Lead Industries Association, Inc.

292 Madison Avenue • New York, N.Y. 10017 • Telephone: (212) 679-6080

August 26, 1971

SUBJECT: <u>NEW PUBLICATION DEALING WITH LEAD GLAZES</u>

To: Members of the Lead Industries Association, Inc.:

It has been quite apparent from recent publicity regarding potential and actual lead poisoning problems that many hobbyists and art or studio potters lack correct information about lead bearing glazes. The enclosed booklet, "Facts About Lead Glazes for Art Potters and Hobbyists," is aimed at correcting that unfortunate situation.

Based almost in its entirety on research data developed by ILZRO in cooperation with the U.S. Potters Association, this booklet will be distributed widely through craft and professional associations, as well as through cooperating hobby glaze producers and their distributors.

It is expected that this booklet will go a long way towards eliminating tragic and unnecessary deaths due to ingestion of lead from poorly glazed and fired ceramic food and beverage utensils.

If you wish to have a few extra copies of this publication, please let me know.

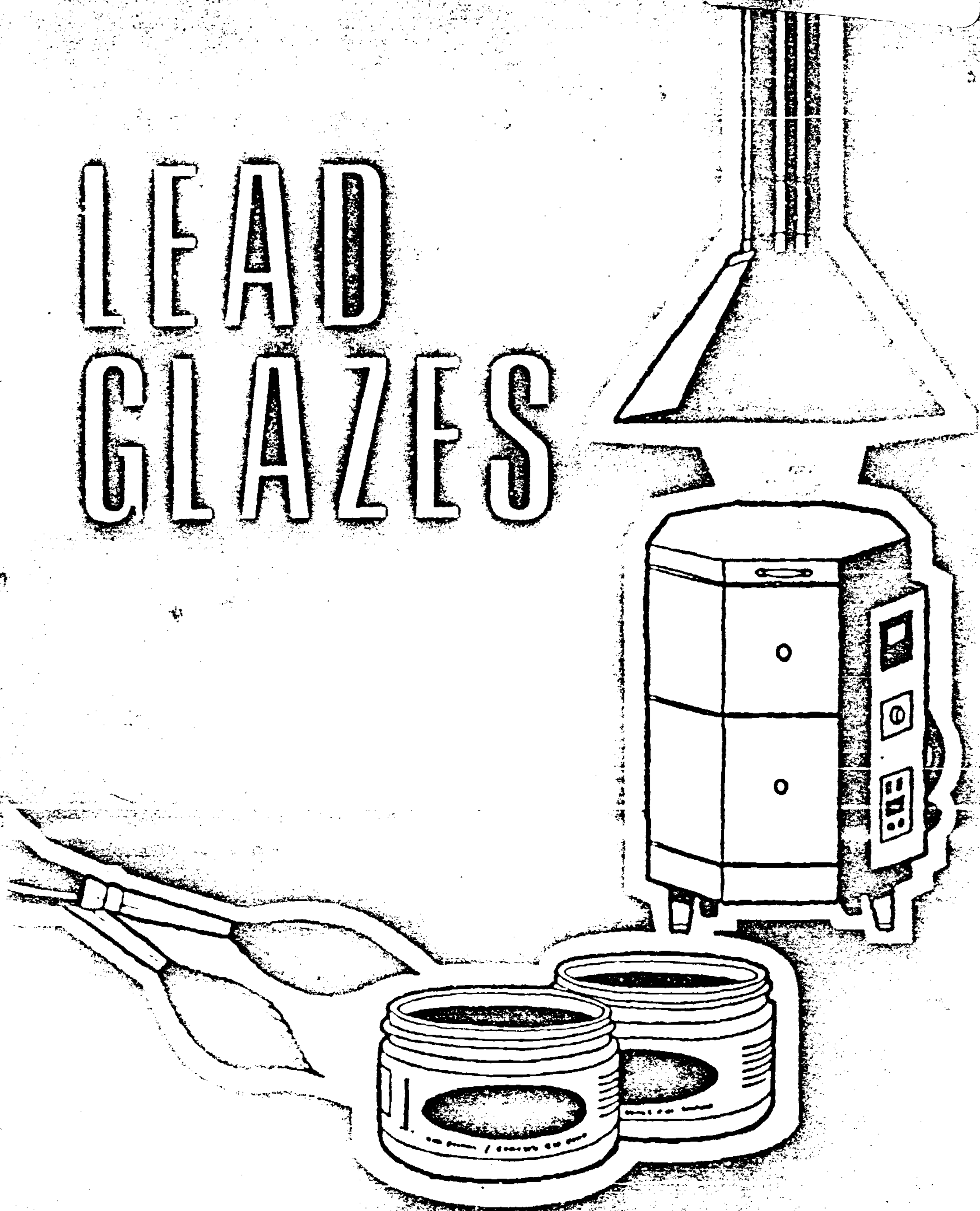
Very truly yours,

Jerome F. Smith

JFS:lm
Enclosure

Jerome F. Smith
Manager, Advertising & Technical Service

LEAD GLAZES



N 3445.01

SUMMARY

These recommendations and observations concern glazes intended for food contact surfaces:

1. Glazes consist of ingredients, often including lead, which melt together and become a glass at high temperatures.
2. Unless the glaze is properly formulated, handled, applied and fired, it can be dangerous both to the potter and to his customer.
3. No element, alone or in combination, imparts all of the desirable properties to a glaze that lead does.
4. Although ceramic materials are very durable, glazes are not completely insoluble. Acids will extract ingredients from the glaze—including lead, *if it is present*. The amount of lead that may be extracted from any given glaze varies with the *chemical composition*. Other factors which have a direct bearing on the lead solubility are:
   - *The ratio of ingredients*
   - *Thickness of glaze application*
   - *Time and temperature of firing*
   - *The condition of the kiln atmosphere*
5. It will be evident from the text that glazes for use on food contact surfaces should not be combined. Blending of different glazes will disturb the "balance of ingredients," and retesting would be necessary before use.
6. It is often implied that removal of lead will make the glaze nontoxic. However, lead-free glazes may contain other potentially toxic heavy metals; and testing should be done to determine solubility for these as well.
7. Copper should not be added, either as a stain or mill addition, to any lead glaze intended for food contact surfaces. Regardless of how it is added, copper will increase the lead release of the glaze.
8. Raw lead compounds *should not* be used to make glazes for food service utensils. Only *"low solubility"* frits should be used because they are much safer.
9. Glazes must be retested *if* any changes are made in formulation, handling, application or firing.
10. Persons formulating glazes for tableware should obtain *and read* the "ILZRO Manual, Lead Glazes for Dinnerware."
11. When ware is produced on a routine basis for food service, "screen testing" of production items should be done frequently.
12. Kilns should be operated under hoods vented to the atmosphere.
13. Scrupulously hygienic procedures should be observed in the ceramic workshop—no smoking, eating or drinking. Every care should be exercised to avoid any possible transfer of toxic materials from hands and clothing to the mouth.

FOREWORD

The activities of the non-professional engaged in the production of glazed ceramic ware can be separated into one of two broad categories: (1) Art Pottery and. (2) Hobby Pottery. The art potter will be considered here as one who creates his own ware for profit or pleasure, and who most frequently compounds his own glazes. He usually does his own firing as well. In preparing glazes, the art potter can proceed in one of two ways: purchase frits to make his glaze; or start with the various compounds in powder form and combine them in the proper amounts. On the other hand, the hobbyist is one who does not mix glazes, but purchases them packaged or readymade for application to ware. Nearly all of these packaged glazes are already fritted. Frequently, the hobbyist may not even do his own firing, but rather, may return his ware to a hobby or art center to have it fired.

Because this booklet deals with two groups whose knowledge of the subject at hand may be widely divergent, some of the information is elementary. Much of the material here is based on substantial research jointly sponsored by the International Lead Zinc Research Organization, Inc., and the United States Potters Association.[1] Some details covered are of vital importance which cannot be overemphasized.

We have outlined the safe means for the non-professional to handle and apply lead containing glazes. The objective is to provide information which will assist the art potter and hobbyist in producing a safe finished product—*particularly as relates to glazed ceramic items intended for food and beverage use.* There is, as well, background information on some of the materials with which he is working.

Jerome F. Smith
Manager, Technical Service
LEAD INDUSTRIES ASSOCIATION, INC.
July, 1971

1

THE CERAMIC GLAZE

IS IT A PAINT? Let's begin by dispelling one popular misconception: A ceramic glaze is not a paint. Once the glaze has been applied and fused into a glassy coating, it is much more chemically resistant and has far greater heat and light stability than any paint could have.

Perhaps some confusion results because the glaze is usually applied—prior to fusion—by dipping, spraying or brushing, much as a paint. But the similarity ends there. No normal paint could withstand the extremely high firing temperature necessary to fuse the glaze into a glass.

WHAT IS IT? A ceramic glaze is a thin glassy coating, generally containing silica, which is applied and fused onto a clayware body. After fusion, or firing in the potter's kiln, the glaze closely resembles a pane of glass. It is continuous, impervious and almost completely insoluble when properly formulated, applied and fired.

OF WHAT IS IT COMPOSED? A ceramic glaze might be viewed, in a simple analogy, as a group of minerals or rock components which have been fused in a high temperature kiln—much the same as Nature produces molten lava in an erupting volcano and sometimes coats the earth with its glassy substance. A major difference, though, between volcanic lava and man-made glazes is that, with the latter, a flux is generally used. A flux is a material that, at high temperatures, reacts with and helps dissolve all of the glaze components to form a glass. Lead oxide is a good example of a flux. It is an active solvent. In addition to its fluxing action, lead also lowers the glazing temperature.[1]

Besides lead and silica, glazes often are formulated with varying amounts of other elements. Any of the following elements might be found in an art or hobby glaze formulation: antimony, barium, boron, cadmium, calcium, cobalt, copper, fluorine, lithium, manganese, sodium, potassium, strontium, uranium, zinc and zirconium. It is evident from the foregoing list that glaze chemistry can be extremely complex. It is further complicated by the fact that we are dealing with reactions (both within the glaze, and between the glaze and body) that occur at extremely high temperatures.

IS THE GLAZE SOLUBLE? Historians, geologists, and other students of the past have established that nothing in the world is permanent. And even though ceramic materials are among the most permanent, durability can only be judged by comparing one object against another. Thus one glaze coating may change or dissolve less quickly than another, but *neither is totally insoluble*. This is important to keep in mind when considering the question of glaze solubility.

HOW IS GLAZE SOLUBILITY MEASURED? It has become standard practice in the U.S. dinnerware industry to measure the solubility of a fired glaze by determining its *acid resistance*. More specifically, what is determined is the ability of a given concentration of acid to extract glaze ingredients from a sample under rigid test conditions. It is possible, using these tests, to determine the amount of lead, cadmium, copper, barium, or other potentially toxic heavy metals that leach from a glaze.

If the glaze has been properly formulated, applied and fired, the quantity of any of these is very small. For lead, it is less than seven parts per million parts of solution —an amount scarcely measurable with accuracy less than 10 years ago. Normally, these extraction tests use an organic acid similar to vinegar.

The best current test is that developed by the United States Food and Drug Administration, Division of Compliance Programs, Bureau of Foods. This method was originally published as *FDA Laboratory Information Bulletin No. 834*, and is produced in the Appendix.

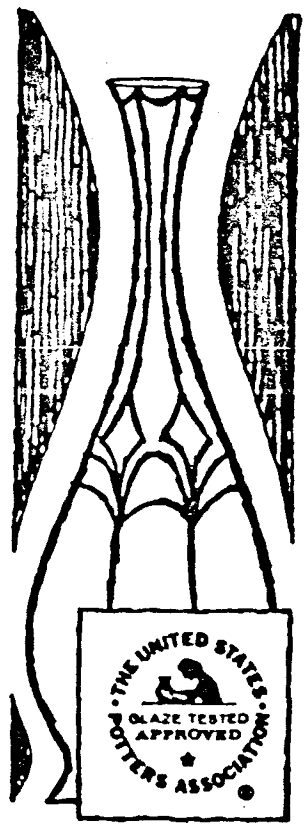
The FDA test is used to verify and enforce product safety, and has gained universal application in the U.S. It has replaced the older ASTM test. *All* glazed ceramic food service utensils manufactured in the U.S. must meet the FDA lead release guideline of less than *7 micrograms of lead per milliliter of leaching solution* when analyzed by the FDA method.

WHY USE LEAD IN GLAZES? Lead oxide, chemically PbO, is a valuable component of many glasses and glazes. Because of its essential usefulness, it has received wide attention from ceramic researchers since the 18th century. For example, over three hundred separate articles on this subject are referenced in one publication.[1]

Some of the more important characteristics of glazes, derived from their lead oxide content, include:

1. *Low Melting Range.* Lead oxide is one of the classic glass network modifiers. Its strong fluxing action permits the formulation of durable (highly acid resistant) glazes that mature at relatively lower temperatures than their leadless counterparts.
2. *Wide Softening Range.* Lead oxide increases glaze fluidity (reduces its viscosity) during firing, and in addition, extends this property over a wider firing range. Because of the greater margin of safety imparted by lead under variable firing conditions, leaded glazes are more foolproof.
3. *Low Surface Tension.* Low surface tension is the property which contributes to the ability of lead glazes to heal over blisters, drying cracks, and other defects. Coupled with the wide softening range of lead glazes, it accounts for their superior maturing qualities.
4. *High Index of Refraction.* Brilliant glaze surfaces are attained, due to the high index of refraction imparted by PbO.
5. *Resistance to Devitrification.* The presence of PbO in the glaze reduces tendencies towards undesirable surface crystallization, or devitrification, of the glaze.
6. *Color Compatibility.* Lead is beneficial to most coloring oxides used in art glazes.

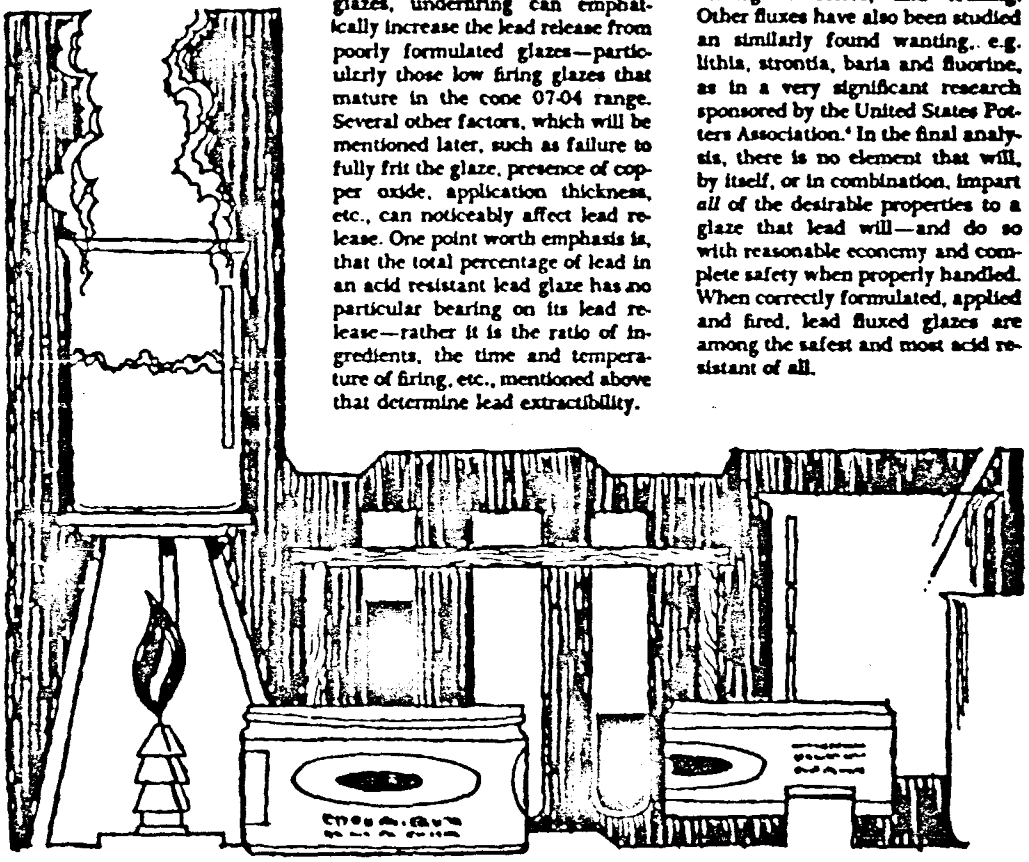
WHAT IS LEAD RELEASE? As was pointed out earlier, all glazes are at least slightly soluble in acid. However, research by the International Lead Zinc Research Organization and the U.S. Potters Association has shown that certain processing variables within the formulation, application and firing operations have major influence on the resultant acid resistance, and in the absence of proper control, can



greatly increase the solubility (extractability) of lead and other heavy metals from the glaze. It is these high solubility glazes that are cause for concern.

CAN LEAD RELEASE BE A PROBLEM? Yes. Certain poorly designed glazes—known to be low in acid resistance, even when properly fired—should not be used on pottery intended for food and beverage service. Large amounts of lead or other toxic substances could be ingested by the user. The same problem could develop if a glaze were underfired. While much less of a problem for well designed glazes, underfiring can emphatically increase the lead release from poorly formulated glazes—particularly those low firing glazes that mature in the cone 07-04 range. Several other factors, which will be mentioned later, such as failure to fully frit the glaze, presence of copper oxide, application thickness, etc., can noticeably affect lead release. One point worth emphasis is, that the total percentage of lead in an acid resistant lead glaze has no particular bearing on its lead release—rather it is the ratio of ingredients, the time and temperature of firing, etc., mentioned above that determine lead extractibility.

WHY NOT USE A SUBSTITUTE FOR LEAD? There have been many and extensive investigations during the past fifty years aimed at developing a satisfactory substitute for lead in glazes for the dinnerware industry. Many leadless glaze formulas have been developed by making substantial increases in the quantities of alkali and boron oxides in the glaze batch. These better reproduce the low fusion properties found in leaded glazes than the remaining standard glaze ingredients, but at the same time fall far short with respect to solubility and toxicity, as well as affecting underglaze colors, and crazing. Other fluxes have also been studied an similarly found wanting.. e.g. lithia, strontia, baria and fluorine, as in a very significant research sponsored by the United States Potters Association.[4] In the final analysis, there is no element that will, by itself, or in combination, impart *all* of the desirable properties to a glaze that lead will—and do so with reasonable econcmy and complete safety when properly handled. When correctly formulated, applied and fired, lead fluxed glazes are among the safest and most acid resistant of all.



2

CONTROL OF LEAD RELEASE

HOW CAN LEAD RELEASE FROM FOOD CONTACT SURFACES BE CONTROLLED? "Control" of lead release is essential if the hobbyist's or art potter's end product is to present no danger to the public.

It can be achieved by following one or more of these procedures:

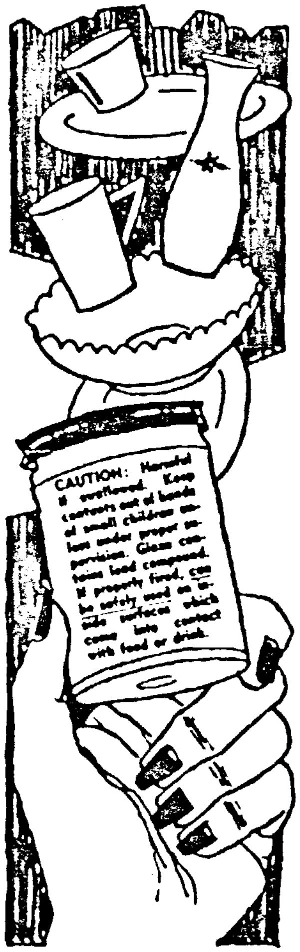
1. Design and fire purely decorative pieces *only*.
2. Use *only* highly acid resistant lead glazes for food and beverage contact surfaces, and fire properly.
3. Use *leadless glazes* for food and beverage surfaces.

While all these solutions are practical, the first (1) is by far the most easily achieved. In this case, if the art potter is concerned about the safety of his products, or if he is at all uncertain of his ability to control their end use, then he should make any such items useless for foods and beverages by the simple expedient of drilling one or more holes up the sides or in their bottoms. Pitchers, mugs, vases, or other potential beverage containers can thus be rendered unfit for use. No one will drink or pour out of a "dribbler." Another technique for averting unintentional food use is to fire a warning label into the glaze. Such a label as "This container is not safe for foodstuffs," should suffice. For teachers and instructors in art pottery, the procedures mentioned above should be stressed at the beginning and repeated throughout any course in art pottery. In this context, it is also highly desirable that beginning students be discouraged altogether from designing and firing cups, mugs or other food and beverage utensils.

The second method (2) for controlling lead release—i.e., the use of proper glazes and proper firing—is much more complicated. While we do not yet have all the answers, some of the potential difficulties are discussed and their solutions indicated in the following section. Particulalry as regards low-fire (hobby-type, cone 07-02) glazes, there is still much to be learned on the subject of glaze solubility and proper firing.

Much of the more definitive glaze research work done up to now has addressed itself mainly to the higher fired (cones 4 & 5) dinnerware glazes. Even though a number of important factors involving hobby-type glazes were investigated, it has become apparent that the low fire glazes present additional risks with respect to lead release unless particular care and judgment are exercised in their use. Research is now in progress that is expected to shed more light on the low temperature glazes.

Regarding procedure (3), suggesting that leadless glazes be used for food and beverage utensils, much of the fine stoneware manufactured by art craft studios today either is not glazed, or is glazed with a leadless mix—including even those based on salt. Stoneware is fired at a higher temperature, usually above cone 6. Art potters and hobbyists who would employ this technique to avoid use of lead should therefore be certain the temperatures required are not beyond the firing capabilities of their kilns. As for low temperature leadless



glazes, it is still not known whether these are safe for food contact surfaces. Much additional development work will have to be done before it can be stated with assurance that the heavy metal solubility of such glazes will provide an adequate degree of safety for either the art potter or the consumer.

WHAT PROCESSING VARIABLES INFLUENCE LEAD RELEASE? There are several variables in low temperature art or hobby glazing whereby a problem on food vessels can occur. First, since the *firing temperature* (heat energy input) is lower than for the high firing glazes, the constituents of low temperature glazes are not as likely to fully react with one another and with the body—sometimes with the result that a good, acid resistant glaze is not formed.

For the hobbyist, the solution to this problem is, on food surfaces, to use only glazes that give a low lead release. Such glazes should release LESS THAN seven parts per million when tested by the FDA test. The hobbyist should carefully check the label on each packaged glaze container and follow all instructions to the letter.

NO GLAZE SHOULD EVER BE USED BY THE HOBBYIST FOR FOOD CONTACT SURFACES UNLESS THE MANUFACTURER'S LABEL STATES THAT THE GLAZE IS APPROVED FOR SUCH USE WHEN FIRED ACCORDING TO THE INSTRUCTIONS.*

More will be said later concerning the art potter who makes his own glaze.

* A list of hobby glaze suppliers who are members of the United States Potters Association "Ceramic Dinnerware Surveillance Program" appears in the Appendix. All of these suppliers have tested and labeled their glazes.

Regarding other variables that can increase the lead release from a low temperature glaze, copper oxide (CuO) is most to be avoided. Whether the addition is made directly or as a stain component is of no consequence; *under no condition should copper oxide be added to a lead glaze intended for food surfaces.* Regardless of the care used in processing and firing, research has shown that the addition of copper to a lead glaze will produce an uncontrollable—and therefore potentially hazardous—increase in the lead release.

Firing time is another factor that affects lead release. This is especially important where low temperature or art-type glazes are being used. Such glazes customarily call for less heat input than the commercial dinnerware glaze. It is very important for the hobbyist and art potter to always use pyrometric cones—never to fire by time alone.

TABLE I

STANDARD PYROMETRIC CONES

Cone Number	Temperature Equivalents*	
07	1803°F	984°C
06	1830	999
05	1915	1046
04	1940	1060
03	2014	1101
02	2048	1120

* The temperature equivalents apply only to Large (2½") Orton Pyrometric Cones ® when heated at the rate of 270°F ([illegible]°C) per hour in an air atmosphere.

The proper use of cones will insure that correct time and temperature of firing has been achieved.

Another processing step that assumes added importance in low fire glazing is *thickness of glaze application.* Marquis[4] has shown that a thin glaze can, during firing, react with and dissolve body constituents. This is desirable because invariably these new ingredients migrate throughout the glaze network, strengthen it, and make the glaze more acid resistant. Conversely, with a heavier application (above 3 mils), these dissolved body constituents may not penetrate the entire glaze, and—if the glaze is not of an inherently acid resistant type—body dissolution will not then provide the needed materials to develop low lead release.

The point is then, that while certain marginal glazes (with respect to lead release) may have been used on food service utensils in the past, this practice is risky and should not be continued. Certainly, as Marquis observed: "... (these) glazes should not be used for dinnerware or food containers unless the relevant product parameters are controlled." *Frequent testing for lead release is mandatory with such glazes.* To put it another way, it is far more practical and reliable to BEGIN with a highly acid resistant lead glaze or frit composition in order to insure the safety of the fired glaze.

WHAT ABOUT THE POTTER WHO MAKES HIS OWN GLAZE?

A good deal of the art or studio potter's success in firing acid resistant lead glazes will depend upon his kiln and his willingness to avoid heretofore popular, "cookbook" formulations—at least for food and beverage surfaces.

Over the years, literally thousands of glaze formulations have been offered in publications aimed at the studio potter. *If these were used on food utensils, few would pass current FDA limits for lead, cadmium, or other heavy metal release.* What then, should be done? We are printing herewith the empirical and weight percent formulas of several cone 06 glazes which have been developed and tested, and which *consistently* gave a lead release of less than 7 parts per million (ppm)—even when fired in a static atmosphere electric kiln. If any other glazes are to be used, they must be tested before they can be considered safe for food and beverage applications.

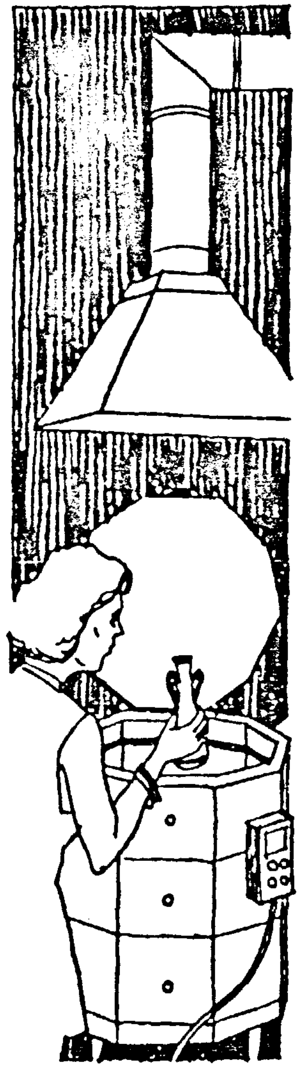


TABLE II

CONE 06 ACID RESISTANT GLAZES

(Glazes made from 90% Frit and 10% Kaolin)

Empirical Formula of Glaze

	Na_2O	CaO	SrO	PbO	Al_2O_3	B_2O_3	SiO_2	ZrO_2
1	0.05	0.06	—	0.89	0.27	0.15	2.58	0.01
2	0.10	0.14	—	0.76	0.27	0.32	2.69	0.02
3	0.05	0.07	0.22	0.72	0.27	0.24	2.68	0.01
4	0.16	0.21	—	0.63	0.28	0.49	2.80	0.03
5	0.10	0.13	0.14	0.62	0.27	0.36	2.65	0.02
6	0.16	0.20	0.08	0.56	0.27	0.51	2.78	0.03

Weight Per Cent Formula of Glaze

	Na_2O	CaO	SrO	PbO	Al_2O_3	B_2O_3	SiO_2	ZrO_2
1	0.78	0.93	—	49.53	6.96	2.71	38.83	0.25
2	1.61	1.92	—	42.69	7.03	5.55	40.67	0.52
3	0.81	0.96	5.78	40.51	7.11	4.22	40.34	0.26
4	2.49	2.94	—	35.71	7.11	8.54	42.61	0.80
5	1.64	1.96	3.89	36.47	7.13	6.63	41.74	0.53
6	2.51	2.97	1.97	32.31	7.14	9.12	43.17	0.81

Note: While all of these glazes are clear, numbers 1, 2, and 3 develop a slight yellowish cast. Formulations 4, 5 and 6 are clear and colorless.

If the potter is using a smaller electric kiln to fire food service vessels, great care should be exercised, especially with glazes other than those listed above, to assure that sufficient ventilation exists at all times within the kiln. This will help to prevent redeposition of volatilized lead on the surface of the ware. Recent findings have indicated that a distinct "skin effect" or surface layer of lead can occur on ware fired in small "static atmosphere" kilns. Such deposits cannot chemically recombine with the glaze, and great variation in the lead release will frequently occur under these conditions. This is true even if it has been shown that the glaze would otherwise show lead release of less than 7 ppm when fired in a well ventilated kiln. (These are the "marginal" glazes referred to earlier.)

3

THE FRITTED GLAZE

Nearly 35 years ago, J. H. Koenig,[8] pointed out that the introduction of lead to a dinnerware glaze in the form of a properly constituted, acid resistant frit provided, ". . . a vast improvement in the reduction of the industrial hazard, as all industrial toxicologists agreed." Now, talking about consumer hazard it has become even more obvious, indeed imperative, *that the lead compounds in glazes used for food surfaces must be rendered insoluble*. Lead compounds can best be made insoluble through fritting, which is the core of this statement.

WHAT ARE FRITS? Frits are glaze components which have been fused or melted in a separate furnace before incorporation in the glaze. Either the entire glaze or various components may be fritted. These pre-treated glass particles are then reduced to powder form and applied to the pottery for firing.

One of the primary objectives in pre-melting (fritting) glaze materials *is to make them less soluble*—both before application and after firing. In addition, properly designed lead frits and fritted glazes eliminate—or greatly minimize—lead volatility under glost kiln conditions.

A note of caution, however. *More frits are soluble than is commonly understood.* Many commercial frits now supplied and used for glaze formulation are very soluble, and could not resist even dilute acid attack (for instance, in stomach acids). Merely melting the glaze components to form a frit does not insure that it has been rendered insoluble. Just as with the fired glaze, the acid resistance of a frit is closely related to its chemical composition. This complicates the problem facing the art potter who wishes to make a "safe" glaze. Unless he is extremely lucky—or unless he uses a fritted glaze known to be acid resistant, his product can become a hazard to an unsuspecting consumer.

Three lead frit formulations shown by Marquis[9] to be highly acid resistant are listed below in Table III. Even these frits can be used to formulate an unsafe or highly soluble glaze unless the art potter *carefully avoids* overloading the glaze with additional raw lead, or borax or even copper stains. More on this subject may be found in the publication "Lead Glazes for Dinnerware,"[7] available through Lead Industries Association, Inc.

TABLE III

Low Solubility Lead Frits
Molecular Formula

	PbO	Alumina	Silica
1.	1.0	0.03	1.94
2.	1.0	0.11	2.16
3.	1.0	0.25	1.92

Note: These are broadly available commercially.

Raw Lead Glazes. Instead of making a glaze from lead containing frits, it is quite possible to begin with "raw lead" compounds. When properly formulated, such "raw lead" glazes will fire out to have excellent acid resistance. It should be emphasized that glazes made from such "raw lead" compounds unless perfectly balanced, can be extremely dangerous if applied to food service vessels. Some people feel that the use of "raw lead" results in a better glaze finish. This is not the case. A fully fritted glaze will produce a finish every bit as good as if "raw lead" had been used. And the equivalent fritted glaze will mature at a lower temperature as well. Additionally, "raw lead" glazes are a hazard to the art potter himself. The use of fritted glazes is the best practice by which the art potter can be assured of low lead release from his product and safety for himself.

4

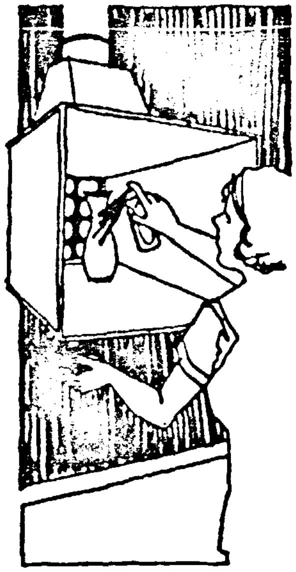
HEALTH AND SAFETY

THE IMPORTANCE OF GOOD HOUSEKEEPING. This section should probably have come first instead of last. In any event, the necessity for good housekeeping cannot be over emphasized.

Every type of lead product can be safely handled—if it is handled with suitable care and the proper equipment as in industry. The same long-established hygienic control procedures apply to lead as to silica, barium, beryllium, cadmium, etc. *Dust of any kind in the ceramic workshop is likely to be a health hazard.* All operations which disperse dust and fumes should be controlled by forced exhaust ventilation.

Fortunately, hobby glazes come packaged in containers of various sizes and no particular handling problem with regard to dust is likely to occur. For the art potter, however, care in mixing and grinding should be exercised to avoid spills. In addition, when mixing batches of dry materials, respiratory protective equipment should be used—and only respirators approved by the U.S. Bureau of Mines[8] for toxic dusts. Any other type will most likely be ineffective.

"Raw lead" compounds *should not be used by the art potter for application to food and beverage containers.* However, if such materials are being used in the glazing of non-food ware, all spills should be immediately damp sponged, and if any dust should appear, it should be vacuumed thoroughly. Shelves



and flat surfaces should be mopped regularly and meticulously.

Spraying of glazes should be done only in a well ventilated booth, exhausted to the out-of-doors—and not in the vicinity of children. On the subject of children, all glaze materials should be stored *only* in locked cabinets *out of their reach*. Young children should *never* be permitted to play in the ceramic workshop area. Young learners should always be supervised by a responsible person to avoid burns, spills and other undesirable accidents. Little children have even been known to drink the contents of open bottles and jars in the workshop.

As we noted earlier, during glaze firing, lead will volatilize from the glaze and permeate the atmosphere within the kiln. Depending upon the size of the kiln, and the quantity of ware being fired, the atmosphere around the kiln (assuming the kiln is properly ventilated) can constitute a very real health hazard. It therefore follows that the kiln *should not* be located in the kitchen, den, children's playroom or any other area where children or adults may unwittingly be exposed to lead fumes. In addition, the kiln should be fitted with a hood exhausting to the outdoors. This is especially true for schools and craft clubs where whole batteries of kilns may be in operation simultaneously.

Personal hygiene is an elemental part of safe hobby glazing. All crafters must be scrupulous about washing hands, and take extreme care to avoid transferring lead from the hands to the mouth—THIS MEANS NO EATING, DRINKING OR SMOKING IN THE CERAMIC WORKSHOP AREA. If gloves are not worn when glazes are being dipped or poured, fingernails and hands must be thoroughly scrubbed (use fingernail brush) upon finishing. A protective change of clothing, or a long smock should be worn in the workshop and never worn elsewhere in the home, especially where toddlers may come in contact with the clothing.

In summary, observance of all the foregoing precautions will permit the hobbyist or art potter the broadest possible enjoyment of his pursuit while at the same time providing safety for himself, his family and those who use his products.

APPENDIX

FDA-LIB 834

METHOD FOR DETERMINATION OF LEAD EXTRACTED FROM GLAZED POTTERY

Apparatus and Reagents

(a) **Atomic absorption spectrometer**—Perkin-Elmer Model 303 or equivalent, with the following operating conditions: wavelength 218 mm; slit 4; lead hollow cathode lamp; air acetylene burner (0.5 x 110 mm slit) with supply of air at 60 psi (flow meter 9.0) and acetylene at 10 psi (flow meter 9.0) for an aspiration rate of 0.8 ml/minute.

(b) **Standard solution**—Dissolve any soluble lead salt in 4% acetic acid to a lead concentration of 1 mg/ml. Dilute this standard stock solution with 4% acetic acid to obtain working standards with final concentrations of 10, 20, 30 and 40 ug of lead per ml.

Preparation of Sample (Leaching) Solution
(Individually analyze 6 units of each sample.)

Prior to analysis wash all vessels with household detergent, followed by a thorough rinse with distilled water. Discard the water and dry the unit; then fill each unit with 4% acetic acid so that the acid comes within ¼" of overflowing the container. Measure the volume of acid, by difference, as the units are being filled (use graduates or burets calibrated "to deliver"). Cover each unit with a watch glass or other suitable cover, being sure not to allow the cover to come in contact with the acid. Let stand at room temperature for 24 hours.

Determination

Stir sample (leaching) solution and determine absorbence by atomic absorption spectrometry, diluting if required with 4% acetic acid. Determine the absorbence of the standard solutions in a similar fashion. Prepare a standard curve of absorbence versus concentration. Determine the amount of lead from the standard curve. Calculate results as ug of lead/ml of leaching solution.

A sample is considered violative if the average of the six units examined contains 7.0 ug lead/ml of leaching solution or more.

REFERENCES

1. Anon., *"Lead Glazes for Dinnerware, ILZRO Manual, Ceramics #1,"* New York, International Lead Zinc Research Organization, Inc., 1970.

2. Ceramic Technical Committee, "Lead in the Ceramic Industries," New York, Lead Industries Association, Inc., 1956, Section 8.

3. C. F. Leiser, "Importance of Lead in Glass," *Glass Industry*, 44 (9) 509-14; (10) 574-76, 594; (11) 630-32 (1963).

4. Orlowski, H. J., and Marquis, J., "Lead Replacements in Dinnerware Glazes," *Journal of the American Ceramic Society*, 28, (12) 343-57 (1945).

5. Marquis, J. E., "Lead in Glazes—Benefits and Safety Precautions," *Proceedings, 1970 Fall Meeting, Materials and Equipment and White Wares Divisions, American Ceramic Society*, Columbus, Ohio, American Ceramic Society (1971).

6. Koenig, J. H., "Lead Frits and Fritted Glazes," *Ohio State University Studies Engineering Series*, Vol. VI, No. 2, Engineering Experiment Station Bulletin No. 95, July, 1937.

7. Marquis, J. E., Op. Cit.

8. U.S. Bureau of Mines, Information Circular 8436, *Respiratory Protective Devices Approved By the Bureau of Mines as Of December 31, 1968*: a revision of Information Circular 8281, Washington, D.C., by R. H. Schutz and E. J. Kloos, U.S. Bureau of Mines, Dept. of the Interior, (1969).

ON-GLAZE DECORATIONS

The U.S. Food and Drug Administration has recently reported that on-glaze decals can be a source for leachable lead and cadmium if the decal is not properly formulated, applied and fired. This same warning should apply to low temperature decorations for glass (glass enamels) as well.

TESTING LABORATORIES

As of July 10, 1971, four laboratories in the U.S. were approved by the United States Potters Association for the performance of lead extraction tests on glazed pottery. They were:

Pittsburgh Testing Laboratory
850 Poplar Street
Pittsburgh, Pennsylvania 15220

The Twining Laboratories, Inc.
P.O. Box 1472
Fresno, California 93716

Bio-Technics Labs, Inc.
1133 Crenshaw Blvd.
Los Angeles, California 90019

Coors Spectro-Chemical Laboratory
P.O. Box 5865
Denver, Colorado 80217

Hobby glaze suppliers who were members of the U.S.P.A. "Ceramic Dinnerware Surveillance Program" as of July, 1971:

1. American Art Clay Co., Indianapolis, Indiana
2. American Beauty Ceramics, Willoughby, Ohio
3. Ceramichrome, Inc., Gardena, California
4. Ducan Ceramic Products, Inc., Fresno, California
5. Gare, Inc., Haverhill, Massachusetts
6. Pemberton-Neal Ceramic Supplies, Bellflower, California
7. Reward Ceramic Color Mfrs., Inc., Glen Burnie, Maryland