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December 7, 1973

SUBJECT: LEAD FOR SOUND CONTROL

TO THE MEMBERS OF THE LEAD INDUSTRIES ASSOCIATION, INC.:

Excessive noise in industry, aircraft, schools, apartments and office buildings, has been attracting a good deal of editorial attention. It has also been attracting attention from OSHA, among other groups concerned with sound pollution.

The attached feature article, placed by LIA in "Product Engineering," tells of several successful case histories on the use of lead to reduce sound levels. In "Product Engineering," it reached over 107,000 design engineers.

In addition, LIA has reprinted 5,000 copies to help answer specific inquiries. Limited additional copies are available free of charge as long as our supply lasts.

Sincerely,

Lewis E. Gage

Lewis E. Gage
Assistant Secretary and
Director of Communications

LEG:mki
Enclosure

Product Engineering

Lead proves a heavy favorite as sound control material

Heavy metal, often combined with plastic foam and elastomers, is helping to meet OSHA requirements in factory machinery and quieting factory made products

Lead is best for blanketing the sound coming from noisy machinery, says the Lead Industries Association (LIA)

It is being incorporated in many products because it offers excellent sound insulation properties and can be tailored to meet the various specific demands for noise control.

Noise pollution is one of the most serious problems facing industry today. Statistics show that more than 10% of the country's working population suffers some noise-related hearing impairment and it has even suggested that workers subjected to the highest industrial noise levels are prone to heart disorders, circulatory and equilibrium problems.

As the result of such problems, the Occupational Safety and Health Act (OSHA) now requires that any industry with noise levels of more than 90 dBA must provide a hearing conservation program for its employees. This requirement encompasses approximately 40% of all industrial manufacturers, and it is expected that approximately $1.8 billion will be spent to implement the hearing conservation program to comply with OSHA regulations. Most of the funds allocated by industry for noise control will be spent for new products and systems that will dampen, muffle or insulate machinery noises.

Some typical examples of its use in industrial noise control include a specially designed, sound-insulated furniture machinery enclosure; a multi-material shroud to reduce the sound of a large centrifugal compressor by 67%; and lead bonded to steel to decrease the sound of a plastics grinder/granulator by 85%.

Lead plus foam. Sound insulated machinery enclosures are one method to control noise from industrial equipment that originally was considered either too large to equip with adequate sound control, or else is already installed without built-in noise control.

According to LIA, an increasing number of machinery enclosure manufacturers are taking advantage of the sound barrier properties of lead to insure sound attenuation effectiveness of their products. Many of these enclosures are made up of panels consisting of sheet lead and accoustical polyurethane foam combinations. Some of these combinations contain more than one sheet of lead separated by layers of foam to enhance sound attenuation properties over that of an equal mass of lead in a single sheet.

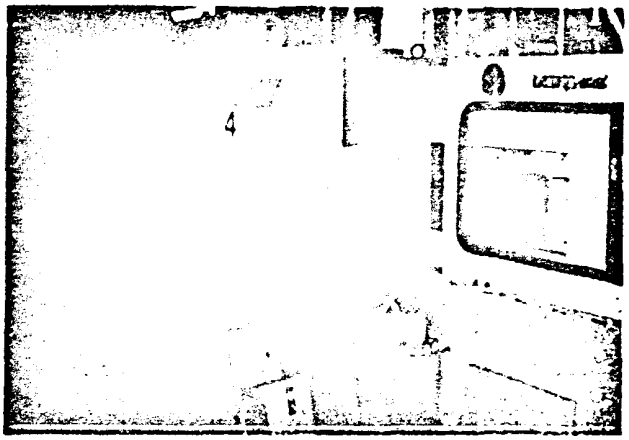
Lead foam systems. Typical of such machinery enclosures is a new modular sound control system to enclose furniture production machinery developed by Maher Engineering, Des Plaines, Illinois. The furniture machinery noise control system consists of 1½-in. thick lead/foam material; an extruded aluminum framing system; and flat aluminum sheets, in gauges ranging from .049-in. to .062-in., for the exterior face of the panel.

The combination lead and acoustical foam material, produced by the Soundcast Co., Brooklyn, N.Y., is a modular panel system consisting of two ½ psf (.0078-in. thick) sheets of lead sandwiched in acoustical foam. This combination is then bonded to the backside of the metal exterior and interior face panels. The acoustical foam will not "dust out" or delaminate from the sheet lead like some other materials. The lead/acoustical foam also tends to be self-healing should workmen have to drill holes in the panel, e.g., for electrical conduit. The material encircles the cable and tends to seal potential openings through which sound could travel.

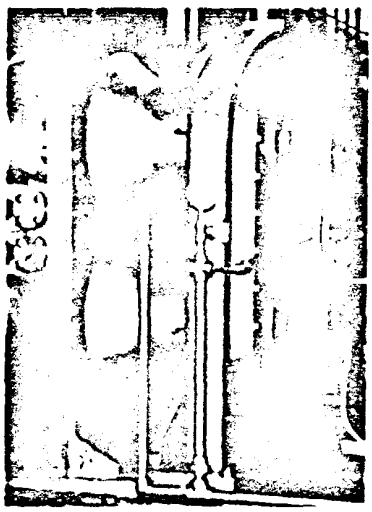
The enclosure system meets regulations for fire retardance and it is designed to meet OSHA standards depending on how carefully it is installed and the original noise levels encountered.

The system is designed to bring 98 dBA machinery noise sound levels to 90 dBA outside the unit. OSHA regulations say a worker can perform tasks for eight hours in a 90 dBA noise environment. This compares to a sound level of 115 dBA at which a worker can perform for only 15 minutes unless protected from such noise levels. They are so high that conversation is impossible.

According to Maher Engineering, the system can be custom-built to enclose any type of machinery regardless of size and configuration. The enclosure design features openings at either end so that stock input and output can enter and leave the work station. Glass panels installed in the sides of the enclosure permit an unobstructed view of the work being performed and, in addition, allows visual communication between the



Laminated directly to exterior, lead blocks unwanted noise on plastic scrap grinder. Noise was cut by 85% compared to unprotected version of machine



Gear and impeller section of compressor has noise barrier made of foam/lead

Air cushion vehicle, made by Grumman, applies lead as sound shielding material in several areas, including passenger compartment and power compartment

operators, who wear ear plugs or muffers, and their supervisor.

Plastic plus lead. A vinyl-and-lead lamination installed by Ingersoll-Rand's Centac Products Division, Mayfield, Kentucky, achieved a 67% noise reduction in its line of 7000 CFM packaged centrifugal compressors. It used a steel shroud laminated to a combination lead/foam sound barrier to achieve the 67% decrease in noise.

Because of its design, the Centac produces noise only from areas of its main drive gears, impeller vanes and gear-type oil pump. Noise reduction was primarily achieved by covering these areas, located in the mid-section of the unit, with the multi-layer steel shroud and lead/foam combination.

The lead/foam combination consisted of a 1 psf (.0156-in. thick) sheet lead sound barrier sandwiched in an in. thick layer of foam. It was applied over a previously sprayed-on undercoat layer and then the steel shroud was placed over the top of the enclosed section. To conduct away heat build-up within the shroud, specially designed louvers were placed at the bottom and top of the enclosure.

Engineering Industries, Inc., Madison, Wisconsin, solved a major noise problem and realized a $2500 cost savings by installing thin, continuous cast sheet lead to five in-production plastic scrap grinders. Noise from the machines, used to grind or granulate hard plastic materials must be controlled since they produce noise levels that are as high as 88 dBA two feet from the grinder, a level that is in excess of OSHA allowances.

Two noise control techniques were considered: shipping the machines 400 miles to the Engineering Industries plant where a noise retardant cavity skin could be installed, or applying sheet lead directly to them at the plastics plant. The latter technique was used because it saved more than $3,000 in shipping costs and eliminated 10 to 12 weeks of downtime while the machines were being altered.

Several techniques were tested to determine how the sheet lead could be most effectively and economically installed in the first test, sheet lead was laminated to the interior face of all hopper walls, underneath portions, and the interior of pedestals, stands and covers of one machine. This required 20 hours.

In the second test, the outside face of two machines were laminated in 15 hours. The latter sheet lead installation technique was faster and just as effective as the first technique and it was therefore used to attenuate the sound of the three remaining plastics grinding machines. Laminating the sheet lead to the exterior of the machines permitted the lead surfaces to be spray-painted to match the color of the machines. Each machine required about 25 sq. ft. of 2 psf (.312 in. thick) sheet lead. A special urethane adhesive was utilized to bond the sheet lead to the exterior of the machines. A mechanic installed the sheet lead. The total cost of the labor and materials was $100 per grinder, a $500 cost saving over the first installation technique tested.

Sound meter readings before installation of the lead sheet was 88 dBA at two feet from the grinder. Following installation, the count was 64 dBA, a drop of 24 decibels. Engineering Industries reports that it achieved a noise reduction of approximately 85%.

Planes and trains. Lead is also quieting products that leave the factory and go into the hands of consumers. One such example is a sleek business jet, the Gulfstream II, made by Grumman Aerospace Corp.

Powered by two turbofan engines that provide a maximum speed of nearly 600 mph, the G-II encounters high intensity aerodynamic noise, also known as boundary layer noise. Aerodynamic noise increases with velocity, and this in turn creates a continual excitation of the fuselage skin. Depending on the aircraft's speed and shape, such boundary layer noise can cause extremely high noise inside the craft.

The combined effect of the boundary layer noise and that of the powerful tur-

bofan engines created an overall noise level of 110 decibels in the untreated cabin. This uncomfortable sound level, which can be detrimental to hearing, compares to the noise of a jet fighter at 1000 feet.

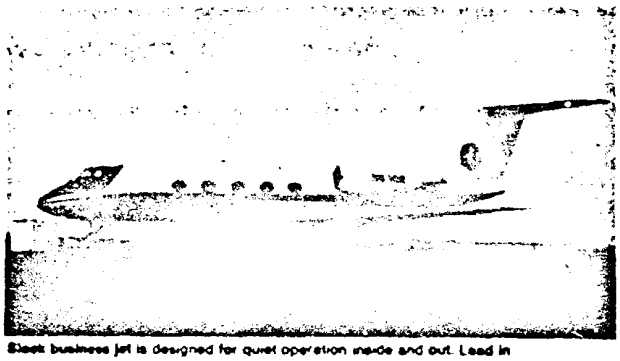
Despite this high exterior noise level, Grumman specifications called for a cabin interior that was "living room quiet." The company's engineers therefore were faced with the task of developing a sound control system to overcome noise problems common to all jet aircraft.

Grumman's G-II sound control system incorporates three essential elements: 1) a barrier between the craft's engines and the cabin interior to block the path of exterior sound; 2) methods to damp interior structure borne sound radiation and isolate engine vibration; 3) a method to absorb sound inside the cabin and prevent its reverberation.

The sound barrier between the exterior skin and the cabin interior headliner was a critical element in the total sound system. Grumman engineers selected a multi-material system incorporating lead. The sound barrier, leaded vinyl (lead powder dispersed in vinyl), is sandwiched between two layers of compressed acoustical foam and is secured in place by the cabin headliner. This installation technique eliminates the need for fasteners which would have penetrated the leaded vinyl and provided a large number of routes for noise to enter the cabin. Another major advantage of using leaded vinyl in this form is that it is virtually free-floating, thereby improving its effectiveness.

The weight of the leaded vinyl was increased for forward sections of the aircraft because these areas are subjected to higher noise levels of boundary layer noise at maximum cruise speeds and, in addition, the glass enclosed cockpit is more susceptible to noise penetration. Three weights of leaded vinyl were used–1.5 psf for the cockpit, 0.57 psf for the forward section of the cabin, and 0.28 psf for the mid and rear sections of the cabin.

Another modern vehicle, also from Grumman, got the lead treatment too. It's a tracked air cushion train now being tested as part of the U.S. Department of Transportation's plan to develop high speed railroad vehicles that will provide passenger and cargo service between urban areas. Though different in design and function, the TACRV faced the same problems as that of the Gulfstream-II (o-II) Business Jet-turbofan engine noise and aerodynamic related engine noise (the o-II at 600 mph at 35,000 ft. has almost the same free-stream dynamic pressure as the TACRV at 300 mph at sea level). However, Grumman engineers had a distinct advantage in designing the TACRV since they had already designed the highly effective sound control system for the o-II. Based on this previous experience and knowledge gained in developing the sound control system, it was easily incorporated into the vehicle.



Sleek business jet is designed for quiet operation inside and out. Lead in combinations with plastic foam, and in thin sheets block unwanted noise

Heavy metal was chosen for Grumman business jet despite weight penalty because it proved to be the most efficient noise barrier

To insulate the cabin, the multi-material noise insulation system was applied in the same manner as the system installed in the Gulfstream II: damping foam was applied to about 50 per cent of the skin area, a 4-in. thickness of low density fiberglass was compressed into the 3-in. depth between the frame caps and a 1 psf leaded vinyl sandwiched between two ½ in. thicknesses of polyurethane foam was installed over the fiberglass before the cabin lining was installed. In addition, a 1 psf leaded vinyl curtain was suspended behind the aft cockpit bulkhead to provide additional insulation from the noise of the rear-mounted turbofans.

The noise insulation is providing the research vehicle operator and test engineers with a quiet environment for the test program. During the present phase when the vehicle is being tested for speeds of up to 125 mph, noise protection from the turbofan jets is a primary consideration. Later, when the second phase of the tests are underway and the linear induction motor is used to achieve the vehicle's maximum 300 mph speeds, noise will come from two sources—turbofan engine noise and boundary layer noise.

ADDITIONAL INFORMATION AVAILABLE

For further details or engineering assistance with a noise problem contact Lead Industries Association.

J-4
"DIRECTORY OF ACOUSTIC SPECIALTIES"
A 26-page brochure including descriptions of various lead bearing elements in sheet, laminated, powder, or bulk form for acoustical purposes and including lists of manufacturers.

J-8
"INDUSTRIAL NOISE — HOW TO CONTROL IT"
Technical data on the causes of industrial noise and information on methods of controlling it. List of control materials available. Graphs.

J-9
"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 the Occupational Safety and Health Administration. Two pages.

J-12
"CONTROLLING SOUND WITH LEAD"
Reprint from Building Operating Management covers the applications of lead in reducing vibration and airborne noise. Case studies on three new structures are discussed. Illustrated. Four pages.

J-13
"LEAD KEEPS CLASSROOMS QUIET"
Reprint from Better Schools describes the application of lead for noise insulation in a large elementary school. Details of installation. Illustrated. Two pages.

J-15
"PRACTICAL APPLICATION OF SHEET LEAD FOR NOISE BARRIERS"
Discusses how the use of various thicknesses of lead bonded to or used in conjunction with other construction materials determines the Sound Transmission Class (STC) rating of walls and partitions.

Distributed by

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