'-3"	4 7/8"	3'-5 7/16"		10	10		20
3'-4"	5"	3'-6 1/2"		10	11		21
3'-5"	5 1/8"	3'-7 7/16"		10	11		21
3'-6"	5 1/4"	3'-8 5/8"		10	11		21
3'-7"	5 3/8"	3'-9 13/16"		10	12		22
3'-8"	5 1/2"	3'-10 3/4"		9	13		22
3'-9"	5 5/8"	3'-11 13/16"		9	14		23
3'-10"	5 3/4"	4'-0 3/8"		9	14		23
3'-11"	5 7/8"	4'-1 5/16"		9	15		24
4'-0"	6"	4'-3"		8	16		24
4'-1"	6 1/8"	4'-4 1/16"		8	16		24
4'-2"	6 1/4"	4'-5 1/8"		8	17		25
4'-3"	6 3/8"	4'-6 3/16"		7	18		25
4'-4"	6 1/2"	4'-7 1/4"		7	19		26
4'-5"	6 5/8"	4'-8 3/16"		7	19		26
4'-6"	6 3/4"	4'-9 5/8"		6	20		26
4'-7"	6 7/8"	4'-10 13/16"		6	21		27
4'-8"	7"	4'-11 1/2"		6	21		27
4'-9"	7 1/8"	5'-0 9/16"		6	22		28
4'-10"	7 1/4"	5'-1 3/8"		5	23		28
4'-11"	7 3/8"	5'-2 11/16"		5	23		28
5'-0"	7 1/2"	5'-3 3/4"		5	24		29
5'-1"	7 5/8"	5'-4 13/16"		4	25		29
5'-2"	7 3/4"	5'-5 7/8"		4	26		30



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"—Concluded
1 1/2" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course				Total
			No. 2 Wedge	No. 1 Wedge	No. 1-X Wedge	Straight	
5'-3"	7 7/8"	5'-6 13/16"		4	26		30
5'-4"	8"	5'-8"		4	27		31
5'-5"	8 1/8"	5'-9 1/16"		3	28		31
5'-6"	8 1/4"	5'-10 1/8"		3	28		31
5'-7"	8 3/8"	5'-11 3/16"		3	29		32
5'-8"	8 1/2"	6'-0 1/4"		2	30		32
5'-9"	8 5/8"	6'-1 13/16"		2	31		33
5'-10"	8 3/4"	6'-2 3/8"		2	31		33
5'-11"	8 7/8"	6'-3 7/16"		1	32		33
6'-0"	9"	6'-4 1/2"		1	33		34
6'-1"	9 1/8"	6'-5 5/16"		1	33		34
6'-2"	9 1/4"	6'-6 5/8"		1	34		35
6'-3"	9 3/8"	6'-7 11/16"			35		35
6'-4"	9 1/2"	6'-8 3/4"			36		36
6'-5"	9 5/8"	6'-9 13/16"			36		36
6'-6"	9 3/4"	6'-10 7/8"			36		36
6'-9"	10 1/8"	7'-2 1/16"			36	2	38
7'-0"	10 1/2"	7'-5 1/4"			36	3	39
7'-3"	10 7/8"	7'-8 7/16"			36	4	40
7'-6"	11 1/4"	7'-11 5/8"			36	5	41
7'-9"	11 5/8"	8'-2 13/16"			36	7	43
8'-0"	1'-0"	8'-6"			36	8	44
8'-3"	1'-0 1/8"	8'-9 3/16"			36	9	45
8'-6"	1'-0 1/4"	9'-0 1/8"			36	10	46
8'-9"	1'-1 1/8"	9'-3 3/16"			36	12	48
9'-0"	1'-1 1/2"	9'-6 3/4"			36	13	49
9'-3"	1'-1 7/8"	9'-9 15/16"			36	14	50
9'-6"	1'-2 1/4"	10'-1 1/8"			36	15	51
9'-9"	1'-2 5/8"	10'-4 5/16"			36	17	53
10'-0"	1'-3"	10'-7 1/2"			36	18	54
10'-3"	1'-3 3/8"	10'-10 11/16"			36	19	55
10'-6"	1'-3 3/4"	11'-1 7/8"			36	20	56
10'-9"	1'-4 1/8"	11'-5 1/16"			36	22	58
11'-0"	1'-4 1/2"	11'-8 1/4"			36	23	59
11'-3"	1'-4 7/8"	11'-11 7/16"			36	24	60
11'-6"	1'-5 1/4"	12'-2 5/8"			36	25	61
11'-9"	1'-5 5/8"	12'-5 13/16"			36	27	63
12'-0"	1'-6"	12'-9"			36	28	64
12'-3"	1'-6 3/8"	13'-0 3/16"			36	29	65
12'-6"	1'-6 3/4"	13'-3 1/8"			36	30	66
12'-9"	1'-7 1/8"	13'-6 9/16"			36	32	68
13'-0"	1'-7 1/2"	13'-9 1/4"			36	33	69
13'-3"	1'-7 7/8"	14'-0 15/16"			36	34	70
13'-6"	1'-8 1/4"	14'-4 1/8"			36	35	71
13'-9"	1'-8 5/8"	14'-7 5/16"			36	37	73



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"

1 1/2" Rise Per Foot of Span

This table can be used also for 13 1/2" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			Total
			No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	
1' 6"	2 1/4"	1' 7 1/8"	9	1		10
1' 7"	2 1/8"	1' 8 1/16"	8	2		10
1' 8"	2 1/2"	1' 9 1/4"	8	2		10
1' 9"	2 5/8"	1' 10 3/16"	8	3		11
1' 10"	2 3/4"	1' 11 1/8"	7	4		11
1' 11"	2 7/8"	2' 0 7/16"	7	4		11
2' 0"	3"	2' 1 1/2"	7	5		12
2' 1"	3 1/8"	2' 2 9/16"	6	6		12
2' 2"	3 1/4"	2' 3 5/8"	6	6		12
2' 3"	3 3/8"	2' 4 11/16"	6	7		13
2' 4"	3 1/2"	2' 5 3/4"	5	8		13
2' 5"	3 5/8"	2' 6 13/16"	5	8		13
2' 6"	3 3/4"	2' 7 7/8"	5	9		14
2' 7"	3 7/8"	2' 8 15/16"	4	10		14
2' 8"	4"	2' 10"	4	10		14
2' 9"	4 1/8"	2' 11 1/16"	4	11		15
2' 10"	4 1/4"	3' 0 1/8"	3	12		15
2' 11"	4 3/8"	3' 1 3/16"	3	12		15
3' 0"	4 1/2"	3' 2 1/4"	3	13		16
3' 1"	4 5/8"	3' 3 5/16"	2	14		16
3' 2"	4 3/4"	3' 4 3/8"	2	15		17
3' 3"	4 7/8"	3' 5 7/16"	1	16		17
3' 4"	5"	3' 6 1/2"	1	16		17
3' 5"	5 1/8"	3' 7 9/16"	1	17		18
3' 6"	5 1/4"	3' 8 5/8"		18		18
3' 7"	5 3/8"	3' 9 11/16"		18		18
3' 8"	5 1/2"	3' 10 3/4"		17	2	19
3' 9"	5 5/8"	3' 11 13/16"		17	2	19
3' 10"	5 3/4"	4' 0 7/8"		16	3	19
3' 11"	5 7/8"	4' 1 15/16"		16	4	20
4' 0"	6"	4' 3"		16	4	20
4' 1"	6 1/8"	4' 4 1/16"		15	5	20
4' 2"	6 1/4"	4' 5 1/8"		15	6	21
4' 3"	6 3/8"	4' 6 3/16"		15	6	21
4' 4"	6 1/2"	4' 7 1/4"		14	7	21
4' 5"	6 5/8"	4' 8 9/16"		14	8	22
4' 6"	6 3/4"	4' 9 5/8"		14	8	22
4' 7"	6 7/8"	4' 10 7/16"		13	9	22
4' 8"	7"	4' 11 1/2"		13	10	23
4' 9"	7 1/8"	5' 0 9/16"		13	10	23
4' 10"	7 1/4"	5' 1 5/8"		12	11	23
4' 11"	7 3/8"	5' 2 11/16"		12	12	24

9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"

—Concluded

1 1/2" Rise Per Foot of Span

This table can be used also for 13 1/2" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course				Total
			No. 2 Wedge	No. 1 Wedge	Straight		
5' 0"	7 1/2"	5' 3 3/4"	12	12			24
5' 1"	7 5/8"	5' 4 13/16"	12	13			25
5' 2"	7 3/4"	5' 5 7/8"	11	14			25
5' 3"	7 7/8"	5' 6 15/16"	11	14			25
5' 4"	8"	5' 8"	11	15			26
5' 5"	8 1/8"	5' 9 1/16"	10	16			26
5' 6"	8 1/4"	5' 10 1/8"	10	16			26
5' 7"	8 3/8"	5' 11 3/16"	9	18			27
5' 8"	8 1/2"	6' 0 1/4"	9	18			27
5' 9"	8 5/8"	6' 1 3/16"	8	19			27
5' 10"	8 3/4"	6' 2 1/8"	8	20			28
5' 11"	8 7/8"	6' 3 7/16"	8	20			28
6' 0"	9"	6' 4 1/2"	7	21			28
6' 1"	9 1/8"	6' 5 9/16"	7	22			29
6' 2"	9 1/4"	6' 6 5/8"	7	22			29
6' 3"	9 3/8"	6' 7 11/16"	6	23			29
6' 4"	9 1/2"	6' 8 3/4"	6	24			30
6' 5"	9 5/8"	6' 9 13/16"	6	24			30
6' 6"	9 3/4"	6' 10 7/8"	5	25			30
6' 7"	9 7/8"	6' 11 15/16"	5	26			31
6' 8"	10"	7' 1"	5	26			31
6' 9"	10 1/8"	7' 2 1/16"	4	27			31
6' 10"	10 1/4"	7' 3 1/8"	4	28			32
6' 11"	10 3/8"	7' 4 1/16"	4	28			32
7' 0"	10 1/2"	7' 5 1/4"	3	29			32
7' 1"	10 5/8"	7' 6 3/16"	3	30			33
7' 2"	10 3/4"	7' 7 3/8"	3	30			33
7' 3"	10 7/8"	7' 8 7/16"	3	31			34
7' 4"	11"	7' 9 1/2"	2	32			34
7' 5"	11 1/8"	7' 10 9/16"	2	32			34
7' 6"	11 1/4"	7' 11 5/8"	2	33			35
7' 7"	11 3/8"	8' 0 11/16"	1	34			35
7' 8"	11 1/2"	8' 1 1/4"	1	34			35
7' 9"	11 5/8"	8' 2 13/16"		36			36
7' 10"	11 3/4"	8' 3 7/8"		36			36
7' 11"	11 7/8"	8' 4 15/16"		36			36
8' 0"	1' 0"	8' 6"		36	1		37
8' 6"	1' 0 1/4"	9' 0 1/8"		36	3		39
9' 0"	1' 1 1/2"	9' 6 1/4"		36	5		41
9' 6"	1' 2 1/4"	10' 1 1/8"		36	7		43
10' 0"	1' 3"	10' 7 1/2"		36	9		45
10' 6"	1' 3 1/4"	11' 1 7/8"		36	11		47





9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"

1.608" Rise Per Foot of Span (60° Central Angle)

Span	Rise	Inside Radius	Number Required Per Course			Total
			No. 2 Wedge	No. 1 Wedge	No. 1-X Wedge	
1'-6"	2 11/12"	1'-6"	7	5		12
1'-7"	2 11/12"	1'-7"	6	6		12
1'-8"	2 11/16"	1'-8"	5	8		13
1'-9"	2 11/16"	1'-9"	4	9		13
1'-10"	2 11/16"	1'-10"	3	10		13
1'-11"	3 1/12"	1'-11"	3	11		14
2'-0"	3 1/12"	2'-0"	2	12		14
2'-1"	3 11/12"	2'-1"	2	13		15
2'-2"	3 11/12"	2'-2"	1	14		15
2'-3"	3 5/8"	2'-3"		15		15
2'-4"	3 1/2"	2'-4"		15	1	16
2'-5"	3 1/8"	2'-5"		15	1	16
2'-6"	4 1/12"	2'-6"		15	2	17
2'-7"	4 1/12"	2'-7"		14	3	17
2'-8"	4 1/12"	2'-8"		14	4	18
2'-9"	4 1/16"	2'-9"		14	4	18
2'-10"	4 9/16"	2'-10"		13	5	18
2'-11"	4 11/16"	2'-11"		13	6	19
3'-0"	4 11/16"	3'-0"		13	6	19
3'-1"	4 11/16"	3'-1"		13	7	20
3'-2"	5 1/12"	3'-2"		12	8	20
3'-3"	5 1/12"	3'-3"		12	9	21
3'-4"	5 11/12"	3'-4"		12	9	21
3'-5"	5 1/2"	3'-5"		11	10	21
3'-6"	5 5/8"	3'-6"		11	11	22
3'-7"	5 1/4"	3'-7"		11	11	22
3'-8"	5 29/32"	3'-8"		11	12	23
3'-9"	6 1/12"	3'-9"		10	13	23
3'-10"	6 5/12"	3'-10"		10	13	23
3'-11"	6 9/12"	3'-11"		10	14	24
4'-0"	6 7/16"	4'-0"		9	15	24
4'-1"	6 9/16"	4'-1"		9	16	25
4'-2"	6 11/16"	4'-2"		9	16	25
4'-3"	6 13/16"	4'-3"		9	17	26
4'-4"	6 11/2"	4'-4"		8	18	26
4'-5"	7 1/12"	4'-5"		8	18	26
4'-6"	7 1/4"	4'-6"		8	19	27
4'-7"	7 3/8"	4'-7"		7	20	27
4'-8"	7 1/2"	4'-8"		7	21	28
4'-9"	7 5/8"	4'-9"		7	21	28
4'-10"	7 29/32"	4'-10"		6	22	28
4'-11"	7 29/32"	4'-11"		6	23	29
5'-0"	8 1/32"	5'-0"		6	23	29
5'-1"	8 1/16"	5'-1"		6	24	30
5'-2"	8 5/16"	5'-2"		5	25	30

9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2" - Concluded

1.608" Rise Per Foot of Span (60° Central Angle)



Span	Rise	Inside Radius	Number Required Per Course				Total
			No. 1 Wedge	No. 1-X Wedge	Straight		
5'-3"	8 7/16"	5'-3"	5	26			31
5'-4"	8 9/16"	5'-4"	5	26			31
5'-5"	8 11/16"	5'-5"	4	27			31
5'-6"	8 27/32"	5'-6"	4	28			32
5'-7"	8 11/12"	5'-7"	4	28			32
5'-8"	9 1/8"	5'-8"	4	29			33
5'-9"	9 1/4"	5'-9"	4	29			33
5'-10"	9 3/8"	5'-10"	3	30			33
5'-11"	9 1/2"	5'-11"	3	31			34
6'-0"	9 21/32"	6'-0"	3	31			34
6'-1"	9 25/32"	6'-1"	3	32			35
6'-2"	9 29/32"	6'-2"	2	33			35
6'-3"	10 1/16"	6'-3"	2	34			36
6'-4"	10 1/16"	6'-4"	2	34			36
6'-5"	10 3/16"	6'-5"	1	35			36
6'-6"	10 7/16"	6'-6"	1	36			37
6'-7"	10 19/32"	6'-7"	1	36			37
6'-8"	10 21/32"	6'-8"	1	37			38
6'-9"	10 27/32"	6'-9"		38			38
7'-0"	11 1/4"	7'-0"		38	1		39
7'-3"	11 21/32"	7'-3"		38	3		41
7'-6"	1'-0 1/16"	7'-6"		38	4		42
7'-9"	1'-0 15/32"	7'-9"		38	5		43
8'-0"	1'-0 7/8"	8'-0"		38	6		44
8'-3"	1'-1 1/4"	8'-3"		38	8		46
8'-6"	1'-1 21/32"	8'-6"		38	9		47
8'-9"	1'-2 1/16"	8'-9"		38	10		48
9'-0"	1'-2 15/32"	9'-0"		38	11		49
9'-3"	1'-2 7/8"	9'-3"		38	13		51
9'-6"	1'-3 1/12"	9'-6"		38	14		52
9'-9"	1'-3 11/16"	9'-9"		38	15		53
10'-0"	1'-4 1/16"	10'-0"		38	16		54
10'-3"	1'-4 15/32"	10'-3"		38	18		56
10'-6"	1'-4 7/8"	10'-6"		38	19		57
10'-9"	1'-5 1/12"	10'-9"		38	20		58
11'-0"	1'-5 11/16"	11'-0"		38	21		59
11'-3"	1'-6 1/12"	11'-3"		38	23		61
11'-6"	1'-6 1/2"	11'-6"		38	24		62
11'-9"	1'-6 7/8"	11'-9"		38	25		63
12'-0"	1'-7 9/12"	12'-0"		38	26		64
12'-3"	1'-7 11/16"	12'-3"		38	28		66
12'-6"	1'-8 1/12"	12'-6"		38	29		67
12'-9"	1'-8 1/2"	12'-9"		38	30		68
13'-0"	1'-8 29/32"	13'-0"		38	32		70
13'-3"	1'-9 1/16"	13'-3"		38	33		71



9" ARCH THICKNESS — WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"
1.608" Rise Per Foot of Span
(60° Central Angle)

This table can be used also for 13 1/4" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	Total
1'- 6"	2 1/4"	1'- 6"	10			10
1'- 7"	2 1/2"	1'- 7"	9	1		10
1'- 8"	2 1/2"	1'- 8"	9	2		11
1'- 9"	2 3/4"	1'- 9"	9	2		11
1'-10"	2 3/4"	1'-10"	8	3		11
1'-11"	3 1/4"	1'-11"	8	4		12
2'- 0"	3 3/4"	2'- 0"	8	4		12
2'- 1"	3 11/16"	2'- 1"	7	5		12
2'- 2"	3 11/16"	2'- 2"	7	6		13
2'- 3"	3 5/8"	2'- 3"	7	6		13
2'- 4"	3 5/8"	2'- 4"	6	7		13
2'- 5"	3 7/8"	2'- 5"	6	8		14
2'- 6"	4 1/16"	2'- 6"	5	9		14
2'- 7"	4 1/16"	2'- 7"	5	9		14
2'- 8"	4 1/16"	2'- 8"	5	10		15
2'- 9"	4 1/16"	2'- 9"	4	11		15
2'-10"	4 1/16"	2'-10"	4	11		15
2'-11"	4 11/16"	2'-11"	4	12		16
3'- 0"	4 13/16"	3'- 0"	3	13		16
3'- 1"	4 13/16"	3'- 1"	3	13		16
3'- 2"	5 3/32"	3'- 2"	3	14		17
3'- 3"	5 3/32"	3'- 3"	2	15		17
3'- 4"	5 11/32"	3'- 4"	2	16		18
3'- 5"	5 1/2"	3'- 5"	2	16		18
3'- 6"	5 5/8"	3'- 6"	1	17		18
3'- 7"	5 3/4"	3'- 7"	1	18		19
3'- 8"	5 29/32"	3'- 8"	1	18		19
3'- 9"	6 1/32"	3'- 9"		19		19
3'-10"	6 3/32"	3'-10"		19	1	20
3'-11"	6 3/32"	3'-11"		18	2	20
4'- 0"	6 7/16"	4'- 0"		18	2	20
4'- 1"	6 9/16"	4'- 1"		18	3	21
4'- 2"	6 11/16"	4'- 2"		17	4	21
4'- 3"	6 27/32"	4'- 3"		17	4	21
4'- 4"	6 31/32"	4'- 4"		17	5	22
4'- 5"	7 3/32"	4'- 5"		16	6	22
4'- 6"	7 1/4"	4'- 6"		16	6	22
4'- 7"	7 3/8"	4'- 7"		16	7	23
4'- 8"	7 1/2"	4'- 8"		15	8	23
4'- 9"	7 5/8"	4'- 9"		15	8	23
4'-10"	7 25/32"	4'-10"		15	9	24
4'-11"	7 29/32"	4'-11"		14	10	24

9" ARCH THICKNESS — WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"
—Concluded

1.608" Rise Per Foot of Span (60° Central Angle)

This table can be used also for 13 1/4" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	Straight	Total
5'- 0"	8 1/32"	5'- 0"	14	10		24
5'- 1"	8 3/16"	5'- 1"	14	11		25
5'- 2"	8 5/16"	5'- 2"	13	12		25
5'- 3"	8 7/16"	5'- 3"	13	12		25
5'- 4"	8 9/16"	5'- 4"	12	14		26
5'- 5"	8 23/32"	5'- 5"	12	14		26
5'- 6"	8 27/32"	5'- 6"	12	15		27
5'- 7"	8 31/32"	5'- 7"	11	16		27
5'- 8"	9 1/8"	5'- 8"	11	16		27
5'- 9"	9 1/4"	5'- 9"	11	17		28
5'-10"	9 3/8"	5'-10"	10	18		28
5'-11"	9 1/2"	5'-11"	10	18		28
6'- 0"	9 11/16"	6'- 0"	10	19		29
6'- 1"	9 25/16"	6'- 1"	9	20		29
6'- 2"	9 27/16"	6'- 2"	9	20		29
6'- 3"	10 1/16"	6'- 3"	9	21		30
6'- 4"	10 3/16"	6'- 4"	8	22		30
6'- 5"	10 5/16"	6'- 5"	8	22		30
6'- 6"	10 7/16"	6'- 6"	8	23		31
6'- 7"	10 9/16"	6'- 7"	7	24		31
6'- 8"	10 11/16"	6'- 8"	7	24		31
6'- 9"	10 27/32"	6'- 9"	7	25		32
6'-10"	11 1/32"	6'-10"	6	26		32
6'-11"	11 1/8"	6'-11"	6	27		33
7'- 0"	11 1/4"	7'- 0"	6	27		33
7'- 1"	11 3/8"	7'- 1"	5	28		33
7'- 2"	11 17/32"	7'- 2"	5	29		34
7'- 3"	11 21/32"	7'- 3"	4	30		34
7'- 4"	11 25/32"	7'- 4"	4	30		34
7'- 5"	11 29/32"	7'- 5"	4	31		35
7'- 6"	12 1/16"	7'- 6"	3	32		35
7'- 9"	12 0 1/32"	7'- 9"	2	34		36
8'- 0"	12 0 7/8"	8'- 0"	1	36		37
8'- 3"	12 1 1/4"	8'- 3"		38		38
8'- 6"	12 1 1/2"	8'- 6"		38	1	39
9'- 0"	12 2 5/16"	9'- 0"		38	3	41
9'- 6"	12 3 9/16"	9'- 6"		38	5	43
10'- 0"	12 4 1/16"	10'- 0"		38	7	45
10'- 6"	12 4 7/8"	10'- 6"		38	10	48
11'- 0"	12 5 11/16"	11'- 0"		38	12	50
11'- 6"	12 6 1/2"	11'- 6"		38	14	52
12'- 0"	12 7 9/16"	12'- 0"		38	16	54





9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"

2" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	No. 1-X Wedge	Total
1'- 6"	3'	1'- 3"	11	2		13
1'- 7"	3 5/12"	1'- 3 7/12"	10	3		13
1'- 8"	3 11/12"	1'- 4 1/12"	9	5		14
1'- 9"	3 1/2"	1'- 5 1/2"	8	6		14
1'- 10"	3 7/12"	1'- 6 11/12"	7	7		14
1'- 11"	3 7/12"	1'- 7 5/12"	7	8		15
2'- 0"	4"	1'- 8"	6	9		15
2'- 1"	4 5/12"	1'- 8 7/12"	6	10		16
2'- 2"	4 11/12"	1'- 9 1/12"	5	11		16
2'- 3"	4 1/2"	1'- 10 1/2"	4	13		17
2'- 4"	4 7/12"	1'- 11 11/12"	3	14		17
2'- 5"	4 7/12"	2'- 0 5/12"	2	15		17
2'- 6"	5"	2'- 1"	2	16		18
2'- 7"	5 5/12"	2'- 1 7/12"	1	17		18
2'- 8"	5 11/12"	2'- 2 1/12"	1	18		19
2'- 9"	5 1/2"	2'- 3 1/2"		18	1	19
2'- 10"	5 7/12"	2'- 4 11/12"		18	2	20
2'- 11"	5 7/12"	2'- 5 5/12"		18	2	20
3'- 0"	6"	2'- 6"		17	3	20
3'- 1"	6 5/12"	2'- 6 7/12"		17	4	21
3'- 2"	6 11/12"	2'- 7 1/12"		17	4	21
3'- 3"	6 1/2"	2'- 8 1/2"		17	5	22
3'- 4"	6 7/12"	2'- 9 11/12"		16	6	22
3'- 5"	6 7/12"	2'- 10 5/12"		16	7	23
3'- 6"	7"	2'- 11"		16	7	23
3'- 7"	7 5/12"	2'- 11 7/12"		15	8	23
3'- 8"	7 11/12"	3'- 0 1/12"		15	9	24
3'- 9"	7 1/2"	3'- 1 1/2"		15	9	24
3'- 10"	7 7/12"	3'- 2 11/12"		15	10	25
3'- 11"	7 7/12"	3'- 3 5/12"		14	11	25
4'- 0"	8"	3'- 4"		14	12	26
4'- 1"	8 5/12"	3'- 4 7/12"		14	12	26
4'- 2"	8 11/12"	3'- 5 1/12"		13	13	26
4'- 3"	8 1/2"	3'- 6 1/2"		13	14	27
4'- 4"	8 7/12"	3'- 7 11/12"		13	14	27
4'- 5"	8 7/12"	3'- 8 5/12"		13	15	28
4'- 6"	9"	3'- 9"		12	16	28
4'- 7"	9 5/12"	3'- 9 7/12"		12	17	29
4'- 8"	9 11/12"	3'- 10 1/12"		12	17	29
4'- 9"	9 1/2"	3'- 11 1/2"		11	18	29
4'- 10"	9 7/12"	4'- 0 11/12"		11	19	30
4'- 11"	9 7/12"	4'- 1 5/12"		11	19	30
5'- 0"	10"	4'- 2"		11	20	31
5'- 1"	10 5/12"	4'- 2 7/12"		10	21	31
5'- 2"	10 11/12"	4'- 3 1/12"		10	22	32

9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"—Concluded

2" Rise Per Foot of Span



Span	Rise	Inside Radius	Number Required Per Course			
			No. 1 Wedge	No. 1-X Wedge	Straight	Total
5'- 3"	10 1/2"	4'- 4 1/2"	10	22		32
5'- 4"	10 5/12"	4'- 5 11/12"	9	23		32
5'- 5"	10 7/12"	4'- 6 5/12"	9	24		33
5'- 6"	11"	4'- 7"	9	24		33
5'- 7"	11 5/12"	4'- 7 7/12"	9	25		34
5'- 8"	11 11/12"	4'- 8 1/12"	8	26		34
5'- 9"	11 1/2"	4'- 9 1/2"	8	27		35
5'- 10"	11 7/12"	4'- 10 11/12"	8	27		35
5'- 11"	11 7/12"	4'- 11 5/12"	7	28		35
6'- 0"	1'- 0"	5'- 0"	7	29		36
6'- 1"	1'- 0 5/12"	5'- 0 7/12"	7	29		36
6'- 2"	1'- 0 11/12"	5'- 1 1/12"	7	30		37
6'- 3"	1'- 0 1/2"	5'- 2 1/2"	6	31		37
6'- 4"	1'- 0 7/12"	5'- 3 11/12"	6	32		38
6'- 5"	1'- 0 7/12"	5'- 4 5/12"	6	32		38
6'- 6"	1'- 1"	5'- 5"	5	33		38
6'- 7"	1'- 1 5/12"	5'- 5 7/12"	5	34		39
6'- 8"	1'- 1 11/12"	5'- 6 1/12"	5	34		39
6'- 9"	1'- 1 1/2"	5'- 7 1/2"	5	35		40
6'- 10"	1'- 1 7/12"	5'- 8 11/12"	4	36		40
6'- 11"	1'- 1 7/12"	5'- 9 5/12"	4	37		41
7'- 0"	1'- 2"	5'- 10"	4	37		41
7'- 1"	1'- 2 5/12"	5'- 10 7/12"	3	38		41
7'- 2"	1'- 2 11/12"	5'- 11 1/12"	3	39		42
7'- 3"	1'- 2 1/2"	6'- 0 1/2"	3	39		42
7'- 4"	1'- 2 11/12"	6'- 1 11/12"	3	40		43
7'- 5"	1'- 2 7/12"	6'- 2 5/12"	2	41		43
7'- 6"	1'- 3"	6'- 3"	2	42		44
7'- 9"	1'- 3 1/2"	6'- 5 1/2"	1	44		45
8'- 0"	1'- 4"	6'- 8"		46		46
8'- 3"	1'- 4 1/2"	6'- 10 1/2"		47	1	48
8'- 6"	1'- 5"	7'- 1"		47	2	49
9'- 0"	1'- 6"	7'- 6"		47	4	51
9'- 6"	1'- 7"	7'- 11"		47	7	54
10'- 0"	1'- 8"	8'- 4"		47	10	57
10'- 6"	1'- 9"	8'- 9"		47	12	59
11'- 0"	1'- 10"	9'- 2"		47	15	62
11'- 6"	1'- 11"	9'- 7"		47	17	64
12'- 0"	2'- 0"	10'- 0"		47	20	67
12'- 6"	2'- 1"	10'- 5"		47	22	69
13'- 0"	2'- 2"	10'- 10"		47	25	72
13'- 6"	2'- 3"	11'- 3"		47	28	75
14'- 0"	2'- 4"	11'- 8"		47	30	77
14'- 6"	2'- 5"	12'- 1"		47	33	80
15'- 0"	2'- 6"	12'- 6"		47	35	82



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"

2" Rise Per Foot of Span

This table can be used for 13 1/2" x 9" x 3" arch brick, by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	Total
1'-0"	3 1/2"	1'-6 1/2"	12			12
1'-1"	3 3/4"	1'-7 1/2"	11	1		12
2'-0"	4"	1'-8"	11	2		13
2'-1"	4 1/4"	1'-8 1/2"	10	3		13
2'-2"	4 1/2"	1'-9 1/2"	10	4		14
2'-3"	4 3/4"	1'-10 1/2"	10	4		14
2'-4"	4 1/2"	1'-11 1/2"	9	5		14
2'-5"	4 3/4"	2'-0 1/2"	9	6		15
2'-6"	5"	2'-1"	9	6		15
2'-7"	5 1/4"	2'-1 1/2"	8	7		15
2'-8"	5 1/2"	2'-2 1/2"	8	8		16
2'-9"	5 3/4"	2'-3 1/2"	8	8		16
2'-10"	5 1/2"	2'-4 1/2"	7	9		16
2'-11"	5 3/4"	2'-5 1/2"	7	10		17
3'-0"	6"	2'-6"	7	10		17
3'-1"	6 1/4"	2'-6 1/2"	6	11		17
3'-2"	6 1/2"	2'-7 1/2"	6	12		18
3'-3"	6 3/4"	2'-8 1/2"	5	13		18
3'-4"	6 1/2"	2'-9 1/2"	5	14		19
3'-5"	6 3/4"	2'-10 1/2"	5	14		19
3'-6"	7"	2'-11"	4	15		19
3'-7"	7 1/4"	2'-11 1/2"	4	16		20
3'-8"	7 1/2"	3'-0 1/2"	4	16		20
3'-9"	7 3/4"	3'-1 1/2"	3	17		20
3'-10"	7 1/2"	3'-2 1/2"	3	18		21
3'-11"	7 3/4"	3'-3 1/2"	3	18		21
4'-0"	8"	3'-4"	2	19		21
4'-1"	8 1/4"	3'-4 1/2"	2	20		22
4'-2"	8 1/2"	3'-5 1/2"	2	20		22
4'-3"	8 3/4"	3'-6 1/2"	1	21		22
4'-4"	8 1/2"	3'-7 1/2"	1	22		23
4'-5"	8 3/4"	3'-8 1/2"	1	22		23
4'-6"	9"	3'-9"		24		24
4'-7"	9 1/4"	3'-9 1/2"		23	1	24
4'-8"	9 1/2"	3'-10 1/2"		23	1	24
4'-9"	9 3/4"	3'-11 1/2"		22	3	25
4'-10"	9 1/2"	4'-0 1/2"		22	3	25
4'-11"	9 3/4"	4'-1 1/2"		21	4	25
5'-0"	10"	4'-2"		21	5	26
5'-1"	10 1/4"	4'-2 1/2"		21	5	26
5'-2"	10 1/2"	4'-3 1/2"		20	6	26
5'-3"	10 3/4"	4'-4 1/2"		20	7	27

Continued on next page

9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"

—Concluded

2" Rise Per Foot of Span



This table can be used for 13 1/2" x 9" x 3" arch brick, by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	Straight	Total
5'-4"	10 1/2"	4'-5 1/2"	20	7		27
5'-5"	10 3/4"	4'-6 1/2"	19	8		27
5'-6"	11"	4'-7"	19	9		28
5'-7"	11 1/4"	4'-7 1/2"	19	9		28
5'-8"	11 1/2"	4'-8 1/2"	19	10		29
5'-9"	11 3/4"	4'-9 1/2"	18	11		29
5'-10"	11 1/2"	4'-10 1/2"	18	11		29
5'-11"	11 3/4"	4'-11 1/2"	17	13		30
6'-0"	1'-0"	5'-0"	17	13		30
6'-1"	1'-0 1/4"	5'-0 1/2"	16	14		30
6'-2"	1'-0 1/2"	5'-1 1/2"	16	15		31
6'-3"	1'-0 3/4"	5'-2 1/2"	16	15		31
6'-4"	1'-0 1/2"	5'-3 1/2"	15	16		31
6'-5"	1'-0 3/4"	5'-4 1/2"	15	17		32
6'-6"	1'-1"	5'-5"	15	17		32
6'-7"	1'-1 1/4"	5'-5 1/2"	15	18		33
6'-8"	1'-1 1/2"	5'-6 1/2"	14	19		33
6'-9"	1'-1 3/4"	5'-7 1/2"	14	19		33
6'-10"	1'-1 1/2"	5'-8 1/2"	14	20		34
6'-11"	1'-1 3/4"	5'-9 1/2"	13	21		34
7'-0"	1'-2"	5'-10"	13	21		34
7'-1"	1'-2 1/4"	5'-10 1/2"	12	23		35
7'-2"	1'-2 1/2"	5'-11 1/2"	12	23		35
7'-3"	1'-2 3/4"	6'-0 1/2"	11	24		35
7'-4"	1'-2 1/2"	6'-1 1/2"	11	25		36
7'-5"	1'-2 3/4"	6'-2 1/2"	11	25		36
7'-6"	1'-3"	6'-3"	10	26		36
7'-7"	1'-3 1/4"	6'-3 1/2"	10	27		37
7'-8"	1'-3 1/2"	6'-4 1/2"	10	27		37
7'-9"	1'-3 3/4"	6'-5 1/2"	10	28		38
7'-10"	1'-3 1/2"	6'-6 1/2"	9	29		38
7'-11"	1'-3 3/4"	6'-7 1/2"	9	29		38
8'-0"	1'-4"	6'-8"	9	30		39
8'-1"	1'-4 1/4"	6'-8 1/2"	8	31		39
8'-2"	1'-4 1/2"	6'-9 1/2"	8	31		39
8'-3"	1'-4 3/4"	6'-10 1/2"	7	33		40
8'-6"	1'-5"	7'-1"	6	35		41
9'-0"	1'-6"	7'-6"	4	39		43
9'-6"	1'-7"	7'-11"	2	43		45
10'-0"	1'-8"	8'-4"		47		47
10'-6"	1'-9"	8'-9"		47	2	49
11'-0"	1'-10"	9'-2"		47	4	51



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"
2 3/16" Rise Per Foot of Span

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	No. 1-X Wedge	Total
1'-6"	3 1/2"	1'-1 1/2"	14			14
1'-7"	3 7/16"	1'-2 3/16"	13	1		14
1'-8"	3 7/8"	1'-2 5/8"	12	2		14
1'-9"	4 1/8"	1'-3 1/8"	11	4		15
1'-10"	4 1/2"	1'-4 1/2"	10	5		15
1'-11"	4 5/8"	1'-5 1/8"	10	6		16
2'-0"	4 9/16"	1'-5 5/16"	9	7		16
2'-1"	4 5/8"	1'-6 1/8"	9	8		17
2'-2"	5"	1'-7 1/8"	8	9		17
2'-3"	5 1/8"	1'-8 1/8"	7	11		18
2'-4"	5 1/4"	1'-8 5/8"	6	12		18
2'-5"	5 1/2"	1'-9 1/8"	5	13		18
2'-6"	5 3/4"	1'-10 3/16"	5	14		19
2'-7"	5 7/8"	1'-11 1/16"	4	15		19
2'-8"	6 1/8"	1'-11 5/8"	3	17		20
2'-9"	6 1/4"	2'-0 1/4"	2	18		20
2'-10"	6 1/2"	2'-1 1/4"	2	19		21
2'-11"	6 3/4"	2'-2 1/4"	1	20		21
3'-0"	6 7/8"	2'-2 5/8"		21		21
3'-1"	7 1/16"	2'-3 1/16"		21	1	22
3'-2"	7 1/8"	2'-4 1/8"		21	1	22
3'-3"	7 1/4"	2'-5 1/4"		21	2	23
3'-4"	7 1/2"	2'-5 5/8"		20	3	23
3'-5"	7 3/8"	2'-6 1/8"		20	4	24
3'-6"	8 1/16"	2'-7 1/16"		20	4	24
3'-7"	8 1/4"	2'-8 1/4"		20	5	25
3'-8"	8 1/2"	2'-8 5/8"		19	6	25
3'-9"	8 3/8"	2'-9 3/8"		19	6	25
3'-10"	8 5/8"	2'-10 3/8"		18	8	26
3'-11"	9 1/32"	2'-11 1/8"		18	8	26
4'-0"	9 7/16"	2'-11 7/8"		18	9	27
4'-1"	9 1/2"	3'-0 5/8"		17	10	27
4'-2"	9 5/8"	3'-1 5/8"		17	11	28
4'-3"	9 3/4"	3'-2 1/8"		17	11	28
4'-4"	9 7/8"	3'-2 5/8"		16	12	28
4'-5"	10 1/32"	3'-3 1/8"		16	13	29
4'-6"	10 1/8"	3'-4 3/8"		16	13	29
4'-7"	10 3/16"	3'-5 3/16"		16	14	30
4'-8"	10 3/8"	3'-5 7/8"		15	15	30
4'-9"	10 5/16"	3'-6 1/16"		15	16	31
4'-10"	11 1/8"	3'-7 1/8"		15	16	31
4'-11"	11 1/4"	3'-8 1/4"		15	17	32

1 More exactly, 2.302".

9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 2 1/2", 9" x 6 3/4" x 2 1/2" or
9" x 9" x 2 1/2"—Concluded
2 3/16" Rise Per Foot of Span



Span	Rise	Inside Radius	Number Required Per Course			
			No. 1 Wedge	No. 1-X Wedge	Straight	Total
5'-0"	11 1/2"	3'-8 1/2"	14	18		32
5'-1"	11 3/16"	3'-9 1/16"	14	18		32
5'-2"	11 3/8"	3'-10 3/8"	14	19		33
5'-3"	11 1/4"	3'-11 1/4"	13	20		33
5'-4"	11 1/8"	3'-11 7/8"	13	21		34
5'-5"	11 1/2"	4'-0 1/2"	13	21		34
5'-6"	11 5/16"	4'-1 1/16"	13	22		35
5'-7"	11 5/8"	4'-2 1/8"	12	23		35
5'-8"	11 3/4"	4'-2 5/8"	12	23		35
5'-9"	11 7/8"	4'-3 1/8"	12	24		36
5'-10"	12"	4'-4 1/4"	11	25		36
5'-11"	12 1/16"	4'-5 1/16"	11	26		37
6'-0"	12 1/8"	4'-5 5/8"	11	26		37
6'-1"	12 1/4"	4'-6 1/4"	11	27		38
6'-2"	12 1/2"	4'-7 1/2"	10	28		38
6'-3"	12 3/8"	4'-8 3/8"	10	29		39
6'-4"	12 3/16"	4'-8 7/16"	10	29		39
6'-5"	12 3/8"	4'-9 3/8"	9	30		39
6'-6"	12 1/2"	4'-10 1/2"	9	31		40
6'-7"	12 5/16"	4'-11 1/16"	9	31		40
6'-8"	12 5/8"	4'-11 5/8"	9	32		41
6'-9"	12 3/4"	5'-0 3/4"	8	33		41
6'-10"	12 7/8"	5'-1 7/8"	8	34		42
6'-11"	13 1/16"	5'-2 1/16"	8	34		42
7'-0"	13 1/8"	5'-2 5/8"	7	35		42
7'-1"	13 1/4"	5'-3 1/4"	7	36		43
7'-2"	13 1/2"	5'-4 1/2"	7	36		43
7'-3"	13 3/8"	5'-5 3/8"	7	37		44
7'-4"	13 3/16"	5'-5 7/16"	6	38		44
7'-5"	13 3/8"	5'-6 3/8"	6	39		45
7'-6"	13 1/2"	5'-7 1/2"	6	39		45
7'-7"	13 5/16"	5'-8 1/16"	5	41		46
7'-8"	13 5/8"	5'-8 5/8"	5	41		46
7'-9"	13 3/4"	5'-9 3/4"	4	42		46
7'-10"	13 7/8"	5'-10 7/8"	4	43		47
7'-11"	14"	5'-11"	4	43		47
8'-0"	14 1/16"	5'-11 1/16"	4	44		48
8'-6"	14 3/8"	6'-4 3/8"	2	48		50
9'-0"	14 7/8"	6'-8 7/8"		53		53
9'-6"	15 1/8"	7'-1 1/8"		53	3	56
10'-0"	15 1/2"	7'-5 1/2"		53	5	58
10'-6"	16"	7'-10 1/2"		53	8	61

1 More exactly, 2.302".



9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or 9" x 9" x 3"
2 1/16" Rise Per Foot of Span

This table can be used also for 13 1/2" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 3 Wedge	No. 2 Wedge	No. 1 Wedge	Total
2'-0"	4 1/16"	1'-5 1/16"	14			14
2'-1"	4 1/8"	1'-6 1/8"	13	1		14
2'-2"	5"	1'-7 1/8"	13	1		14
2'-3"	5 1/16"	1'-8 1/16"	12	3		15
2'-4"	5 1/8"	1'-8 1/8"	12	3		15
2'-5"	5 1/4"	1'-9 1/4"	11	4		15
2'-6"	5 1/2"	1'-10 1/2"	11	5		16
2'-7"	5 5/8"	1'-11 5/8"	11	5		16
2'-8"	6 1/16"	1'-12 1/16"	10	6		16
2'-9"	6 1/8"	2'-0 1/8"	10	7		17
2'-10"	6 1/4"	2'-0 1/4"	10	7		17
2'-11"	6 3/8"	2'-2 3/8"	10	8		18
3'-0"	6 1/2"	2'-2 1/2"	9	9		18
3'-1"	7 1/16"	2'-3 1/16"	9	9		18
3'-2"	7 1/8"	2'-4 1/8"	8	11		19
3'-3"	7 1/4"	2'-5 1/4"	8	11		19
3'-4"	7 1/2"	2'-5 1/2"	7	12		19
3'-5"	7 3/8"	2'-6 3/8"	7	13		20
3'-6"	8 1/16"	2'-7 1/16"	7	13		20
3'-7"	8 1/8"	2'-8 1/8"	6	14		20
3'-8"	8 1/4"	2'-8 1/4"	6	15		21
3'-9"	8 3/8"	2'-9 3/8"	6	15		21
3'-10"	8 1/2"	2'-10 1/2"	6	16		22
3'-11"	9 1/16"	2'-11 1/16"	5	17		22
4'-0"	9 1/8"	2'-11 1/8"	4	18		22
4'-1"	9 1/4"	3'-0 1/4"	4	19		23
4'-2"	9 3/8"	3'-1 3/8"	4	19		23
4'-3"	9 1/2"	3'-2 1/2"	3	20		23
4'-4"	9 5/8"	3'-2 5/8"	3	21		24
4'-5"	10 1/16"	3'-3 1/16"	3	21		24
4'-6"	10 1/8"	3'-4 1/8"	3	22		25
4'-7"	10 1/4"	3'-5 1/4"	2	23		25
4'-8"	10 3/8"	3'-5 3/8"	2	23		25
4'-9"	10 1/2"	3'-6 1/2"	2	24		26
4'-10"	11 1/16"	3'-7 1/16"	1	25		26
4'-11"	11 1/8"	3'-8 1/8"		26		26
5'-0"	11 1/4"	3'-8 1/4"		27		27
5'-1"	11 3/8"	3'-9 3/8"		26	1	27
5'-2"	11 1/2"	3'-10 1/2"		26	1	27
5'-3"	1'-0 1/16"	3'-11 1/16"		26	2	28
5'-4"	1'-0 1/8"	3'-11 1/8"		25	3	28
5'-5"	1'-0 1/4"	4'-0 1/4"		25	4	29

† More exactly, 2.302".

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9" ARCH THICKNESS—WEDGE BRICK

9" x 4 1/2" x 3", 9" x 6 3/4" x 3" or
9" x 9" x 3"—Concluded
2 1/16" Rise Per Foot of Span

This table can be used also for 13 1/2" x 9" x 3" arch brick by substituting Nos. 1, 2 and 3 arch brick for the corresponding wedge brick.

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	Straight	Total
5'- 6"	1'- 0 ¹¹ / ₁₆ "	4'- 1 ¹¹ / ₁₆ "	25	4		29
5'- 7"	1'- 0 ¹³ / ₃₂ "	4'- 2 ¹ / ₁₆ "	24	5		29
5'- 8"	1'- 1 ¹ / ₁₆ "	4'- 2 ¹³ / ₁₆ "	24	6		30
5'- 9"	1'- 1 ¹ / ₈ "	4'- 3 ¹ / ₁₆ "	23	7		30
5'- 10"	1'- 1 ¹ / ₄ "	4'- 4 ⁵ / ₁₆ "	23	7		30
5'- 11"	1'- 1 ³ / ₈ "	4'- 5 ¹ / ₁₆ "	23	8		31
6'- 0"	1'- 1 ¹³ / ₁₆ "	4'- 5 ¹³ / ₁₆ "	22	9		31
6'- 1"	1'- 2"	4'- 6 ⁷ / ₁₆ "	22	9		31
6'- 2"	1'- 2 ³ / ₁₆ "	4'- 7 ⁵ / ₁₆ "	22	10		32
6'- 3"	1'- 2 ⁵ / ₈ "	4'- 8 ¹ / ₁₆ "	21	11		32
6'- 4"	1'- 2 ¹³ / ₃₂ "	4'- 8 ¹³ / ₁₆ "	21	12		33
6'- 5"	1'- 2 ²⁵ / ₃₂ "	4'- 9 ⁷ / ₁₆ "	20	13		33
6'- 6"	1'- 2 ²³ / ₁₆ "	4'- 10 ⁵ / ₁₆ "	20	13		33
6'- 7"	1'- 3 ¹ / ₃₂ "	4'- 11 ¹ / ₃₂ "	20	14		34
6'- 8"	1'- 3 ¹³ / ₃₂ "	4'- 11 ¹³ / ₃₂ "	19	15		34
6'- 9"	1'- 3 ¹⁷ / ₃₂ "	5'- 0 ¹⁷ / ₃₂ "	19	15		34
6'- 10"	1'- 3 ²¹ / ₃₂ "	5'- 1 ¹ / ₃₂ "	19	16		35
6'- 11"	1'- 3 ²⁵ / ₁₆ "	5'- 2 ¹ / ₃₂ "	18	17		35
7'- 0"	1'- 4 ¹ / ₈ "	5'- 2 ²⁵ / ₃₂ "	18	17		35
7'- 1"	1'- 4 ³ / ₁₆ "	5'- 3 ¹⁷ / ₃₂ "	18	18		36
7'- 2"	1'- 4 ¹ / ₄ "	5'- 4 ⁹ / ₁₆ "	17	19		36
7'- 3"	1'- 4 ¹¹ / ₁₆ "	5'- 5 ¹ / ₁₆ "	17	20		37
7'- 4"	1'- 4 ³ / ₈ "	5'- 5 ¹³ / ₁₆ "	16	21		37
7'- 5"	1'- 5 ¹ / ₁₆ "	5'- 6 ¹⁷ / ₃₂ "	16	21		37
7'- 6"	1'- 5 ⁹ / ₃₂ "	5'- 7 ⁹ / ₃₂ "	16	22		38
7'- 7"	1'- 5 ¹³ / ₃₂ "	5'- 8 ¹ / ₃₂ "	15	23		38
7'- 8"	1'- 5 ¹⁷ / ₃₂ "	5'- 8 ⁵ / ₁₆ "	15	23		38
7'- 9"	1'- 5 ²¹ / ₃₂ "	5'- 9 ¹ / ₂ "	15	24		39
7'- 10"	1'- 6 ¹ / ₃₂ "	5'- 10 ¹ / ₄ "	14	25		39
7'- 11"	1'- 6 ⁵ / ₃₂ "	5'- 11"	14	25		39
8'- 0"	1'- 6 ¹³ / ₃₂ "	5'- 11 ¹ / ₄ "	14	26		40
8'- 1"	1'- 7"	6'- 2"	12	29		41
8'- 6"	1'- 7 ⁹ / ₁₆ "	6'- 4 ¹ / ₄ "	11	31		42
8'- 9"	1'- 8 ¹ / ₃₂ "	6'- 6 ¹³ / ₃₂ "	10	33		43
9'- 0"	1'- 8 ²¹ / ₃₂ "	6'- 8 ²¹ / ₃₂ "	9	35		44
9'- 6"	1'- 9 ⁷ / ₈ "	7'- 1 ⁷ / ₃₂ "	7	39		46
10'- 0"	1'- 11 ¹ / ₁₆ "	7'- 5 ¹¹ / ₁₆ "	5	44		49
10'- 6"	2'- 0 ⁷ / ₁₆ "	7'- 10 ⁷ / ₁₆ "	3	48		51
11'- 0"	2'- 1 ⁷ / ₁₆ "	8'- 2 ²¹ / ₁₆ "		53		53
11'- 6"	2'- 2 ⁵ / ₁₆ "	8'- 7 ⁵ / ₁₆ "		53	2	55
12'- 0"	2'- 3 ⁵ / ₈ "	8'- 11 ⁵ / ₈ "		53	4	57
12'- 6"	2'- 4 ²⁵ / ₁₆ "	9'- 4 ¹ / ₈ "		53	7	60



12" ARCH THICKNESS—WEDGE BRICK

12" x 4 1/2" x 3", 12" x 6" x 3" or 12" x 9" x 3"

1.608" Rise Per Foot of Span
(60° Central Angle)

Span	Rise	Inside Radius	Number Required Per Course			
			No. 2 Wedge	No. 1 Wedge	No. 1-X* Wedge	Total
6'-0"	9 1/4"	6'-0"	21	9		30
6'-3"	10 1/16"	6'-3"	20	11		31
6'-6"	10 7/16"	6'-6"	19	13		32
6'-9"	10 1/2"	6'-9"	18	15		33
7'-0"	11 1/4"	7'-0"	17	17		34
7'-3"	11 1/2"	7'-3"	16	19		35
7'-6"	1'-0 1/16"	7'-6"	15	21		36
7'-9"	1'-0 1/8"	7'-9"	14	23		37
8'-0"	1'-0 7/8"	8'-0"	13	25		38
8'-3"	1'-1 1/4"	8'-3"	12	27		39
8'-6"	1'-1 1/2"	8'-6"	11	29		40
8'-9"	1'-2 1/16"	8'-9"	10	31		41
9'-0"	1'-2 1/8"	9'-0"	8	34		42
9'-3"	1'-2 3/8"	9'-3"	7	36		43
9'-6"	1'-3 1/16"	9'-6"	6	38		44
9'-9"	1'-3 1/8"	9'-9"	5	40		45
10'-0"	1'-4 1/16"	10'-0"	4	42		46
10'-3"	1'-4 1/8"	10'-3"	4	44		48
10'-6"	1'-4 1/2"	10'-6"	3	46		49
10'-9"	1'-5 1/32"	10'-9"	1	49		50
11'-0"	1'-5 1/16"	11'-0"		51		51
11'-3"	1'-6 1/32"	11'-3"		50	2	52
11'-6"	1'-6 1/2"	11'-6"		48	5	53
11'-9"	1'-6 3/8"	11'-9"		47	7	54
12'-0"	1'-7 9/32"	12'-0"		46	9	55
12'-3"	1'-7 11/16"	12'-3"		45	11	56
12'-6"	1'-8 1/16"	12'-6"		44	13	57
12'-9"	1'-8 1/2"	12'-9"		43	15	58
13'-0"	1'-8 23/32"	13'-0"		42	17	59
13'-3"	1'-9 5/16"	13'-3"		41	19	60
13'-6"	1'-9 11/16"	13'-6"		40	21	61
13'-9"	1'-10 1/32"	13'-9"		39	23	62
14'-0"	1'-10 1/2"	14'-0"		38	25	63
14'-3"	1'-10 29/32"	14'-3"		37	27	64
14'-6"	1'-11 5/16"	14'-6"		36	29	65
14'-9"	1'-11 23/32"	14'-9"		35	31	66
15'-0"	2'-0 1/8"	15'-0"		34	33	67
15'-3"	2'-0 17/32"	15'-3"		32	36	68
15'-6"	2'-0 25/32"	15'-6"		32	38	70
15'-9"	2'-1 1/16"	15'-9"		31	40	71

Continued on next page

*NOTE: The No. 1-X Wedge is standard in Silica Material only. For Fireclay Material in the case of Arches with Spans over 11'-0", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 51. The quantity of Straight brick is determined by subtracting 51 from the quantity given in the column "Total".

12" ARCH THICKNESS—WEDGE BRICK

12" x 4 1/2" x 3", 12" x 6" x 3" or

12" x 9" x 3"—Concluded

1.608" Rise Per Foot of Span (60° Central Angle)



Span	Rise	Inside Radius	Number Required Per Course			
			No. 1 Wedge	No. 1-X* Wedge	Straight	Total
16'-0"	2'-1 13/32"	16'-0"	30	42		72
16'-3"	2'-2 1/8"	16'-3"	29	44		73
16'-6"	2'-2 13/32"	16'-6"	28	46		74
16'-9"	2'-2 15/16"	16'-9"	27	48		75
17'-0"	2'-3 11/32"	17'-0"	25	51		76
17'-3"	2'-3 13/32"	17'-3"	24	53		77
17'-6"	2'-4 1/8"	17'-6"	23	55		78
17'-9"	2'-4 17/32"	17'-9"	22	57		79
18'-0"	2'-4 15/16"	18'-0"	21	59		80
18'-3"	2'-5 11/32"	18'-3"	20	61		81
18'-6"	2'-5 3/4"	18'-6"	19	63		82
18'-9"	2'-6 5/32"	18'-9"	18	65		83
19'-0"	2'-6 17/32"	19'-0"	17	67		84
19'-3"	2'-6 15/16"	19'-3"	16	69		85
19'-6"	2'-7 11/32"	19'-6"	15	71		86
19'-9"	2'-7 1/4"	19'-9"	14	73		87
20'-0"	2'-8 5/32"	20'-0"	13	75		88
20'-3"	2'-8 9/16"	20'-3"	12	77		89
20'-6"	2'-8 11/32"	20'-6"	10	80		90
20'-9"	2'-9 11/32"	20'-9"	10	82		92
21'-0"	2'-9 3/4"	21'-0"	9	84		93
21'-3"	2'-10 5/32"	21'-3"	8	86		94
21'-6"	2'-10 9/16"	21'-6"	7	88		95
21'-9"	2'-10 11/32"	21'-9"	6	90		96
22'-0"	2'-11 1/8"	22'-0"	5	92		97
22'-3"	2'-11 25/32"	22'-3"	3	95		98
22'-6"	3'-0 3/16"	22'-6"	2	97		99
22'-9"	3'-0 7/16"	22'-9"	1	99		100
23'-0"	3'-0 31/32"	23'-0"		101		101
23'-3"	3'-1 1/8"	23'-3"		101	1	102
23'-6"	3'-1 25/32"	23'-6"		101	2	103
23'-9"	3'-2 1/16"	23'-9"		101	3	104
24'-0"	3'-2 19/32"	24'-0"		101	4	105
24'-3"	3'-3"	24'-3"		101	5	106
24'-6"	3'-3 3/8"	24'-6"		101	6	107
24'-9"	3'-3 25/32"	24'-9"		101	7	108
25'-0"	3'-4 1/16"	25'-0"		101	8	109
25'-3"	3'-4 19/32"	25'-3"		101	9	110
25'-6"	3'-5"	25'-6"		101	10	111
25'-9"	3'-5 11/32"	25'-9"		101	11	112

*NOTE: The No. 1-X Wedge is standard in Silica Material only. For Fireclay Material in the case of Arches with Spans over 11'-0", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 51. The quantity of Straight brick is determined by subtracting 51 from the quantity given in the column "Total".



13 1/2" ARCH THICKNESS—WEDGE BRICK

13 1/2" x 4 1/2" x 3", 13 1/2" x 6" x 3" or
13 1/2" x 9" x 3"

1.608" Rise Per Foot of Span (60° Central Angle)

Span	Rise	Inside Radius	Number Required Per Course			Total
			No. 2 Wedge	No. 1 Wedge	No. 1-X* Wedge	
6' 0"	9 1/4"	6' 0"	27	3		30
6' 3"	10 1/16"	6' 3"	26	5		31
6' 6"	10 7/16"	6' 6"	25	7		32
6' 9"	10 23/32"	6' 9"	24	9		33
7' 0"	11 1/4"	7' 0"	22	12		34
7' 3"	11 21/32"	7' 3"	21	14		35
7' 6"	1' 0 1/16"	7' 6"	21	16		37
7' 9"	1' 0 15/32"	7' 9"	20	18		38
8' 0"	1' 0 7/8"	8' 0"	19	20		39
8' 3"	1' 1 1/4"	8' 3"	18	22		40
8' 6"	1' 1 21/32"	8' 6"	17	24		41
8' 9"	1' 2 1/16"	8' 9"	16	26		42
9' 0"	1' 2 15/32"	9' 0"	14	29		43
9' 3"	1' 2 7/8"	9' 3"	13	31		44
9' 6"	1' 3 1/16"	9' 6"	12	33		45
9' 9"	1' 3 11/16"	9' 9"	11	35		46
10' 0"	1' 4 1/16"	10' 0"	10	37		47
10' 3"	1' 4 13/32"	10' 3"	9	39		48
10' 6"	1' 4 7/8"	10' 6"	8	41		49
10' 9"	1' 5 1/32"	10' 9"	7	43		50
11' 0"	1' 5 11/16"	11' 0"	6	45		51
11' 3"	1' 6 1/32"	11' 3"	5	47		52
11' 6"	1' 6 1/2"	11' 6"	4	49		53
11' 9"	1' 6 7/8"	11' 9"	3	51		54
12' 0"	1' 7 1/32"	12' 0"	2	53		55
12' 3"	1' 7 11/16"	12' 3"	1	55		56
12' 6"	1' 7 23/32"	12' 6"		57		57
12' 9"	1' 8 1/32"	12' 9"		56	1	57
12' 12"	1' 8 1/2"	12' 12"		55	4	59
13' 0"	1' 8 23/32"	13' 0"		54	6	60
13' 3"	1' 9 1/16"	13' 3"		53	8	61
13' 6"	1' 9 11/16"	13' 6"		52	10	62
13' 9"	1' 10 1/32"	13' 9"		51	12	63
14' 0"	1' 10 1/2"	14' 0"		50	14	64
14' 3"	1' 10 23/32"	14' 3"		49	16	65
14' 6"	1' 11 1/16"	14' 6"		48	18	66
14' 9"	1' 11 11/32"	14' 9"		47	20	67
15' 0"	2' 0 1/8"	15' 0"		46	22	68
15' 3"	2' 0 13/32"	15' 3"		45	24	69
15' 6"	2' 0 15/32"	15' 6"		44	26	70

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*NOTE: The No. 1-X Wedge is standard in Silica Material only. For Fireclay Material in the case of Arches with Spans over 12' 4 1/2", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 57. The quantity of Straight brick is determined by subtracting 57 from the quantity given in the column "Total".

13 1/2" ARCH THICKNESS—WEDGE BRICK

13 1/2" x 4 1/2" x 3", 13 1/2" x 6" x 3" or
13 1/2" x 9" x 3"—Concluded

1.608" Rise Per Foot of Span (60° Central Angle)



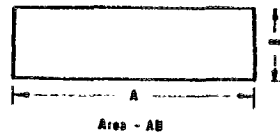
Span	Rise	Inside Radius	Number Required Per Course			Total
			No. 1 Wedge	No. 1-X* Wedge	Straight	
15' 9"	2' 1 5/16"	15' 9"	43	28		71
16' 0"	2' 1 13/32"	16' 0"	41	31		72
16' 3"	2' 2 1/8"	16' 3"	40	33		73
16' 6"	2' 2 11/32"	16' 6"	39	35		74
16' 9"	2' 2 15/16"	16' 9"	38	37		75
17' 0"	2' 3 11/32"	17' 0"	37	39		76
17' 3"	2' 3 23/32"	17' 3"	36	41		77
17' 6"	2' 4 1/8"	17' 6"	35	43		78
17' 9"	2' 4 15/32"	17' 9"	34	45		79
18' 0"	2' 4 5/16"	18' 0"	33	48		81
18' 3"	2' 5 11/32"	18' 3"	32	50		82
18' 6"	2' 5 3/4"	18' 6"	31	52		83
18' 9"	2' 6 1/32"	18' 9"	30	54		84
19' 0"	2' 6 17/32"	19' 0"	29	56		85
19' 3"	2' 6 15/16"	19' 3"	28	58		86
19' 6"	2' 7 11/32"	19' 6"	27	60		87
19' 9"	2' 7 3/4"	19' 9"	26	62		88
20' 0"	2' 8 5/32"	20' 0"	25	64		89
20' 3"	2' 8 9/16"	20' 3"	24	66		90
20' 6"	2' 8 31/32"	20' 6"	23	68		91
20' 9"	2' 9 11/32"	20' 9"	22	70		92
21' 0"	2' 9 3/4"	21' 0"	21	72		93
21' 3"	2' 10 5/32"	21' 3"	19	75		94
21' 6"	2' 10 9/16"	21' 6"	18	77		95
21' 9"	2' 10 23/32"	21' 9"	17	79		96
22' 0"	2' 11 1/8"	22' 0"	16	81		97
22' 3"	2' 11 23/32"	22' 3"	15	83		98
22' 6"	3' 0 1/16"	22' 6"	14	85		99
22' 9"	3' 0 5/16"	22' 9"	13	87		100
23' 0"	3' 0 11/32"	23' 0"	12	89		101
23' 3"	3' 1 13/32"	23' 3"	10	94		104
24' 0"	3' 2 11/32"	24' 0"	8	98		106
24' 6"	3' 3 3/8"	24' 6"	6	102		108
25' 0"	3' 4 1/16"	25' 0"	4	106		110
25' 6"	3' 5"	25' 6"	2	110		112
26' 0"	3' 5 11/16"	26' 0"		113	1	114
26' 6"	3' 6 13/32"	26' 6"		113	3	116
27' 0"	3' 7 11/32"	27' 0"		113	5	118
27' 6"	3' 8 7/32"	27' 6"		113	7	120
28' 0"	3' 9"	28' 0"		113	9	122

*NOTE: The No. 1-X Wedge is standard in Silica Material only. For Fireclay Material in the case of Arches with Spans over 12' 4 1/2", use combinations of No. 1 Wedge and Straight brick. The quantity of No. 1 Wedge brick remains constant at 57. The quantity of Straight brick is determined by subtracting 57 from the quantity given in the column "Total".

GEOMETRIC FORMULAS

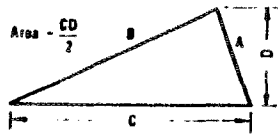
The following formulas for areas and volumes are useful in calculating refractory brickwork.

RECTANGLE



$$\text{Area} = AB$$

ACUTE ANGLED TRIANGLE



$$\text{Area} = \frac{CD}{2}$$

$$\text{Area} = \frac{1}{2} S(S-A)(S-B)(S-C)$$

where $S = \frac{1}{2}(A+B+C)$

REGULAR POLYGON



$$\text{Area} = \frac{MSR}{2}$$

(where M = Number of Sides)

CIRCLE



$$\text{Area} = \pi R^2$$

$$\text{or } \frac{\pi D^2}{4}$$

$$\text{Circumference} = 2\pi R \text{ or } \pi D$$

SECTOR OF CIRCLE



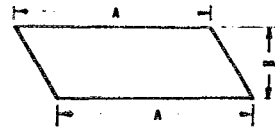
$$L = \frac{R\theta}{180}$$

$$57.296 \frac{L}{R}$$

$$R = \frac{2 \times \text{Area}}{L}$$

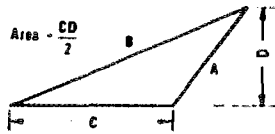
$$\text{Area} = \frac{RL}{2} \text{ or } R^2 \times \frac{\theta}{360}$$

PARALLELOGRAM



$$\text{Area} = AB$$

OBTUSE ANGLED TRIANGLE

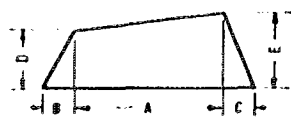


$$\text{Area} = \frac{CD}{2}$$

$$\text{Area} = \frac{1}{2} S(S-A)(S-B)(S-C)$$

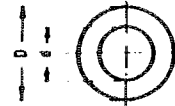
where $S = \frac{1}{2}(A+B+C)$

TRAPEZIUM



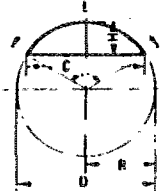
$$\text{Area} = \frac{1}{2} (A+B)D$$

ANNULAR RING



$$\text{Area} = \frac{\pi}{4} (D^2 - d^2)$$

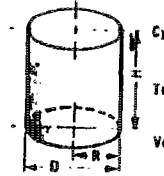
SEGMENT OF CIRCLE



$$\text{Area} = \frac{1}{2} RL$$

$$\text{or } R^2 \left(\frac{C}{H} - \frac{C^2}{8H} \right)$$

CYLINDER

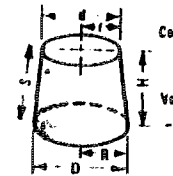


$$\text{Cylindrical Surface} = 2\pi RH$$

$$\text{Total Surface} = 2\pi R(R+H)$$

$$\text{Volume} = \pi R^2 H$$

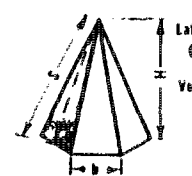
FRUSTUM OF CONE



$$\text{Conical Surface} = \pi S(R+r)$$

$$\text{Volume} = \frac{1}{3} \pi H(R^2 + Rr + r^2)$$

PYRAMID



$$\text{Lateral Area} = \frac{1}{2} S(Ns)$$

(N = Number of Sides)

$$\text{Volume} = \frac{1}{3} S(\text{Area of base})$$

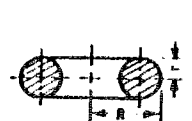
FILLET OR SPANDREL



$$\text{Area} = R^2 \left(\frac{\pi}{4} - \frac{A}{R} \right)$$

$$\text{or } 0.2146R^2$$

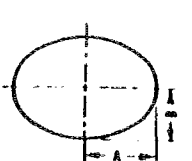
TORUS



$$\text{Area} = 4\pi^2 Rr$$

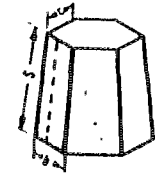
$$\text{Volume} = 2\pi^2 Rr^2$$

ELLIPSE



$$\text{Area} = \pi AB$$

FRUSTUM OF PYRAMID



$$\text{Lateral Area} = \frac{1}{2} S(Nc + Nb)$$

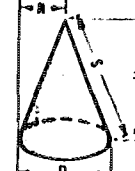
(N = Number of Sides)

$$\text{Volume} = \frac{H}{3} (A^2 + a^2 + Aa)$$

(A = Area of base)

(a = Area of top)

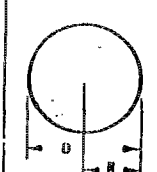
CONE



$$\text{Conical Surface} = \pi RS$$

$$\text{Volume} = \frac{1}{3} \pi R^2 H$$

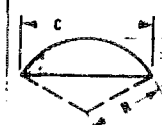
SPHERE



$$\text{Area} = 4\pi R^2 \text{ or } \pi D^2$$

$$\text{Volume} = \frac{4}{3} \pi R^3 \text{ or } \frac{\pi D^3}{6}$$

SEGMENT OF SPHERE



$$\text{Spherical Surface} = 2\pi RH$$

$$\text{Total Surface} = \frac{\pi}{4} (C^2 + 8RH)$$

$$\text{Volume} = \frac{\pi H}{24} (3C^2 + 4H^2)$$

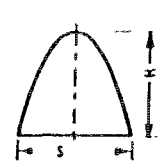
SECTOR OF SPHERE



$$\text{Total Surface} = \pi R (2H + \frac{C}{2})$$

$$\text{Volume} = \frac{2}{3} \pi R^2 H$$

PARABOLIC SEGMENT



$$\text{Area} = \frac{2}{3} SH$$



CIRCUMFERENCES AND AREAS OF CIRCLES FROM $\frac{1}{64}$ to 100

Diameter	Circumference	Area	Diameter	Circumference	Area
$\frac{1}{64}$	04909	00019	5	15 708	19 635
$\frac{1}{32}$	09818	00077	$5\frac{1}{8}$	16 101	20 629
$\frac{1}{16}$	19635	00307	$5\frac{1}{4}$	16 493	21 648
$\frac{1}{8}$	39270	01227	$5\frac{1}{2}$	16 886	22 691
$\frac{3}{16}$	58905	02761	$5\frac{3}{4}$	17 279	23 758
$\frac{1}{4}$	78540	04909	$5\frac{7}{8}$	17 672	24 850
$\frac{5}{16}$	98175	07670	$5\frac{1}{2}$	18 064	25 967
$\frac{3}{8}$	1 1781	11045	$5\frac{3}{4}$	18 457	27 109
$\frac{7}{16}$	1 3745	15033			
$\frac{1}{2}$	1 5708	19635	6	18 850	28 274
$\frac{9}{16}$	1 7672	24850	$6\frac{1}{8}$	19 242	29 465
$\frac{5}{8}$	1 9635	30680	$6\frac{1}{4}$	19 635	30 680
$\frac{11}{16}$	2 1598	37122	$6\frac{3}{8}$	20 028	31 919
$\frac{3}{4}$	2 3562	44179	$6\frac{1}{2}$	20 420	33 183
$\frac{13}{16}$	2 5525	51849	$6\frac{5}{8}$	20 813	34 472
$\frac{7}{8}$	2 7489	60132	$6\frac{3}{4}$	21 206	35 785
$\frac{15}{16}$	2 9452	69029	$6\frac{7}{8}$	21 598	37 122
1	3 1416	78540	7	21 991	38 485
$1\frac{1}{8}$	3 5343	99402	$7\frac{1}{8}$	22 384	39 871
$1\frac{1}{4}$	3 9270	1 2272	$7\frac{1}{4}$	22 777	41 282
$1\frac{3}{8}$	4 3197	1 4849	$7\frac{3}{8}$	23 169	42 718
$1\frac{1}{2}$	4 7124	1 7671	$7\frac{1}{2}$	23 562	44 179
$1\frac{5}{8}$	5 1051	2 0739	$7\frac{5}{8}$	23 955	45 664
$1\frac{3}{4}$	5 4978	2 4053	$7\frac{3}{4}$	24 347	47 173
$1\frac{7}{8}$	5 8905	2 7612	$7\frac{7}{8}$	24 740	48 707
2	6 2832	3 1416	8	25 133	50 265
$2\frac{1}{8}$	6 6759	3 5466	$8\frac{1}{8}$	25 525	51 849
$2\frac{1}{4}$	7 0686	3 9761	$8\frac{1}{4}$	25 918	53 456
$2\frac{3}{8}$	7 4613	4 4301	$8\frac{3}{8}$	26 311	55 088
$2\frac{1}{2}$	7 8540	4 9087	$8\frac{1}{2}$	26 704	56 745
$2\frac{5}{8}$	8 2467	5 4119	$8\frac{5}{8}$	27 096	58 426
$2\frac{3}{4}$	8 6394	5 9396	$8\frac{3}{4}$	27 489	60 132
$2\frac{7}{8}$	9 0321	6 4918	$8\frac{7}{8}$	27 882	61 862
3	9 4248	7 0686	9	28 274	63 617
$3\frac{1}{8}$	9 8175	7 6699	$9\frac{1}{8}$	28 667	65 397
$3\frac{1}{4}$	10 210	8 2958	$9\frac{1}{4}$	29 060	67 201
$3\frac{3}{8}$	10 603	8 9462	$9\frac{3}{8}$	29 452	69 029
$3\frac{1}{2}$	10 996	9 6211	$9\frac{1}{2}$	29 845	70 882
$3\frac{5}{8}$	11 388	10 321	$9\frac{5}{8}$	30 238	72 760
$3\frac{3}{4}$	11 781	11 045	$9\frac{3}{4}$	30 631	74 662
$3\frac{7}{8}$	12 174	11 793	$9\frac{7}{8}$	31 023	76 589
4	12 566	12 566	10	31 416	78 540
$4\frac{1}{8}$	12 959	13 364	$10\frac{1}{8}$	31 809	80 516
$4\frac{1}{4}$	13 352	14 186	$10\frac{1}{4}$	32 201	82 516
$4\frac{3}{8}$	13 745	15 033	10	32 594	84 541
$4\frac{1}{2}$	14 137	15 904	$10\frac{1}{2}$	32 987	86 590
$4\frac{5}{8}$	14 530	16 800	$10\frac{5}{8}$	33 379	88 664
$4\frac{3}{4}$	14 923	17 721	$10\frac{3}{4}$	33 772	90 763
$4\frac{7}{8}$	15 315	18 665	$10\frac{7}{8}$	34 165	92 886



CIRCUMFERENCES AND AREAS OF CIRCLES —Continued

Diameter	Circumference	Area	Diameter	Circumference	Area
11	34 558	95 033	17	53 407	226 98
$11\frac{1}{8}$	34 950	97 205	$17\frac{1}{8}$	53 800	230 33
$11\frac{1}{4}$	35 343	99 402	$17\frac{1}{4}$	54 193	233 71
$11\frac{3}{8}$	35 736	101 62	$17\frac{3}{8}$	54 585	237 10
$11\frac{1}{2}$	36 128	103 87	$17\frac{1}{2}$	54 978	240 53
$11\frac{5}{8}$	36 521	106 14	$17\frac{5}{8}$	55 371	243 98
$11\frac{3}{4}$	36 914	108 43	$17\frac{3}{4}$	55 763	247 45
$11\frac{7}{8}$	37 306	110 75	$17\frac{7}{8}$	56 156	250 95
12	37 699	113 10	18	56 549	254 47
$12\frac{1}{8}$	38 092	115 47	$18\frac{1}{8}$	56 941	258 02
$12\frac{1}{4}$	38 485	117 86	$18\frac{1}{4}$	57 334	261 59
$12\frac{3}{8}$	38 877	120 28	$18\frac{3}{8}$	57 727	265 18
$12\frac{1}{2}$	39 270	122 72	$18\frac{1}{2}$	58 120	268 80
$12\frac{5}{8}$	39 663	125 19	$18\frac{5}{8}$	58 512	272 45
$12\frac{3}{4}$	40 055	127 68	$18\frac{3}{4}$	58 905	276 12
$12\frac{7}{8}$	40 448	130 19	$18\frac{7}{8}$	59 298	279 81
13	40 841	132 73	19	59 690	283 53
$13\frac{1}{8}$	41 233	135 30	$19\frac{1}{8}$	60 083	287 27
$13\frac{1}{4}$	41 626	137 89	$19\frac{1}{4}$	60 476	291 04
$13\frac{3}{8}$	42 019	140 50	$19\frac{3}{8}$	60 868	294 83
$13\frac{1}{2}$	42 412	143 14	$19\frac{1}{2}$	61 261	298 65
$13\frac{5}{8}$	42 804	145 80	$19\frac{5}{8}$	61 654	302 49
$13\frac{3}{4}$	43 197	148 49	$19\frac{3}{4}$	62 047	306 35
$13\frac{7}{8}$	43 590	151 20	$19\frac{7}{8}$	62 439	310 24
14	43 982	153 94	20	62 832	314 16
$14\frac{1}{8}$	44 375	156 70	$20\frac{1}{8}$	63 225	318 10
$14\frac{1}{4}$	44 768	159 48	$20\frac{1}{4}$	63 617	322 06
$14\frac{3}{8}$	45 160	162 30	$20\frac{3}{8}$	64 010	326 05
$14\frac{1}{2}$	45 553	165 13	$20\frac{1}{2}$	64 403	330 06
$14\frac{5}{8}$	45 946	167 99	$20\frac{5}{8}$	64 795	334 10
$14\frac{3}{4}$	46 339	170 87	$20\frac{3}{4}$	65 188	338 16
$14\frac{7}{8}$	46 731	173 78	$20\frac{7}{8}$	65 581	342 25
15	47 124	176 71	21	65 973	346 36
$15\frac{1}{8}$	47 517	179 67	$21\frac{1}{8}$	66 366	350 50
$15\frac{1}{4}$	47 909	182 65	$21\frac{1}{4}$	66 759	354 66
$15\frac{3}{8}$	48 302	185 66	$21\frac{3}{8}$	67 152	358 84
$15\frac{1}{2}$	48 695	188 69	$21\frac{1}{2}$	67 544	363 05
$15\frac{5}{8}$	49 087	191 75	$21\frac{5}{8}$	67 937	367 28
$15\frac{3}{4}$	49 480	194 83	$21\frac{3}{4}$	68 330	371 54
$15\frac{7}{8}$	49 873	197 93	$21\frac{7}{8}$	68 722	375 83
16	50 266	201 06	22	69 115	380 13
$16\frac{1}{8}$	50 658	204 22	$22\frac{1}{8}$	69 508	384 46
$16\frac{1}{4}$	51 051	207 39	$22\frac{1}{4}$	69 900	388 82
$16\frac{3}{8}$	51 444	210 60	$22\frac{3}{8}$	70 293	393 20
$16\frac{1}{2}$	51 836	213 82	$22\frac{1}{2}$	70 686	397 61
$16\frac{5}{8}$	52 229	217 08	$22\frac{5}{8}$	71 079	402 04
$16\frac{3}{4}$	52 622	220 35	$22\frac{3}{4}$	71 471	406 49
$16\frac{7}{8}$	53 014	223 65	$22\frac{7}{8}$	71 864	410 97



CIRCUMFERENCES AND AREAS OF CIRCLES

—Continued—

Diameter	Circumference	Area
23	72 257	415 48
23 ¹ / ₈	72 649	420 00
23 ¹ / ₄	73 042	424 56
23 ¹ / ₂	73 435	429 13
23 ³ / ₄	73 827	433 74
24	74 220	438 36
24 ¹ / ₈	74 613	443 01
24 ¹ / ₄	75 006	447 69
24	75 398	452 39
24 ¹ / ₈	75 791	457 11
24 ¹ / ₄	76 184	461 86
24 ¹ / ₂	76 578	466 64
24 ³ / ₄	76 969	471 44
25	77 362	476 26
25 ¹ / ₈	77 754	481 11
25 ¹ / ₄	78 147	485 98
25	78 540	490 87
25 ¹ / ₈	78 933	495 79
25 ¹ / ₄	79 325	500 74
25 ¹ / ₂	79 718	505 71
25 ³ / ₄	80 111	510 71
26	80 503	515 72
26 ¹ / ₈	80 896	520 77
26 ¹ / ₄	81 289	525 84
26	81 681	530 93
26 ¹ / ₈	82 074	536 05
26 ¹ / ₄	82 467	541 19
26 ¹ / ₂	82 860	546 35
26 ³ / ₄	83 252	551 55
27	83 645	556 76
27 ¹ / ₈	84 038	562 00
27 ¹ / ₄	84 430	567 27
27	84 823	572 56
27 ¹ / ₈	85 216	577 87
27 ¹ / ₄	85 608	583 21
27 ¹ / ₂	86 001	588 57
27 ³ / ₄	86 394	593 96
28	86 787	599 37
28 ¹ / ₈	87 179	604 81
28 ¹ / ₄	87 572	610 27
28	87 965	615 75
28 ¹ / ₈	88 357	621 26
28 ¹ / ₄	88 750	626 80
28 ¹ / ₂	89 143	632 36
28 ³ / ₄	89 535	637 94
29	89 928	643 55
29 ¹ / ₈	90 321	649 18
29 ¹ / ₄	90 714	654 84

Diameter	Circumference	Area
29	91 106	660 52
29 ¹ / ₈	91 499	666 23
29 ¹ / ₄	91 892	671 96
29 ¹ / ₂	92 284	677 71
29 ³ / ₄	92 677	683 49
30	93 070	689 30
30 ¹ / ₈	93 462	695 13
30 ¹ / ₄	93 855	700 98
30	94 248	706 86
30 ¹ / ₈	94 641	712 76
30 ¹ / ₄	95 033	718 69
30 ¹ / ₂	95 426	724 64
30 ³ / ₄	95 819	730 62
31	96 211	736 62
31 ¹ / ₈	96 604	742 64
31 ¹ / ₄	96 997	748 69
31	97 389	754 77
31 ¹ / ₈	97 782	760 87
31 ¹ / ₄	98 175	766 99
31 ¹ / ₂	98 568	773 14
31 ³ / ₄	98 960	779 31
32	99 353	785 51
32 ¹ / ₈	99 746	791 73
32 ¹ / ₄	100 14	797 98
32	100 53	804 25
32 ¹ / ₈	100 92	810 54
32 ¹ / ₄	101 32	816 86
32 ¹ / ₂	101 71	823 21
32 ³ / ₄	102 10	829 58
33	102 49	835 97
33 ¹ / ₈	102 89	842 39
33 ¹ / ₄	103 28	848 83
33	103 67	855 30
33 ¹ / ₈	104 07	861 79
33 ¹ / ₄	104 46	868 31
33 ¹ / ₂	104 85	874 85
33 ³ / ₄	105 24	881 41
34	105 64	888 00
34 ¹ / ₈	106 03	894 62
34 ¹ / ₄	106 42	901 26
34	106 81	907 92
34 ¹ / ₈	107 21	914 61
34 ¹ / ₄	107 60	921 32
34 ¹ / ₂	107 99	928 06
34 ³ / ₄	108 39	934 82
35	108 78	941 61
35 ¹ / ₈	109 17	948 42
35 ¹ / ₄	109 56	955 25

CIRCUMFERENCES AND AREAS OF CIRCLES

—Continued—

Diameter	Circumference	Area
35	109 96	962 11
35 ¹ / ₈	110 35	969 00
35 ¹ / ₄	110 74	975 91
35 ¹ / ₂	111 13	982 84
35 ³ / ₄	111 53	989 80
36	111 92	996 78
36 ¹ / ₈	112 31	1003 8
36 ¹ / ₄	112 71	1010 8
36	113 10	1017 9
36 ¹ / ₈	113 49	1025 0
36 ¹ / ₄	113 88	1032 1
36 ¹ / ₂	114 28	1039 2
36 ³ / ₄	114 67	1046 3
37	115 06	1053 5
37 ¹ / ₈	115 45	1060 7
37 ¹ / ₄	115 85	1068 0
37	116 24	1075 2
37 ¹ / ₈	116 63	1082 5
37 ¹ / ₄	117 02	1089 8
37 ¹ / ₂	117 42	1097 1
37 ³ / ₄	117 81	1104 5
38	118 20	1111 8
38 ¹ / ₈	118 60	1119 2
38 ¹ / ₄	118 99	1126 7
38	119 38	1134 1
38 ¹ / ₈	119 77	1141 6
38 ¹ / ₄	120 17	1149 1
38 ¹ / ₂	120 56	1156 6
38 ³ / ₄	120 95	1164 2
39	121 34	1171 7
39 ¹ / ₈	121 74	1179 3
39 ¹ / ₄	122 13	1186 9
39	122 52	1194 6
39 ¹ / ₈	122 92	1202 3
39 ¹ / ₄	123 31	1210 0
39 ¹ / ₂	123 70	1217 7
39 ³ / ₄	124 09	1225 4
40	124 49	1233 2
40 ¹ / ₈	124 88	1241 0
40 ¹ / ₄	125 27	1248 8
40	125 66	1256 6
40 ¹ / ₈	126 06	1264 5
40 ¹ / ₄	126 45	1272 4
40 ¹ / ₂	126 84	1280 3
40 ³ / ₄	127 24	1288 2
41	127 63	1296 2
41 ¹ / ₈	128 02	1304 2
41 ¹ / ₄	128 41	1312 2

Diameter	Circumference	Area
41	128 81	1320 3
41 ¹ / ₈	129 20	1328 3
41 ¹ / ₄	129 59	1336 4
41 ¹ / ₂	129 98	1344 5
41 ³ / ₄	130 38	1352 7
42	130 77	1360 8
42 ¹ / ₈	131 16	1369 0
42 ¹ / ₄	131 55	1377 2
42	131 95	1385 4
42 ¹ / ₈	132 34	1393 7
42 ¹ / ₄	132 73	1402 0
42 ¹ / ₂	133 13	1410 3
42 ³ / ₄	133 52	1418 6
43	133 91	1427 0
43 ¹ / ₈	134 30	1435 4
43 ¹ / ₄	134 70	1443 8
43	135 09	1452 2
43 ¹ / ₈	135 48	1460 7
43 ¹ / ₄	135 87	1469 1
43 ¹ / ₂	136 27	1477 6
43 ³ / ₄	136 66	1486 2
44	137 05	1494 7
44 ¹ / ₈	137 45	1503 3
44 ¹ / ₄	137 84	1511 9
44	138 23	1520 5
44 ¹ / ₈	138 62	1529 2
44 ¹ / ₄	139 02	1537 9
44 ¹ / ₂	139 41	1546 6
44 ³ / ₄	139 80	1555 3
45	140 19	1564 0
45 ¹ / ₈	140 59	1572 8
45 ¹ / ₄	140 98	1581 6
45	141 37	1590 4
45 ¹ / ₈	141 76	1599 3
45 ¹ / ₄	142 16	1608 2
45 ¹ / ₂	142 55	1617 0
45 ³ / ₄	142 94	1626 0
46	143 34	1634 9
46 ¹ / ₈	143 73	1643 9
46 ¹ / ₄	144 12	1652 9
46	144 51	1661 9
46 ¹ / ₈	144 91	1670 9
46 ¹ / ₄	145 30	1680 0
46 ¹ / ₂	145 69	1689 1
46 ³ / ₄	146 08	1698 2
47	146 48	1707 4
47 ¹ / ₈	146 87	1716 5
47 ¹ / ₄	147 26	1725 7



CIRCUMFERENCES AND AREAS OF CIRCLES —Concluded—

Diameter	Circumference	Area	Diameter	Circumference	Area
47	147.66	1734.9	61	191.64	2922.5
47 ¹ / ₈	148.05	1744.2	62	194.78	3019.1
47 ¹ / ₄	148.44	1753.5	63	197.92	3117.2
47 ³ / ₈	148.83	1762.7	64	201.06	3217.0
47 ¹ / ₂	149.23	1772.1	65	204.20	3318.3
47 ⁵ / ₈	149.62	1781.4	66	207.35	3421.2
47 ³ / ₄	150.01	1790.8	67	210.49	3525.7
47 ⁷ / ₈	150.40	1800.1	68	213.63	3631.7
48	150.80	1809.6	69	216.77	3739.3
48 ¹ / ₈	151.19	1819.0	70	219.91	3848.5
48 ¹ / ₄	151.58	1828.5	71	223.05	3959.2
48 ³ / ₈	151.98	1837.9	72	226.20	4071.5
48 ¹ / ₂	152.37	1847.5	73	229.34	4185.4
48 ⁵ / ₈	152.76	1857.0	74	232.48	4300.8
48 ³ / ₄	153.15	1866.5	75	235.62	4417.9
48 ⁷ / ₈	153.55	1876.1	76	238.76	4536.5
49	153.94	1885.7	77	241.90	4656.6
49 ¹ / ₈	154.33	1895.4	78	245.04	4778.4
49 ¹ / ₄	154.72	1905.0	79	248.19	4901.7
49 ³ / ₈	155.12	1914.7	80	251.33	5026.5
49 ¹ / ₂	155.51	1924.4	81	254.47	5153.0
49 ⁵ / ₈	155.90	1934.2	82	257.61	5281.0
49 ³ / ₄	156.29	1943.9	83	260.75	5410.6
49 ⁷ / ₈	156.69	1953.7	84	263.89	5541.8
50	157.08	1963.5	85	267.04	5674.5
51	160.22	2042.8	86	270.18	5808.8
52	163.36	2123.7	87	273.32	5944.7
53	166.50	2206.2	88	276.46	6082.1
54	169.65	2290.2	89	279.60	6221.1
55	172.79	2375.8	90	282.74	6361.7
56	175.93	2463.0	91	285.89	6503.9
57	179.07	2551.8	92	289.03	6647.6
58	182.21	2642.1	93	292.17	6792.9
59	185.35	2734.0	94	295.31	6939.8
60	188.50	2827.4	95	298.45	7088.2
			96	301.59	7238.2
			97	304.73	7389.8
			98	307.88	7543.0
			99	311.02	7697.7
			100	314.16	7854.0

DECIMALS OF AN INCH FOR EACH 1/64



Common Fraction	Decimal	Common Fraction	Decimal
1/64	.015625	33/64	.515625
2/64	.03125	35/64	.53125
3/64	.046875	37/64	.546875
4/64	.0625	39/64	.5625
5/64	.078125	41/64	.578125
6/64	.09375	43/64	.59375
7/64	.109375	45/64	.609375
1/8	.125	47/64	.625
9/64	.140625	49/64	.640625
10/64	.15625	51/64	.65625
11/64	.171875	53/64	.671875
12/64	.1875	55/64	.6875
13/64	.203125	57/64	.703125
14/64	.21875	59/64	.71875
15/64	.234375	61/64	.734375
1/4	.25	63/64	.75
17/64	.265625	65/64	.765625
18/64	.28125	67/64	.78125
19/64	.296875	69/64	.796875
20/64	.3125	71/64	.8125
21/64	.328125	73/64	.828125
22/64	.34375	75/64	.84375
23/64	.359375	77/64	.859375
3/8	.375	79/64	.875
25/64	.390625	81/64	.890625
26/64	.40625	83/64	.90625
27/64	.421875	85/64	.921875
28/64	.4375	87/64	.9375
29/64	.453125	89/64	.953125
30/64	.46875	91/64	.96875
31/64	.484375	93/64	.984375
1/2	.5	95/64	1
		97/64	1
		99/64	1
		100/64	1

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LENGTH EQUIVALENTS									
Kilometer	Meter	Centimeter	Millimeter	Inch	Foot	Yard	Miles	Sq. Centimeter	Sq. Millimeter
1	1,000	10 ⁴	10 ⁴	39.37	3.280.83	1,093.61	0.62137	10 ⁴	10 ⁴
10 ⁻³	0.001	100	1,000	39.37	3.280.83	1,093.61	0.62137	10 ⁴	10 ⁴
10 ⁻⁴	0.01	1	10	0.3937	0.032808	0.109361	0.00006214	10 ⁴	10 ⁴
2 54x10 ⁻⁴	0.001	0.1	1	0.3937	0.032808	0.109361	0.00006214	10 ⁴	10 ⁴
3 048x10 ⁻⁴	0.0254	2 540	25 400.05	0.03937	0.0032808	0.010936	0.0000062	10 ⁴	10 ⁴
9.144x10 ⁻⁴	0.30480	30 480	304 801	1	0.083333	0.02778	0.0000158	10 ⁴	10 ⁴
	0.914402	91 440	914 4	36	3	0.33333	0.0018939	10 ⁴	10 ⁴
							0.003682	10 ⁴	10 ⁴

SURFACE AND AREA EQUIVALENTS									
Sq. Meters	Sq. Inches	Sq. Feet	Sq. Yard	Sq. Meter	Sq. Feet	Sq. Yard	Sq. Meter	Sq. Centimeter	Sq. Millimeter
1	1,550	10.76	1.196	0.000274	0.000003861	10,000	6.452	10 ⁴	10 ⁴
0.0006452	144	0.006944	0.0007716	0.000001594	0.00000002491	829 0	836.1	10 ⁴	10 ⁴
0.09290	144	0.1111	0.0002296	0.000000358	0.00000003288	8.361	836.131	10 ⁴	10 ⁴
0.8361	1,296	9	0.0002066	0.0000003288	0.0000003288	40.468.726	40.468.726	10 ⁴	10 ⁴
4.047	6,272.640	43.560	4.840	1	0.001562	25 9x10 ⁴	25 9x10 ⁴	10 ⁴	10 ⁴
2,589,998		27,878,400	3,097,600	640	1			10 ⁴	10 ⁴

VOLUME AND CAPACITY EQUIVALENTS									
Cu. Inch	Cu. Foot	Cu. Yard	U.S. Fluid Oz.	U.S. Quart	U.S. Gallon	Liters	Cu. Centimeter	Cu. Millimeter	Cu. Centimeter
1	0.000578	0.0002143	0.5541	0.01732	0.01486	0.01639	16.39	16.39	16.39
1.728	1	0.03704	95.75	29.92	25.71	28.32	28.320	28.320	28.320
46.656	27	1	25.853	807.9	694.3	764.6	764.559	764.559	764.559
1 805	0.001044	0.00003868	10.5	0.3125	0.26	0.2957	29.57	29.57	29.57
57.75	0.03342	0.001238	32	1	0.8594	0.9463	946.3	946.3	946.3
67.20	0.03889	0.00144	37.24	1.164	1	1.101	1.101	1.101	1.101
231	0.1337	0.004931	128	4	3.437	3.785	3.785	3.785	3.785
61.02	0.03531	0.001308	33.81	1.057	0.9081	1	1.000	1.000	1.000

WEIGHT EQUIVALENTS									
Cu. Inch	Cu. Foot	Cu. Yard	U.S. Fluid Oz.	U.S. Quart	U.S. Gallon	Liters	Cu. Centimeter	Cu. Millimeter	Cu. Centimeter
1	0.000578	0.0002143	0.5541	0.01732	0.01486	0.01639	16.39	16.39	16.39
1.728	1	0.03704	95.75	29.92	25.71	28.32	28.320	28.320	28.320
46.656	27	1	25.853	807.9	694.3	764.6	764.559	764.559	764.559
1 805	0.001044	0.00003868	10.5	0.3125	0.26	0.2957	29.57	29.57	29.57
57.75	0.03342	0.001238	32	1	0.8594	0.9463	946.3	946.3	946.3
67.20	0.03889	0.00144	37.24	1.164	1	1.101	1.101	1.101	1.101
231	0.1337	0.004931	128	4	3.437	3.785	3.785	3.785	3.785
61.02	0.03531	0.001308	33.81	1.057	0.9081	1	1.000	1.000	1.000

Kilograms	Grams	Ounces	Pounds	Short Tons	Long Tons	Grams
1	0 00006480	35 2	2 205	0 001102	0 0009842	1 000 0
0 02835	43 5	0 002286	0 0001429	0 0000007143	0 0000006378	0 0648
0 4336	7 000	1	0 0625	0 00003125	0 00002790	28 35
907 2	14 000 000	32 000	2 000	0 0005	0 0004464	453 59
1 016	15 680 000	35 840	2 240	1 12	0 8929	907 184
		3527	20	0000	0000	1 016 047

Gram Per CC.	Kg. Per Cu. Meter	DENSITY EQUIVALENTS				Tons Per Cu. Yd.	Tons Per Cu. Yd.
		Lb. Per Cu. In.	Lb. Per Cu. Ft.	Lb. Per Cu. Yd.	Lb. Per U. S. Gal.		
1	1.000	0.03613	62.43	1.686	0.8428	20.83	0.7525
1	27.680	1	0.0003613	0.06243	0.008345	25.8428x10-1	0.525x10-1
16.02	0.01602	0.0005287	1.728	46.656	231	0.1350	0.012054
0.5932	0.005932	0.00022743	1	0.03704	0.004951	0.0003	0.0004464
119.8	1.198	0.04325	74.81	202.0	0	1.1010	0.0901
1.139	1.139	0.0401	74.07	2.000	9.902	1.12	0.8979
			82.96	2.240			
		POWER EQUIVALENTS					
550	550						

POWER EQUIVALENTS					ANGULAR MEASURE EQUIVALENTS				
Hp. 550 Standard Ft.-lb. Per sec.	K.w. joules per sec.	M. Kg. per sec.	Ft. lb. per sec.	K. Cal. per sec.	Btu per sec.	Cal. per sec.	Circle Degrees Minutes Seconds Radians		
1	0.7457	6.04	550	0.7457	0.000463	178.23	1		
10	7.457	60.4	5,495	7.457	0.00463	1,782.3	10		
100	74.57	604	54,950	74.57	0.0463	17,823	100		
1,000	745.7	6,040	549,500	745.7	0.463	178,230	1,000		
10,000	7,457	60,400	5,495,000	7,457	4.63	1,782,300	10,000		
100,000	74,570	604,000	54,950,000	74,570	46.3	17,823,000	100,000		
1,000,000	745,700	6,040,000	549,500,000	745,700	463	178,230,000	1,000,000		
10,000,000	7,457,000	60,400,000	5,495,000,000	7,457,000	4,630	1,782,300,000	10,000,000		
100,000,000	74,570,000	604,000,000	54,950,000,000	74,570,000	46,300	17,823,000,000	100,000,000		
1,000,000,000	745,700,000	6,040,000,000	549,500,000,000	745,700,000	463,000	178,230,000,000	1,000,000,000		
10,000,000,000	7,457,000,000	60,400,000,000	5,495,000,000,000	7,457,000,000	4,630,000	1,782,300,000,000	10,000,000,000		
100,000,000,000	74,570,000,000	604,000,000,000	54,950,000,000,000	74,570,000,000	46,300,000	17,823,000,000,000	100,000,000,000		
1,000,000,000,000	745,700,000,000	6,040,000,000,000	549,500,000,000,000	745,700,000,000	463,000,000	178,230,000,000,000	1,000,000,000,000		
10,000,000,000,000	7,457,000,000,000	60,400,000,000,000	5,495,000,000,000,000	7,457,000,000,000	4,630,000,000	1,782,300,000,000,000	10,000,000,000,000		
100,000,000,000,000	74,570,000,000,000	604,000,000,000,000	54,950,000,000,000,000	74,570,000,000,000	46,300,000,000	17,823,000,000,000,000	100,000,000,000,000		
1,000,000,000,000,000	745,700,000,000,000	6,040,000,000,000,000	549,500,000,000,000,000	745,700,000,000,000	463,000,000,000	178,230,000,000,000,000	1,000,000,000,000,000		
10,000,000,000,000,000	7,457,000,000,000,000	60,400,000,000,000,000	5,495,000,000,000,000,000	7,457,000,000,000,000	4,630,000,000,000	1,782,300,000,000,000,000	10,000,000,000,000,000		
100,000,000,000,000,000	74,570,000,000,000,000	604,000,000,000,000,000	54,950,000,000,000,000,000	74,570,000,000,000,000	46,300,000,000,000	17,823,000,000,000,000,000	100,000,000,000,000,000		
1,000,000,000,000,000,000	745,700,000,000,000,000	6,040,000,000,000,000,000	549,500,000,000,000,000,000	745,700,000,000,000,000	463,000,000,000,000	178,230,000,000,000,000,000	1,000,000,000,000,000,000		
10,000,000,000,000,000,000	7,457,000,000,000,000,000	60,400,000,000,000,000,000	5,495,000,000,000,000,000,000	7,457,000,000,000,000,000	4,630,000,000,000,000	1,782,300,000,000,000,000,000	10,000,000,000,000,000,000		
100,000,000,000,000,000,000	74,570,000,000,000,000,000	604,000,000,000,000,000,000	54,950,000,000,000,000,000,000	74,570,000,000,000,000,000	46,300,000,000,000,000	17,823,000,000,000,000,000,000	100,000,000,000,000,000,000		
1,000,000,000,000,000,000,000	745,700,000,000,000,000,000	6,040,000,000,000,000,000,000	549,500,000,000,000,000,000,000	745,700,000,000,000,000,000	463,000,000,000,000,000	178,230,000,000,000,000,000,000	1,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000	60,400,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000	4,630,000,000,000,000,000	1,782,300,000,000,000,000,000,000	10,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000	604,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000	46,300,000,000,000,000,000	17,823,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000	463,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000,000,000,000,000		
100,000,000,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000,000,000	604,000,000,000,000,000,000,000,000,000,000,000,000,000	54,950,000,000,000,000,000,000,000,000,000,000,000,000,000	74,570,000,000,000,000,000,000,000,000,000,000,000,000	46,300,000,000,000,000,000,000,000,000,000,000,000	17,823,000,000,000,000,000,000,000,000,000,000,000,000,000	100,000,000,000,000,000,000,000,000,000,000,000,000,000		
1,000,000,000,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000,000,000	6,040,000,000,000,000,000,000,000,000,000,000,000,000,000	549,500,000,000,000,000,000,000,000,000,000,000,000,000,000	745,700,000,000,000,000,000,000,000,000,000,000,000,000	463,000,000,000,000,000,000,000,000,000,000,000,000	178,230,000,000,000,000,000,000,000,000,000,000,000,000,000	1,000,000,000,000,000,000,000,000,000,000,000,000,000,000		
10,000,000,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000,000,000	60,400,000,000,000,000,000,000,000,000,000,000,000,000,000	5,495,000,000,000,000,000,000,000,000,000,000,000,000,000,000	7,457,000,000,000,000,000,000,000,000,000,000,000,000,000	4,630,000,000,000,000,000,000,000,000,000,000,000,000	1,782,300,000,000,000,000,000,000,000,000,000,000,000,000,000	10,000,000,000,000,000,000,000,000,000,000,000,000,		

THERMAL CONDUCTIVITY EQUIVALENTS			
Cal. per sec. per sq. cm. per cm.	International Cal. per hr. per sq. cm. per cm.	B.t.u. per hr. per sq. ft. per in.	B.t.u. per day per sq. ft. per in.
0.000000	0.000000	0.000000	0.000000
0.000001	0.000001	0.000001	0.000001
0.000002	0.000002	0.000002	0.000002
0.000003	0.000003	0.000003	0.000003
0.000004	0.000004	0.000004	0.000004
0.000005	0.000005	0.000005	0.000005
0.000006	0.000006	0.000006	0.000006
0.000007	0.000007	0.000007	0.000007
0.000008	0.000008	0.000008	0.000008
0.000009	0.000009	0.000009	0.000009
0.000010	0.000010	0.000010	0.000010
0.000011	0.000011	0.000011	0.000011
0.000012	0.000012	0.000012	0.000012
0.000013	0.000013	0.000013	0.000013
0.000014	0.000014	0.000014	0.000014
0.000015	0.000015	0.000015	0.000015
0.000016	0.000016	0.000016	0.000016
0.000017	0.000017	0.000017	0.000017
0.000018	0.000018	0.000018	0.000018
0.000019	0.000019	0.000019	0.000019
0.000020	0.000020	0.000020	0.000020
0.000021	0.000021	0.000021	0.000021
0.000022	0.000022	0.000022	0.000022
0.000023	0.000023	0.000023	0.000023
0.000024	0.000024	0.000024	0.000024
0.000025	0.000025	0.000025	0.000025
0.000026	0.000026	0.000026	0.000026
0.000027	0.000027	0.000027	0.000027
0.000028	0.000028	0.000028	0.000028
0.000029	0.000029	0.000029	0.000029
0.000030	0.000030	0.000030	0.000030
0.000031	0.000031	0.000031	0.000031
0.000032	0.000032	0.000032	0.000032
0.000033	0.000033	0.000033	0.000033
0.000034	0.000034	0.000034	0.000034
0.000035	0.000035	0.000035	0.000035
0.000036	0.000036	0.000036	0.000036
0.000037	0.000037	0.000037	0.000037
0.000038	0.000038	0.000038	0.000038
0.000039	0.000039	0.000039	0.000039
0.000040	0.000040	0.000040	0.000040
0.000041	0.000041	0.000041	0.000041
0.000042	0.000042	0.000042	0.000042
0.000043	0.000043	0.000043	0.000043
0.000044	0.000044	0.000044	0.000044
0.000045	0.000045	0.000045	0.000045
0.000046	0.000046	0.000046	0.000046
0.000047	0.000047	0.000047	0.000047
0.000048	0.000048	0.000048	0.000048
0.000049	0.000049	0.000049	0.000049
0.000050	0.000050	0.000050	0.000050
0.000051	0.000051	0.000051	0.000051
0.000052	0.000052	0.000052	0.000052
0.000053	0.000053	0.000053	0.000053
0.000054	0.000054	0.000054	0.000054
0.000055	0.000055	0.000055	0.000055
0.000056	0.000056	0.000056	0.000056
0.000057	0.000057	0.000057	0.000057
0.000058	0.000058	0.000058	0.000058
0.000059	0.000059	0.000059	0.000059
0.000060	0.000060	0.000060	0.000060
0.000061	0.000061	0.000061	0.000061
0.000062	0.000062	0.000062	0.000062
0.000063	0.000063	0.000063	0.000063
0.000064	0.000064	0.000064	0.000064
0.000065	0.000065	0.000065	0.000065
0.000066	0.000066	0.000066	0.000066
0.000067	0.000067	0.000067	0.000067
0.000068	0.000068	0.000068	0.000068
0.000069	0.000069	0.000069	0.000069
0.000070	0.000070	0.000070	0.000070
0.000071	0.000071	0.000071	0.000071
0.000072	0.000072	0.000072	0.000072
0.000073	0.000073	0.000073	0.000073
0.000074	0.000074	0.000074	0.000074
0.000075	0.000075	0.000075	0.000075
0.000076	0.000076	0.000076	0.000076
0.000077	0.000077	0.000077	0.000077
0.000078	0.000078	0.000078	0.000078
0.000079	0.000079	0.000079	0.000079
0.000080	0.000080	0.000080	0.000080
0.000081	0.000081	0.000081	0.000081
0.000082	0.000082	0.000082	0.000082
0.000083	0.000083	0.000083	0.000083
0.000084	0.000084	0.000084	0.000084
0.000085	0.000085	0.000085	0.000085
0.000086	0.000086	0.000086	0.000086
0.000087	0.000087	0.000087	0.000087
0.000088	0.000088	0.000088	0.000088
0.000089	0.000089	0.000089	0.000089
0.000090	0.000090	0.000090	0.000090
0.000091	0.000091	0.000091	0.000091
0.000092	0.000092	0.000092	0.000092
0.000093	0.000093	0.000093	0.000093
0.000094	0.000094	0.000094	0.000094
0.000095	0.000095	0.000095	0.000095
0.000096	0.000096	0.000096	0.000096
0.000097	0.000097	0.000097	0.000097
0.000098	0.000098	0.000098	0.000098
0.000099	0.000099	0.000099	0.000099
0.000100	0.000100	0.000100	0.000100

VELOCITY EQUIVALENTS									
Cent. per Sec.	M. per Min.	Km. per Hour.	Ft. per Sec.	Ft. per Min.	Miles per Hr.				
1	0.01	0.036	0.03281	1.9685	0.02237				
10	0.6	0.6	3.281	196.85	2.237				
100	60	60	32.81	1968.5	22.37				
1567	16.6	16.6	0.054	3.281	0.03728				
178	6.278	6.278	0.9113	54.68	0.6214				
30	3.048	3.048	1.097	66	0.0818				
5086	50.86	50.86	1.0229	62.14	0.07136				
4470	44.70	44.70	0.1667	10.09	0.1136				
1	0.01	0.036	1.467	88					

HEAT FLOW EQUIVALENTS									
Cal. per sq. cm. sec.	Cal. per sq. cm. hr.	B.t.u. per sq. ft. hr.	B.t.u. per day per sq. ft.						
1	3600	12.46	12.46						
10	36000	124.6	124.6						
100	360000	1246	1246						
1567	564120	18780	18780						
178	63960	2060	2060						
30	10800	349	349						
5086	1831056	59200	59200						
4470	1609320	51600	51600						

Per °C.	Per °F.	Cent. per cm.	Cent. per in.	ft. per in.	ft. per °F.
1	1.8	1	2.54	1	1
10	18	10	25.4	10	10
100	180	100	254	100	100
1567	2820.6	1567	3969.8	1567	1567
178	320.4	178	451.2	178	178
30	54	30	76.2	30	30
5086	9154.8	5086	12904.4	5086	5086
4470	8046.6	4470	11304.6	4470	4470

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TEMPERATURE CONVERSION TABLES

By Albert Sauveur

Note: The numbers in bold face type refer to the temperature either in degrees Centigrade or Fahrenheit which it is desired to convert into the other scale.

0 to 100		100 to 1000	
C.	F.	C.	F.
17 8	0	32	10 6
17 2	1	33 8	11 1
16 7	2	35 6	11 7
16 1	3	37 4	12 2
15 6	4	39 2	12 8
15 0	5	41 0	13 3
14 4	6	42 8	13 9
13 9	7	44 6	14 4
13 3	8	46 4	15 0
12 8	9	48 2	15 6
12 2	10	50 0	16 1
11 7	11	51 8	16 7
11 1	12	53 6	17 2
10 6	13	55 4	17 8
10 0	14	57 2	18 3
9 44	15	59 0	18 9
8 89	16	60 8	19 4
8 33	17	62 6	20 0
7 78	18	64 4	20 6
7 22	19	66 2	21 1
6 67	20	68 0	21 7
6 11	21	69 8	22 2
5 56	22	71 6	22 8
5 00	23	73 4	23 3
4 44	24	75 2	23 9
3 89	25	77 0	24 4
3 33	26	78 8	25 0
2 78	27	80 6	25 6
2 22	28	82 4	26 1
1 67	29	84 2	26 7
1 11	30	86 0	27 2
0 56	31	87 8	27 8
0	32	89 6	28 3
0 56	33	91 4	28 9
1 11	34	93 2	29 4
1 67	35	95 0	30 0
2 22	36	96 8	30 6
2 78	37	98 6	31 1
3 33	38	100 4	31 7
3 89	39	102 2	32 2
4 44	40	104 0	32 8
5 00	41	105 8	33 3
5 56	42	107 6	33 9
6 11	43	109 4	34 4
6 67	44	111 2	35 0
7 22	45	113 0	35 6
7 78	46	114 8	36 1
8 33	47	116 6	36 7
8 89	48	118 4	37 2
9 44	49	120 2	37 8
10 0	50	122 0	

TEMPERATURE CONVERSION TABLES

—Continued
By Albert Sauveur



100 to 1000		INTERPOLATION FACTORS	
C.	F.	C.	F.
38	100	212	288
43	110	230	293
49	120	248	299
54	130	266	304
60	140	284	310
66	150	302	316
71	160	320	321
77	170	338	327
82	180	356	332
88	190	374	338
93	200	392	343
99	210	410	349
100	212	413	354
104	220	428	360
110	230	446	366
116	240	464	371
121	250	482	377
127	260	500	382
132	270	518	388
138	280	536	393
143	290	554	399
149	300	572	404
154	310	590	410
160	320	608	416
166	330	626	421
171	340	644	427
177	350	662	432
182	360	680	438
188	370	698	443
193	380	716	449
199	390	734	454
204	400	752	460
210	410	770	466
216	420	788	471
221	430	806	477
227	440	824	482
232	450	842	488
238	460	860	493
243	470	878	499
249	480	896	504
254	490	914	510
260	500	932	516
266	510	950	521
271	520	968	527
277	530	986	532
282	540	1004	538
			1000

C.	F.	C.	F.
0 56	1	1 8	3 33
1 11	2	3 6	3 89
1 67	3	5 4	4 44
2 22	4	7 2	5 00
2 78	5	9 0	5 56



TEMPERATURE CONVERSION TABLES

—Continued

By Albert Sauveur

1000 to 2000

C.		F.	C.		F.
543	1010	1850	821	1510	2750
549	1020	1868	827	1520	2768
554	1030	1886	832	1530	2786
560	1040	1904	838	1540	2804
566	1050	1922	843	1550	2822
571	1060	1940	849	1560	2840
577	1070	1958	854	1570	2858
582	1080	1976	860	1580	2876
588	1090	1994	866	1590	2894
593	1100	2012	871	1600	2912
599	1110	2030	877	1610	2930
604	1120	2048	882	1620	2948
610	1130	2066	888	1630	2966
616	1140	2084	893	1640	2984
621	1150	2102	899	1650	3002
627	1160	2120	904	1660	3020
632	1170	2138	910	1670	3038
638	1180	2156	916	1680	3056
643	1190	2174	921	1690	3074
649	1200	2192	927	1700	3092
654	1210	2210	932	1710	3110
660	1220	2228	938	1720	3128
666	1230	2246	943	1730	3146
671	1240	2264	949	1740	3164
677	1250	2282	954	1750	3182
682	1260	2300	960	1760	3200
688	1270	2318	966	1770	3218
693	1280	2336	971	1780	3236
699	1290	2354	977	1790	3254
704	1300	2372	982	1800	3272
710	1310	2390	988	1810	3290
716	1320	2408	993	1820	3308
721	1330	2426	999	1830	3326
727	1340	2444	1004	1840	3344
732	1350	2462	1010	1850	3362
738	1360	2480	1016	1860	3380
743	1370	2498	1021	1870	3398
749	1380	2516	1027	1880	3416
754	1390	2534	1032	1890	3434
760	1400	2552	1038	1900	3452
766	1410	2570	1043	1910	3470
771	1420	2588	1049	1920	3488
777	1430	2606	1054	1930	3506
782	1440	2624	1060	1940	3524
788	1450	2642	1066	1950	3542
793	1460	2660	1071	1960	3560
799	1470	2678	1077	1970	3578
804	1480	2696	1082	1980	3596
810	1490	2714	1088	1990	3614
816	1500	2732	1093	2000	3632

TEMPERATURE CONVERSION TABLES

—Concluded

By Albert Sauveur

2000 to 3000

C.		F.	C.		F.
1099	2010	3650	1177	2510	4550
1104	2020	3668	1182	2520	4568
1110	2030	3686	1188	2530	4586
1116	2040	3704	1193	2540	4604
1121	2050	3722	1199	2550	4622
1127	2060	3740	1404	2560	4640
1132	2070	3758	1410	2570	4658
1138	2080	3776	1416	2580	4676
1143	2090	3794	1421	2590	4694
1149	2100	3812	1427	2600	4712
1154	2110	3830	1432	2610	4730
1160	2120	3848	1438	2620	4748
1166	2130	3866	1443	2630	4766
1171	2140	3884	1449	2640	4784
1177	2150	3902	1454	2650	4802
1182	2160	3920	1460	2660	4820
1188	2170	3938	1466	2670	4838
1193	2180	3956	1471	2680	4856
1199	2190	3974	1477	2690	4874
1204	2200	3992	1482	2700	4892
1210	2210	4010	1488	2710	4910
1216	2220	4028	1493	2720	4928
1221	2230	4046	1499	2730	4946
1227	2240	4064	1504	2740	4964
1232	2250	4082	1510	2750	4982
1238	2260	4100	1516	2760	5000
1243	2270	4118	1521	2770	5018
1249	2280	4136	1527	2780	5036
1254	2290	4154	1532	2790	5054
1260	2300	4172	1538	2800	5072
1266	2310	4190	1543	2810	5090
1271	2320	4208	1549	2820	5108
1277	2330	4226	1554	2830	5126
1282	2340	4244	1560	2840	5144
1288	2350	4262	1566	2850	5162
1293	2360	4280	1571	2860	5180
1299	2370	4298	1577	2870	5198
1304	2380	4316	1582	2880	5216
1310	2390	4334	1588	2890	5234
1316	2400	4352	1593	2900	5252
1321	2410	4370	1599	2910	5270
1327	2420	4388	1604	2920	5288
1332	2430	4406	1610	2930	5306
1338	2440	4424	1616	2940	5324
1343	2450	4442	1621	2950	5342
1349	2460	4460	1627	2960	5360
1354	2470	4478	1632	2970	5378
1360	2480	4496	1638	2980	5396
1366	2490	4514	1643	2990	5414
1371	2500	4532	1649	3000	5432



TEMPERATURE END POINTS OF PYROMETRIC CONES

DEFINITION: Pyrometric Cone Equivalent (P. C. E.): In the case of refractories, the number of that standard cone whose tip would touch the supporting plaque simultaneously with a cone of the material being investigated when tested in accordance with the Standard Method of Test for P. C. E. of Fireclay Brick (A. S. T. M. Designation C 24) of the American Society for Testing Materials.

NOTE: The terms "fusion point," "softening point," "deformation point," and "melting point" have heretofore been loosely used for "pyrometric cone equivalent."

No. of Cone	End point*		No. of Cone	End point*	
	Degrees Cent.	Degrees Fahr.		Degrees Cent.	Degrees Fahr.
022	605	1121	7	1250	2282
021	615	1139	8	1260	2300
020	650	1202	9	1285	2345
019	660	1220	10	1305	2381
018	720	1328	11	1325	2417
017	770	1418	12	1335	2435
016	795	1463	13	1350	2462
015	805	1481	14	1400	2552
014	830	1526	15	1435	2615
013	860	1580	16	1465	2669
012	875	1607	17	1475	2687
011	905	1661	18	1490	2714
010	895	1643	19	1520	2768
09	930	1706	20	1530	2786
08	950	1742	23	1580	2876
07	990	1814	26	1595	2903
06	1015	1859	27	1605	2921
05	1040	1904	28	1615	2939
04	1060	1940	29	1640	2984
03	1115	2039	30	1650	3002
02	1125	2057	31	1680	3056
01	1145	2093	32	1700	3092
1	1160	2120	32½	1722	3131
2	1165	2129	33	1745	3173
3	1170	2138	34	1760	3200
4	1190	2174	35	1785	3245
5	1205	2201	36	1810	3290
6	1230	2246	37	1820	3308
			38	1835	3335

*NOTE: Pyrometric cones do not give an accurate measurement of temperature. Where it is desired to interpret P. C. E. values approximately in terms of temperature, the table above may be used. This table has been approved by the A. S. T. M. It is based on the work of Fairchild and Peters, J. Amer. Cer. Soc. 9, 701-41, 1926. Heating rate 150° Cent. per hour for cones 022 to 20, inclusive, and 100° Cent. per hour for cones 21 to 38, inclusive. The temperatures do not apply to the slower rates of heating common in the commercial firing and the use of refractory materials.

(Not included in the tests of Fairchild and Peters. The temperatures given are approximate.)

FURNACE TEMPERATURES



Kind of Furnace	Degrees C	Degrees F
Boilers	1000 to 1600	1800 to 2900
By-Product Coke Ovens	1000 to 1500	1830 to 2730
Cement Kilns, hot zone	1300 to 1600	2400 to 2900
Copper Converters	1200 to 1300	2200 to 2400
Copper Refining Furnaces	1250 to 1550	2300 to 2800
Copper Reverberatories	1300 to 1570	2400 to 2850
Copper Roasters	700 to 810	1300 to 1500
Gas Producer	1260 to 1370	2300 to 2500
Glass Annealing Furnaces	430 to 540	800 to 1000
Glass Tanks, bottle	1370 to 1600	2500 to 2900
Glass Tanks, plate	1370 to 1650	2500 to 3000
Iron and Steel Furnaces		
Annealing Oven	760 to 980	1400 to 1800
Blast Furnace, tapping	1370 to 1540	2500 to 2800
Bessemer Converter	1540 to 1650	2800 to 3000
Electric Furnaces	1450 to 1700	2650 to 3100
Heating Furnaces	980 to 1310	1800 to 2400
Malleable Furnaces	1300 to 1650	2400 to 3000
Open Hearths		
Melting Chamber	650 to 1680	1200 to 3050
Checkers	200 to 1430	400 to 2600
Soaking Pits	1150 to 1370	2100 to 2500

COLOR SCALE FOR TEMPERATURES

Lowest visible red	475	885
Lowest visible red to dark red	475 to 650	885 to 1200
Dark red to cherry red	650 to 750	1200 to 1380
Cherry red to bright cherry red	750 to 815	1380 to 1500
Bright cherry red to orange	815 to 900	1500 to 1650
Orange to yellow	900 to 1090	1650 to 2000
Yellow to light yellow	1090 to 1315	2000 to 2400
Light yellow to white	1315 to 1540	2400 to 2800
White to dazzling white	1540 and over	2800 and over



MELTING POINTS OF METALS AND ALLOYS*

	Degrees Fahrenheit	Degrees Centigrade
Aluminum	1220 ± 10 2	b 660 ± 10 1
Antimony	1166 ± 10 2	b 630 ± 10 1
Bronze	1920 approx.	1050 approx.
Brass	1725 approx.	940 approx.
Cadmium	609 ± 10 2	b 320 ± 10 1
Calcium	1562 ± 35	850 ± 20
Copper	1981 ± 10 2	b 1083 ± 10 1
Gold	1945 ± 10 0	a 1063 ± 10 0
Iridium	4429 ± 5	b 2443 ± 3
Iron, pure	2802 ± 5	1539 ± 3
Cast iron, white	2100 approx.	1150 approx.
Cast iron, gray	2245 approx.	1230 approx.
Steel, plain carbon (1% carbon and less)	2680 approx.	1470 approx.
Wrought iron	2750 approx.	1510 approx.
Lead	621 ± 10 2	b 327 ± 10 1
Magnesium	1202 ± 4	650 ± 2
Nickel	2647 ± 2	b 1453 ± 1
Palladium	2826 ± 2	b 1552 ± 1
Platinum	3216 ± 11 8	b 1769 ± 11
Rhodium	3560 ± 5	b 1960 ± 3
Silicon	2602 ± 35	1428 ± 20
Silver	1761 ± 10 0	a 960 ± 10 0
Tin	449 ± 10 2	b 231 ± 10 1
Titanium	3300 ± 180	1815 ± 100
Tungsten	6116 ± 35	b 3380 ± 20
Vanadium	3145 ± 90	1730 ± 50
Zinc	787 ± 10 2	b 419 ± 10 1

NOTE: a. Primary fixed points, International Temperature Scale of 1948.
b. Secondary fixed points, International Temperature Scale of 1948.

MELTING POINTS OF MINERALS AND OXIDES*

		°F	°C
Alumina (Corundum)	Al ₂ O ₃	3700	2038
Beryllia	BeO	4660	2570
Carbon (Sublimes)	C	6600	3650
Chromium Oxide	Cr ₂ O ₃	4110	2265
Forsterite	2MgO·SiO ₂	3492	1922
Lime	CaO	4658	2570
Magnesia	MgO	5072	2800
Silica (Cristobalite)	SiO ₂	3133	1723
Silicon Carbide (decomposes)	SiC	4082	2250
Spinel	MgO·Al ₂ O ₃	3875	2135
Zirconia	ZrO ₂	4890	2700
Zircon	ZrO ₂ ·SiO ₂	3227†	1775‡

* Adjusted to the International Temperature Scale of 1948.
† Dissociation Temperature.

COMPARISON OF TYLER AND U. S. SIEVE SERIES



TYLER STANDARD SIEVE SERIES*				U. S. Series approx. equivalent
Tyler mesh	Opening, in.	Opening, mm.	Dia. of wire, in.	
3		76.2	0.207	3 in.
2		50.8	192	2 in.
1 1/2		38.1	148	1 1/2 in.
1	0.050	26.67	148	1.06 in.
0	0.883	22.43	135	7/8 in.
	742	18.85	135	3/4 in.
	624	15.85	120	5/8 in.
	525	13.33	105	0.530 in.
	441	11.20	105	7/16 in.
	371	9.423	092	3/8 in.
2 1/2	312	7.925	088	5/16 in.
3	263	6.680	070	0.265 in.
3 1/2	221	5.613	065	No. 3 1/2
4	185	4.699	065	No. 4
5	156	3.962	044	No. 5
6	131	3.327	036	No. 6
7	110	2.794	0328	No. 7
8	093	2.362	032	No. 8
9	078	1.981	033	No. 10
10	065	1.651	035	No. 12
12	055	1.397	028	No. 14
14	046	1.168	025	No. 16
16	0390	0.991	0235	No. 18
20	0328	833	0172	No. 20
24	0276	701	0141	No. 25
28	0232	589	0125	No. 30
32	0195	495	0118	No. 35
35	0164	417	0122	No. 40
42	0138	351	0100	No. 45
48	0116	295	0092	No. 50
60	0097	246	0070	No. 60
65	0082	208	0072	No. 70
80	0069	175	0056	No. 80
100	0058	147	0042	No. 100
115	0049	124	0038	No. 120
150	0041	104	0026	No. 140
170	0035	089	0024	No. 170
200	0029	074	0021	No. 200
250	0024	061	0016	No. 230
270	0021	053	0016	No. 270
325	0017	043	0014	No. 325
400	0015	038	0010	No. 400

* Standard in Refractories Industry.



WEIGHTS OF VARIOUS MATERIALS

Material	Pounds Per Cu Ft. (Avg.)	Material	Pounds Per Cu Ft. (Avg.)
BRICK		METALS	
Building	87 137	Aluminum	166 168
Fireclay	118 152	Brass, cast	523 534
Silica	102 115	Bronze, 14% Sn	555
Chrome	175 180	Copper, cast, rolled	552 550
Magnesia as brick or fused in furnace	162 170	Copper, rolled or wire	555
CEMENT		Iron, gray cast	438 445
Portland, loose	80 90	Iron, white cast	473 482
Aluminous, loose	90 100	Iron, wrought	486 493
FINE GROUND CLAYS, SILICA CEMENT ETC.		Lead, cast	708
Fire Clay	50 110	Lead, rolled	711
Calcined Fire Clay	70 95	Nickel	536 555
Silica Cement	75 83	Steel, cast or rolled	474 490
Magnesia Cement	127	Tin cast	455 459
Chrome Cement	135	Zinc cast	439 447
Grain Magnesite (as shipped)	112		
COAL AND COKE		OILS	
Anthracite	87 112	Crude	48 62
Bituminous	75 94	Fuel Oil	
Charcoal	10 35	No. 1	51 52
Coke	23 32	No. 2	52 53
CONCRETE		No. 3	54 55
Cement, stone, sand	120 155	Bunker C	60 63
Cement, slag, etc.	110 130	Gasoline	44 47
EARTH		Kerosene	48 51
Loam, dry loose	63 76	Lubricating Oil	55 59
Loam, packed	85 95		
Loam, soft, loose mud	90 108	ROCKS IN SOLID	
Loam, dense mud	110 125	Chalk	118 175
GLASS		Dolomite	175 178
Common window	156 160	Granite	165 175
Plate	157 161	Gypsum	143 146
Container	152 159	Limestone and marble	165 172
Laboratory	136 140	Magnesite	187 190
Optical	133 507	Pumice	40 50
LIME		Quartz	162 165
Mortar	100	Sandstone	134-162
Quick, loose lumps	53	Shale	162 172
Quick, fine	75	Slate, American	175
Slaked	81 87	Soapstone, talc.	162 175
Stone, solid	165 172		
Stone, crushed	85 100	SAND	
MASONRY		Dry, loose	100
Granite or limestone	165 172	Dry, packed	110
Mortar rubble	150 155	Wet, packed	120
Sandstone	110 147	Gravel, packed	118
		WATER	
		As ice	57 2
		At 32°F	62 4
		At 212°F	59 8

TYPICAL PROPERTIES OF VARIOUS REFRACTORIES

Brick Type	Typical Constituents	P.C.E.	Spalling Resistance (Relative)	Abrasion Resistance (Relative)	Load Bearing Ability (Relative)	Pounds per 9" equiv.	Mean Coefficient of Expansion per °F Between 32°F and 2000°F Temp.	Thermal Conductivity BTU in. ft. in. at 2000°F.
Silica	96% SiO ₂	31-32	Poor	Good	Very Good	6-6.5	22-30	62x10 ⁻⁷ (2)
High Duty	40% Al ₂ O ₃	31-33	Good	Good	Good	7.5-8.5	10-24	31x10 ⁻⁷
Fireclay	55% SiO ₂	31-33	3-20%	Good	Good	8.5	12-15	30x10 ⁻⁷
Super Duty	42% Al ₂ O ₃	33-34	Excellent	Good	Good	8.9	20-35	32-40x10 ⁻⁷
Fireclay	52% SiO ₂	34-39	0-4%	Good	Good	8.5	15-22	32x10 ⁻⁷
High Alumina	50-80% Al ₂ O ₃	37-39	Excellent	Good	Excellent	8.7-10	13-28	26x10 ⁻⁷
Mullite	62% Al ₂ O ₃	37-40	Excellent	Very Good	Excellent	9-11	20-24	43x10 ⁻⁷
Silicon	35% SiO ₂	37-40	Excellent	Very Good	Excellent	10.5-11	20-28	41x10 ⁻⁷
Carbide	85-90% SiC	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷
Fused Alumina	85-90% Al ₂ O ₃	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷
Chrome	30-45% Cr ₂ O ₃	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷
	15-33% Al ₂ O ₃	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷
	83-93% MgO	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷
Magnesite	2-7% Fe ₂ O ₃	38-41	Good	Fair	Fair	9.5-10	20-28	68x10 ⁻⁷

(1) Dissociates at 4082°F.

(2) Coeff. 68° to 600°F.—163x10⁻⁷; 600° to 2000°F.—24x10⁻⁷.



GLOSSARY OF TERMS RELATING TO REFRACTORIES

- ABRASION OF REFRACTORIES** Wearing away of refractory surfaces by the scouring action of moving solids. (A)
- ABUTMENT** The structural portion of a furnace which withstands the thrust of an arch. (R)
- ACID REFRACTORIES** Refractories containing a substantial amount of uncombined silica which, when heated, may react chemically with basic refractories, slags or fluxes. (R)
- AIR SET** The property of a material to develop high strength when dried, an example being air-setting mortars. (Not to be confused with hydraulic set.) (R)
- AMERICAN BOND** Brickwork in which stretcher courses are the principal portion, with headers laid every 5th, 6th, or 7th course. (R)
- AUGER MACHINE** A machine for extruding moist clay through a die by means of a revolving screw or auger. (R)
- BACK** As applied to an arch, the outer or upper surface. (R)
- BAG WALL** A refractory baffle wall between the combustion chamber and the charge in a kiln or furnace.
- BASIC REFRACTORIES** Refractories whose major constituent is either lime or magnesia and which, when heated, may react chemically with acid refractories, slags or fluxes. (R)
- BASKETWEAVE CHECKERWORK** An arrangement of checker brick with continuous vertical flues in which the plan view suggests the weave of a basket.
- BAT** A broken burned brick or shape. (R)
- BATTER** To reduce the width of brickwork with succeeding courses. (R)
- BLOATING** Swelling of a refractory when in the thermo-plastic state, caused by temperatures in excess of that for which the material is intended, an exception being the use of this property in one type of ladle brick. (See also Secondary Expansion.) (R)
- BULLNOSE BRICK** See Jamb Brick.
- BURN** The degree to which the bond and other necessary physical and chemical properties of a refractory have been developed during manufacture by heat treatment in a kiln. (R)



GLOSSARY—Continued

- BUTTERED JOINT** Mortar joint made by trowelling mortar along the edges of the face of a brick, tile or shape and laying it without a complete mortar bed.
- CLAY-GROG MORTAR** A refractory mortar made of ground clay and grog for use in laying fireclay brick. (R)
- CORBEL** One or more courses of brick, each projecting beyond the one below it to form a support. (R)
- CORROSION OF REFRACTORIES** Destruction of refractory surfaces by the chemical action of external agencies. (A)
- DE-AIRED BRICK** Brick molded or formed from a mix which has been subjected to a partial vacuum during the forming process.
- DIE** A mold used for shaping brick in a machine or a form for shaping an extruded column. (R)
- DIVISION WALL** Wall dividing any two major sections of a furnace.
- DOUBLE SCREENED GROUND REFRACTORARY MATERIAL** A refractory material that contains a natural gradation of particle sizes resulting from grinding or crushing and from which particles coarser and finer than two specified sizes have been removed by screening. (A)
- DROP MACHINE SILICA BRICK** Silica brick formed by dropping a quantity of a prepared mix from a considerable vertical distance into a mold followed by slicking to size.
- DRY PRESS BRICK** Brick formed under high pressure from moistened, but dry-appearing, ground ceramic materials.
- EROSION OF REFRACTORIES** Wearing away of refractory surfaces by the washing action of moving liquids. (A)
- FIRST QUALITY FIRECLAY BRICK** A trade term usually indicating high duty fireclay brick as classified by A.S.T.M.
- FLASH MARKS** Discoloration on the surface of a brick resulting from the adherence of fly ash or the impingement of a reducing flame during burning. (R)
- FLUX BLOCKS** Refractory shapes which are used in contact with molten glass in furnaces. (R)
- FUSION CAST REFRACTORARY** Refractory material made by fusing refractory compositions in an electric furnace and pouring the molten material into molds to solidify and form finished shapes.



GLOSSARY—Continued

- GANISTER** A dense, high silica rock (quartzite), suitable for use in the manufacture of silica refractories. Note Confusion sometimes results from the use of this term because in some parts of the United States it is applied to crushed fire brick or mixtures of either crushed fire brick or silica rock with clay. (R)
- GROG** Burned refractory material, usually calcined clay or crushed fire brick. (R)
- HAUNCH** That portion of an arch which is midway between the skewback and the crown. (R)
- HEADER** A brick laid in a wall on its largest face with its longest dimension at right angles to the face of the wall. (R)
- HEARTH AND BOSH BRICK** Fireclay brick for use in lining the hearth walls and bosh sections of a blast furnace. (R)
- HERRINGBONE BOND** Brick laid in an angular or zigzag fashion, forming a herringbone pattern in the plan view.
- HOT TOP** A special refractory shape or construction which is placed on top of an ingot or casting mold to hold a quantity of molten iron which will later flow downward to compensate for the shrinkage as the ingot solidifies.
- INWALL BRICK** Fireclay brick for use in lining the inwall section of a blast furnace. (R)
- JACK ARCH** A sprung arch with plane, horizontal, outer and inner surfaces.
- JAMB BRICK** A brick modified so that the corner of one end and side is rounded with a radius approximately equal to the width of the brick. (R)
- KILN MARKS** Irregularities on the surface of a refractory caused by deformation under load during burning. (R)
- LAMINATIONS** Planes or contours of weakness in a molded refractory, which may develop during the forming process. (R)
- LEAN MORTAR** Mortar having poor troweling properties. (R)
- NEUTRAL REFRACTORIES** A term applied to refractories which are neither strongly basic nor strongly acid, such as chrome, mullite, or carbon. (R)
- NINE-INCH EQUIVALENT** The volume of a 9"x4½"x2½" brick (101.25 cubic inches) which unit is used to express the amount of material in a single shape, shipment, or period of production of refractory materials.



GLOSSARY—Continued

- NOZZLE BRICK** A tubular refractory shape used in a ladle with a hole through which steel is teemed at the bottom of a ladle, the upper end of the shape serving as a seat for the stopper. (R)
- OVERFIRING** Heating to a temperature sufficient to cause either pronounced deformation or bloating.
- PERMEABILITY** The property of allowing liquids or gases to flow into or through a material. (R)
- PIGEONHOLE CHECKER** An arrangement of checker brick in continuous parallel horizontal rows, so that alternate courses of bricks are parallel and intervening courses are laid at 90 degrees to adjacent courses.
- POURING PIT REFRACTORIES** Refractories used for the transfer and control of flow of molten steel in ingot molds. Note: The materials include ladle brick, sleeves, nozzles, stoppers, hot tops, runner brick, etc. (R)
- RAMMING MIX** A refractory material which, when tempered with water, will have suitable properties to allow it to be rammed into place to form a monolithic furnace lining and which develops structural strength when subsequently heated in the furnace. Note: Usually of a less plastic nature than plastic refractories. (R)
- RED HEART** A harmless reddish core, sometimes found in fire-clay refractories.
- RING** The sound produced when two brick are struck together or when one brick is tapped with a hard object. (R)
- RISE** The vertical distance between a plane connecting the spring lines and the highest point of the under side of an arch. (R)
- ROWLOCK**—Brick laid on edge with their longest dimension at right angles to the furnace wall.
- RUNNER BRICK** A refractory shape having a hole or holes through which molten steel is conveyed during the teeming of bottom-poured ingots. (R)
- SCUTCH** A hand tool resembling a small pick with flat cutting edges for trimming brick to the desired size or shape. (R)
- SECOND QUALITY FIRECLAY BRICK** A trade term usually indicating intermediate duty fireclay brick as classified by A.S.T.M.



GLOSSARY—Concluded

NOTES

SECONDARY EXPANSION A characteristic of some fireclay refractories to develop permanent expansion at temperatures within their useful range in service. Note—A behavior not to be confused with the bloating caused by excessive temperatures which impair the useful properties of a refractory. (R)

SINGLE-SCREENED GROUND REFRACTORY MATERIAL A refractory material that contains a natural gradation of particle sizes resulting from grinding or crushing and from which particles coarser than a specified size have been removed by screening. (A)

SLEEVES Tubular refractory shapes used to protect the metal rod which holds the stopper head in the valve assembly of a bottom-pouring ladle. (R)

SOLDIER COURSE A course of brick laid in a wall on end with their narrower side parallel to the furnace wall. (R)

SPRING LINE The line of contact between the inside surface of an arch and the skewback. (R)

SPRUNG ARCH An arch which is supported by abutments at the sides or ends only. (R)

STEAM PRESSED BRICK Brick made by repressing blanks cut from a column of clay from an auger machine.

STIFF MUD REPRESSED BRICK See steam pressed brick.

STOPPER HEAD A refractory shape, usually made of clay and graphite, which is a movable valve head seating on the nozzle brick, the assembly forming a valve for the metal in bottom-pouring ladles. (R)

STRETCHER A brick laid in a wall with its largest face horizontal and its longest dimension parallel to the face of the wall. (R)

SUSPENDED ARCH An arch in which the brick shapes are suspended from overhead supporting members. (R)

THIRD QUALITY FIRECLAY BRICK A trade term usually indicating low duty fireclay brick, as classified by A.S.T.M.

TILE Rectangular refractory shapes in sizes larger than standard brick and usually typified by thinness with respect to length and width. (R)

TOP BRICK Fireclay brick for use in lining the top section of a blast furnace. (R)

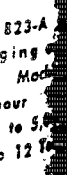
TUYERE BRICK A refractory shape containing one or more holes through which air and other gases are introduced into a furnace. (R)

NOTE:

(A) Definition from A.S.T.M. Definitions of Terms Relating to Refractories C 71.

(R) Definitions of the American Refractories Institute, Bulletin No. 87.

NOTES



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A Department Devoted to the Production of Refractories, Their Performance in Use, and News of the Industry

Permanente Metals Corporation Making Refractories History on West Coast

At the present time the company is producing 13 different refractories products.

They have developed a material for special high-temperature applications that will withstand a load of 25 pounds per square inch up to a temperature of 4,000 degrees F. without shearing.

In the course of operating the largest cement plant in the world, at Permanente, California, which supplied the entire amount of bulk cement used for wartime purposes in the Pacific area, besides operating various other heavy industries, the Henry J. Kaiser concerns naturally ran into many difficult refractory problems. How great these

problems were will be seen from the fact that each kiln in the cement plant alone used 15,000 basic kiln blocks in its hot zone. Equipment was subjected to such strenuous use that 60 days was the average run of Permanente kilns, with the best brick then available.

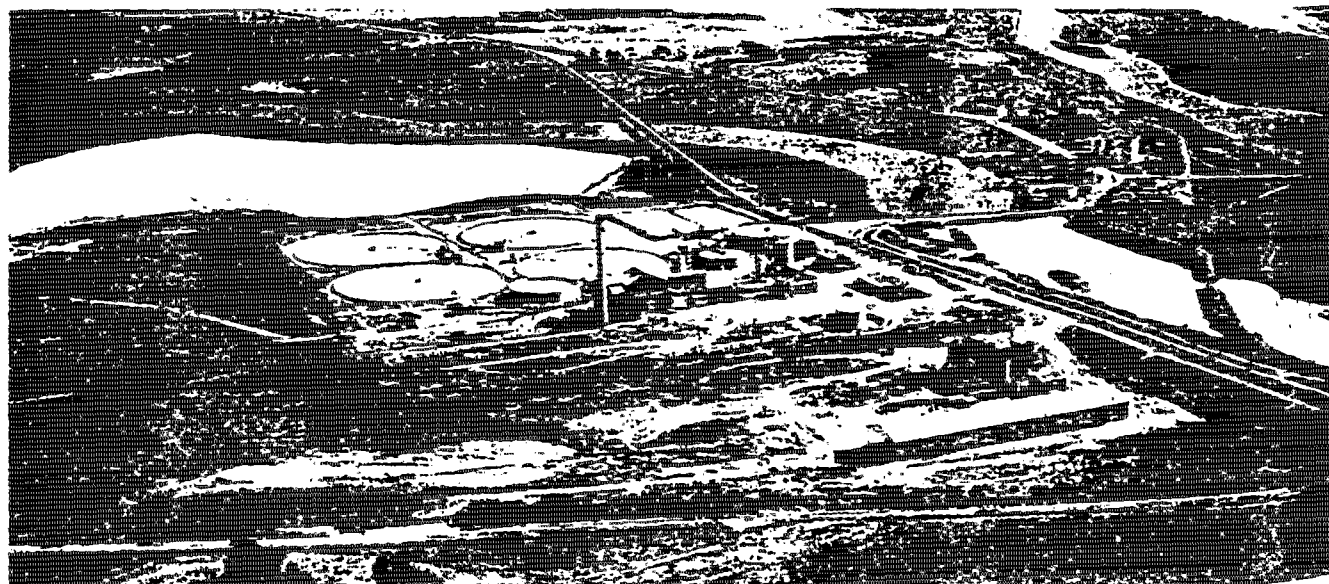
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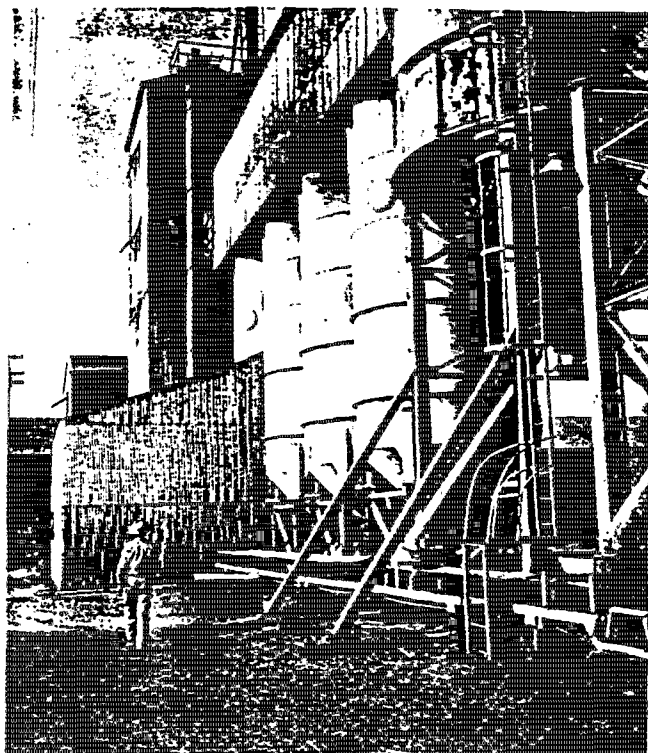
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The Permanente company entered the basic refractory field under circumstances that were unique and favorable for success, as it combined in



Aerial view of the Permanente Metal Corporation's Seawater Chemical and Refractory plants, Moss Landing, Calif. Brick facilities are pictured in right foreground. Shown

in the background are huge thickener tanks (250 feet in diameter), where raw material is processed. This plant is equipped with the latest type machinery and equipment.



Storage bins at the Permanente plant contain tons of mixing materials for proportioning devices, mixers and brick presses. From these bins come the materials for the 13 different refractory products manufactured at this plant.



One of the two, four-mold International presses in use at the Permanente plant which has a rated capacity of 100 tons per shift, or 100 tons every 24 hours, of closely controlled high temperature refractories.

one organization nearby sources of abundant raw material of a high degree of purity, and facilities for testing and proving its products under the varied and exacting demands of its own enterprises. As a consequence, it has been able to achieve results that are novel and revolutionary in the field of refractories.

4,000 Degree F. Refractory

For example, The Permanente Metals Corporation has developed a material for special high-temperature applications that will withstand a load of 25 pounds per square inch up to a temperature of 4,000 degrees F. without shearing. The extent of its uses has not been fully explored. This product, which has an excess of 96% of MgO, is a good example of what can be done with basic refractories.

One of this company's most notable refractory products is that known as Permanente 84 Periclase Ramming Material, the principal component of which is periclase (high grade dead-burned crystalline magnesia), made by the sea water-calcined dolomite process. A typical analysis of the particular type used in Permanente 84 is:

SiO ₂	5.79
R ₂ O ₃	1.24
CaO	1.12
MgO	91.85

As will be seen, the periclase is low in deleterious impurities. It is well shrunk and is resistant to hydration

and the attack of iron oxide and basic slag.

Overcome MgO Difficulties

The difficulties of sintering and bonding encountered in the use of high magnesia materials, under ordinary conditions, have been overcome in forming a grain for Permanente 84 by the fact that the magnesia, as precipitated from the sea water reaction, is in the form of very small crystals of magnesium hydroxide. "This", said Mr. L. W. Austin, head of the Permanente Research Laboratory, Milpitas, California, "makes an excellent media through which to thoroughly disperse any desirable additive which aids in the formation of dense, hard, crystallized grains. Firing to high temperature (above that to which the material will be subjected in use) completes the formation of the periclase."

The difficulty of making magnesia compounds of high MgO content into a dense crystallized mass, the problem of properly bonding the grains, if the formation of fluids at high temperature is to be avoided, and other obstacles, have been overcome by the Permanente company through a process upon which a patent has been allowed. Mr. Austin explained the nature of this process as follows: "The method is to preform a special bond component under rigid specifications. This bonding agent is very finely ground and dispersed in the mass. One feature of this material is that it has a relatively low

sintering or melting point. At this point, however, chemical action takes place with the MgO, with the resultant formation of the high temperature minerals magnesio-ferrite and forsterite. In other words, this thermo-chemical reaction causes the formation of a network of crystals which form directly on the periclase grains and throughout the bond itself. As the temperature is raised, there is not the increase in fluids as would be the case if fluxing agents had been used to secure the bond." (The number 84 happens to be the development number used in the laboratory.)

Some Products Made

Other refractories manufactured by The Permanente Corporation are as follows:

Periclase "A"—This is low in iron, chrome-free, and very refractory. Some of its applications are: glass furnace checkers; cement kilns; dolomite kilns; electric steel furnaces; copper converters, reverberatory and holding furnaces; lead cupola furnaces, and by-product furnaces.

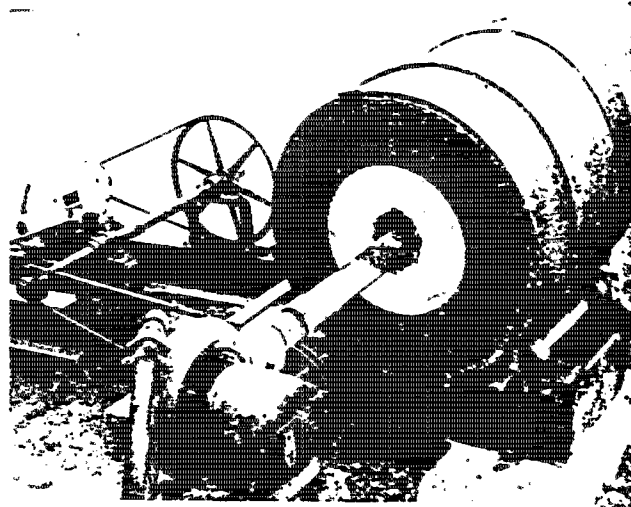
Periclase Chrome "A"—This has a higher spall resistance, and is used in cement kilns and electric steel furnaces.

Chrome Periclase "A"—This has the highest spall resistance, and is used in all applications between roof and bottom.

Chrome (burned only)—characterized by high chromite—corrected—



A view of some of the testing furnaces in the laboratory of the Permanente plant at Milpitas. New development is a brick ramming mix and mortars containing from 96% to 97% MgO.



Rotary furnace for testing the resistance of refractories. Work on new products is continuously carried on by the company.

and is used in steel furnace bottoms.

Permanente 95—a dry chrome plastic, air setting, with low shrinkage. Used in open hearth doors, leveling brick work, forging hearth bottoms, etc.

Permanente 80—characterized by high magnesia, highly refractory, with

quick burn-in. It is used in bonding all basic brick.

Permanente 91—a dry chrome mortar, airsetting, and used for bonding all types of refractory brick.

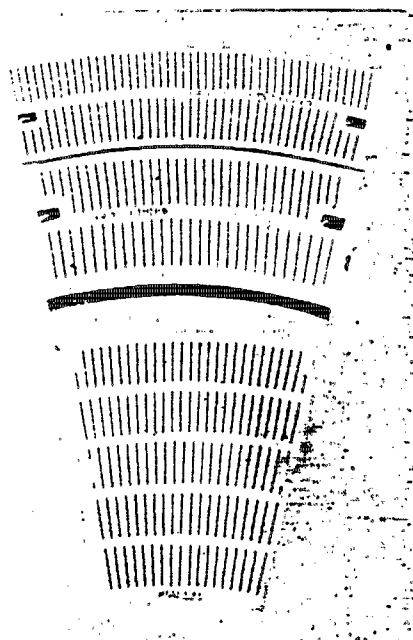
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development of which is a new series of refractories in the form of brick ramming mix and mortars containing from 96% to 97% MgO, and which show very high refractoriness, good spalling resistance, and low shrinkage combined with remarkable resistance to iron oxide and basic slags.

Work on these new products has progressed to the point where they are now being tested by several of the large steel mills, copper smelters, lead smelters, and cement kilns. Because of the very small amount of impurities in these products, they will undoubtedly open up new fields for the use of basic refractories where magnesite was not previously feasible, say Permanente officials.

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MALLIX SCREEN PLATES

NATIONAL MALLEABLE and STEEL CASTINGS CO. • Cleveland, O.

Modern Dust Collector Units Installed at Zero

A modernized dust collecting system has been completed by Standard Fuel Engineering Co., Detroit, Mich., in their Zero Refractory Division. Two Pangborn units, one for crushing and grinding and the other in the mixing department, have been installed in the company's program to increase production and improve working conditions to meet the increasing volume of business.

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Kaiser's New \$5 Million

Columbia Plant

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Columbiana . . .

**Kaiser
Chemicals**

Kaiser's New \$5 Million Refractory Plant

Even before construction was completed, plans were approved to further expand capacity at this new Ohio plant. Strategic location near all forms of transportation has cut delivery time up to two weeks.



ALL BRICK are dried upon leaving the presses at Columbiana. Some are then shipped as chemically bonded brick while others are fired at over 2800 F.

The new basic refractories plant at Kaiser Aluminum & Chemical Corporation's Chemicals Division was dedicated in colorful ceremonies sponsored jointly by the company and the Chamber of Commerce in Columbiana, Ohio, recently.

The \$5 million facility, which has been under construction for a little more than a year, has commenced operations and is now supplying basic refractory brick, ramming mixes, and furnace grains to the steel, cement, glass and copper industries in the east and middle west.

The dedication ceremony climaxed a day-long celebration which drew thousands of residents of Columbiana and the surrounding area. Plant tours were conducted throughout the morning and afternoon. Over 1,500 pounds of beef were served at a public barbecue held at noon in Firestone Park. Guests included company officials and state and local leaders.

Located in Steel Area

The decision to build a new plant at Columbiana was based upon the need for improved service to customers. Here, Kaiser Chemicals are within easy distance of the large consumers

the Midwest and East. Previously customers in the area were supplied from the California facilities of the company. The new plant will shorten delivery time in some cases by as much as 14 days.

Transportation Good

The plant covers more than three acres and is located on a 185-acre site on the main line of the Pennsylvania Railroad and within a few miles of the Ohio-Pennsylvania turnpike system. It is also located strategically to the shipping lanes when the St. Lawrence Seaway is completed.

The plant took 20 months to build and cost nearly \$5 million. Even before the installation was complete, plans were approved to expand its capacity by adding a third press. Ultimately, the Columbiana plant will employ 100 men and will produce more than 110,000 tons of refractory products per year.

Two principal products are manufactured at the Columbiana plant: one is basic refractory brick for high temperature applications in steel, copper, glass, cement and other industries in which extreme temperatures must be withstood. Ramming mix is also produced at this plant from essentially the same materials as the brick, but is sacked dry and shipped to the customer for mixing with water and ramming in place, usually in the bottom of a steel furnace.

Raw Materials Imported

The principal raw materials from which refractory materials are manufactured at Columbiana come from two widely separated geographical locations. Chrome ore is imported from the Philippines and trans-shipped by rail from Baltimore, Md. The opening of the St. Lawrence Seaway will enable the company to receive the ore either in Cleveland or Ashtabula, Ohio, thus reducing rail transportation considerably. The other primary ingredient—periclase—is shipped by rail to Columbiana from the company's sea-water magnesite plant at Moss Landing, Calif.

Raw Materials Preparation

Both periclase and chrome ore are received in railroad hopper cars and emptied into an underground track hopper beneath the railroad siding. The periclase is then removed from the track hopper by conveyor belts and elevators directly to one of the 750-ton primary storage silos for further processing.

The chrome ore is removed from the track hopper and conveyed to a jaw crusher which crushes it to minus 3-in. sizes. A belt conveyor transports the material to a gyratory crusher which breaks the ore into sizes smaller than 1/2 in., after which the ore is transported to a rotary dryer which is 5-ft. in diameter and 80-ft. long. At this point the ore is dried at 300°F. Should the occasion demand, it is possible to

dry as much as 100 tons of chrome ore per hour. From the rotary dryer, the material is conveyed to another 750-ton primary storage silo.

From these primary storage silos, the periclase and chrome ore are moved over independent conveyor systems to grinding mills, screens and classifiers, which sort the material into various sizes. A total of 17 screens are used in separating sizes ranging from —4 mesh down through —40 mesh. Mechanical air separators are used for further classification of the raw material by separating material from —40 mesh through —325 mesh. During this operation, a total of 15 dust collectors are used so that the plant is dust-free at all times. It might be noted at this point that not a single window was installed in the manufacturing plant building testifying to the fact that excessive circulation is unnecessary.

58 Storage Bins Utilized

Each one of the various sizes of processed periclase and chrome ore is held in separate bins. A total of 58 bins, each holding 60 tons, are utilized in storing the different sizes of both chrome ore and periclase, ranging in size from —4 mesh to —325 mesh. Under the bins is a mobile hopper and scale to weigh the materials for each batch. A total of 19 automatic feeders are employed to proportion the proper amount of material into this mobile hopper.

Each batch is taken by belt conveyor from the weigh hopper into a mixer. Here, in a large muller-type mixer,

the bonds are added which bind the combination of periclase and chrome ore for making basic refractory brick. If the batch is for sacked materials, it is conveyed from the weigh-hopper to a tumble-type mixer into which no water is added, as the sacked material is moistened at the time of use.

Forming and Drying

Gravity fed, the material is conveyed from the muller type mixers to two 1,000-ton presses where, under pressure of approximately 12,000 psi, it is formed into shape. The material from the tumble-type mixer is gravity fed into an automatic sacker where the material is put into bags.

The formed brick are set directly onto tunnel kiln cars capable of holding approximately two tons of ware each. These cars are moved through a two-tunnel dryer, each 160 feet long and capable of holding 23 cars. The ware is dried at 600°F. for a period of eight hours. Some of the brick emerge from the dryer as chemically bonded brick and are ready to ship in this condition. Also, at this point, three-sided metal is added to some of the brick and shipped as metal-clad basic ware.

Tunnel Kiln Operation

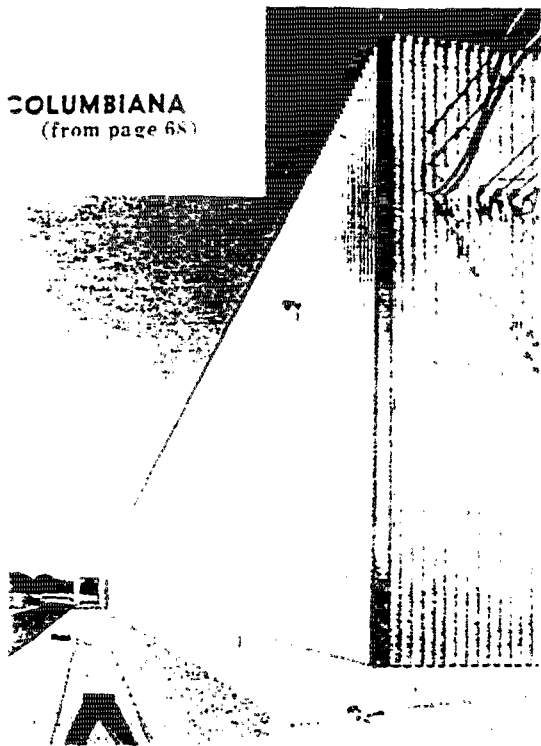
The other brick are moved to the kiln where they are fired at temperatures ranging from 2400°F. to 2900°F., depending on the type of brick. The tunnel kiln is 300 feet long and holds 57 cars of ware. At present, the tunnel kiln is operating on a two and two-

(Continued on following page)

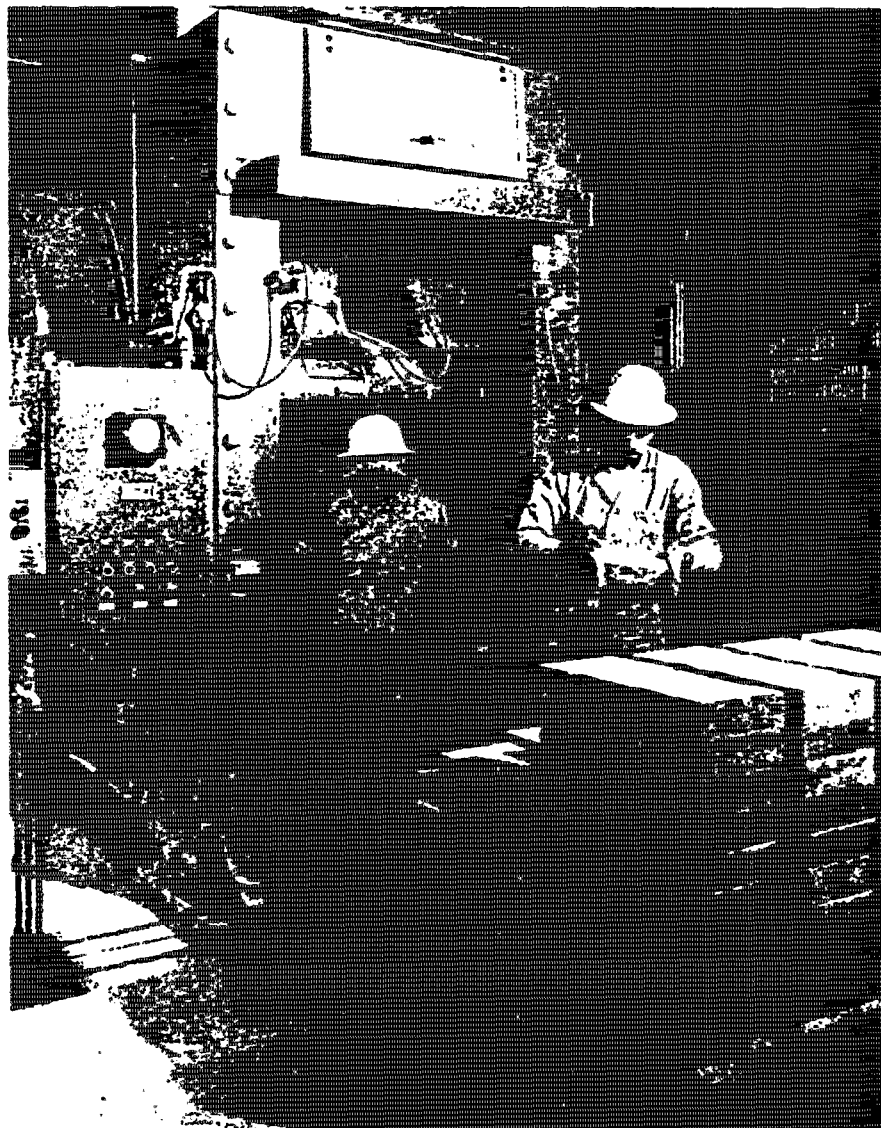


HIGH TEMPERATURE basic refractory brick is stacked ready for shipment. At right is tunnel kiln and in left background is a tunnel dryer.

COLUMBIANA (from page 68)



VIEW OF SIDE of plant also shows road-side welding equipment and storage piles. Below is shown one of the plant's presses.



third day cycle per car, attaining a capacity of 1,200 tons of ware per month. Natural gas is used as the fuel.

All brick, chemically bonded, metal clad, or burned are palletized and strapped for shipment by truck, rail, or ocean vessel. The loading area permits loading under cover of four large semi-trailers simultaneously, a feature very desirable during inclement weather in a peak season. The sacked material is usually palletized for shipping at Columbiana.

Quality Control Laboratory

The products made in Columbiana are under close supervision and laboratory control. Backed by the constant research at the Refractory Research Laboratory at Milpitas, Calif., and by field testing, all products leaving the plant are assured of a constant quality. In addition to the research and quality control laboratory in the Columbiana plant manned by a full-time staff. The laboratory is equipped with the latest in equipment, including pilot plant crushers, pulverizers, screening apparatus, compression testing machines, and even a spectrophotometer.

The company also maintains a machine shop with a standard machine shop equipment installed in it. An 80-ton hydraulic press, a metal shaper, metal lathe, drill press are all parts of the equipment set-up in the shop along with a surface grinder to grind a polish-surface on the faces of all dies used in the plant.

Capacity to Be Increased

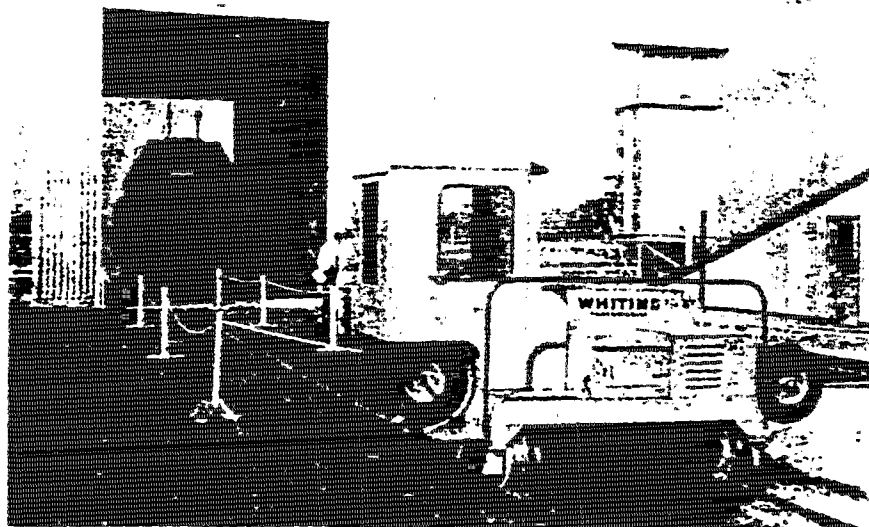
At present the capacity of the plant is 30,000 tons of sacked material per year, along with the 1,200 tons of basic brick each month. When additional equipment now on order is installed by the end of this year, the plant's annual capacity for basic brick, aside from ramming mixes and furnace grains, will be 48,000 tons. This capacity can be achieved by tracing through the original design of the plant again. The plant was so located on the present site so that it can be expanded in three directions.

Plant manager of the new Columbiana facility is E. W. Adams, who has been with the company for 13 years and has been associated with its chemical operations most of the time.

List of Suppliers Kaiser Chemicals Division

Equipment	Suppliers
Car Shaker.....	Allis-Chalmers Mfg. Co. Milwaukee, Wis.
Trackmobile.....	Whiting Corporation Harvey, Ill.
Conveyor Idlers.....	Hewitt-Robins, Inc. Stamford, Conn.
Conveyors	Hewitt-Robins, Inc. Stamford, Conn.
Belting.....	Hewitt-Robins, Inc. Stamford, Conn.
Rotary Dryer.....	Hardinge Co., Inc. York, Pa.
Jaw Crusher.....	Kennedy-Van Saun Mfg. & Engrg. Co., Danville, Pa.
Cone Crusher.....	Smith Engrg. Works Milwaukee, Wis.
Freight Elevator....	Canton Elevator & Mfg. Co., Canton, Ohio
Screens.....	W. S. Tyler Co. Cleveland, Ohio
Scales.....	Richardson Scale Co. Clifton, N. J.
Scales....	Toledo Scale Co., Toledo, Ohio
Transformers.....	General Electric Co. Schenectady, N. Y.
Electrical Stations	Westinghouse Electric Corp., Pittsburgh, Pa.
Power Converters.....	W. S. Tyler Co. Cleveland, Ohio
Fans.....	Robinson Ventilating Co. Zelienople, Pa.
Dust Collectors....	Rees Blow Pipe Mfg. Co., Berkeley, Calif.
Dust Collectors.....	Pangborn Corp. Hagerstown, Md.
Feeders....	Hardinge Co., Inc., York, Pa.
Batch Mixers.....	Worthington Corp. Harrison, N. J.
Batch-weighing Cars	Atlas-Pacific Co., Inc., Oakland, Calif.

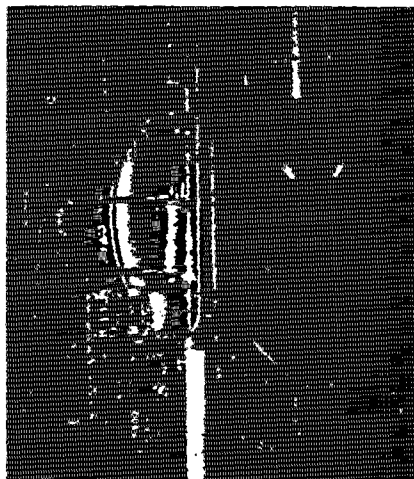
Hardy Scales Electrical Corp.
Maywood, Calif.
Pans.....Chambers Bros. Co.
Philadelphia, Pa.
Mills.....Kennedy-Van Saun Mfg.
& Engrg. Co., Danville, Pa.
Presses.....International Clay
Machinery Co., Dayton, Ohio
Kiln.....Allied Engineering Co.
Cleveland, Ohio
Allied Engineering Co.
Cleveland, Ohio
Compressors.....Gardner-Denver
Co., Denver, Colo.
Batch Mixer.....Simpson Div.,
National Engrg. Co., Chicago, Ill.
& Dryer Controls.....Minneapolis-
Honeywell Co., Philadelphia, Pa.
Hoppers.....Koura Iron Works
Detroit, Mich.
North American Mfg. Co.
Cleveland, Ohio



WHITING TRACKMOBILE is used for shuttling railroad cars to unloading.

Machine Shop Equipment

Hydraulic Press.....Manly Div.,
American Chain & Cable, York, Pa.
Metal Shaper.....Western Machine Tool
Works, Holland, Mich.
Surface Grinder.....Gallmeyer & Living-
ston Co., Grand Rapids, Mich.
Metal Lathe.....Barney Machinery Co.
Pittsburgh, Pa.
Mill Press.....Buffalo Machine Co.
Buffalo, N. Y.



Laboratory Equipment

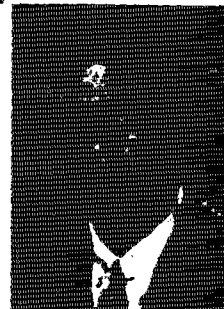
Slide Projector.....Wilson Projector Co.
Cleveland, Ohio
Vibrating.....Syntron Co.
Homer City, Pa.
Screens.....W. S. Tyler Co.
Cleveland, Ohio
Scales.....Toledo Scale Co., Toledo, Ohio
Drying Ovens.....Electric Hotpack Co.,
Inc., Philadelphia, Pa.

WORTHINGTON batch mixer has ca-
pacity of 6,000 lbs. of material for mix-
ing castable batches.

Lab Jaw Crusher.....Bico, Inc.
Burbank, Calif.
Pulverizer.....Bico, Inc., Burbank, Calif.
Compression Testing Machine.....Timius
Olson Testing Machine Co.
Willow Grove, Pa.



F. M. CASHIN
Vice-President



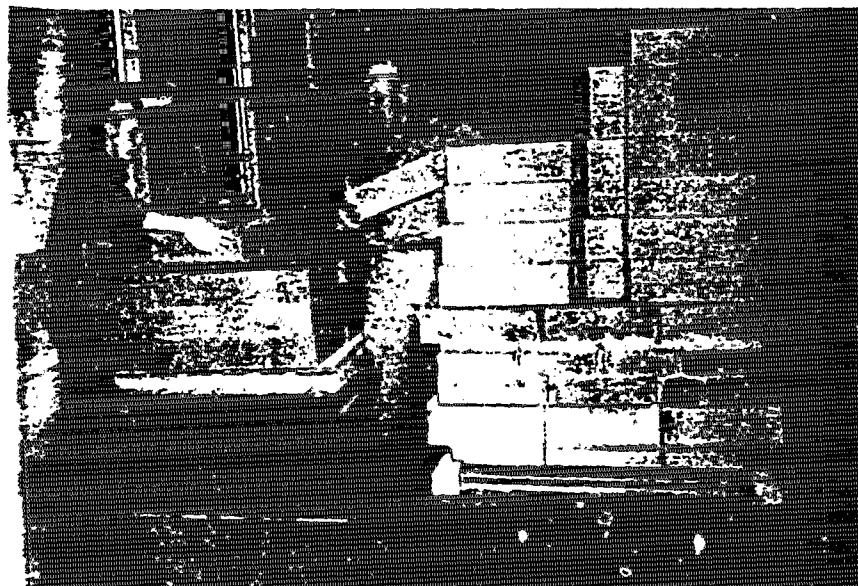
D. A. RHOADES
Vice-President



R. T. DRENNAN
Gen'l. Sales Mgr.



E. W. ADAMS
Plant Manager



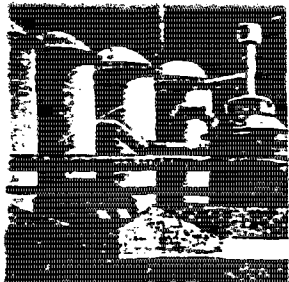
LOADING A KILN car of refractories onto pallets. All workers wear safety helmets.

BRICK & CLAY RECORD

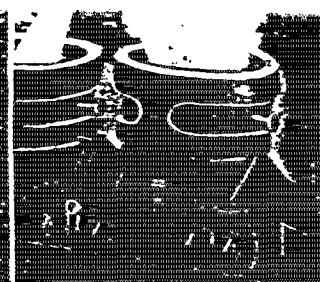
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to 5.00
to 12.00



REFRACTORIES



A Department Devoted to the Production of Refractories, Their Performance in Use, and News of the Industry

Permanente Metals Corporation Making Refractories History on West Coast

At the present time the company is producing 13 different refractories products.

They have developed a material for special high-temperature applications that will withstand a load of 25 pounds per square inch up to a temperature of 4,000 degrees F. without shearing.

In the course of operating the largest cement plant in the world, at Permanente, California, which supplied the entire amount of bulk cement used for wartime purposes in the Pacific area, besides operating various other heavy industries, the Henry J. Kaiser concerns naturally ran into many difficult refractory problems. How great these

problems were will be seen from the fact that each kiln in the cement plant alone used 15,000 basic kiln blocks in its hot zone. Equipment was subjected to such strenuous use that 60 days was the average run of Permanente kilns, with the best brick then available.

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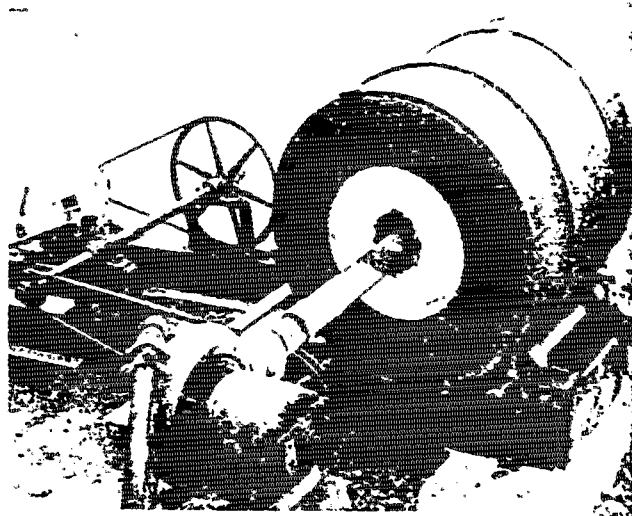


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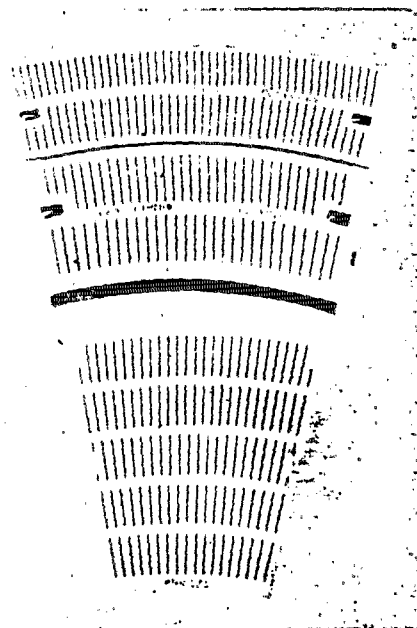
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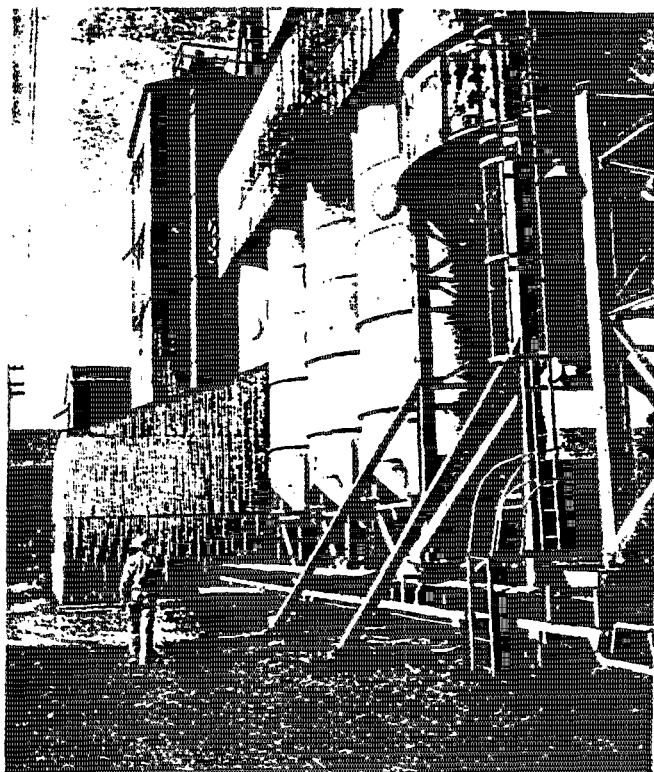
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one organization nearby sources of abundant raw material of a high degree of purity, and facilities for testing and proving its products under the varied and exacting demands of its own enterprises. As a consequence, it has been able to achieve results that are novel and revolutionary in the field of refractories.

4,000 Degree F. Refractory

For example, The Permanente Metals Corporation has developed a material for special high-temperature applications that will withstand a load of 25 pounds per square inch up to a temperature of 4,000 degrees F. without shearing. The extent of its uses has not been fully explored. This product, which has an excess of 96% of MgO, is a good example of what can be done with basic refractories.

One of this company's most notable refractory products is that known as Permanente 84 Periclase Ramming Material, the principal component of which is periclase (high grade dead-burned crystalline magnesia), made by the sea water-calcined dolomite process. A typical analysis of the particular type used in Permanente 84 is:

SiO ₂	5.79
R ₂ O ₃	1.24
CaO	1.12
MgO	91.85

As will be seen, the periclase is low in deleterious impurities. It is well shrunk and is resistant to hydration

and the attack of iron oxide and basic slag.

Overcome MgO Difficulties

The difficulties of sintering and bonding encountered in the use of high magnesia materials, under ordinary conditions, have been overcome in forming a grain for Permanente 84 by the fact that the magnesia, as precipitated from the sea water reaction, is in the form of very small crystals of magnesium hydroxide. "This", said Mr. L. W. Austin, head of the Permanente Research Laboratory, Milpitas, California, "makes an excellent media through which to thoroughly disperse any desirable additive which aids in the formation of dense, hard, crystallized grains. Firing to high temperature (above that to which the material will be subjected in use) completes the formation of the periclase."

The difficulty of making magnesia compounds of high MgO content into a dense crystallized mass, the problem of properly bonding the grains, if the formation of fluids at high temperature is to be avoided, and other obstacles, have been overcome by the Permanente company through a process upon which a patent has been allowed. Mr. Austin explained the nature of this process as follows: "The method is to preform a special bond component under rigid specifications. This bonding agent is very finely ground and dispersed in the mass. One feature of this material is that it has a relatively low

sintering or melting point. At this point, however, chemical action takes place with the MgO, with the result: formation of the high temperature minerals magnesio-ferrite and forsterite. In other words, this thermo-chemical reaction causes the formation of a network of crystals which form directly on the periclase grains and throughout the bond itself. As the temperature is raised, there is not the increase in fluids as would be the case if fluxing agents had been used to secure the bond." (The number 84 happens to be the development number used in the laboratory.)

Some Products Made

Other refractories manufactured by The Permanente Corporation are as follows:

Periclase "A"—This is low in iron, chrome-free, and very refractory. Some of its applications are: glass furnace checkers; cement kilns; dolomite kilns; electric steel furnaces; copper converters, reverberatory and holding furnaces; lead cupola furnaces, and by-product furnaces.

Periclase Chrome "A"—This has a higher spall resistance, and is used in cement kilns and electric steel furnaces.

Chrome Periclase "A"—This has the highest spall resistance, and is used in all applications between roof and bottom.

Chrome (burned only)—characterized by high chromite—corrected—

Brick & Clay Record

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Kaiser's New \$5 Million

AUTOMATION—How can a small plant go into automation, what cost and planning 53

SHALITE — Continuity of the production process is key to success of this Tennessee lightweight co. 40

\$60,000 — Will be saved annually by the three Laclede pipe plants with new packaging idea. 57

PLUS — New Mission Valley Plant (44); Pa. Ceramic Meet (73); Seanor (75); Clemson Meet (46); Belden Tour (38); Haws Anniversary (69); News of the Industry (32); Refractory News (63).

Columbiana . . .

*Kaiser
Chemicals*

Kaiser's New \$5 Million Refractory Plant

Even before construction was completed, plans were approved to further expand capacity at this new Ohio plant. Strategic location near all forms of transportation has cut delivery time up to two weeks.



ALL BRICK are dried upon leaving the presses at Columbiana. Some are then shipped as chemically bonded brick while others are fired at over 2800 F.

The new basic refractories plant at Kaiser Aluminum & Chemical Corporation's Chemicals Division was dedicated in colorful ceremonies sponsored jointly by the company and the Chamber of Commerce in Columbiana, Ohio recently.

The \$5 million facility, which has been under construction for a little more than a year, has commenced operations and is now supplying basic refractory brick, ramming mixes, and furnace grains to the steel, cement, glass and copper industries in the east and middle west.

The dedication ceremony climaxed a day-long celebration which drew thousands of residents of Columbiana and the surrounding area. Plant tours were conducted throughout the morning and afternoon. Over 1,500 pounds of beef were served at a public barbecue held at noon in Firestone Park. Guests included company officials and state and local leaders.

Located in Steel Area

The decision to build a new plant at Columbiana was based upon the need for improved service to customers. Here, Kaiser Chemicals are within easy distance of the large consumer

BRICK & CLAY RECORD

the Midwest and East. Previously customers in the area were supplied from the California facilities of the company. The new plant will shorten delivery time in some cases by as much as 14 days.

Transportation Good

The plant covers more than three acres and is located on a 185-acre site on the main line of the Pennsylvania Railroad and within a few miles of the Ohio-Pennsylvania turnpike system. It is also located strategically to the shipping lanes when the St. Lawrence Seaway is completed.

The plant took 20 months to build and cost nearly \$5 million. Even before the installation was complete, plans were approved to expand its capacity by adding a third press. Ultimately, the Columbiana plant will employ 100 men and will produce more than 110,000 tons of refractory products per year.

Two principal products are manufactured at the Columbiana plant; one is basic refractory brick for high temperature applications in steel, copper, glass, cement and other industries in which extreme temperatures must be withstood. Ramming mix is also produced at this plant from essentially the same materials as the brick, but is sacked dry and shipped to the customer for mixing with water and ramming in place, usually in the bottom of a steel furnace.

Raw Materials Imported

The principal raw materials from which refractory materials are manufactured at Columbiana come from two widely separated geographical locations. Chrome ore is imported from the Philippines and trans-shipped by rail from Baltimore, Md. The opening of the St. Lawrence Seaway will enable the company to receive the ore either in Cleveland or Ashtabula, Ohio, thus reducing rail transportation considerably. The other primary ingredient—periclase—is shipped by rail to Columbiana from the company's sea-water magnesite plant at Moss Landing, Calif.

Raw Materials Preparation

Both periclase and chrome ore are received in railroad hopper cars and emptied into an underground truck chopper beneath the railroad siding. The periclase is then removed from the truck hopper by conveyor belts and elevators directly to one of the 750-ton primary storage silos for further processing.

The chrome ore is removed from the truck hopper and conveyed to a jaw crusher which crushes it to minus 3-in. sizes. A belt conveyor transports the material to a gyratory crusher which breaks the ore into sizes smaller than 1 1/2 in., after which the ore is transported to a rotary dryer which is 5-ft. in diameter and 80-ft. long. At this point the ore is dried at 300° F. Should the occasion demand, it is possible to

dry as much as 100 tons of chrome ore per hour. From the rotary dryer, the material is conveyed to another 750-ton primary storage silo.

From these primary storage silos, the periclase and chrome ore are moved over independent conveyor systems to grinding mills, screens and classifiers, which sort the material into various sizes. A total of 17 screens are used in separating sizes ranging from —4 mesh down through —40 mesh. Mechanical air separators are used for further classification of the raw material by separating material from —40 mesh through —325 mesh. During this operation, a total of 15 dust collectors are used so that the plant is dust-free at all times. It might be noted at this point that not a single window was installed in the manufacturing plant building testifying to the fact that excessive circulation is unnecessary.

58 Storage Bins Utilized

Each one of the various sizes of processed periclase and chrome ore is held in separate bins. A total of 58 bins, each holding 60 tons, are utilized in storing the different sizes of both chrome ore and periclase, ranging in size from —4 mesh to —325 mesh. Under the bins is a mobile hopper and scale to weigh the materials for each batch. A total of 19 automatic feeders are employed to proportion the proper amount of material into this mobile hopper.

Each batch is taken by belt conveyor from the weigh hopper into a mixer. Here, in a large muller-type mixer,

the bonds are added which bind the combination of periclase and chrome ore for making basic refractory brick. If the batch is for sacked materials, it is conveyed from the weigh-hopper to a tumble-type mixer into which no water is added, as the sacked material is moistened at the time of use.

Forming and Drying

Gravity fed, the material is conveyed from the muller type mixers to two 1,000-ton presses where, under pressure of approximately 12,000 psi, it is formed into shape. The material from the tumble-type mixer is gravity fed into an automatic sacker where the material is put into bags.

The formed brick are set directly onto tunnel kiln cars capable of holding approximately two tons of ware each. These cars are moved through a two-tunnel dryer, each 160 feet long and capable of holding 23 cars. The ware is dried at 600° F. for a period of eight hours. Some of the brick emerge from the dryer as chemically bonded brick and are ready to ship in this condition. Also, at this point, three-sided metal is added to some of the brick and shipped as metal-clad basic ware.

Tunnel Kiln Operation

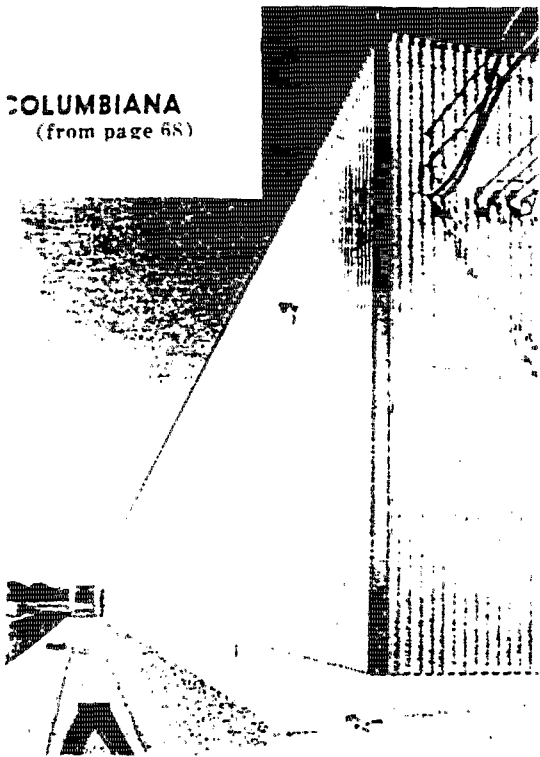
The other brick are moved to the kiln where they are fired at temperatures ranging from 2400° F. to 2900° F., depending on the type of brick. The tunnel kiln is 300 feet long and holds 57 cars of ware. At present, the tunnel kiln is operating on a two and two-

(Continued on following page)



HIGH-TEMPERATURE basic refractory brick is stacked ready for shipment. At right is tunnel kiln and in left background is a tunnel drier.

COLUMBIANA (from page 68)



VIEW OF SIDE of plant also shows roadside welding equipment and storage piles. Below is shown one of the plant's presses.



third day cycle per unit, attaining a capacity of 1,200 tons of ware per month. Natural gas is used as the fuel.

All brick, chemically bonded, metal clad, or burned are palletized and strapped for shipment by truck, rail, or ocean vessel. The loading area permits loading under cover of four large semi-trailers simultaneously, a feature very desirable during inclement weather in a peak season. The sacked material is usually palletized for shipping at Columbiana.

Quality Control Laboratory

The products made in Columbiana are under close supervision and laboratory control. Backed by the constant research at the Refractory Research Laboratory at Milpitas, Calif., and by field testing, all products leaving the plant are assured of a constant quality. In addition to the research and quality control laboratory in the Columbiana plant manned by a full-time staff. The laboratory is equipped with the latest in equipment, including pilot plant crushers, pulverizers, screening apparatus, compression testing machines, and even a spectrophotometer.

The company also maintains its own machine shop with a standard machine shop equipment installed in it. An 80-ton hydraulic press, a metal shaper, metal lathe, drill press are all parts of the equipment set-up in the shop along with a surface grinder to grind a polish surface on the faces of all dies used in the plant.

Capacity to Be Increased

At present the capacity of the plant is 30,000 tons of sacked material per year, along with the 1,200 tons of basic brick each month. When additional equipment now on order is installed by the end of this year, the plant's annual capacity for basic brick, aside from ramming mixes and furnace grains, will be 48,000 tons. This capacity can be achieved by tracing through the original design of the plant again. The plant was so located on the present site so that it can be expanded in three directions.

Plant manager of the new Columbiana facility is E. W. Adams, who has been with the company for 13 years and has been associated with its chemical operations most of the time.

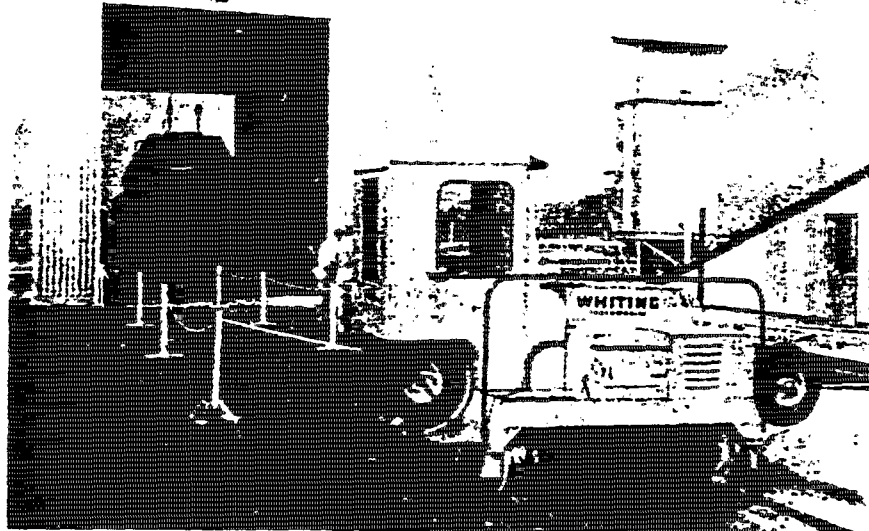
List of Suppliers Kaiser Chemicals Division

Equipment	Suppliers
Car Shaker.....	Allis-Chalmers Mfg. Co. Milwaukee, Wis.
Trackmobile.....	Whiting Corporation Harvey, Ill.
Conveyor Idlers.....	Hewitt-Robins, Inc. Stamford, Conn.
Conveyors	Hewitt-Robins, Inc. Stamford, Conn.
Belting.....	Hewitt-Robins, Inc. Stamford, Conn.
Rotary Dryer.....	Hardinge Co., Inc. York, Pa.
Jaw Crusher.....	Kennedy-Van Saun Mfg. & Engrg. Co., Danville, Pa.
Cone Crusher.....	Smith Engrg. Works Milwaukee, Wis.
Freight Elevator....	Canton Elevator & Mfg. Co., Canton, Ohio
Screens.....	W. S. Tyler Co. Cleveland, Ohio
Scales.....	Richardson Scale Co. Clifton, N. J.
Scales....	Toledo Scale Co., Toledo, Ohio
Transformers.....	General Electric Co. Schenectady, N. Y.
Electrical Stations	Westinghouse Electric Corp., Pittsburgh, Pa.
Power Converters.....	W. S. Tyler Co. Cleveland, Ohio
Fans.....	Robinson Ventilating Co. Zelienople, Pa.
Dust Collectors.....	Rees Blow Pipe Mfg. Co., Berkeley, Calif.
Dust Collectors.....	Pangborn Corp. Hagerstown, Md.
Feeders....	Hardinge Co., Inc., York, Pa.
Batch Mixers.....	Worthington Corp. Harrison, N. J.
Batch-weighing Cars	Atlas-Pacific Co., Inc., Oakland, Calif.

Hardy Scales Electrical Corp.
Maywood, Calif.
Pans.....Chambers Bros. Co.
Philadelphia, Pa.
Mills.....Kennedy-Van Saun Mfg.
& Engrg. Co., Danville, Pa.
Presses.....International Clay
Machinery Co., Dayton, Ohio
Kiln.....Allied Engineering Co.
Cleveland, Ohio
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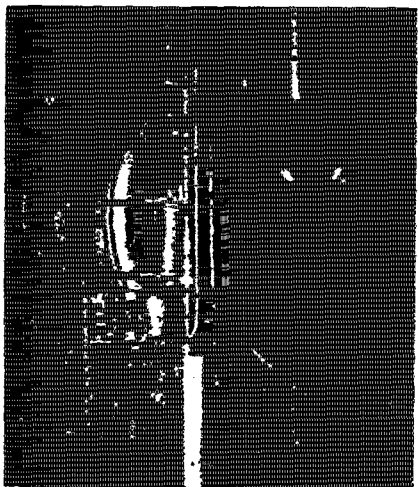
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3 83



WHITING TRACKMOBILE is used for shuttling railroad cars to unloading.

Machine Shop Equipment

ton Hydraulic Press.....Manly Div.,
American Chain & Cable, York, Pa.
al Shaper.....Western Machine Tool
Works, Holland, Mich.
urface Grinder.....Gallmeyer & Living-
ston Co., Grand Rapids, Mich.
etal Lathe.....Barney Machinery Co.
Pittsburgh, Pa.
ill Press.....Buffalo Machine Co.
Buffalo, N. Y.



WORTHINGTON batch mixer has capacity of 6,000 lbs. of material for mixing castable batches.



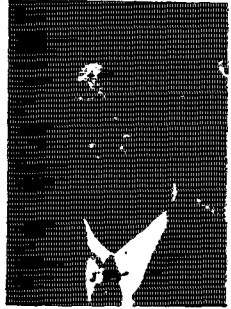
F. M. CASHIN
Vice-President

Laboratory Equipment

ide Projector.....Wilson Projector Co.
Cleveland, Ohio
erating.....Synttron Co.
Homer City, Pa.
creens.....W. S. Tyler Co.
Cleveland, Ohio
cales.....Toledo Scale Co., Toledo, Ohio
rying Ovens.....Electric Hotpack Co.,
Inc., Philadelphia, Pa.

Lah Jaw Crusher.....Bico, Inc.
Burbank, Calif.
Pulverizer.....Bico, Inc., Burbank, Calif.
Compression Testing Machine.....Tinius
Olson Testing Machine Co.
Willow Grove, Pa.

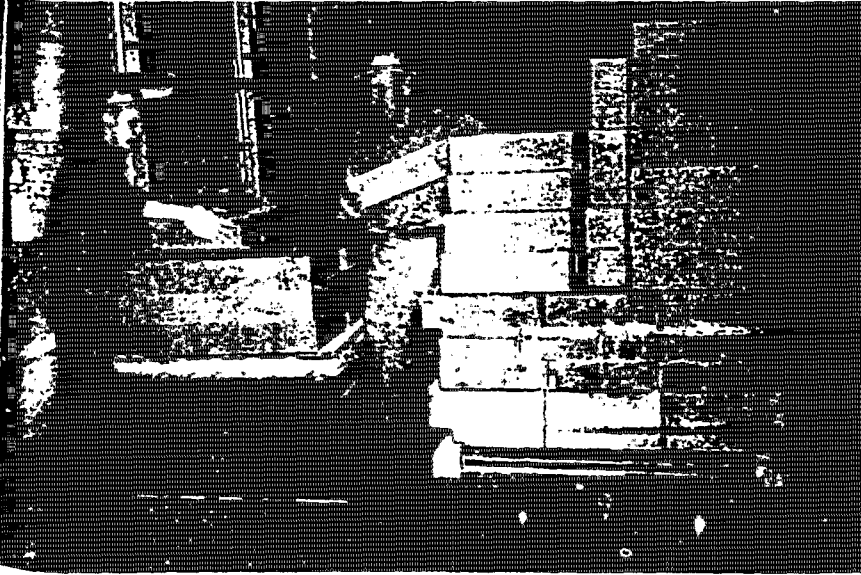
D. A. RHOADES
Vice-President



R. T. DRENNAN
Gen'l Sales Mgr.



E. W. ADAMS
Plant Manager



UNLOADING A KILN car of refractories onto pallets. All workers wear safety helmets.

Case	6-11
Room	
Field	
City	
State	

Dear Joe:

I am attaching a copy of that portion of the report which gives the details of this step.

At your convenience, would you let us know taken with respect to the cements which we your label.

THE EAGLE


John P. H.
General S
Industrial

Att.

cc: Mr. H. F. Munn
Mr. A. L. Jones

June 2, 1964

Stories Company
The Building

of the Board of Directors of the National Insulation
ation, it was brought out that one of the major
rers was planning to add a cautionary note to
products involved included asbestos as a constituent.

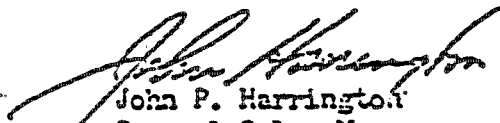
by of that portion of the minutes of this meeting
ils of this step.

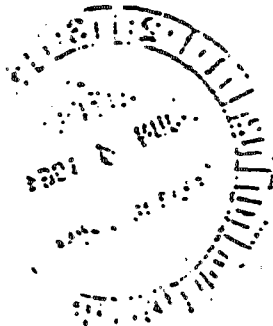
use this same cautionary note, having it printed
present stocks run out. The Eagle-Picher products
"66" Cement, One-Cote Cement, "33" Cement and
corresponding products are: Staz-On and Unicote.

, would you let us know if you wish similar action
to the cements which we are manufacturing under

Sincerely,

THE EAGLE-PICHER COMPANY

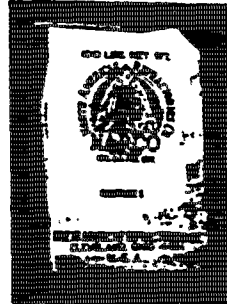

John P. Harrington
General Sales Manager
Industrial Insulation



GUNNING MIXES

NARCOLINE G is a dry graphitic type, slag resistant gun mix. Grain size distribution is balanced to give the best gunning properties possible. It has good strength, high density and is resistant to graphite burn out which is essential to maintain maximum slag resistance.

NARCOLINE G is supplied dry in 100 pound multiwall bags.



NARMAG CM-18 is a chrome ore base gun mix with air setting properties. It is applied with a dry type nozzle mix gun where water is added at the nozzle. NARMAG CM-18 finds wide usage in veneering open walls, uptakes and slag pockets as well as studded tube boiler walls. Supplied in 50 and 100 lb. multiwall paper bags.

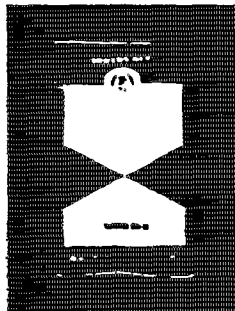


EXHIBIT	1
Witness	L. Schuler
Date	4-26-94
Rpt.	3/11
Powers & Garrison	