Pint and Eng / Pack. Bound

LEAD INDUSTRIES ASSOCIATION

292 MADISON AVENUE
NEW YORK 17, N. Y.

December 8, 1960

SUBJECT: DESIGN ENGINEERING CATALOG

To Members of the Lead Industries Association:

We are attaching a reprint of our catalog which will appear in the 1961 edition of Sweet's Design Engineering File. Bound in the Sweet's File, it will be placed in the offices of more than 18,000 design engineers in all lines of industry. We hope that it will bring to their attention many properties of lead with which they may not be familiar which would help in their design problems.

We are also circulating the reprint to our own mailing list of about 1,000 design engineers with most of whom we have had personal contact either at our exhibits at Design Engineering Shows or through correspondence.

Additional copies are available in quantities up to 25 free of charge, and in larger quantities at 10 cents per copy.

Very truly yours,

[signature]

Secretary

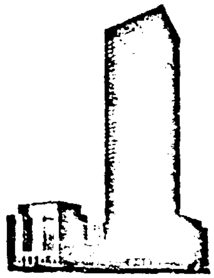
RLZ:JRH

Att.

LIA24422

look ahead with **LEAD**

a material for modern design



This 54-story New York skyscraper rests on lead-asbestos antivibration pads

Nearly 700 lbs. of loaded plastic sound insulation quiets cabin space in modern jetliners

Lead shielding safely confines gamma rays on naval and merchant ships

Lead telluride thermo-electric generators power advanced satellites

As new as tomorrow, lead provides the solution to the problems of modern design . . . It serves the needs of advancing technology in thousands of ways

LEAD INDUSTRIES ASSOCIATION
[illegible]

N 1700.01

LIA24423

LEAD as a design material

Lead is more readily and inexpensively fabricated into a greater variety of useful forms than almost any other common metal. These readily available forms, combined with lead's interesting variety of properties — high density, low melting point, corrosion resistance, malleability, lubricity, unusual electrical properties, and ability to form useful alloys and chemical compounds — provide a unique material for the solution of a wide range of design problems.

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look ahead with LEAD

... a material for modern design

LEAD

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design factors favoring LEAD

corrosion resistance

... Lead is a permanent metal under varying conditions of weather, exposure to most types of soil, marine and industrial environments, and action of corrosive chemicals.

radiation resistance

... The most impervious of all common metals to X-ray and gamma radiation, lead is the accepted standards of reference. It occupies minimum space and adds the least weight.

vibration control

... Massive without being stiff, lead is a poor conductor of vibration. Its ability to effectively block vibration makes it a popular material for use in mountings and heavy footings.

sound control

... In products ranging from home appliances to submarines, lead and leaded materials act to deaden ringing vibrations and isolate sound.

lubricity

... No other single metal matches the inherent slickness of lead and lead alloys under sliding loads. This feature is used to advantage in tiny bearings as well as under the massive supporting slabs of the Niagara Power Project conduits

solid state properties

... In the field of solid state physics, lead shows outstanding promise as a superconductor. Lead telluride is one of the few semi-metals used commercially in a thermoelectric power generator; lead zirconate-titanate is highly efficient in ceramic piezoelectric elements.

other unique properties

... The most dense common metal
... Low melting point
... Easily fabricated
... Wide range of forms available
... Easily alloyed

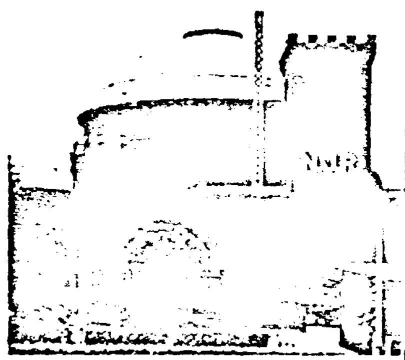
LIA24425

LEAD

for corrosion resistance

Made entirely from cast 8 percent antimonial lead, this seventeen-ton evaporator is used to concentrate corrosive boiling titanium sulphate solution.

This lead roofed dome at Rahway, N. J. has given 25 years of trouble free service. It has nearly three centuries to go to equal the lead domes at St. Sophia's in Istanbul, which appear to be in their original state, although installed in the middle of the seventeenth century.



Sulphuric acid has been manufactured in this lead-lined chamber for over 60 years. During this period only a few patches were necessary and average corrosion penetration was only 0.0078 in.

LIA24426

LEAD

for corrosion control

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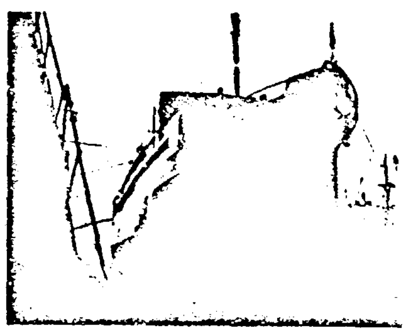
Expected to give years of service without paint, without attention, this automobile gas tank is made of terne plate—lead coated steel. No corrosion will take place inside, either, to clog fuel lines. Beyond corrosion protection, the lead coating makes drawing and forming of the tank easier by lubricating the dies, and insures leak proof seams because it is easy to solder.

This power station in Georgia relies on lead anodes to prevent corrosion in the sea water piping providing cooling at the condensers.

Drydocked for scraping and repainting—with red lead primer. Severe service conditions of marine exposure are among those which have proved red lead excellent when corrosive conditions are ramount.



This famous bridge across the San Francisco harbor, as well as hundreds of others throughout the country, depend on red lead primers to protect them from the ravages of corrosion.

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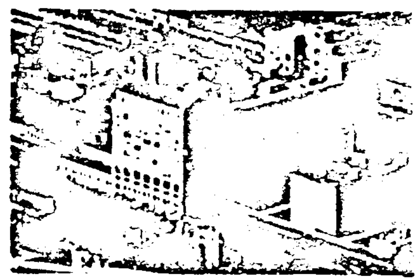
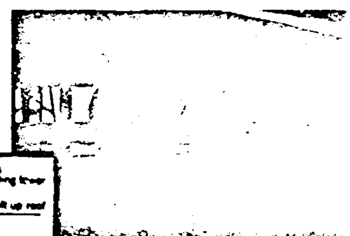
LEAD

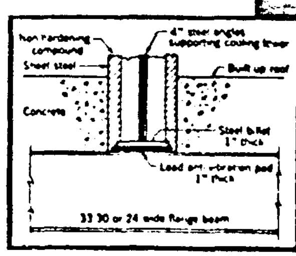
for vibration control

New York's 54-story Union Carbide Building rests on 115 lead-asbestos pads.

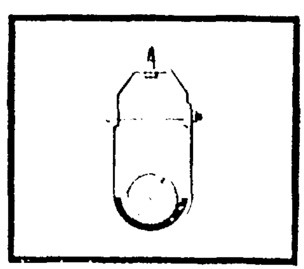


Look closely — a railroad runs through floors 2-3 of the face of the Bell Telephone Building in New York. Resting on lead-asbestos pads, the railroad structure does not transmit vibration into the building sufficiently to bar the use of the delicate instruments in the labs.





Between the steel structure of the tower and the steel roof beams of the building, small lead-asbestos pads soak up any vibration created by this rooftop cooling tower. Lasting indefinitely, the pads also helped cut costs by permitting the construction to go ahead as one job of steelwork. Conventional pads require completion of the building and roof, then erection of the tower separately.



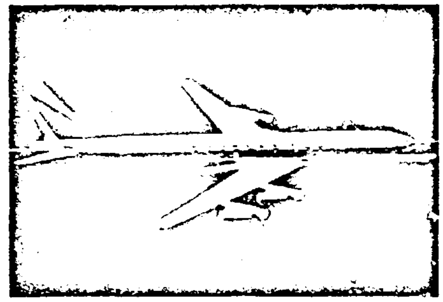
A simple design employs lead to confine the vibration of overhead pipe.

LEAD

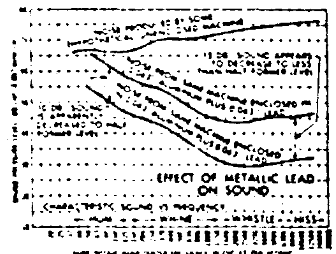
for sound and noise control

look ahead with LEAD

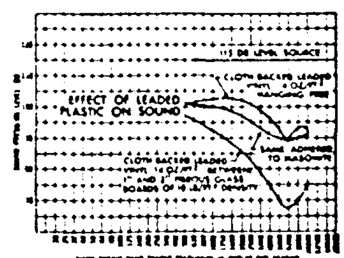
. . . a material for modern design



Modern airlines depend on leaded plastics—nearly 700 pounds per plane—to still the cabin from the roar of the jets.



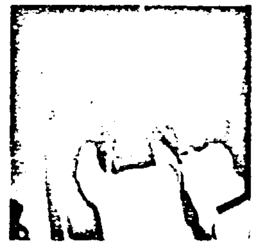
How lead can quiet a noisy machine. Top curve shows the noise intensity vs frequency for a hypothetical machine. Two lower curves show how much noise can be "contained" by an enclosure of 1/16-inch aluminum, and by the same enclosure to which has been added 1/16-inch sheet lead. For each 10 db the intensity is lowered, the machine sounds about half as noisy as before.



Leaded plastics produce the same effect. Here noise reduction from a white noise source is shown for free-hanging leaded vinyl, the same material adhered to masonite, and an acoustical partition material combining leaded plastic and glass fiber.

LEAD
for radiation shielding

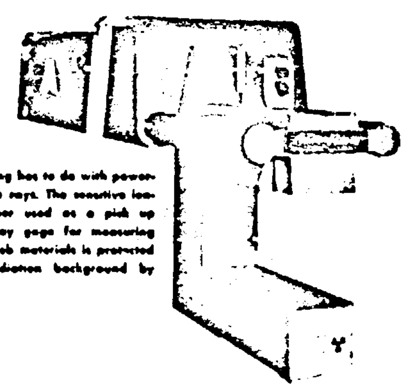
A huge, lead-shielded chamber for loading and unloading Southern California Edison's sodium reactor hovers over the core sunk deep beneath the ground.



Brookhaven technicians moving a three-ton lead shipping container carrying six cobalt-60 sources.

Light rays but not gamma rays will pass through this 42-inch thick lead glass window. This is the view technicians have as they remove a cobalt-60 source from its container.

This two million volt X-ray unit uses lead to collimate and direct the beam. Lead shielding, of course, is installed for the protection of the operator.



Not all shielding has to do with powerful, destructive rays. The sensitive ionization chamber used as a pick up in this beta-ray gage for measuring thickness of web materials is protected from any radiation background by lead.

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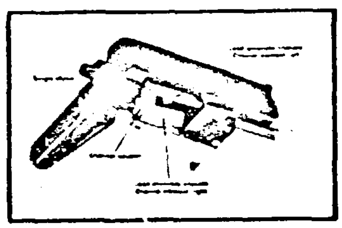
LEAD
for electrical energy sources

SNAP III—power for satellites in orbit—makes use of lead telluride in a 3-watt thermoelectric generator. Larger units are planned and will provide long-life sources for hundreds and thousands of watts of power.

Left-to-right: A cigaret, an electrically ignited cigaret lighter, and the two-volt lead-acid battery that allows a resistance wire to replace the flint. Despite its postage stamp size, the battery will produce three to six months of lights for a chain smoker.



Where just a whisper of power is needed so long as it faithfully reproduces the signal, lead zirconate titanate piezoelectric ceramics have advantages. This stereo phono cartridge employs them.

Powered electrically, this truck travels for a fuel cost of 3¢ per mile. (Comparable internal combustion trucks used 3.66¢ worth of fuel under the same conditions.) Maintenance and depreciation are lower, too. Lead acid batteries also power golf carts, radios, mine locomotives, submarines and lawn mowers.

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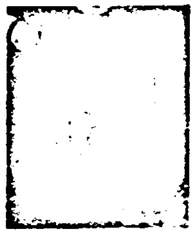
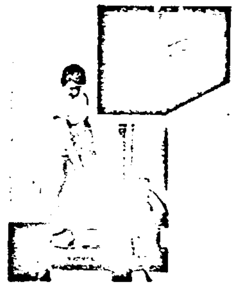
LEAD in other roles

soldering and joining



Lead-tin solder is the standard method of attaching handles to stainless steel cans.



Pumping a jet of molten solder up above the bath (arrow, left, and dore up), this automatic soldering machine can complete all the connections in a circuit board in a second or so.

Although solder is generally thought of as an alloy of lead and tin, there are many other solders in which lead is alloyed with one or more metals such as silver, bismuth, antimony, indium, etc. The composite melting point range, embraced by all of these alloys extends from 117 to 588°. Such solders are widely used, of course, in joining copper, for seams in tin cans, automobile radiators and other products. It is also practical to solder aluminum, copper-nickel, monel, nickel, stainless steel and zinc as well as most of the other common metals.

Solder is used to fill dents and repair damage to sheet metal and to join lead pipes and cable sheathing by wiping. Wide or narrow melting range alloys meet the special demands of each situation—for wide or narrow temperature ranges of plasticity. Recently the soldering of electronic circuits has become automatic with the advent of soldering machines which will solder dozens or hundreds of connections in a circuit in a matter of seconds.

ceramics

Lead glazes for insulator bodies meet tough military specs.

A powerful flux lead oxide has been lowering firing temperatures and promoting smooth, lustrous surfaces in ceramics for centuries. Despite this long recognition, ceramists are still making discoveries about lead's usefulness. In the past few years, for example, they have learned to produce economical fired-on coatings for thin gage aluminum. Thin and tough, this porcelain enamel coating can actually be sawed without serious spalling. The same development has made it possible to enamel cast aluminum and even magnesium. The familiar blackboard of the schoolroom is giving way to "greenboards" and "blueboards"; consisting of an extra low temperature porcelain enamel on steel. These same frits now, for the first time, make possible a porcelain finish on complicated shapes formerly finished only with paints. Glazed brick containing lead is a colorful material for contemporary buildings along New York's Fifth Avenue and the suburbs. Soon to be seen is a cousin of this material—lightweight building block, glazed on both sides to permit colorful and durable inner and outer walls with one block.

pearlescent pigments

Incorporated in the plastic of these combs and hairbrushes, pearlescent lead pigments produce a rich, sleek appearance. They can be used with a wide range of tints.

The "pearliness" of a pearl is due to a combination of lenticular crystal structure and double refraction. Until recently commercial pearl pigments were natural products. Today there are two simple lead compounds which, in addition to being laboratory controlled for reproducible "pearliness", are available in abundant and predictable supply at stable prices. Suitably tinted, these have been much in evidence in plastic and leather finish for shoes and accessories. They are being used for hard plastic tiles and moldings, as a custom finish for luxury automobiles, and for adding distinction to many products molded of plastic or given a protective paint coating.

lubricants

Long an ingredient of heavy duty greases, lead and its compounds are finding still wider use as lubricants today. In greases, the finely powdered lead helps retain the "body" of the grease at high temperatures and pressures. On pitted or scored bearing surfaces, lead particles smear out to fill surface irregularities and present a smooth, slick surface. For the same reason, babbitt and other lead alloy bearing metals have long been used in electric motors, as railroad bearings, and for other heavy duty service. The world's largest bearings are each four miles long. They are sheet lead strips under the conduit walls of the Niagara Power Project and serve to seal water in the conduit as well as to lubricate the joint, permitting it to slide with earth movements. Bearings designed never to see oil in Rolls Royce engines and in space satellites also make use of lead. The automotive type embodies lead powder in a Teflon coating and operates from -325 to 535°F. without any further lubrication. NASA's development of a "space bearing" made use of a coating of vitreous lead monoxide, good for temperatures up to 1250°F.

look ahead with LEAD

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properties of LEAD

general properties

Color	Bluish gray
Patina	On atmospheric exposure lead takes on a silvery gray patina except in industrial atmospheres where it changes to dark gray to black
Atomic number	82
Atomic arrangement	Cubic face-centered
Length of lattice edge	4.9389 A
Atomic weight	207.21

weight and density

density

Cast lead, 20°C	11.34g. per c.c.
Rolled, 20°C	11.35 to 11.37 g. per c.c.
Just solid, 327.4°C	11.005 g. per c.c.
Just liquid, 327.4°C	10.686 g. per c.c.
Density, vapor (Hydrogen 1), calculated	103.6

weight

Cast lead, 20°C., calculated	0.4092 lb. per cu. in.
equivalent to	707 lb. per cu. ft.
Rolled, 20°C. (density 11.37) calculated	0.4103 lb. per cu. in.
equivalent to	709 lb. per cu. ft.
Liquid, 327.4°C., calculated	0.3354 lb. per cu. in.
equivalent to	666 lb. per cu. ft.
Sheet lead, 1 ft. square by 1/64 in. thick	approximately 1 lb.
Volume of 1 lb. cast lead, 20°C., calculated	2.44 cu. in.

thermal properties

Melting point, common lead	327.4°C. (621°F.)
Melting point, chemical lead	325.6°C. (618°F.)
Elevation of melting point for each 150 atm. increase in pressure	1.2°C (2.16°F.)
Casting temperature	790 to 830°F.

boiling point at different pressures

Pressure, in atmospheres	0.14	0.35	1.0	6.3	11.7
Boiling point, °C.	1325	1410	1525	1873	2100
Boiling point, °F.	2417	2570	2777	3403	3812

vapor pressure

Temperature, °C.	808	1000	1200	1365	1525	1870	2100
Pressure, mm. Hg.	0.08	1.77	23.29	166.	760.	6.3 atm.	11.7 atm.

specific heat (cal. per g.)

Temp. °C	specific heat
−150	0.02805
−100	0.02880
−50	0.0298
0	0.0303
50	0.0309
100	0.0315
200	0.0325
300	0.0338
327.4 (solid)	0.0340
327.4 (liquid)	0.0333
378	0.0338
418	0.0335
459	0.0335

thermal conductivity (cal./cm.²/°C./sec.)

temp. °C.	
−247.1	0.117
−160	0.092
0	0.083
100	0.081
200	0.077
300	0.074
400	0.038
500	0.037
600	0.036

Latent heat of fusion	6.26 cal. per g. or 11.27 B.T.U. per lb.
To melt 1 lb. of lead heating from 20°C requires	7100 g. cal. or 28.2 B.T.U.
Latent heat of vaporization	202 cal. per g.
Relative thermal conductivity (silver 100)	8.2

coefficient of expansion

Linear (−190 to 19°C. mean)	0.0000265 per °C.
Linear (17 to 100°C. mean)	0.0000293 per °C. or 0.0000163 per °F.
Cubical (liquid at melting point to 357°C.)	0.000129 per °C.
Increase in volume from 20°C. to liquid at melting point	6.1%
Decrease in volume from liquid at melting point to 20°C. calculated	5.8%
Increase in volume on melting	4.01%
Decrease in volume on solidification	3.85%
Shrinkage on casting taken in practice as 7/64 to 5/16 in. per ft.	

low temperature properties

temperature °F.	tensile strength psi	elongation percent	Brinell	impact
cast lead				
room	3000	33	4.3	2.3
−300	6200	40	9.0	3.8
rolled lead				
59	3600	52		
−4	7200	40		
−40	13300	31		
−103	15200	24		

mechanical properties

Hardness, Moh's scale			1.5
Brinell no., 1 cm. ball, 30 sec., 100 kg. load			
Common lead			3.2 to 4.5
Chemical lead			4.5 to 6.0
Influence of temperature on Brinell hardness (chemical lead)			
Temperature °C	25	100	150
Hardness	5.3	3.6	2.6
Ultimate tensile strength			
Common lead			[illegible] to 1700 lb. per sq. in.
Chemical lead			2300 to [illegible] lb. per sq. in.

Effect of temperature on tensile properties (lead annealed at 100°C.)

Temperature		Tensile strength psi	Elongation percent	Reduction in area percent
°C	°F			
20	68	1920	31	100
82	180	1140	24	100
150	302	710	33	100
195	383	570	20	100
265	509	280	20	100

tensile strength and elongation

(laboratory rolled specimens, room temperature, pulling speed ¼ in. per min. per in. of test section)

grade of lead	tensile strength psi	elongation percent
common (99.85 + 0.13 Bi)	1931	34.4
corroding (99.99 + 0.006 Bi)	1904	37.7
common (99.98 + no Bi)	2093	43.0
chemical (99.92 + 0.06 Cu)	2961	42.2
chemical (commercial sheet)	2454	47.0
chemical (extruded)	2200	48.0

resistance to bending

(extruded strips under 200 lbs. per sq. in. stress subjected to alternate 90° reverse bends over 5-in. rolls, 11 cycles per min.)

grade of lead	cycles to failure	elongation percent
common	72	49
chemical	103	52
corroding	54	35

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properties of LEAD

creep (room temperature)

stress lb. per sq. in.	creep, percent per hour: common lead	creep, percent per hour: chemical or copper lead
200	5 x 10[illegible]	0.4 x 10[illegible]
300	3.5 x 10[illegible]	1.5 x 10[illegible]
400	11 x 10[illegible]	3 x 10[illegible]

fatigue

Fatigue limit (50,000,000 cycles extruded 215 lb. per sq. in.)

metal	endurance limit at 5 x 10[illegible] cycles, lb. per sq. in.	endurance limit at 10[illegible] cycles lb. per sq. in.
lead	215–400	470
lead + 0.026% calcium		1038
lead + 0.038% calcium	685–840	
lead + 0.04% calcium	820–1500	
lead + 0.041% calcium		1180
lead + 0.06% calcium	1120	
lead + 1% antimony	300–1000	
lead + 2% tin	800	
lead + 0.06% copper	600	725
lead + (0.045% tellurium / 0.06% copper)		1000

electrical properties

Specific electrical conductance	
at 0°C.	5.05 x 10^4 cm.$^{-1}$ ohms^{-1}
18°C.	4.83
melting point	1.06
Atomic electrical conductance, calculated	1.139 x 10[illegible]
Relative electrical conductance (copper 100)	7.82
Relative electrical resistance (copper 100)	1280
Magnetic susceptibility per g.	
18–330°C.	−0.12 x 10[illegible]
300–600°C.	−0.08 x 10[illegible]
Electrolytic solution pressure	
ions of Pb++	6.3 x 10[illegible] atm.
ions of Pb++++	3.0 x 10[illegible] atm.

the LEAD library

These publications contain data, drawings and specifications on the use of lead and lead products. They are free of charge to qualified design engineers. Please address your requests to LEAD INDUSTRIES ASSOCIATION, 292 MADISON AVE., NEW YORK 17, N.Y.

general

Materials of Construction Review

Lead and lead alloys in design and construction. Four separate reviews for the years 1956 through 1959 are available. With bibliography. Reprinted from "Industrial and Engineering Chemistry."

Lead in Modern Industry

(Please send request on company letterhead)

Fully illustrated 230-page hard bound book, describing all phases of lead production and uses. Comprehensive data section is included.

corrosion

Corrosion Data for Lead and its Alloys

Chart form presentation of corrosion resistance of lead and its alloys to 188 chemical materials at the temperature at which they are normally handled. Reprinted from "Chemical Engineering" February, 1953.

Lead Dome's Silver Anniversary

A review of 25 years of service and maintenance records of the lead dome of New Jersey State Penitentiary at Rahway, N. J. Construction method is also illustrated. Reprinted from "Heating and Air Conditioning Contractor".

Anodes for Ship Protection

Results of a detailed examination of lead-silver anodes for corrosion protection of ships. Operating efficiency and behavior are given and lead is compared with other anode materials. Reprinted from "Corrosion", November, 1959.

Seamless Terne for Roofing

Shows architectural use and specifications, but also contains descriptive and engineering data on terne plate.

Summary Specifications for Red Lead Paints

A summary of all foregoing L.I.A. recommendations and specifications for red lead anti-corrosive paints.

sound and vibration

Lead Asbestos Pads

Current practice in the use of anti-vibration pads for building footings is detailed in this four page bulletin. Drawings and specifications included.

Lead Sound Barriers

Twelve-page engineering report on basic design of sound barriers, cost considerations, and calculation methods for simple barriers.

Isolating Cooling Tower Vibration

Reprint shows how lead-asbestos pads were used to isolate a roof-top cooling tower from the steel structure of a modern office building. Drawing and loading data are given.

ceramics

Lead in the Ceramic Industries

Loose leaf binder, supplements issued periodically, of all of the principal uses of lead in ceramics together with basic data, performance studies and typical formulations.

Ultra Low Loss Ceramics

Technical discussion of new formulations for ultra low loss ceramics together with possible mechanisms of behavior.

electrical and power

Truck Cost Calculator

Twelve-page nomographic calculator for industrial trucks. Rapid estimation methods show capital expense, operating and maintenance costs separately. In addition, the bulletin contains basic information on the cost of power from lead-acid batteries and internal combustion engines.