

# The Doorway

A Publication of The Gill Corporation

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Volume 58 - Number 4 - Fall 2022



# BOEING 777



ANTIMICROBIAL TREATED

**T**here are many important factors that influence an Original Equipment Manufacturer's (OEM) decision to launch a new aircraft design. Informed by cost, market requirements, operating efficiencies and airworthiness regulations, OEMs look to fill 'gaps in the market'; wherein a class or design of aircraft does not yet exist, but where there would be significant demand.

By the mid-1980s, the aviation industry had made improvements to airplane systems and engines that ultimately led the FAA to approve Extended-range Twin-engine Operations Performance Standards, also known as ETOPS. Although this approval enabled airlines to operate more direct, fuel efficient, trans-Atlantic and trans-Pacific routes, there remained a gap in the market for a high capacity, twin engine aircraft.

In 1989, Boeing officially launched the B777 program, the world's largest twin jet aircraft, developed in collaboration with eight airlines to establish capacity and specifications. In June 1995, the B777-200, entered service with launch customer United Airlines, becoming the first airplane in aviation history to have FAA approval to fly ETOPS at the time of service entry. Since then, two generations and a total of five variants have entered service.

In 2019, the B777 became the most popular wide-body aircraft, due to its superior range and fuel efficiency. Of the 20 longest commercial routes flown today, half are operated by a B777. As of October 2022, more than 60 customers have placed orders for 2,141 aircraft with 1,696 delivered.<sup>1</sup>

The 3rd generation B777X, scheduled to enter service in 2025, will be the largest, and highest capacity twin engine to date with a length of 76 meters and capacity up to 426 passengers in a two-class configuration.<sup>2</sup> Despite commonality with earlier B777 aircraft, the B777X will feature new engines and larger wings to achieve even greater efficiency, capacity, and range.

### 1ST GENERATION

B777-200  
B777-200ER  
B777-300



### 2ND GENERATION

B777-300ER  
B777-200LR  
B777F



### 3RD GENERATION

B777X



<sup>1</sup> <https://www.boeing.com/commercial/#/orders-deliveries>

<sup>2</sup> <https://www.boeing.com/commercial/777x/>

B777X photograph: MB-one, clipping: Marc Lacoste, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

## WEIGHT VS. PERFORMANCE

Achieving an optimum balance between weight and strength is a critical aspect of aircraft design. The structure must be strong and stiff enough to withstand the forces introduced during flight operations and durable enough to withstand these forces throughout the service life of the aircraft. This analysis often involves technical trade-offs. The best design typically provides maximum performance at the lowest weight. Accordingly, high performance composite materials that exhibit high strength-to-weight and stiffness-to-weight ratios have become integral to next generation aircraft design, often replacing metallic structures.

The B777 achieved a 20% weight reduction by incorporating composite materials in the wing's fixed leading edge, the trailing-edge panels, the flaps and flaperons, the spoilers, the outboard aileron, floor beams, wing-to-body fairing and the landing gear doors. Using composite materials for the empennage alone saves approximately 1,500 pounds in weight.

The Gill Corporation (TGC) has a longstanding history supporting the B777 program with lightweight, high-performance materials. Today, TGC's support of the B777 program includes fabricated floor panel kits, cargo bay lining, interior monuments, stowage bins, flight control surfaces, engine nacelles, inner fixed structures, tail cones, lightning protection, and many other applications.



## CABIN AND CARGO FLOOR PANELS AND CARGO LINERS

Each generation of B777s have required further weight savings with no sacrifice to mechanical strength. In response, TGC has continued to leverage advancements in materials and technologies to meet the increasingly stringent demands of each generation.

**Gillfloor® 4709**, qualified to BMS 4-20 Types II, III, and V, is a lightweight, high-strength floor panel made from unidirectional carbon reinforced epoxy facings, bonded to meta-aramid honeycomb core. The outer panel surfaces feature a lightweight glass reinforced isolation barrier to help protect against galvanic corrosion. Gillfloor® 4709 is installed under seat and main aisle locations of the B777 passenger compartment and offers a 10-12% weight savings compared to a panel having unidirectional glass reinforced facings.

**Gillfloor® 4809**, qualified to BMS 4-20 Types VI through IX, is an ultra-lightweight, high strength floor panel made from unidirectional carbon reinforced epoxy facings, bonded to para-aramid honeycomb core. The outer surfaces feature a lightweight glass reinforced isolation barrier to protect against galvanic corrosion. Originally developed for the B787 aircraft, Gillfloor® 4809 has been specified for use in the B777X, providing a 13% to 21% weight reduction as compared to Gillfloor® 4709 used in the 1st and 2nd generation aircraft.

**Gillfloor® 4417 & 4417A**, qualified to BMS 4-17 Types I through IX, are high strength floor panels made from unidirectional glass reinforced epoxy facings, bonded to meta-aramid honeycomb core. Gillfloor® 4417 & 4417A are installed in the wet and/or highly loaded areas of the B777 such as entries, galleys and lavatories, EE Bays, and in the lower cargo hold floors.

**Gillfloor® 4518**, qualified to BMS 4-17 Types X and XI, is a lightweight, high-strength floor panel made of unidirectional and woven glass reinforced epoxy facings, bonded to para-aramid honeycomb core. Gillfloor®4518 is installed in the main deck floor locations of the B777 freighter aircraft.

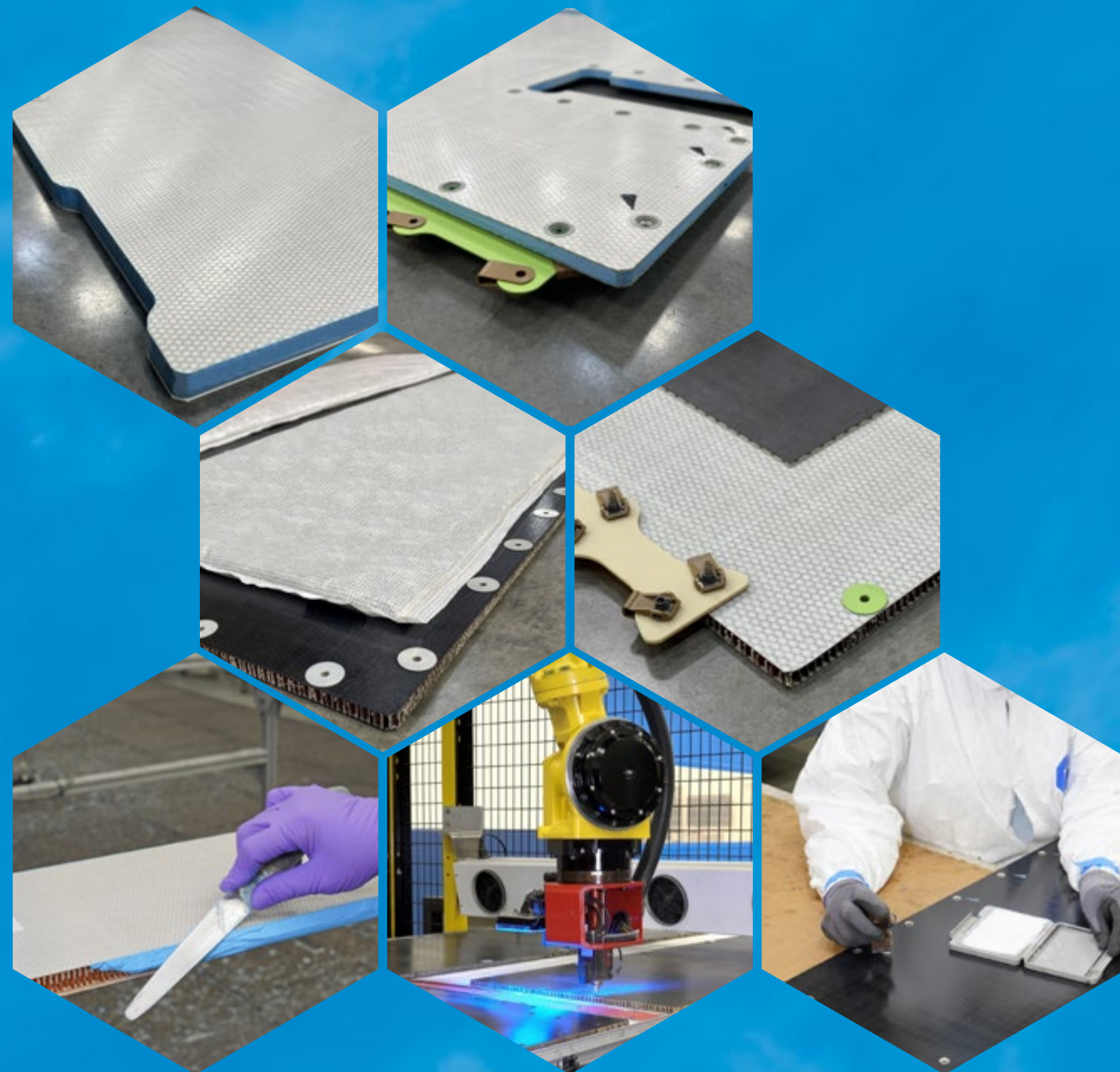
**Gillfab® 1368B**, qualified to BMS 8-223 Class 4, Grade B, Types 13-50, is a high strength, lightweight cargo liner with low-smoke and toxicity flammability characteristics made using woven S-glass reinforcement with a modified phenolic resin matrix. The high strength-to-weight ratio of S-glass achieves a 15-20% weight savings compared to a hybrid (E/S-glass) construction with no sacrifice to mechanical properties. Gillfab® 1368B is installed in sidewall linings in B777 cargo bays.

**Gillfab® 5433E**, qualified to BMS 7-326 Type VII, Class 2/1, Grade C, is a hybrid laminate made from aluminum facings bonded to a woven fiberglass reinforced epoxy laminate. Gillfab® 5433E achieves higher strength characteristics than solid aluminum at a 9% weight savings, and is designed for use in high abuse, bulk cargo floor areas of B777.



## BOEING FABRICATED PANEL PROGRAMS

In 2016, TCG was successful in bidding the fabricated floor panel statement of work for the new 777X and later the 777 program, which is now entirely 777-200 freighter configurations. Between the platforms, the fabrication work includes CNC cutting of 4417/4417A, 4709, 4518, and 4809 panels, insert installation, edge fill, bulb seals, bonding of insulation blankets, dampers, non skid tape, and attaching stiffeners, as called out per drawings. In 2022, TGC was awarded an extension and will continue to provide the drop-in ready kitted shipsets directly to Boeing.



## HONEYCOMB

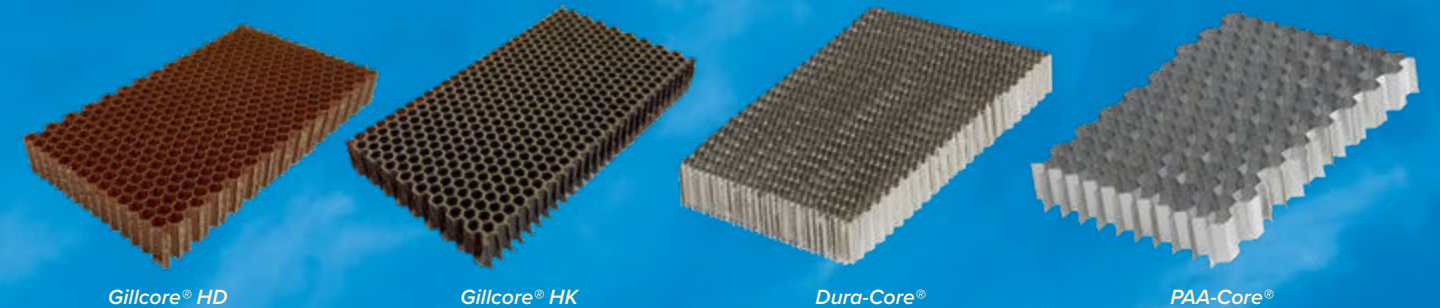
TGC supplies both aramid and metallic honeycomb cores to the B777 program. These materials are supplied in block, sheet, or machined core details and bonded assemblies depending on application. Sheet stock is typically converted to a sandwich structure for use in interior monuments such as overhead bins, class dividers, crew rests, etc.

**Gillcore® HD**, qualified to BMS 8-124 Class IV, Types I-VI, is a meta-aramid fiber reinforced honeycomb coated with heat resistant phenolic resin to solve most structural design challenges in composite aerostructures when non-metallic honeycomb is preferred.

**Gillcore® HK**, qualified to BMS 8-124 Class VI, Types V and VI, is a para-aramid fiber reinforced honeycomb coated with heat resistant phenolic resin for translation of shear and compressive properties and is suitable for applications requiring a high degree of forming. It's up to 25% lighter than meta-aramid with enhanced performance characteristics including strength, stiffness and fatigue. Gillcore® HK offers exceptional performance/weight ratio for all applications.

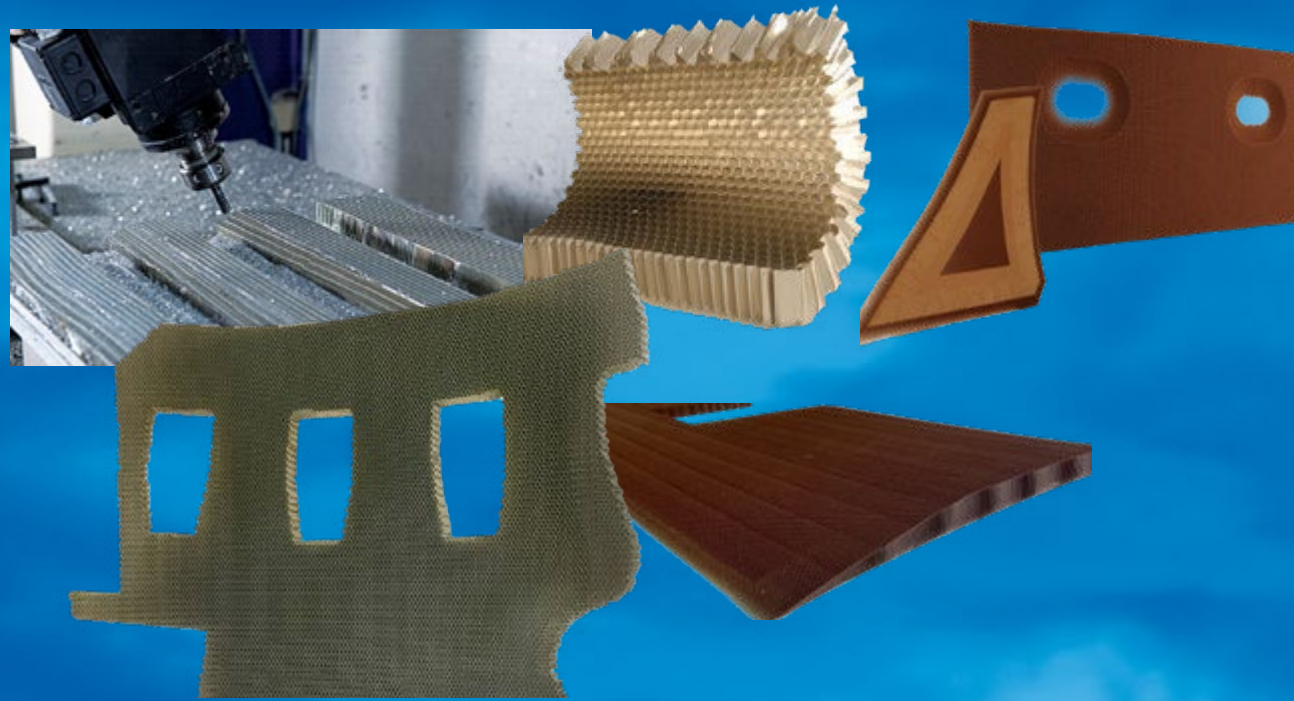
**Dura-Core®**, qualified to BMS 4-4 Class N, P, ND Grade I, Types All, is a high performance aluminum honeycomb core that solves light weight structural design challenges and exhibits excellent corrosion resistance in hostile environments, especially salt fog.

**PAA-Core®**, qualified to BMS 4-4 Class NPA Grade I, Types All, including engine nacelle suppliers, is the ultimate aluminum honeycomb core. Our Phosphoric Acid Anodized (PAA) foil treatment process yields unsurpassed corrosion resistance with excellent bonding properties and allows for the bonding of carbon skins without the risk of galvanic corrosion. One of its distinctions is a high strength-to-weight ratio. It's been proven over the years to provide critical bond durability between core and skins, critical to long part life, and for this, PAA-Core® has no equal.



## MACHINED HONEYCOMB

TGC has three Centers of Excellence (CoE) for honeycomb machining. Each CoE manufactures machined details that are supplied to sub-tier suppliers who incorporate those details into parts and assemblies such as flight control surfaces, engine and nacelle components, landing gear doors, and fairings.



## STRIKEGRID® LIGHTENING PROTECTION

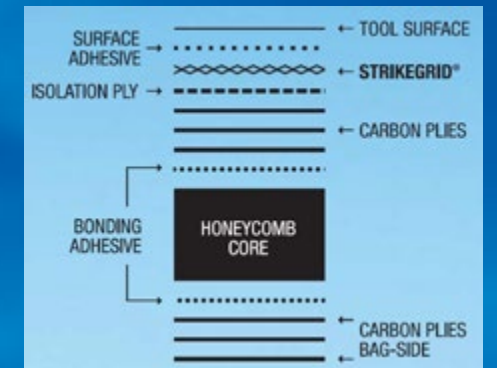
While use of high-performance composites can accomplish significant weight savings as compared to metallic structures, differences in material characteristics, including the ability to withstand environmental conditions must be considered.

Lightning is a natural threat that must be addressed during the design and certification of an aircraft. While protecting aluminum body aircraft from lightning strikes involves wicking away the electric charge through the conductive metal structure, composites structures do not have the same conductive characteristics. The increase in use of composites to fabricate fuselage and exterior airframe structures has created a requirement for new protective systems for dealing with lightning strikes.



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 (PAA) and coated with a proprietary coating, it outperforms all other ductile materials.

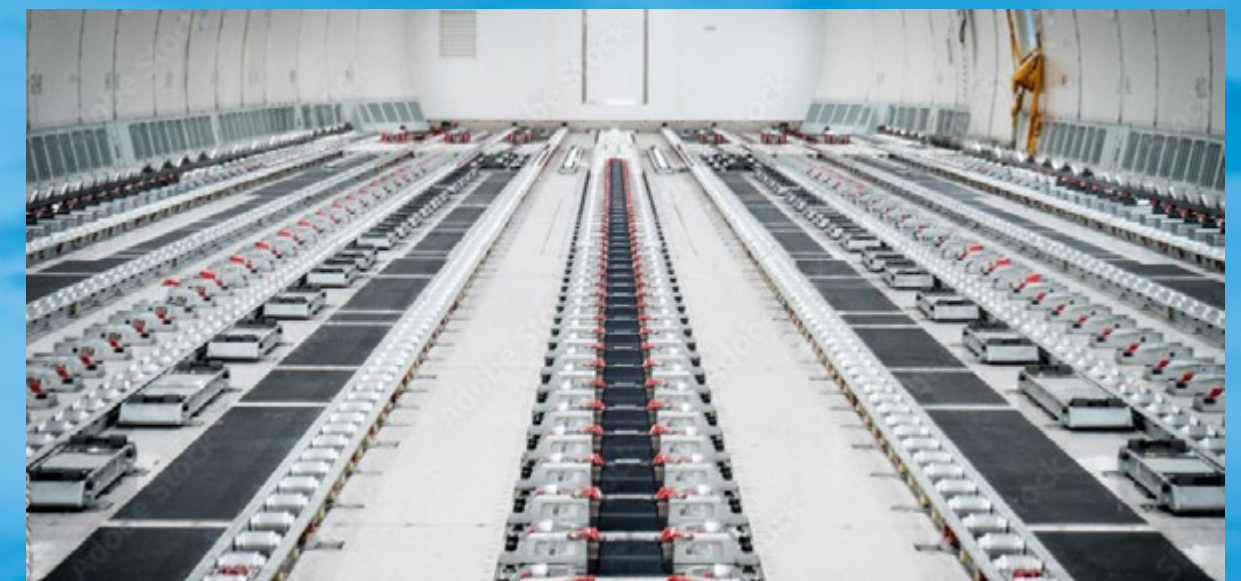
Strikegrid® materials are qualified to BMS 8-336, Type 1, Class 2, Grade 013, Form B, Style F for SG-3, 2 mil thick material and Type 1, Class 2, Grade 016, Form B, Style F for SG-4, 4 mil thick material. Strikegrid® CEAF features on various exterior surfaces of the B777 aircraft.



## AFTERMARKET SUPPORT – MRO AND PASSENGER-TO-FREIGHTER CONVERSIONS

TGC's support of B777 aircraft extends to the global aftermarket, where it supplies airlines and maintenance, repair, and overhaul operations with OEM-qualified floor panels, cargo liners, and honeycomb core. These products are used in routine maintenance, cabin modifications, and passenger to freighter conversion programs.

For more than 35 years, TGC has been supplying freighter aircraft programs with floor panels, cargo liners, interior panels, and honeycombs. These products are supplied as details, fabricated parts, assemblies, shipset kits or in sheet stock form. Our supply to Boeing of high-performance materials through fabricated drop-in ready B777 assemblies lays the foundation to offer customized products and finished assemblies to all modification companies developing B777 passenger to freighter aircraft.



## HONEYCOMB

PRODUCT	DESCRIPTION	CORE	STRENGTH	APPLICATION	SPECIFICATION
<b>Gillcore® HD</b>	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 Class IV, Types I-VI
<b>Gillcore® HK</b>	Para-aramid fiber reinforced honeycomb which is coated with heat resistant phenolic resin.	Para-aramid honeycomb	High shear strength and modulus.	Interior aircraft panels including flooring, sidewalls, ceilings, galleys and lavatories. Exterior aircraft panels including trailing and leading edges, flaps, ailerons, radomes, fairings, helicopter blades, access panels and doors.	BMS 8-124 Class VI, Types V and VI
<b>Dura-Core® II 5052 and 5056</b>	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
<b>PAA-Core® 5052 and 5056</b>	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 ration. 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

## ALUMINUM FOIL

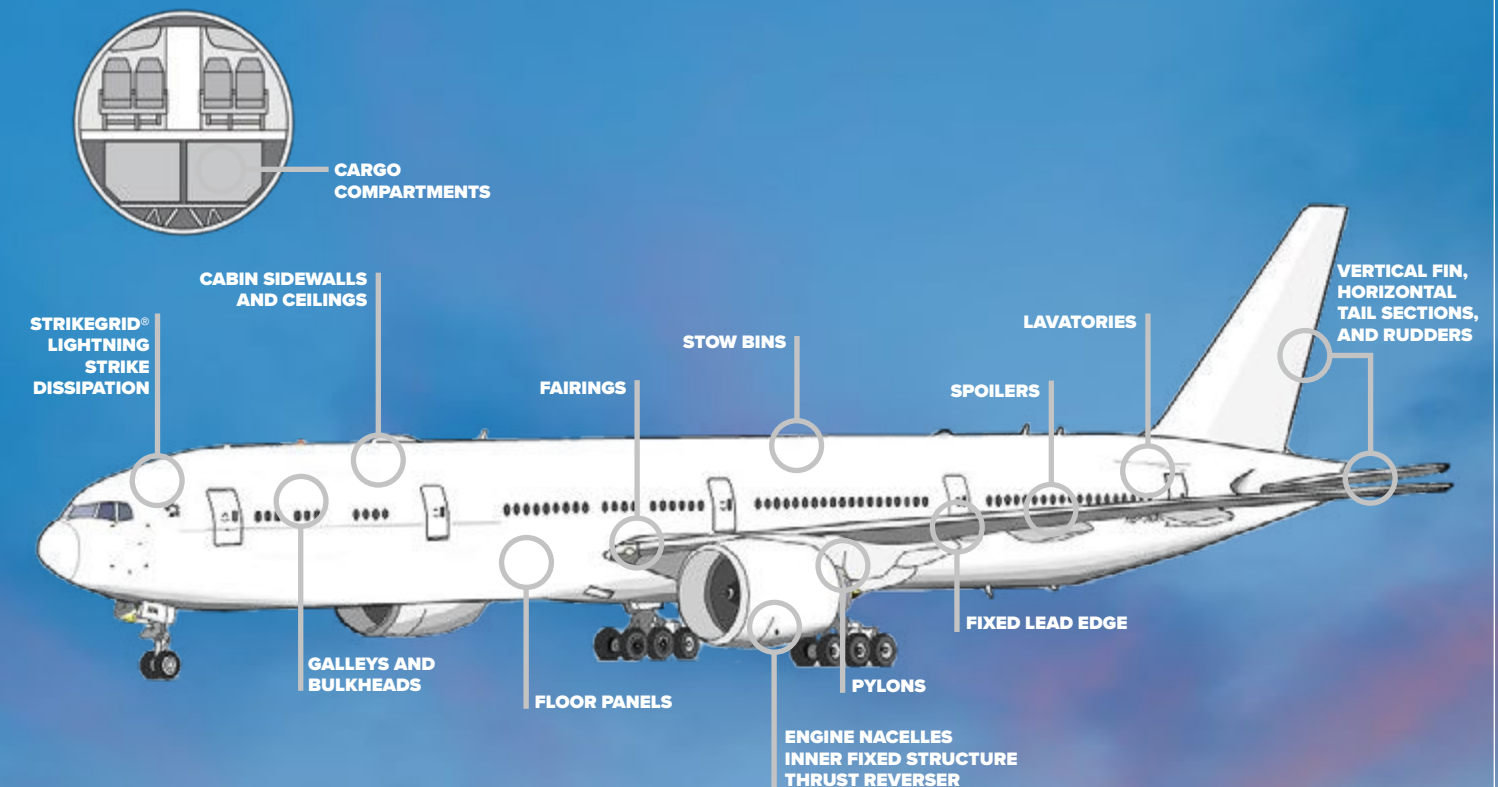
PRODUCT	MATERIAL	STRENGTH	APPLICATION	SPECIFICATION
<b>Strikegrid®</b>	Strikegrid® CEAF is a phosphoric acid anodized (PAA) continuous expanded aluminum foil (CEAF) product that also includes a proprietary coating which combines to negate the effects of galvanic corrosion when used in conjunction with carbon prepreg materials.	Superior protection versus industry incumbent copper and phos-bronze mesh products of similar thickness and composition.	Strikegrid® can be bonded to aircraft structures either as an outer ply or embedded 'one-ply down' beneath a layer of surfacing film.	BMS 8-336 Type 1, Class 2, Grade 013, Form B, Style F for SG-3, 2 mil thick material and Type 1, Class 2, Grade 016, Form B, Style F for SG-4, 4 mil thick material.

## LAMINATES

PRODUCT	MATERIAL	RESIN	STRENGTH	APPLICATION	SPECIFICATION
<b>Gillfab® 1367B/1368B</b>	Woven S-glass with white Tedlar® overlay on the face side	Phenolic	Lightweight, high impact resistance; low smoke and toxicity grade.	Sidewalls, ceiling, partition walls and bulkhead of lower cargo hold and main deck (freighter).	BMS 8-223 Class 4, Grade B

## PANELS

PRODUCT	FACING	RESIN	CORE	STRENGTH	APPLICATION	SPECIFICATION
<b>Gillfloor® 4709</b>	Unidirectional carbon fiber with lightweight woven glass scrim	Epoxy	Meta-aramid honeycomb	Lightweight, high strength	Under seat, aisle	BMS 4-20 Types II, III and V
<b>Gillfloor® 4417</b>	Unidirectional glass	Epoxy	Meta-aramid honeycomb	High strength	Wet and/or highly loaded areas	BMS 4-17 Types II and V
<b>Gillfloor® 4417A</b>	Unidirectional glass	Epoxy	Meta-aramid honeycomb	High strength	Wet and/or highly loaded areas	BMS 4-17 Type VI
<b>Gillfloor® 4518</b>	Unidirectional and woven glass	Epoxy	Para-aramid honeycomb	Lightweight, high strength	Main deck flooring	BMS 4-17 Types X, XI
<b>Gillfloor® 4809</b>	Unidirectional carbon fiber with lightweight woven glass scrim	Epoxy	Para-aramid honeycomb	Lightweight, high strength	Under seat, aisle	BMS 4-20 Types VI, VII and IX
<b>Gillfab® 5433E</b>	Aluminum sheet 2024T3 Al Clad	Epoxy	Woven S-glass reinforced epoxy laminate	Lightweight, high strength	Cargo flooring	BMS 7-326 Types VII, Class 2/1, Grade C



This is not an all 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 777 aircraft.



# Quotables

I am extraordinarily patient, provided I get my own way in the end.

—**Margaret Thatcher, Politician**

You have to be different in a way or a small number of ways to be important to your customers.

—**Mitch Gooze, Vistage Speaker**

If I stop to kick every barking dog I am not going to get where I'm going.

—**Jackie Joyner-Kersey, Olympic Athlete**

You must learn from the mistakes of others. You can't possibly live long enough to make them all yourself.

—**Sam Levenson, Comedian**

Let's not confuse activity with progress.

—**Paul Bortree**

My first message is: Listen, listen, listen to the people who do the work.

—**H. Ross Perot, Industrialist**

The only real difference between one organization and another is the performance of its people.

—**Bobby Bowden, Football Coach**

The trouble with being punctual is that nobody's there to appreciate it.

—**Irving S. Cobb, Humorist**

You can't train for once and for all, any more than you can eat for once and for all.

—**James Newton, Vistage Speaker**

You'll never have all the information you need to make a decision. If you did, it would be a forgone conclusion, not a decision.

—**Unknown**

Change is good; you go first.

—**Dilbert, Cartoon Character**

If you listen closely enough your customers will explain your business to you.

—**Peter Schutz, Vistage Speaker**

Knowing is the enemy of learning.

—**Larry Wilson, Vistage Speaker**

Never let the urgent crowd out the important.

—**Stephen R. Covey, Author**

We cannot direct the wind, but we can adjust the sails.

—**Dolly Parton, Singer-songwriter**

Most of the problems you have are yesterday's solution.

—**Bill Schwarz, Vistage Speaker**



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