

# TPS

REINVENTING THERMAL  
PROTECTION IN AEROSPACE  
APPLICATIONS



Reinventing how cork engages the world.



**AMORIM**

CORK COMPOSITES

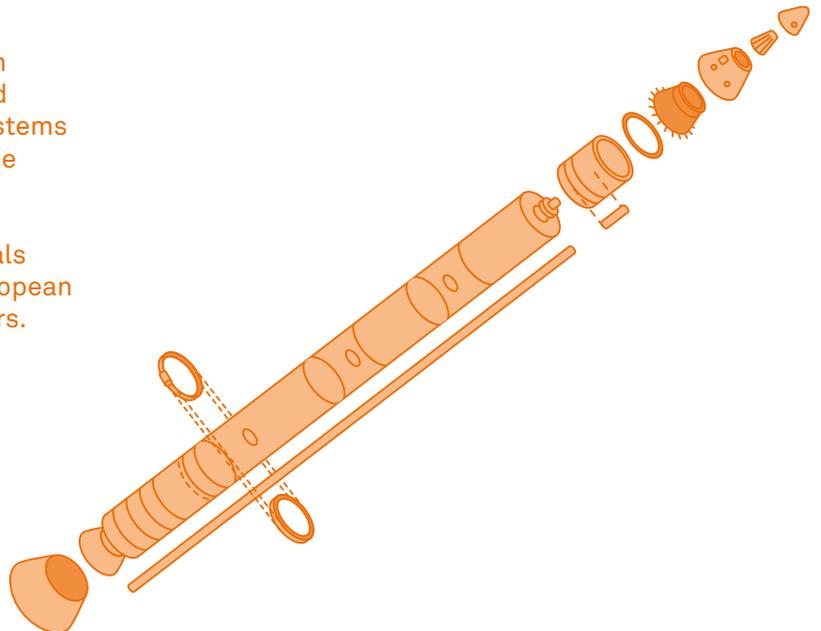
# WE TAKE NATURE FURTHER



## The best solution for Thermal Protection Systems.

**Amorim Cork Composites (ACC)** has been manufacturing and supplying cork-based materials used in Thermal Protection Systems (TPS) for the Aerospace Industry since the beginning of the space age.

ACC supplies ablative cork sheet materials or specially graded cork granules for European and North American aerospace customers.





## Bringing nature into space.

ACC is part of the Amorim Group, the world leader in cork products, with production sites in Portugal, Spain and United States. Amorim supplies a wide range of industrial, commercial, automotive, and household applications. Cork, the bark of the Cork Oak tree (*Quercus Suber*), is nature's foam with a unique combination of properties.

Cork's chemical and physical structure make it them ideal for ablative materials, with excellent insulation properties, maintaining low weight to low thermal conductivity results.

Cork based ablative materials work by absorbing a great amount of heat through a phase change. During the phase change, a char layer is formed which acts as an insulator, protecting the inner material and slowing the thermal degradation of the shield while maintaining geometry.

# NATURE APPLIED TO AEROSPACE THROUGH INNOVATION



## Product range

		P45	P50	P60
MATERIAL PROPERTIES	Cork particle size (mm)	1/2	0,5/1	0,5/1
	Sheet dimension (mm)	1270X710	1270X710	1000X500
	Sheet dimension (in)	50X28	50X28	40X20
	Density @ 20° C <sup>1</sup>	0,32	0,48	0,45
	Tensile Strength (psi) <sup>2</sup>	110	250	160
	Tensile Strength (MPa) <sup>2</sup>	0,76	1,50	1,10
	Elongation (%) <sup>2</sup>	30	13	7
	Thermal Conductivity (Btu in)/(h ft <sup>2</sup> °F) <sup>3</sup>	0,45	0,50	0,55
	Thermal Conductivity (W)/(m°K) <sup>3</sup>	0,06	0,07	0,08
	Specific Heat (Btu/lb °F)	0,6	0,5	0,4
	Specific Heat (KJ/Kg/°K) <sup>4</sup>	2,5	2,1	1,9
Substrates to bond	Metal and Composite			

<sup>(1)</sup> ASTM F1315

<sup>(2)</sup> ASTM F152, Method B

<sup>(3)</sup> ASTM C177

<sup>(4)</sup> ASTM C351

Other sheet sizes may be available.



## Applications

Our aerospace cork products are applied to various areas of a rocket or missile. Application specifications have included nose cone, frustum, forward skirt, aft skirt, external tank attach ring covers, integrated encoder assembly covers, systems tunnel covers, and range safety system crossover covers.

Launch systems that have used Amorim aerospace cork products include the Space Shuttle, Delta, Atlas, Titan, Arienne, and many other vehicles.

Amorim aerospace cork provides thermal protection to these components as they are exposed to an air stream environment during launch.

Proper cork cohesion and adhesion to substrate is critical to prevent Thermal Protective System (TPS) debris from coming off the structures during launch ascent.

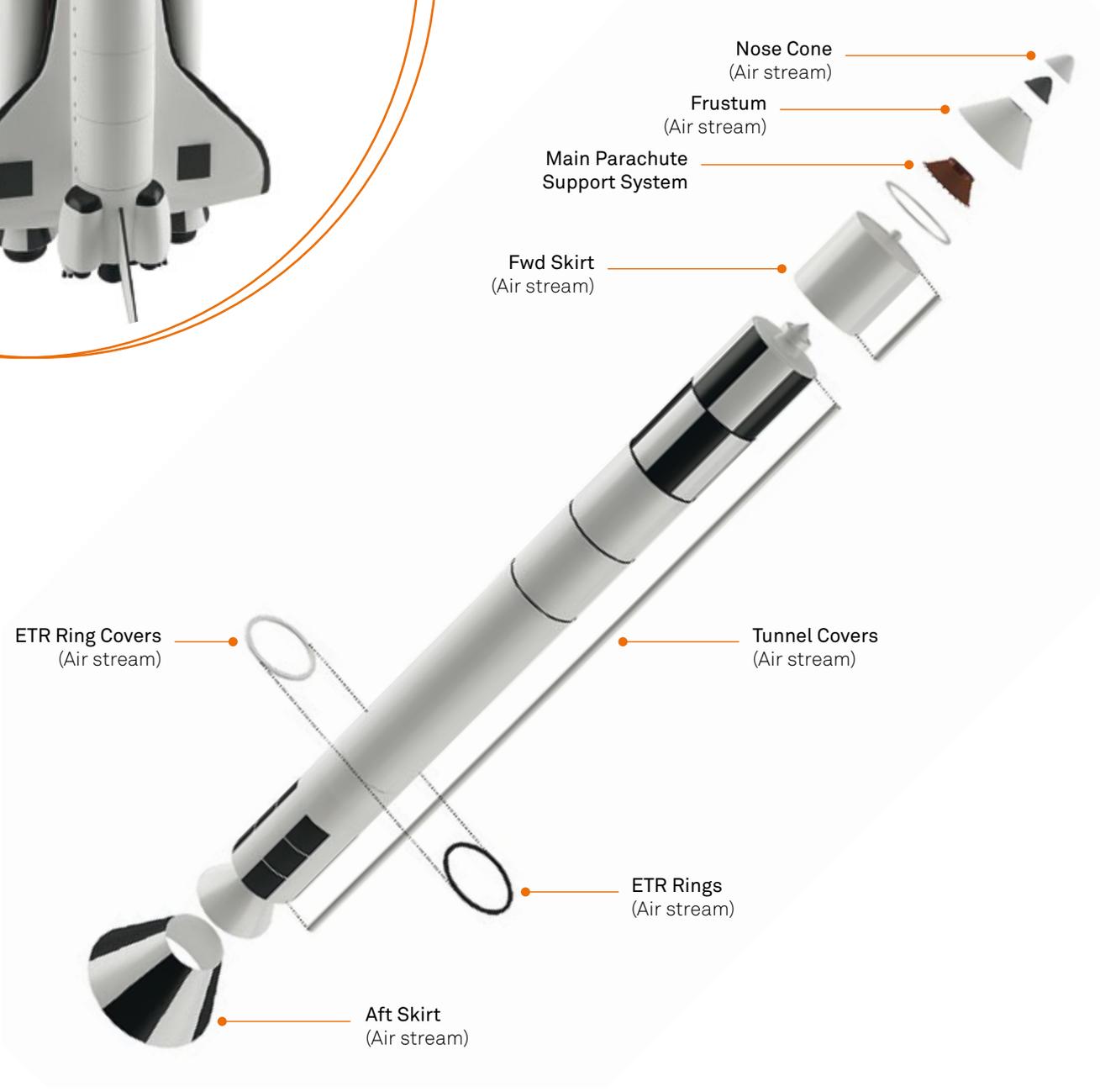


### REINVENTING SUSTAINABILITY FOR THE FUTURE

Cork's chemical structure is resistant to acids, most fuels, oils, and does not rot when immersed in water for long periods of time. The main constituent, Suberin, makes the cork cell membrane impermeable and the cell airtight.



Some typical applications where Thermal Protection Systems products have been used.



# Main advantages

PROCESS FRIENDLY MATERIALS	FLEXIBLE SUPPLY	PROVEN TECHNOLOGY
Easily bonded to most substrate materials, using common adhesive systems.	Materials are made of cork granules agglomerated with special phenolic binders that can be tailored to suit a particular requirement (fire-proof, anti-fungi, etc).	Our materials are used in TPS applications based in ablative heat shields for rocket applications as well as in space probe entry heat shields.
Can be trimmed and machined with regular tools or equipment without the need of any specific protection equipment.	Sheet thickness according to customer requirements.	Internal thermal insulation in hot structures.
Easily covered with specific coatings or varnishes.	Especially graded cork granules can be supplied for your own products.	Impact protection due to debris mitigation or pyrotechnic solutions, in several launch vehicles.
Easily integrated on sandwiches (CFRP composites); no need for complex fitting techniques.	Easy installation material.	Light-weight.
	Orders shipped worldwide from our two production sites (Europe and North America).	

## Exclusive knowledge and know-how for over 30 years

“Cork is nature's foam, a foam with unique combination of properties”.

in NASA Technical Reports Server.

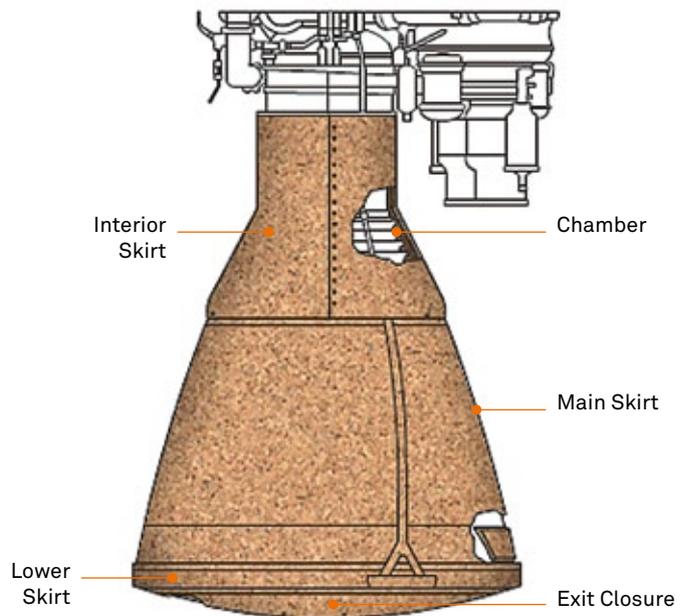
### SCOUT Rockets

“A series of five flight experiments was conducted aboard the NASA Scout, RAM, and four-stage research vehicles for the purpose of testing lightweight phenolic cork as a thermal protection material. (...)”.

in NASA report :“Free-flight test results on the performance of Cork as a thermal protection material”, from Sept. 1964

### APOLLO Spacecraft Systems

The boost-protective cover protects the command module from aerodynamic heating during boosted flight and from heat and soot from the launch escape and Jettison motors of the launch escape system. It is made of ablative Cork and Teflon-impregnated glass cloth, supported by glass honeycomb in the upper portion.



The data provided in this brochure represents typical values. This information is not intended to be used as a purchasing specification and does not imply suitability for use in a specific application. Failure to select the proper product may result in either product damage or personal injury. Please contact Amorim Cork Composites regarding specific application recommendations. Amorim Cork Composites expressly disclaims all warranties, including any implied warranties or merchantability or of fitness for a particular purpose. Amorim Cork Composites is not liable for any indirect, special, incidental, consequential, or punitive damages as a result of using the information listed in this brochure, any of its material specification sheets, its products or any future use or re-use of them by any person or entity.