LIA14769

Lead Industries Association, Inc.

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October 5, 1972

SUBJECT: REPRINT - "LEAD A MODERN MATERIAL"

TO THE MEMBERS OF THE LEAD INDUSTRIES ASSOCIATION, INC.

Enclosed is the latest edition of our publication "LEAD A MODERN MATERIAL". Written for design engineers and upper level engineering and materials students, it describes the multitude of applications of the metal and its numerous forms. Commonly referred to physical properties are also listed.

If you would like to have additional copies of this booklet for distribution to your staff or customers, please do not hesitate to contact us.

Very truly yours,

LEAD INDUSTRIES ASSOCIATION, INC.

R. Assadi

R. Assadi
Manager Publications

RA:cm
Encl.

LEAD

SHOT

ALLOYS

SHEET AND FOIL

CASTINGS

MIXTURES

POWDER

WOOL

EXTRUSIONS

COMPOUNDS

BONDED SHEATH

LAMINATIONS

LIA14771

LEAD

■ LEAD OFFERS THESE OUTSTANDING PROPERTIES . . .

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 standard 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 under buildings and machinery.

sound control . . . In products ranging from home appliances to submarines, lead and leaded materials act to deaden ringing vibration and insulate against airborne noise.

lubricity . . . Few metals have the low coefficient of friction 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. Lead telluride is used commercially in a thermoelectric power generator; lead zirconate titanate is highly efficient as a piezoelectric material in both ultrasonics and electrical energy generation.

other unique properties . . . The most dense common metal . . . low melting point . . . easily fabricated . . . wide range of forms available . . . easily alloyed.

■ TO BENEFIT THESE INDUSTRIES

electrical Storage batteries, thermoelectric generators, piezoelectric elements, solder, cable sheathing, ceramics

transportation Storage batteries, solder, sound and vibration proofing, shielding for mobile reactors, bearings, anti-knock compounds, marine anodes

manufacturing Free machining leaded steels, brasses and bronzes, terne plate, solder, coatings, castings, machinery, noise control

chemical Tanks, reactor vessels, process equipment and piping, valves, chemical compounds and intermediates, scrubbers, precipitators

construction Sound-proofing, vibration-proofing, and water-proofing, flashing, roofing, piping, calking, ceramics, paints, bearing plates, coatings

nuclear Gamma ray shielding for shipping containers, reactors, laboratories, plants, industrial and medical radiography, non destructive testing instruments

LIA14772

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

... as a modern design material

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.

LEAD/FORMS AVAILABLE

sheet and foil Because of its malleability, lead can be rolled to any desired thickness down to 0.0078 in. Foils can be readily rolled to 0.0005 in. Sheets are produced in standard widths up to 8 ft., with larger sizes available for special requirements.

extrusions Lead is easily extruded in the form of pipe, rod, wire or practically any desired cross section. Commercially available extrusions range in size from 12 in. pipe down to solder wire 0.010 in. diameter.

castings Lead is one of the simplest metals to cast. Type metal, renowned for its ability to reproduce minute detail, and battery grids are examples of common lead castings. Small die castings are produced with wall thickness as low as 0.05 in. and "as cast" dimensions are reproducible to 0.001.

laminations Originally developed for X-ray protection, a large family of lead laminates is now used for noise control. Typical examples include lead-plywood, lead-gypsum board, lead-cinder block, leaded plastic and glass fiber combinations.

bonded sheath Lead in thicknesses from 1/8 in. to a foot or more may be bonded to other metals to impart special qualities. For example, lead may be combined with steel, copper or aluminum for corrosion resistance and strength or for gamma shielding and heat transfer.

powder Particles and flakes of lead from 4 micron diameter up, impart special properties when added to greases, paints and pipe joint compounds. Powdered lead is also used as a constituent of bearings, brake and clutch facings.

shot Produced in abundance in this form, over 30,000 tons of lead each year go into shotgun ammunition in sizes ranging from 0.04 to 0.44 in. Easily handled, shot is also useful for packing when mass or shielding is required inside an irregular enclosure.

wool By passing molten lead through a fine sieve and allowing it to solidify in the air, a loose rope of fibers is produced, weighing about 0.4 lbs. per foot. When this is driven under pressure into a crevice, the fibers are cold welded into a homogeneous mass forming a solid metal seal. This jointing procedure is especially useful where temperature or explosion hazards prohibit other methods which require heat.

alloys The extremely wide range of lead alloys permits only limited coverage here. Scores of fusible alloys and solders are available with melting temperatures from 117 to 588°F. A number of bearing alloys—the most familiar of which is babbitt—make use of lead. Small quantities of antimony and arsenic are frequently added to lead for hardening and strengthening such products as type metal. Calcium has also been alloyed with lead for use in battery plates and roofing.

compounds Tetraethyl lead controls the flame propagation rate in internal combustion engines resulting in greater efficiency and even combustion. Litharge (PbO) is used in storage batteries, crystal glass (and leaded glass radiation shielding windows), in pigments, and to vulcanize rubber. Newer chemical derivatives of lead with the same basic action—are also being used. Other lead components stabilize modern plastics. Lead oxide (Pb_3O_4) is the ubiquitous red lead valued for its corrosion resistance, and lead chromates—yellow, orange, and red—are similar pigments. Lead carbonate is the familiar white lead for house paint and nacreous coatings; lead azide is a standard explosive detonator; lead arsenate is an insecticide and herbicide; lead silicates are paint pigments and enameling frits.

mixtures Lead powder and paraffin mixtures combine the gamma shielding ability of lead with the neutron capturing quality of an organic to produce a removable shield with a melting point of about 200°F. Many lead organic mixtures are similarly used. Lead-plastic mixtures show unusual sound attenuation properties. A mixture of lead and polyethylene has been used to mold precision parts with substantial mass, and lead shot in neoprene forms a combination acoustical, antifouling, antiturbulence coating for submarines.

LIA14773

as a coating

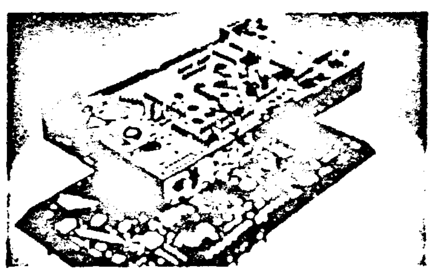
Coatings of lead and lead alloys over steel and other metals are available in thicknesses from a few thousandths of an inch to several inches. Terne (15% tin/85% lead), other hot dipped coatings, electroplate, flame sprayed lead and solder, are some of the common forms. Terne is an especially versatile material. The TV chassis shown is made from terne because, 1) die life is extended by the coating's lubricity, 2) terne eliminates the need for additional corrosion protective measures, 3) it is easily soldered and joined.

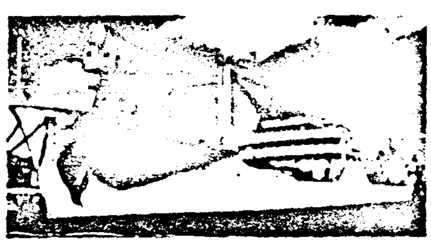
applications: automotive gas tanks, air filters, distributor head tubes, oil filters, instruments, oil pans, radiator parts, valve rocker arm covers, gaskets, car heaters, washers, vacuum actuators

air handling and heating oil stoves and heaters, furnaces, air cleaners, radiators, air conditioners

as an anode

In an impressed current system the electrical power is expended to force the corrosive action to take place largely at the anode. Under these conditions, lead has been particularly successful as an anode material. Initial penetration of the lead is stopped by the formation of a heavy film of lead peroxide which offers good electrical conductivity without permitting corrosive penetration to the lead. Successful applications have been made on salt water ships and piers, in brackish water, and in several types of soil. High current density can be attained without sacrificing anode life.





This lead shielded cask is used for the safe shipment of nuclear wastes or spent fuel elements from an atomic reactor.

for radiation control

Lead is first in materials to be considered in any design for X-ray or gamma radiation shielding. When other materials are considered, "comparisons are usually expressed in terms of lead because it represents the best practical gamma shield material for most applications." (Quoted from AEC's authoritative "Reactor Shielding Design Manual")

Although lead's primary quality is massiveness, the use of lead in shielding almost invariably saves weight and space. Its low cost, density, and the ease with which it can be cast, extruded, rolled, machined or otherwise formed, combine to make it one of the most efficient of shielding materials.

as a corrosion-proof material

Lead's corrosion resistance is an important factor in its usefulness. The statue will suffer no weathering, even in the corrosive atmosphere of the city. Corrosion resistance enables the pipes to carry many thousands of gallons of concentrated sulphuric acid during the many years that they will be in service. This excellent resistance to corrosives accounts for about 60 percent of the metallic lead used in the United States. Applications include cable sheathing, battery grid metal, corrosion resistant linings in chemical process equipment and roofing for city buildings.

POLLUTION CONTROL

Again, lead's outstanding resistance to SO_2, H_2SO_3 and H_2SO_4 makes it a wise choice as a lining material for electrostatic and acid mist precipitators and gas scrubbers. A unique passivating layer of insoluble lead sulphate serves to protect the lead from the corrosive action of these chemicals and others yielding longer equipment life and more efficient operation.

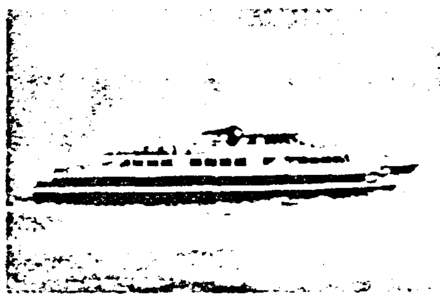
SO_2 — the gas generated by roasting sulphur bearing ores at high temperature — can be a critical problem in the non-ferrous metals industry, both in air pollution and corrosion. Control of SO_2 is usually channelled into production of Sulphuric Acid, an important industrial solvent and one to which lead stands up especially well.

■ for sound / vibration control

Noise and Vibration Control

Today lead and leaded materials are being used in office equipment, transportation, skyscrapers, and industry to control noise. In typewriters and sound movie cameras leaded damping materials are modifying the character of the noise produced. In jet airliners, military helicopters, and turbine-powered marine craft, sheet lead, sheet lead composites, and leaded plastic sheets are blocking out engine noise.

Lead, by virtue of its high internal damping, is one of the most efficient noise attenuators known. No other materials in its economic range stop noise per pound or per inch of thickness. Leaded plastics in sheet, tile, or castings are effective in blocking airborne noise as well as damping the ringing of metal structures — from small stamped metal panels of an ordinary typewriter to steel decking of special railroad cars.



One of the Golden Gate Ferries. The engine room is lined with lead for acoustical insulation.

Passengers on today's luxurious airliners are well protected from the 150 db roar of the engines, thanks to lead. On passenger aircraft and executive aircraft as well, leaded vinyl is sandwiched in the fuselage to effectively insulate the cabin interior.

The Golden Gate Ferries, as depicted here, are driven by three aircraft type gas turbines and Jacuzzi water jets. Sheet lead, 2-lb/ft² has been specified for engine room noise treatment.

In industry, harmful noise levels are stopped by lead sound barriers. Leaded vinyl curtains can block as much as 25 db of noise, if not more. Velcro fasteners ensure a tight, "noise-proof" seal. Available in a variety of densities, colors, and finishes, leaded vinyl noise barriers can be specified for practically any installation requiring a flexible, durable, movable partition.

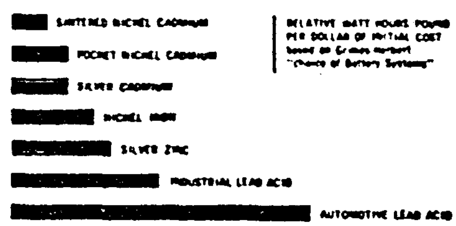
Lead and asbestos anti-vibration pads can also be used to cut noise and vibration from intense sources. Accepting static loads up to and above 1000 psi, anti-vibration pads block the structural path by which vibration can get to radiating surfaces where it appears as noise.

■ for electrical energy sources

The power to detect, sense, and drive tomorrow's electrical and electronic products will come, in many cases, from sources which utilize some of lead's inherent characteristics — thermoelectric activity of lead alloy semi-metals, piezo electric activity of lead ceramics, or from the reliable lead acid storage battery.

A large power source employs lead telluride in place of thermocouples in thermoelectric generators. Lead telluride is selected because it generates so much power from the heat source that no amplification or secondary power source is needed to drive controls. It has been a critical power source for lunar exploration.

Lead zirconate-titanate ceramics demonstrate remarkable efficiency in producing ultrasonic vibrations or in generating high outputs of electricity when mechanically stressed. Completely sealed lead-acid batteries requiring no maintenance—not even the addition of water—are available in a variety of sizes representing an efficient power source in a compact package.



comparison of common battery systems rated at 100 amp-hr, 12 volts

Type	Ave. volts/cell	No. of cells (12v)	Watt-hours per lb.	Watt-hours per in.³	Est. life	Estimated Cost $	$/yr.	$/cycle
Lead-acid industrial	1.9	6	13.1	1.36	1500 cycles 5-10 years	70	6	.040
automotive	1.9	6	15.0	1.2	200 cycles 3 years	40	10	.22
Nickel-cadmium pocket	1.2	10	11.0	0.8	2000 cycles 10-20 years	150	8	.075
sintered	1.2	10	11.5	0.85	2000 cycles 10-20 years	600	30	.30
Nickel-iron (tube type)	1.2	10	10.0	0.87	2000 cycles 15-20 years	130	7.5	.065
Silver-zinc	1.35	8	50-100	3.0	200 cycles 1 year	800	800	4.00
Silver-cadmium	1.05	11	35-75	2.5	500 cycles 2-3 years	1000		2.00
H_2-O_2, fuel cell	0.7	18	— not applicable or available —					

From "The Choice of Battery Systems," by C. E. Grimes and W. S. Herbert.

■ for soldering

Lead-tin alloys Numerous soldering alloys of lead are available for almost any metal joining purpose. The most widely used solders are the lead-tin alloys. Many of these begin to melt at 361°F. Lead-tin solder is compatible for use with nearly all base metal cleaners and fluxes, and heating methods.

Other Lead Solders Lead-tin-antimony alloys are frequently used where greater mechanical strength and higher operating temperatures are necessary. Lead silver alloys are suitable for application temperatures up to 350°F. Minor additions of tin (less than 1.5%) are sometimes made to the silver solders to reduce corrosion susceptibility.

The Fusible Alloys These generally contain a combination of lead, tin, bismuth, and cadmium or indium. To achieve better properties minor additions of certain other elements are sometimes made. One group of these alloys is based on the ternary eutectic containing 15.5% tin, 52.5% bismuth, and 32% lead. Wood's and Lipowitz's alloys are typical of the quaternary eutectic, containing lead, tin, bismuth and cadmium. These melt around 158°F. Tensile strengths for the fusible alloys range from 4,000 to more than 13,000 lb./sq. in. however, mechanical properties of most tend to change over a period of time and care should be taken in their selection.

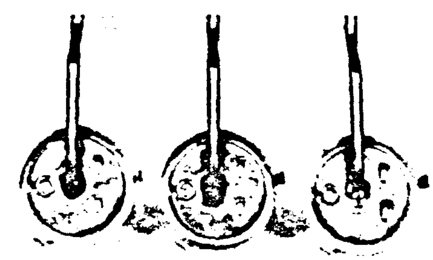
Design Considerations The designer must tailor each solder joint to meet the specific requirements of his application if he wishes to fully utilize solder's versatility as a joining material. He must consider choice of alloy, base metals, flux and flux removal, and joint geometry. The latter includes taking advantage of the mechanical strength of the base metal rather than relying solely on the solder's strength.

Paste Solders Powdered solders blended with fluxes and neutral suspending agents are termed "paste solders". They can save time and money in that fluxing and solder placement are carried out in one step. Precise amounts of solder metal can be metered out by automatic dispensers and nearly any alloy or flux can be incorporated into the paste.

Automotive applications for mechanized paste solder operations are many. Here an oil filler tube on a power steering assembly receives paste solder stripe prior to soldering with a gas flame.

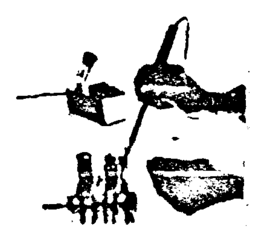
■ for ceramics

Lead glasses with their inherent high volume resistivity, high dielectric constant and low loss factor as well as excellent low-temperature working properties are very important for electrical and electronic applications in glazes and enamels for insulator bodies, as filament supports for incandescent bulbs, for high-temperature ceramic coated wire, and as a glaze coating for spark plugs. Simple lead silicate glasses have been used successfully as extreme high temperature lubricants at sliding velocities greater than 1000 ft./minute in supersonic aircraft engines and the like. Friction coefficients of 0.05 to 0.08 at temperatures above 1200°F are doubtless due to formation of a lead oxide glaze in the sliding zone. Of course, high density lead glasses (often 80% or more lead content) have traditionally been used in radiation-protective windows because they retain their excellent transparency while effectively shielding the viewer nearly as well as sheet lead would do. Lead's electroceramic and magnetoceramic applications are of special interest to engineers also. Barium ferrite permanent ceramic magnets modified with lead additions, and piezoelectric ceramics based on the lead zirconate-lead titanate system are being used increasingly for their better design characteristics—and often lower in-the-product costs. Lead-lanthanum zirconate titanate has a remarkable image storing capacity which may eventually make the wafer-thin television a reality.



Fuel level sensing devices depend on a perfect seal between tube and cover plate. Paste solder provides the solution.

Automatic rotary soldering machines help to meet high production requirements in the automotive industry.



Precision in joining is a foremost requirement in industry. Solder is the key for close tolerances.

LIA14776

properties

general properties

Color .... Bluish gray
Patina .... On atmospheric exposure lead takes on a silvery gray patina except in industrial atmosphere where it changes to dark gray to black
Atomic number 82
Atomic arrangement .... Cubic face-centered
Length of lattice edge .... 4.9398 A
Atomic weight 207.21

weight and density

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 .... 0.3854 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.

density

Cast lead, 20°C .... 11.34 g 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

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	0.06	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./cm²/°C./sec.)

Temp °C	specific heat
−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				
50	3600	52	..	..
−4	7200	40	..	..
−40	13300	31	..	..
−103	15200	24	..	..

electrical properties

Specific electrical conductance
  at 0°C. .... 5.05×10^{4} cm^{-1} ohms^{-1}
  18°C 4.83
  melting point 1.06
Atomic electrical conductance, calculated .... 1.139×10^{6}
Relative electrical conductance (copper 100) 7.82
Relative electrical resistance (copper 100) 1280
Magnetic susceptibility per g.
  18–330°C. .... -0.12×10^{-6}
  300–600°C. .... -0.08×10^{-6}
Electrolytic solution pressure
  ions of Pb^{++} .... 6.3×10^{-9} atm.
  ions of Pb^{++++} .... 3.0 x 10^- [illegible] atm.

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 .... 1400 to 1700 lb per sq. in.
  Chemical lead .... 2300 to 2800 lb per sq. in.

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

Temperature °C	Temperature °F	Tensile strength psi	Elongation percent	Reduction in area percent
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

LEAD INDUSTRIES ASSOCIATION, INC.

properties continued

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	48.8

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

creep (room temperature)

stress lb per sq. in.	creep, percent per hour	
	common lead	chemical or copper lead
200	5×10^{-6}	0.4×10^{-6}
300	3.5×10^{-4}	1.5×10^{-6}
400	11×10^{-4}	3×10^{-6}

fatigue

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

metal	endurance limit at 5×10^7 cycles, lb per sq. in.	endurance limit at 2^7 cycles lb per sq. in.
lead	215—400	407
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	900	
lead + 0.06% copper	600	725
lead + {0.045% tellurium, 0.06% copper}		1000

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, INC., DEPT. DE, 292 MADISON AVE., NEW YORK, N.Y. 10017

order by code no.

BATTERIES

A primer on the lead-acid battery

A condensed story of the principles of the lead-acid battery and its chemistry, including some of the fundamentals and definitions of direct-current electric energy. Two pages. L-4

Electric trucks are the choice

Reprint from Electrical World. Operational and maintenance experience of various industrial companies with battery powered in-plant vehicles. Four pages. L-10

Lift profits electrically

Provides performance data on electric battery powered vehicles for industrial use. Cost calculators are designed to help buyer estimate depreciation, operating and maintenance costs. Sixteen pages. L-14

CABLE SHEATHING

Lead-covered underground cable use increasing

Reprint outlining a major utility's recent experience with lead sheathed underground cable. Details on where this type cable is desirable. Graphs. Four pages. C-2

CERAMICS

Facts about lead glazes for art potters and hobbyists

Detailed information on the proper formulation, firing techniques, handling, etc. of lead fused glazes used by art potters and hobby ceramists. Illustrated. Sixteen pages. M-21

Lead in glazes

Reprint from American Ceramic Society Bulletin. Six papers on subject of lead release testing on ceramic dinnerware glazes. Charts and tables. Twelve pages. B-10

CHEMICAL CONSTRUCTION & CORROSION PROTECTION

Corrosion resistance of lead in chemical applications

A chart presentation of the corrosion resistance of lead and its alloys against 186 chemicals from 0° to 300°F. Six pages. H-3

Lead in modern chemical construction

Reprint from Encyclopedia of Chemical Process Equipment. Describes installation, proper design application, and testing of lead linings. Twelve pages. Illustrated. H-1

PAINTS

Follow the safety line with chrome yellow

Formulations and suggested applications for chrome yellow safety paints. Illustrated. Eight pages. M-8

Red lead based paint systems

Provides details on generic properties and suggested uses of recommended paints. Instructions on surface preparation for a variety of applications. [illegible] of LIA recommended formulations. Thirty-two pages. P-4

PLUMBING

Lead plumbing catalog and specifications

Specifications and details for the use of lead in plumbing. Waste connections, shower and tele pans and chemical laboratory drains are covered. Four pages. D-2

SOUND BARRIERS

Directory of acoustic specialists

Summary of available materials for sound insulation by barrier, damping and absorption methods. Sixteen page list of materials by brand name and manufacturer. Eighteen pages. J-4

Sheet lead plenum barriers

Detailed description of acoustical plenum barriers and how to install them. Materials and installation procedures described and illustrated. Eight pages. J-10

Lead a major factor in new machinery noise suppression systems

Description of techniques used to lower machinery noise levels with lead and lead composites. Lists machines that normally exceed noise level allowed by Walsh-Healey Public Contracts Act. Two pages. J-8