The Doorway
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BOEING 737

ANTIMICROBIAL TREATED

The Gill Corporation (TGC) has supplied The Boeing Company with qualified composite materials for nearly 60 years. These lightweight, high-performance materials are supplied directly to Boeing and throughout Boeing's global supply chain. TGC supports airlines, maintenance organizations and passenger-to-freight conversion companies around the world with OEM qualified replacement materials as well as proprietary materials optimized for aftermarket applications in the form of materials, parts, assemblies and shipset kits.

In 1964 Boeing began development of the B737, a twin engine jet designed for short routes. It made its first flight in 1967. Since then, several generations of the B737 have been introduced, each requiring higher performance materials than the last. Through continued research and development and by evolving our products with the newest technologies and materials, TGC has been able to meet the new demands of each generation.

TGC product offerings have steadily increased over the years through research and development of more advanced material solutions to meet or exceed the challenges of each generation of Boeing 737 aircraft. These proprietary solutions include qualified materials to produce floor panels, cargo bay linings, interior monuments, stowage bins, flight control surfaces, engine nacelles, inner fixed structures, tail cones, lightning protection, and many other applications.

Boeing Family:

- 1st Generation, the "Original" generation: the 737-100 and -200, as well as the military T-43 and C-43.

- 2nd Generation, the "Classic" generation: 737-300, -400 and -500 series.
- 3rd Generation, the "NG" series: 737-600, -700, -800 and -900 series, also the military C-40 and P-8.

- 4th Generation: 737 MAX series.

737

CARGO LINER – A HISTORICAL PERSPECTIVE

It has been nearly 60 years since TGC received its first cargo liner order that launched the company into the aviation industry. At this same time, the commercial aviation industry was experiencing an evolution of its own. Aircraft design was transitioning from piston to jet engines, a move that would shape the aviation industry for the next half century. Each new generation of aircraft brought a demand for lighter, stronger, and more abrasion resistant materials. As a pioneer of composite materials, TGC has been steadfast in developing new technologies to meet the new demands.

Although even the earliest fiber reinforced plastics (FRP) represented a major breakthrough in cargo liner material, these products possessed fewer than half of the characteristics offered by contemporary designs. In fact, most of the tests used to measure key characteristics (e.g. impact resistance, edge bearing strength, and abrasion resistance) were not developed until the mid 1960's or later. Advancements in glass reinforcements (fiber, weave and finishes), resin technologies, and alternative processing techniques have helped to transform cargo liner to some of the most advanced designs offered today.

EVOLUTION OF PRODUCTS

BMS 8-2 (Polyester)

- **Class 1, c. 1961** — E-Glass Reinforced, General Purpose Liner
- **Class 2, c. 1982** — S, E/S Reinforced, High Impact Resistant
- **Class 3, c. 1995** — E-Glass Reinforced, High Abrasion Resistant

TGC Proprietary (Polyester)

- **Gilliner™ 1366D, c. 2015** — E/S Reinforced with surfacing scrim, High Impact, Edge-Bearing, Abrasion Resistant

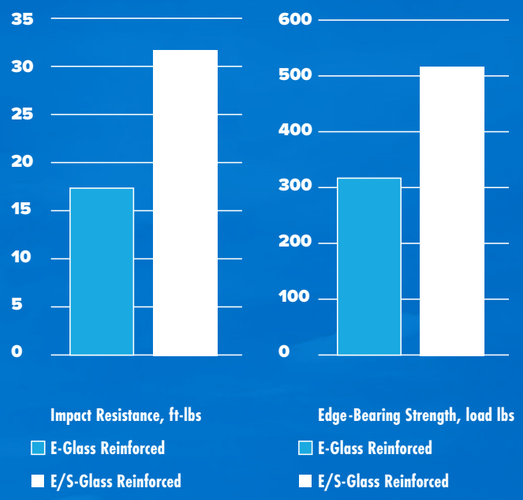
BMS 8-223 (Phenolic)

- **Class 2, c. 1990** — S, E/S Reinforced, High Impact Resistance/ Low FST
- **Class 4, c. 1992** — S-Glass Reinforced, Lightweight, High Impact Resistance/Low FST
- **Class 5, c. 2006** — S-Glass Reinforced, Ultra lightweight, High Impact Resistance/Low FST

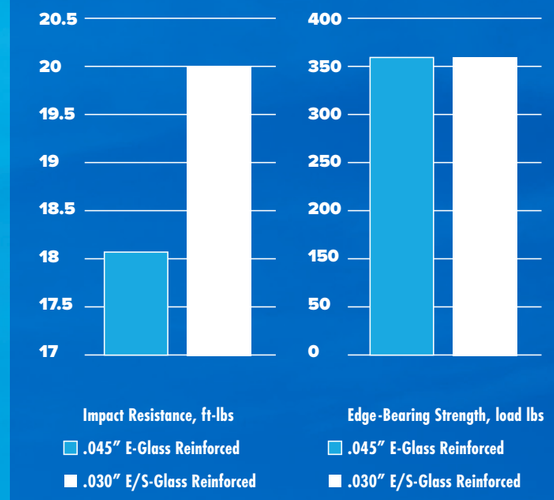
Most early cargo liner designs, including BMS 8-2 Class 1, rely on E-glass reinforcement laminated with a polyester resin matrix. Although E-glass exhibits good mechanical properties and offers a balance between cost and strength, it has limited design flexibility. Some improvement can be achieved using different weaves and finishes, however, increasing thickness is generally the approach to achieving higher strength. Of course, an increase to thickness comes with an increase in weight.

In the late 1960's a new glass reinforcement was introduced that revolutionized cargo liner design. Originally developed by Owens Corning Textile Products in the early 1960's for military applications, S-glass has an estimated 40% higher tensile strength and 20% higher modulus than E-glass. Used as a reinforcement in cargo liner, S-glass yields higher strength at a lower weight. Gilliner® 1366 is designed using a combination of woven E- and S-glass to optimize strength, cost, and weight. Originally introduced as a TGC proprietary product in the mid 1970's, Gilliner® 1366 established the benchmark for high strength polyester cargo liner and was qualified to BMS 8-2 Class 2 in 1982.

STRENGTH OF E-GLASS VS E/S-GLASS CONSTRUCTION (.045" THICK)



WEIGHT SAVINGS POTENTIAL OF E/S-GLASS (.030" THICK) VS. E-GLASS (0.45" THICK)

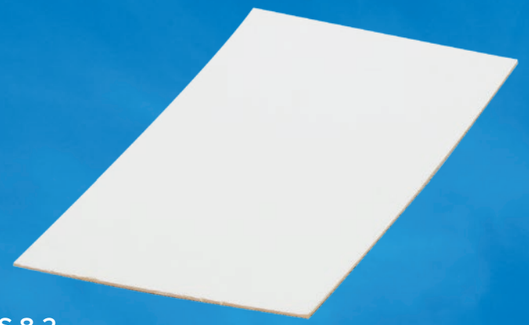


During the mid-1980's, the Federal Aviation Administration (FAA) conducted a series of studies on the effects of fire, smoke, and toxicity (FST) levels to survivability in a post crash environment. Speculating the possibility of more stringent flammability requirements in the cargo hold, OEM's turned their focus to phenolic cargo liner due to its low FST characteristics. Beginning in 1990, TGC introduced a family of phenolic liners that are qualified to BMS 8-223 Class 2, 4, and 5. The Gillfab® 1367 series (now 1368 series) is produced in both woven E/S- and S-glass constructions to deliver some of the highest strength to weight ratios of any cargo liner material.

To date, the FAA has not imposed smoke and toxicity requirements for cargo liners. For B737 aircraft, polyester remains the standard cargo lining material.

In the mid-1990's, Boeing reverted back to polyester cargo liner for the B737 lower sidewall, adding a Class 3 to the BMS 8-2 specification. Class 3 established the requirements for a high wear resistant grade and introduced a new test procedure to measure abrasion. Gilliner® 1076D, qualified to BMS 8-2 Class 3 in 1995, is constructed from woven E-glass cloth with a polyester resin matrix. This product features resin rich surfaces to prevent wear-through over frame sections and attach points that are associated with repetitive bulk cargo handling.

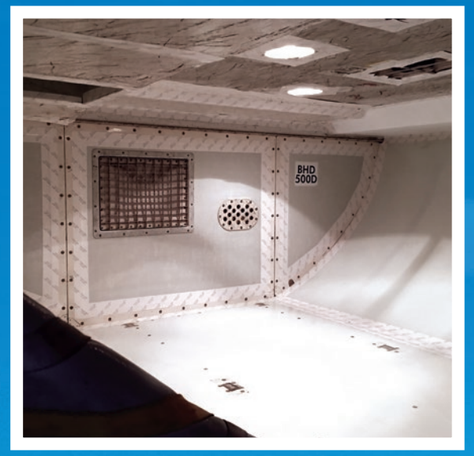
B737 LOWER SIDEWALLS – A GILL PROPRIETARY SOLUTION



In 2015, TGC commenced development of a new cargo liner in direct response to airlines' request for a higher strength alternative to BMS 8-2 Class 3. The objective was to develop a liner that would provide superior impact-resistance, edge-bearing and flexural strength, and also be highly abrasion resistant.

While there are a variety of test methods that have been developed to simulate in-service conditions and measure key material characteristics, they are not necessarily predictive of in-service durability. For abrasion-resistance, there are two test methods defined in the specifications but neither yielded results that matched the inputs received from airlines. Products either passed testing all of the time or the weight loss involved was so small that it was difficult to measure actual change. In order to differentiate between candidate materials, TGC's R&D team developed a more rigorous test method that clarified material differences. The results were validated through in-service trials.

Introduced in 2016, Gilliner® 1366D, is a culmination of more than 40 years of proven technology blended to deliver a product with superior in-service durability. Produced using a combination of woven E- and S-glass reinforcement with resin rich surfaces that are supported by a nylon scrim, Gilliner® 1366D yields almost 2X the impact resistance required by Class 3 and more than 40% higher edge-bearing strength. This product is available in .045" and .060" thicknesses.

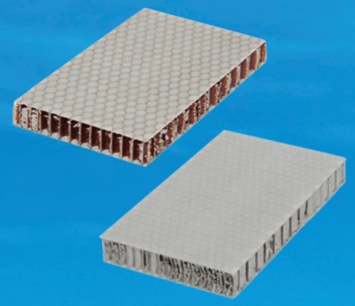


Today, TGC continues to develop and evaluate new resin systems, reinforcements and surfacing scrims to prepare for demands of the next generation.

FLOOR PANELS – TGC'S CONTINUED COMMITMENT TO PRODUCT DEVELOPMENT AND VERTICAL INTEGRATION

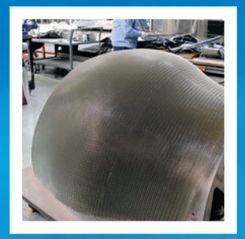
Advancements in FRP technology have also driven advanced floor panel designs. During the 1960's, most floor panels utilized end-grain balsa wood core with either aluminum or fiberglass facings (BMS 4-10). While these panels offered good stiffness, core shear, and point load resistance, they were relatively heavy and lacked design flexibility. In the 1970's, floor panel design shifted to aramid honeycomb with unidirectional glass reinforced epoxy facings (BMS 4-17). Aramid core provides high shear and compression strength and exhibits high fatigue resistance in floor structures. Aramid honeycomb is available in a variety of cell sizes and densities. When combined with FRP facings, this panel offers the potential to optimize constructions to meet the varying service conditions of the aircraft (under seat, aisle, highly loaded, etc.). In the 1980's, BMS 4-23 was introduced as a lower cost alternative to BMS 4-17. Similar to BMS 4-17 in weight and strength, BMS 4-23 features an aluminum honeycomb, a lower cost alternative to aramid. Today, TGC produces both BMS 4-17 and BMS 4-23 panels used in B737 passenger cabin and main-deck freighter applications.

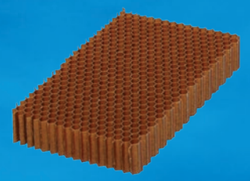
Meeting the demands of each new generation of aircraft requires significant financial investment. For the B737 program, TGC's investment included the acquisition of a key material supplier. In 2001, TGC acquired the assets of Alcore, Inc. in Edgewood, Maryland, and Alcore Brigantine in Biarritz, France, (known today as TGC-Maryland and TGC-France). At the time of these acquisitions, Alcore, Inc. was a major supplier of structural metallic honeycomb cores used in TGC's sandwich panel production. After being awarded the exclusive contract for BMS 4-23 floor panels, this acquisition expanded TGC's vertically integrated manufacturing to include both metallic and non-metallic honeycomb core. In addition to the manufacture of metallic honeycomb, this acquisition also expanded our capabilities to include 5-axis machining of both metallic and non-metallic honeycombs.

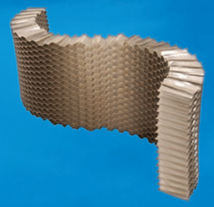


HONEYCOMB SUPPORT OF B737 PROGRAM

TGC supplies both aramid and aluminum honeycomb cores to B737 program. These materials are supplied in block, sheet, or machined details depending on application. Sheet stock is typically converted to a sandwich structure for use in interior monuments such as overhead bins, class dividers, crew rests, etc. Machined details are supplied to Tier 1 suppliers who bond skins to these details to create flight control surfaces and engine components. Today, TGC supplies a variety of honeycomb for B737 assemblies including spoilers, outer walls of engine nacelles, tail cones and inner fixed structures.







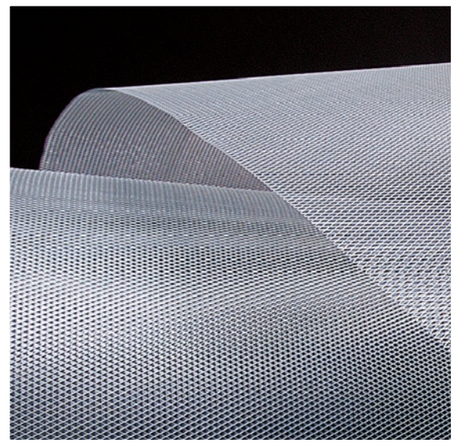
STRIKEGRID® LIGHTNING PROTECTION SUPPORTS THE B737 MAX

Lightning is a natural threat that must be considered for increased safety in the design and the certification of aircraft. Protecting aluminum body aircraft from lightning strikes involves wicking away the electric charge through the conductive metal structure. With advances in the use of composites to fabricate aircraft structures, including use of much more composite materials in the fuselage, new systems for dealing with lightning strikes are being introduced.

In 2004, TGC introduced PAA Strikegrid® Continuous Expanded Aluminum Foil (CEAF). It is the industry's highest-performing lightning-strike dissipation material. Phosphoric acid-anodized and coated with a proprietary coating, it outperforms all other ductile materials. Decades of operational experience have shown that bond durability between lightning-strike materials and face sheets or surfacing materials is critical to long part life; and for this, PAA-Strikegrid® foil has no equal.

B737 PASSENGER TO FREIGHTER CONVERSIONS

For more than 20 years, TGC has been supporting B737 passenger-to-freighter conversion programs with main-deck floor panels, cargo liners, interior panels, and honeycombs. Industry analysts project that the global fleet of single-aisle freighters will grow by more than 42% by 2037. An estimated 90% of single-aisle freighters are converted aircraft, and the average age at the time of conversion is 21-22 years. Converting passenger aircraft during this "window of conversion" allows for extension of the economic life of the aircraft while enabling freight operators to realize significant savings vs. new production freighters. B737 P2F conversion programs supported by TGC include both Classic and Next Generation models with multiple Supplemental Type Certificate (STC) holders.

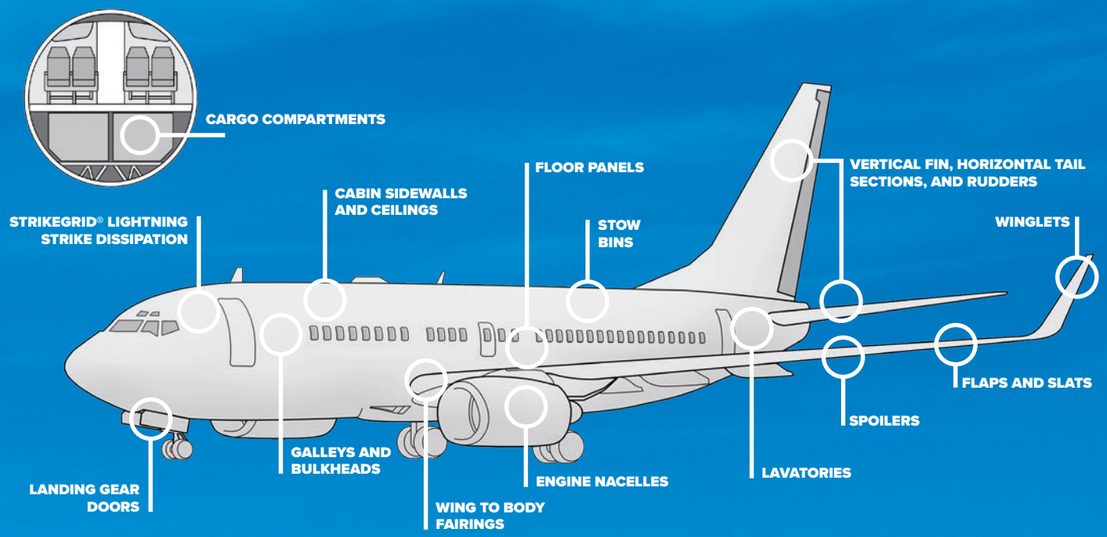


Strikegrid· Lightning Strike Dissipation

LAMINATES

PRODUCT	MATERIAL	RESIN	STRENGTH	APPLICATION	SPECIFICATION
Gilliner® 1076C/ 1566C/1567A	Woven E-glass cloth	Polyester	General purpose grade.	Sidewalls, ceilings, partition walls and bulkhead facings of the lower cargo hold and main deck (freighters).	BMS 8-2 Cl 1 Gr A
Gilliner® 1366*/1566/ 1569A	Woven E- and S-glass cloth	Polyester	High impact grade. Offers higher strength-to-weight ratio compared to all E-glass constructions.	Sidewalls, ceilings, partition walls and bulkhead facings of the lower cargo hold and main deck (freighters).	BMS 8-2 Cl 2 Gr A
Gilliner® 1366T/1566T/ 1570A	Same as Gilliner® 1566/1569A but with a white Tedlar® overlay on the face side	Polyester	High impact grade.	Sidewalls, ceilings, partition walls and bulkhead facings of the lower cargo hold and main deck (freighters).	BMS 8-2 Cl 2 Gr B
Gilliner® 1076D/1566D/ 1568A	Woven E-glass cloth	Polyester	High wear resistant grade.	Sidewalls, ceilings, partition walls and bulkhead facings of the lower cargo hold and main deck (freighters).	BMS 8-2 Cl 3 Gr A
Gillfab® 1367/1367A/ 1368/1368A	Woven E- and/ or S-glass. Tedlar on the face side	Phenolic	High impact, low smoke and toxicity grade.	Cargo liner. Backing material for non-textile floor mats used in wet areas of cabin interiors (without PVP film overlay).	BMS 8-223 Cl 2 Gr B
Gilliner® 1366D	Woven E- and S-glass cloth with a nylon surface scrim	Polyester	High impact, edge-bearing and abrasion resistance.	B737 lower sidewall.	FAR Part 25 App F Parts I and III

**This part number is still available as a TGC proprietary product.*



This is not an inclusive list of where TGC products are used. TGC metallic and non-metallic honeycomb cores are sold to customers around the world for use in many applications across the Boeing 737 aircraft.

HONEYCOMB

PRODUCT	DESCRIPTION	CORE	STRENGTH	APPLICATION	SPECIFICATION
Gillcore® HD	Meta-aramid fiber reinforced honeycomb which is coated with heat resistant phenolic resin.	Meta-aramid honeycomb	High strength-to-weight ratio.	Interior aircraft panels including flooring, sidewalls, ceilings, galleys and lavatories. Exterior aircraft panels including trailing and leading edges, flaps, ailerons, fairings, helicopter blades, access panels and doors.	BMS 8-124 Cl IV, Types I-VI
DURA-CORE® II 5052 and 5056	Aluminum honeycomb which provides the aerospace and commercial markets with a high degree of flexibility in solving lightweight structural design challenges.	Aluminum honeycomb	Excellent corrosion resistance in hostile environments, especially salt fog.	Plane exteriors - It provides the aerospace and commercial markets with a high degree of flexibility in solving light weight structural design challenges. Prior to bonding, the foil is cleaned and treated using a proprietary chemical conversion coating.	BMS 4-4 Class N, P, ND Grade I Types All
PAA-CORE® 5052 and 5056	Uses a phosphoric acid anodized metal treatment process which is highly corrosion resistant aluminum honeycomb core with excellent bonding capability and durability.	Aluminum honeycomb	Highest performing core material - high strength-to-weight ratio. Corrosion resistance and phosphoric acid anodized and coated with a proprietary primer, it outperforms all other core materials.	Plane exteriors.	BMS 4-4 Class NPA Grade I Types All

PANELS

PRODUCT	MATERIAL	ADHESIVE	CORE	STRENGTH	APPLICATION	SPECIFICATION
Gillfloor® 4417	Unidirectional glass	Epoxy	Meta-aramid honeycomb	High strength.	Wet and/or highly-loaded areas.	BMS 4-17 Ty I, II, III, VI
Gillfloor® 4417A	Unidirectional glass	Epoxy	Meta-aramid honeycomb	High strength.	Wet and/or highly-loaded areas.	BMS 4-17, Ty VI
Gillfloor® 5424	Unidirectional fiberglass	Epoxy	Aluminum honeycomb core	High strength.	Under seat, aisle, main deck (freighter).	BMS 4-23, Ty I, II, III

Quotables

Don't spend your time on anything your customers don't perceive to be of value.

—Michael Basch, Vistage Speaker

You may have to fight a battle more than once to win it.

—Margaret Thatcher, Politician

The issues of the CEO inevitably re-emerge as issues within the organization.

—James Newton, Vistage Speaker

The downfall of the magician is the belief in his own magic.

—Russ Walden, Ridgewood Properties

You can always spot a well-informed man – his views are the same as yours.

—Ilka Chase, Actress

You can go a long way with a smile. You can go a lot further with a smile and a gun.

—Al Capone, Gangster

When you are arguing with a fool, make sure he's not doing the same thing.

—Unknown

You can live to be 100 if you want to give up all the things that make you want to live to 100.

—Woody Allen, Entertainer

Things will get better despite our efforts to improve them.

—Will Rogers, Humorist

The most terrifying words in the English language are, "I'm from the government and I'm here to help."

—Ronald Reagan, President

A boat is an anchor.

—Frank Forencich, Scholar

The older I get; the better I was.

—Sandy Koufax, Baseball player

It's always supervision.

—Stephen Gill

The place has become so popular that nobody goes there, anymore.

—Yogi Berra, Baseball Player

Everybody gets so much information all day long that they lose their common sense.

—Gertrude Stein, American Author

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