

SOUND PROOFING LIGHT AIRCRAFT (and other stuff too!)

Introduction

I first put these ideas down in 1990, in the form of an instruction sheet we handed out with the Super Sound Proofing mat. Over the years we've added more to them, mostly by feedback from users of the product and printed thousands of these little booklets.

You are invited to pass back your experiences with this and the other products that have been added to our arsenal in the fight against noise. We've now got acoustical foam materials to be used in Boats, Trucks and Cars as well as new materials used in Architectural applications for home movie rooms, sound studios, gyms, industrial as well as for band practice in the garage!

Our first specialty is aircraft applications as it is the most challenging! We are always available for free consulting at anytime for any application, to help you with what we know about methods and materials for soundproofing.

We provide free copies to groups and associations, just let us know how many you need.

The latest version of this manual is available from our website at <http://www.freeyellow.com/members/aircraft-reman/page2.htm>

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SOUND PROOFING LIGHT AIRCRAFT

Much has been discussed as well as written about the noisiness of aircraft - inside and out. Because of these valid concerns, sound measurements have been made that indicate that sometimes the noise levels are so high in some aircraft that damage to the hearing over the long term can and indeed does, result. Elaborate techniques now exist to drastically reduce such noise. While time and expense are important considerations, installing soundproofing is not a luxury; it is an investment in the

physical well-being of the flyers in addition to a valuable upgrade of the aircraft. Information presented here is applicable to all types of planes from "puddle-jumpers" to jets. The addendum to this booklet has info regarding other vehicles as well as business, shop and office.

In a properly soundproofed airplane, the radio can be used with speaker and hand mike, instead of only the headsets. You will even enjoy better direct communications between passengers and will not have to worry about damage to your hearing. Contrary to popular belief, wearing headsets will not protect your hearing much. After being properly soundproofed, using the latest space age materials, the noise level in most aircraft will be so low you'll probably be able to have conversations in normal tones. You'll wonder why you ever put up with all the noise before. The quieter aircraft will seem to have gained quality and feel more solid and plusher. Such an improvement should not be considered costly.

Before we tell you how to accomplish this, we will discuss some commonly used materials for sound attenuation. Also, keep in mind that soundproofing involves two (2) concepts that require two different materials:

1. *Sound absorption, and*
2. *Sound blocking, or barrier material.*

Vibration of the airframe, penetration of sound into the cabin from the engine/prop and airflow over the airframe are three distinct effects and you need to use the proper materials to control them. We have found the ordinary "foam rubber" and fiberglass batting as supplied by the aircraft manufacturers to be virtually worthless.

"Super Soundproofing" Mat for Sound Absorption:

It is a closed cell vinyl/nitrile insulating material which will not absorb water or oil. Materials that absorb liquids are not suitable because if they get wet, they will promote corrosion and increase their weight. The mat also conserves and blocks heat because it is an insulator. It has fire retardant qualities and we have the manufacturer's assurance that, in thicknesses over 1/8", it meets the requirements of FAR 25.853b. Therefore, it is suitable for aircraft use.

It is available in 48" widths in thicknesses of 1/8, 1/4, 3/8, 1/2, 3/4 and 1 inch. It may easily be cemented together to make other thicknesses.

The Noise Mat Barrier:

If one were to make a mat of sound absorbing material rather thicker and use a metal barrier inside it, it would be very effective in really stopping engine noise coming through the firewall. So if ordinary kitchen Reynolds Aluminum Foil is sandwiched between the mats, (use contact cement), most of that noise will be prevented from entering the cabin. A 2" minimum total thickness is recommended.

Finish Cloths and Vinyls: These are available from your local automotive upholstery wholesaler in a myriad of thicknesses and colors. Most types of automotive materials meet some auto industry inflammability requirements, but perhaps not specifically those as applied to aviation. It is the duty of the installer to make sure that applicable F.A.R.s are complied with.

For aircraft applications, you would be interested in thin vinyl materials such as used for automobile headliners and durable cloths that have a thin foam backing. These can easily be drawn tight and contact cemented to the above described soundproofing mats (or metal backing panels), to produce very attractive, professionally finished surfaces. The use of contact cement in spray cans simplifies application. A heat gun (hair dryer) and some moisture will shrink out most wrinkles.

Other types of soundproofing materials.

A mention should be made here of some popular materials marketed by others. One is a white foam material that is provided in a kit, specially cut for each aircraft it is designed for.... It has contact cement on one side with a peel-off covering and comes with a diagram as to where each piece fits into the aircraft. This is a very expensive proposition because all this prep work has been done for you and you are charged accordingly. A lot of time is wasted trying to find where each piece fits. These kits can run up to \$3000 per aircraft (and more) plus installation.

Another one is a lead-backed material developed for the military. It is so expensive and heavy it would not be a contender for installation in light aircraft, even airliners, even though it can sometimes be found surplus. Other materials are either not F.A.A. approved, not closed cell material or are far more costly than our proven Super Sound Proofing Mat! Check carefully before you buy!

Installation Considerations

Each aircraft has its "hot spots". That's certain areas where noise is the loudest. A good soundproofing job would concentrate on these places that are the noisiest by placing more material there. However, in general, the places in a light plane that admit sound most readily are the firewall, cowl forward of the windshield/instrument panel, kickpanels, sidewalls of the cabin, roof and wing-roots. But the honor of the most noisy goes to the windows! When replacing windows, use the thickest material you can.

A thorough soundproofing job would place heavier layers of materials where the sound was the loudest, near the front and lighter insulation aft. The entire cabin should receive the treatment, above, below and all around including doors.

In an aircraft that has been flying, the best time to put in this material is when the interior has been removed. Then it can be installed with a minimum of effort. However, an installation can be made piecemeal. That is, section by section, as the budget or time allows, with steadily improving results as more and more of the cabin area is insulated. Some installers might do the doors on a weekend, the firewall on another, etc. In all cases, investigate thoroughly for evidence of corrosion or other damage before applying any batting that might cover it up.

While we cannot provide explicit instructions for each and every aircraft, we can give you some general pointers to insure a good, effective job.

- *Installation; Soundproofing Mat*

1. Cut your material to precise size and shape beginning with the largest area.

The material comes in different thicknesses to be cut to fit inside and to fill the formers and frames, cabin sides and ceiling. (See diagrams). We do not recommend using razor blades or knives. They will leave ragged edges. Cut it with an electric knife, the kind that is used for carving turkeys. We use a Hamilton Beach battery-powered unit. These are inexpensive home appliance models. The rechargeable feature is handy where an AC plug-in isn't available, such as out on the aircraft ramp tiedown area. Cut material a little oversized so that it fits *inside* the former or frame with a push tight fit. It comes with a smooth "skin" side and a rougher side. Either side can be cemented but the smooth side is more suitable. A dab of contact cement here and there will ensure that it stays put, but it should fit well enough so that is quite tight. If the area you are covering is rather large, apply a coating of Super Sound Proofing Liquid and allow to dry first.

Use waterproof contact cement. Do not overdo the cementing because you may want to remove the material someday to look for corrosion, run wires, etc. Use judicious dabs of cement. Use a brush for this. You must put soundproofing every place where the inside of the skin is exposed, especially on the firewall and inside the upper instrument cowling and kick panel sides forward of the windshield. If it's difficult to cut and fit the material directly because of obstructions, make a little cardboard pattern by which to cut and fit the material.

Take your time. Don't get into a hurry. Make it fit as neatly as possible. It goes without saying the material is to be installed only on the cabin side of the firewall! If the firewall is covered with some kind of decorative mickey mouse firewall covering, or fiberglass batting, remove it. It may then be reinstalled, but it's probably better to just leave it off.

1. Use the bits and pieces left over to insulate the smaller remaining spaces.

Material can be contact cemented together to make larger pieces, so not much need be wasted. Window frames and 'U' channels can simply be pushed full of the scraps. Leftovers can also be used in the floor access panels by gluing them on the underside of the covers, then reinstalling the panels and access covers. If you have some left over, it's worth it to glue it to the inside of the belly access covers too. Every place sound can enter should be covered as much as possible, but installing the material everywhere inside the underside of the floor many times isn't practical. Don't worry, even without that, the sound reduction will be very impressive. If your plane is apart for repairs or overhaul, or an experimental under construction, a more complete job can be done. However, do not overdo the gluing job. If you do, the material can be difficult to remove if and when inspection is necessary in the future.

AN ALTERNATIVE METHOD OF INSTALLATION FOR EVEN GREATER SOUND REDUCTION

If your aircraft has 'snap-in' metal or fiberglass upholstery panels that are held in frames, we have had great success with the following method which uses 1/2" or thinner mat material:

1. Remove all such panels. Or, if you don't have them, make some.

Cut your mat materials a bit oversized. Then carefully cement a 1/2" layer of material to the inside backside of the panel. Leave the edge of the soundproofing around the edge slightly loose so that it can slide over the inside flange of the mounting frame. Here, because these panels are nonstructural, and inspection won't be necessary, a full even coating of contact cement on both the panel and mat and then assembly will ensure that the material will not come loose, ever.

2. Cut and fit thinner insulation material to the inside skin areas same as the application of the material detailed previously.

The idea here is to create a sound deadened boxed-in area with a dead-air space between the two insulation layers. This is very effective and lighter, but requires more time and effort.

For First Time Construction

1. Those of you building experimentals will have good results by just using the material on the inside of the cockpit area as explained. However, in addition, if you wish to make removable upholstery panels as mentioned above, here's how:

1. Using either very thin aluminum sheet (.015" is a

1. **good thickness), or very thin fiberglass sheet (some call it "tank Liner"), a bit thicker, cut it to the size of the area you wish to cover. Don't try to make the area to be covered too large or make the panel with curved edges or with compound curves. The squarer, the better.**

Pop rivet aluminum "T" "H" or "C" channel,

(obtainable from the Reynolds Aluminum stock rack at your favorite hardware store) to the structure of the area that your panel will be mounted. Cut, fit and trim it so that a fairly loose fit of all four sides of your panel is obtained. The channel you use must have a slot wide enough that will accept the panel and the folded over upholstery material at its edge. It must not fit so tightly that it can't be snapped in or out of place by bowing it. If needed, an upholstery 'snap button' can be judiciously placed to hold it tightly.

Now, evenly glue 1/8" or 3/16" soundproofing mat to what is to be the front side of the panel, leaving about an even 1/2" or 3/4" or so, open area up to the edges. This will make a cushioned panel when covered with your automotive finish cloth or vinyl. Lay this upholstery finish covering material over your panel, using it as a pattern and cut it 2-3" oversize. Applying a coating of "Plio-Bond" (or several coats of contact cement) to the metal or plastic then allowing it to dry, will provide a proper base for gluing material to the back edge of your panel. Lay the panel, with soundproof mat down, on the backside of the finish sheet and cement it down to the back of the panel, pulling the wrinkles on the front out gently. Do not glue to the front at all. If you start with the contact cement slightly wet, you can work out the wrinkles very easily. When dry, trim the backside material away evenly and neatly with a razor blade. Leave about 3/4" holding it. This creates a smooth, cushioned panel that will snap into your aluminum frame very professionally, better than in factory planes! You may use thin 1/8" foam rubber available from the upholstery shop instead of the soundproof mat. Put the soundproof mat on the back side of the panel as explained earlier or, even better, to both sides of your panel AND the inside structure for additional "Super" soundproofing.

You can simply wrap the mat with your upholstery finish sheeting, just gluing it to the back edge of the smooth backside, then gluing the panel in place. The spray on kind of contact cement is very useful here. You can spray and attach it directly to the smooth side if you wish. A little extra attention to the corners of your finish material will be worthwhile for a neat job. A glue like "GOOP" works very well for this.

Larger Aircraft such as Airliners.

Cabin walls will need to be insulated thoroughly in the manner explained above. Many times soundproofing of these types of aircraft is usually done perfunctorily by workers who have no idea what it's all about. Without some knowledge and careful attention to detail the consequence is a soundproofing job that is not very effective.

A Special Note About Helicopters

An application of the thickest material available (we can supply it up to 2" thick and these thicknesses may be contact cemented together for even thicker) installed between the rear cabin and engine/transmission will result in a definite, noticeable noise reduction. Most of the time this is easy to do as these areas are usually quite accessible. It may also be cemented to the inside upper bubble, seat backs and in the underside floor areas for even better results. This may not have a totally silencing effect on the flying noise, but can make conversation possible when on the ground without having to reduce power or use the intercom. The best results will be had by then cementing a layer of Reynolds Aluminum "Noise Barrier" into the mat as was explained.

The Federal Trade Commission says that there are no existing test methods or standards devised to prove the flammability of any material. Or are there accurate indicators of the performance of cellular plastic materials under actual fire conditions. Almost any material will burn under the "right" conditions. The test procedures of F.A.R. 853.b, U.L. 94 or "Class A" are intended only as measurements of the performance of materials under specific controlled conditions. These tests generally mean the material will burn, but not support a flame, or will not support an flame but will create smoke. You can get a good idea about any material you intend to use by burning a scrap of it with a match. Materials used by aircraft manufacturer's years ago may not even meet present day "standards." Generally, if a person is responsible for returning a certified aircraft to service as a shop or mechanic, he should use materials that are FAA approved and follow approved procedures. If it is in the experimental category, you can use whatever you wish. For certified aircraft, a letter is included here in this booklet certifying that it meets requirements of F.A.R 25.853b(3). One may wish to place the letter in the aircraft logbook.

Sound Proofing Ratings. We haven't provided charts and graphs here because these theoretical ratings are pretty much meaningless in the real world.

However, there are useful methods of judging the effectiveness of a soundproofing material by measuring it's absorption and transmissibility properties.

Weight, How Far To Go

There is a weight penalty, of course. The Super Soundproofing Mat weighs from .10 pound for the 1/8" to .7 pounds for the 1" material. (Per sq. ft.) A roll of the popular 1/2" X 50' (200 sq. ft.) mat weighs about 50 Lbs. Obviously, if you put it all in your plane, that's what the weight increase will be, less, of course whatever you pulled out. Generally it takes about 3/4 of a roll of 1/2" mat to do a good job on an aircraft such as a Cessna 182. (about 30 Lbs).

Such weights are not much of a consideration in a heavy twin, but can mean a lot in an ultralight. Common sense counts here. If a few extra pounds of soundproofing, perhaps even combined with an attractive interior offends your pocketbook or sensibilities, perhaps an additional investment would be made in noise-canceling headsets for everyone! In such a case, your wallet will be the one undergoing a dramatic weight reduction! And you thought acoustical material was expensive! Remember, headsets will not protect your hearing in the long term. In general, even a little material is better than none. Here usually, more is better, is the rule.

MORE NOISE REDUCTION RECOMMENDATIONS

The neatness and care that is taken to ensure a good, tight fit and thorough application and covering of the inside skin areas around the cabin will determine the effectiveness of your soundproofing job. There is just so much you can do as a lot of sound is still going to come in the windows. Flat acrylic sheets can be bought from a plastics wholesaler and cut to fit much cheaper than buying pre-cut windows. Those of you that are building experimentals, overhauling or rebuilding aircraft, should consider additional methods of sound reduction i.e. replacing plexiglass windows and windshields with the thickest possible material available (up to 3/8"). Our tests have shown that there is no advantage to using any thicker material. Plexiglas edges of thicker plastic window material can be trimmed down with a router to still fit in the original thinner frames and is well worth the extra trouble.

Also, a fiberglass firewall batting cover fitted on the engine side will also help quiet single engine aircraft. This can be fabricated by your upholstery shop out of heat resistant materials. Cutouts for wiring and other necessary openings through the firewall can be closed by velcro fastenings and is well worth the additional cost and effort.

Loose fitting fairings causing gaps between the wing and fuselage in high wing aircraft can generate lots of wind noise. This must be stopped. An easy way to do this is by using a caulking gun filled with white weatherproof silicone caulk. (Use clear if your paint in that area is not white!) For best results, apply it wet while the fuselage/wing joining cover is off. Clean up with water. First tucking soundproofing mat firmly between the wing/root and the fuselage will really help. This is usually not a problem in low wing planes, but should be investigated.

A noisy door because of a gap in its frame can mean the seal needs replacement or if the door cannot be made to fit properly, (try some very careful bending!), perhaps even a inflatable door seal. There are dealers for inflatable door seal kits for many types of aircraft and such kits can be adapted to most others.

Super Sound Proofing Liquid!

This is a lightweight insulating material designed to add mass to metal surfaces thereby reducing reverberant sound. Several coats can be built up to suit sound proofing need. It also acts as a sound absorption/barrier where mat cannot be applied. Use it in tail cones, under flooring panels, on firewalls and in corners mat cannot go. Brush on, available in half-pints, pints, quarts and gallons.

Super Sound Proofing Flooring!

By popular demand, we are now making our flooring mat available. We've combined a tough, wear resistant vinyl surface with a layer of closed cell foam to cushion and isolate noise and vibration. It is designed for floorboards and firewalls in vehicles, including aircraft. Thickness is about 1/4" and quite lightweight. It comes in 54" widths by the running foot.

In any event, we're here to help you with any questions.

Addendum to "Soundproofing the Light Aircraft" For Boats, RVs and Cars

The principles and applications described in the foregoing for aircraft are completely applicable to other vehicles and even homes and offices. Absorption and blocking of noise are the principles of most importance. How this is accomplished is a measure of the effectiveness of the soundproofing job. First, we will discuss some specifics of

soundproofing certain kinds of vehicles and the specialties of noise reduction in the business, shop, home or office.

- *Autos/Trucks*

In this application the two principle sound producing items are road noise and engine noise. These are dealt with somewhat differently. However, in most cases the method of absorption is used. The engine compartment usually has pretty good noise blocking capabilities, so lining the compartment inside and out (where practical) will do an excellent job. The hood is a particularly important place to start. Factory material is usually not anywhere near adequate to do an acceptable soundproofing job. The hood must be removed and thoroughly cleaned before applying soundproofing!

Road noise can be controlled by placing soundproofing mat on the firewall and Flooring Mat on the floorboards, good coverage is essential. Mat can be cut into squares and heated with a heat gun to help it conform to unusual shapes. Some pretty expensive mat is available from some auto paint wholesalers called Dynamat. Contact cement will hold it permanently in place. (Be sure its waterproof cement!). The walls and roof should receive the treatment if practicable. Our Super Soundproofing Mat is better for this as it comes in one piece instead of 12" squares. Voids (open) areas can be closed up with expanding foam that is sold in cans. This will cut down on an echoing effect. Be sure to do the trunk area as it will tend to resonate like a drum into the passenger compartment from road noise. (Volvos are notorious for this.) "Cadillac" quality comes from lots of soundproofing material and attention to details of covering every square inch with material. Long distance truckers can really benefit from soundproofing their cabs and sleepers and heavy equipment operators will find fatigue greatly reduced as their noisy environment is quieted! Again, a side benefit is the reduction of heat and cold.

- *Boats*

Most noise is generated by the engine and carefully covering the engine compartment with soundproofing mat will do a marvelous job of sound reduction. Soundproofing the engine room walls and ceiling are most important in larger boats (ships), and hanging mats often can often be very effective. More about that in the next section!

Other: Businesses, Shop, Home or Office

Businesses can really benefit by reducing noise pollution. Not only will workers, who spend long hours in the same place every day, but customers (maybe more importantly) will really appreciate a quieter environment. Generally, annoying noise in these areas is caused by machines or people. In an office or business, hard reflective surfaces tend to severely accentuate noise. This is one reason why rugs make a room quieter. Here, soundproofing mat can be placed in strips of one or two feet high and run along the top of walls and even attached to ceilings for impressive noise reduction. These sound absorption runners do a very effective job, the more

the better!! In noisy areas such as a shop, hanging barriers are made by attaching soundproofing mat to plywood squares (both sides!), and suspending them between the offensive noise producing machine and the receiver of the noise. This works wonders. These barriers may be either permanent or temporary. If temporary, they may be moved out of the way with some sort of wheels, hinge, cable or hook arrangement. Temporary ones on casters are useful or suppressing grinding machines or other loud noises that occur at different places around the shop. (Or, for band practice in the garage!) Hanging squares are also effective in high noise areas such as machinery rooms, pizza parlors, game rooms, halls, etc. They need not be long or large enough to be very noticeable. Hang them from the ceiling in rows (at least one foot tall), and notice how the quiet develops! We have acoustical foam wedges, pyramids and for max sound control, anechoic wedges in blocks and squares.

Contact us direct for help in other noise control situations, such as architectural acoustics. We provide free consultation!

SUPER SOUNDPROOFING CO

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To The Pilot, Mechanic or Installer!!

Most of the materials mentioned are available

from a variety of sources, your common

hardware store has some of the items. The

[SUPER SOUNDPROOFING MAT](#)

is only available from us and:

AIRCRAFT SPRUCE & SPECIALTY

225 Airport Circle 91720

P.O. Box 4000 91718

Corona, CA. U.S.A.

Questions? Certs? We are happy to offer recommendations, advice, assistance and free samples, or a hard copy of this booklet. Just call or write us.

Logbook Certification letter:

SUPER SOUNDPROOFING CO

Vista, CA 92084

September 3, 1996

**RE: FAA CERTIFICATION OF "SUPER
SOUNDPROOFING" MATERIAL**

To Whom it may Concern:

This letter provides information regarding Super Soundproofing Material for which we are the mill distributors. This letter is to certify the material has FAA approval.

Our Super Soundproofing Material, is a vinyl-nitrile closed cell expanded foam. It has been tested by an FAA approved laboratory that has determined the material, in thicknesses over 1/8th inch meets, or exceeds, the flammability test criteria that is contained in FAR 25.853(b). Results are available on request.

This material, in all thicknesses, meets various portions of U.L. Lab criteria regarding different qualities and parts of D.O.T. "Proposed Guidelines for Flammability and Smoke Emission Specifications."

In addition, the material meets MIL Spec. MIL-P-15280-H Form S. regardless of its thickness.

I herewith certify the above is true and correct.

William Nash

General Manager

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