



This form must be completed and uploaded to the “My Team” area on the FSG website **no later than the date specified** in the Action Deadlines. **A printed copy of this form must be presented together with the vehicle at Technical Inspection.**

The Impact Attenuator Data (IAD) and supporting calculations must be submitted electronically in Adobe Acrobat format (*.pdf).

Contact Details

Car number(s) (eg. 42 (FSG))

Team name

University name

Team Contact Person

Last name, first name

Telephone number

E-mail address

Please NOTE: FS Germany accepts only dynamic test as mentioned in T3.19.1!

The Impact Attenuator Data (IAD) must include the following points:

If the IA (Impact Attenuator) is a **“Standard IA Design”**, the following points must be included:

1. The first **two pages** must always be this FSG Impact Attenuator Data Form, including the completed general and (if applicable) testing summary
2. The report must be written in English and in „engineering style“ (e.g. contents, captions, symbols, page numbers)
3. Images and description of the design of the Impact Attenuator (IA), positioning on the Anti-Intrusion Plate (AIP) and IA volume (T3.17.2) above the ground (dimensions in mm)
4. Method for attachment of the IA to the AIP (including data sheets, with referenced strength values highlighted), e.g. if they are bonded together). Note: for mounting the Standard IA to the AIP the adhesive shear strength must be at least 24 MPa (T3.17.7).
5. Dimensions of the front bulkhead (FBH) (dimensions in mm)
6. Proof of additional diagonal or X-bracing in the FBH or equivalent per T3.17.7 if the FBH width is larger than 400 mm and/or height is larger than 350 mm
7. Design of the AIP (material, thickness and dimension in mm)
8. Method for attachment of the IA assembly to the FBH
9. Current receipt of the material, a packing slip or letter of donation of the IA. Note: these must be actual receipts, no (open) offer or request forms.
10. Pictures (or sketches) and description of the attachment on the car, including front wing attachments and non-crushable object(s) such as sensors, if applicable.

If the IA (Impact Attenuator) is a **“Team’s Own IA Design”**, the following additional points must be included:

1. FS Germany accepts only dynamic impact attenuator tests (e.g. sledge test or drop down) with real test data (see T3.19.1), including impact attenuator, anti intrusion plate (AIP), (representative) front bulkhead and, if applicable (per T3.19.4) the front wing, other non-crushable object(s) and/or structurally representative dummies thereof in front of the AIP.
2. Description of the test set up (including sensor, data acquisition system, test fixture)



3. If alternative materials are used for the AIP, equivalency to T3.17.3 must be proven by physical testing as in T3.19.2. Test fixture must be made from the same materials as the intended chassis (consistent with SES).
4. If the test is accomplished at a company or research center, a letter of conformity must be attached.
5. If the test is accomplished at the university, an official of the university (with contact details) must sign a letter of conformity (must be attached to the report).
6. Graphs of average deceleration and peak deceleration over an interval of time, absorbed energy over an interval of time and force over displacement and/or interval of time.
7. Pictures before and after the dynamic impact attenuator test, including proof of measurement of permanent deflection of the AIP (proof, T3.19.2). Note: the FBH cannot be structurally compromised after the test.

General Summary

IA type

IA description (e.g. form/shape/lay-up)

IA to AIP attachment

IA to AIP attachment description (e.g. adhesive type/name, method & shear strength)

AIP thickness & material

AIP description

AIP to FBH attachment

AIP to FBH attachment description

FBH type

FBH description (e.g. dimensions tubes/material/lay-up)

FBH dimensions (width & height, mm)

FBH with diagonal or X-brace (T3.17.7)?

Dynamic testing (T3.19)

Dynamic Testing Summary

Test type (e.g. barrier/drop test), date & site

Test speed (> 7 m/s)Test weight (≤ 300 kg)Energy absorbed (≥ 7350 J)Peak deceleration (≤ 40 g)Avg. deceleration (≤ 20 g)

Peak force (kN)

Aerodynamic devices and/or sensors in front of FBH (add description)?

Aerodynamic devices, sensors and/or dummies thereof included in test (add description)?

Combined peak force (≤ 120 kN)

Max. displacement (during test) (mm)

AIP deformation (≤ 25 mm)



ÉCOLE CENTRALE LYON

Impact Attenuator Data Form

Sommaire

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1 Design of IA, positionning on the AIP

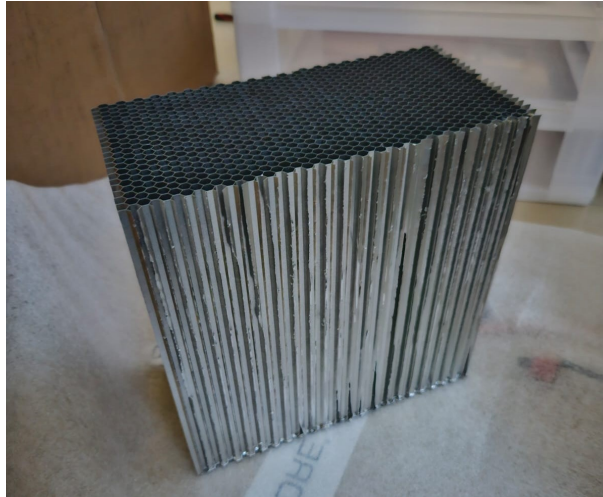


FIGURE 1 – Impact Attenuator

The IA is the Standard honeycomb IA (pre-crushed) one and has a volume of $100 \times 200 \times 200 \text{ mm}^3$. This entire volume is positioned 335 mm above the ground, as you can see in Figure 2. The IA is glued to the AIP, as explained in Section 5, and its positioning regarding the AIP is shown in Figure 3.

Since **there is no front wing**, there are no non-crushable objects that might interfere with the IA crushing.

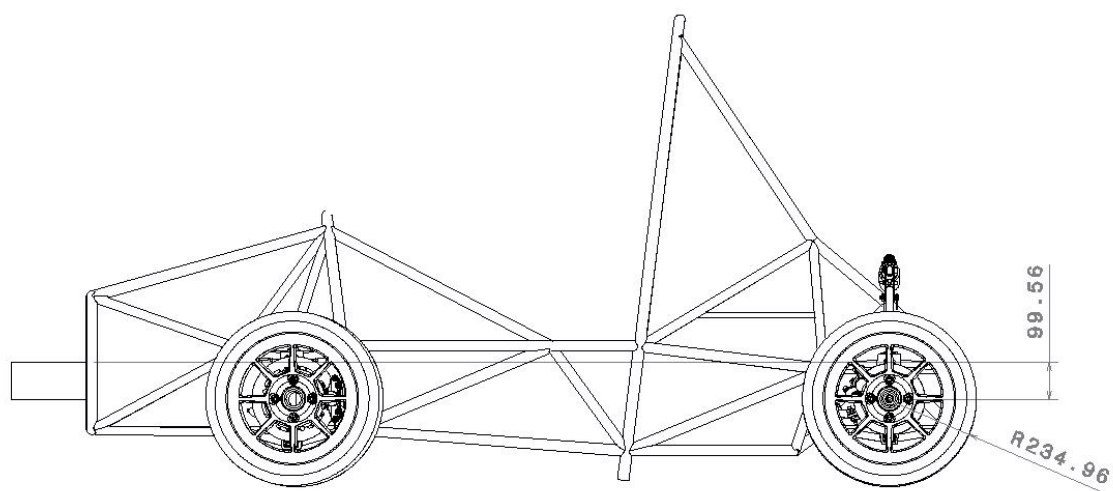


FIGURE 2 – IA Positioning over the ground

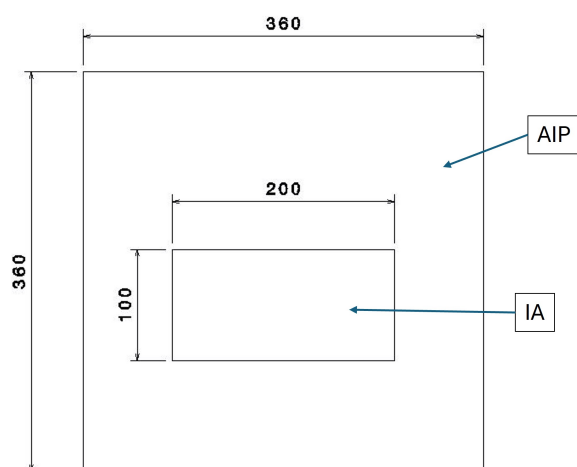


FIGURE 3 – IA Positioning on the AIP

2 Method for attachment of the IA to the AIP

The IA is glued to the AIP on its non pre-crushed face. Figure 5 presents the technical sheet of the glue used, while Figure 4 diagrams the intended distribution of glue between a cell of the IA and the AIP.

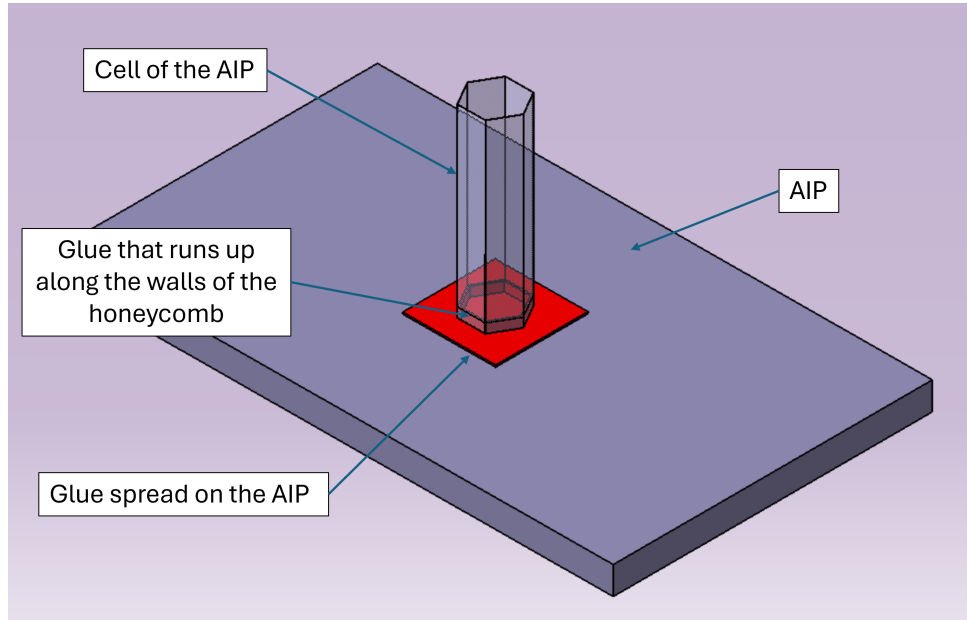


FIGURE 4 – Glue spreading in a cell of the IA

Each cell of our IA is hexagonal with a side length of 3 mm. The cell thickness is 0.05 mm. The application of the glue should not only be limited to the base of the cell, but the glue should also penetrate the cell and adhere to its walls. In our calculations, we thus consider two surfaces of the cell in contact with the glue :

- The base surface. Since the area of a hexagon with side length a is calculated as $\frac{3\sqrt{3}}{2}a^2$, we got a surface $A_{\text{base}} = 0.8 \text{ mm}^2$.
- The adhesive surface. We estimate the glue to penetrate up to 0.5 mm in the cells. Thus, $A_{\text{adh}} = 6 \cdot (3 - 0.05) \cdot 0.5 = 9 \text{ mm}^2$.

Our IA is made of approximately $N = 20 \times 45 = 900$ hexagonal cells. The total contact area is thus estimated to be : $A = N \times (A_{\text{base}} + A_{\text{adh}}) = 8820 \text{ mm}^2$.

We plan to glue the IA to the AIP and let the glue strengthen for a week at ambient temperature. Thus, the shear strength in every direction at 23°C will be $30.2 \text{ N} \cdot \text{mm}^{-2}$, according to the datasheet of the glue. Accordingly, the resistance of the attachment in every direction is estimated to be 270 kN, which complies with T3.17.5 since it imposes a resistance of 60 kN in every direction.

The system has not been fabricated yet, so we can not provide any photography.

3M
Scotch-Weld™
EPX™ Adhesive DP490

Product Data Sheet

Updated : March 1996
Supersedes : November 1993

Product Description	DP490 is a black, thixotropic, gap filling two component epoxy adhesive with particularly good application characteristics.	It is designed for use where toughness and high strength are required and shows special benefits in the construction of composite assemblies.	The product has excellent heat and environmental resistance.
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Physical Properties <small>Not for specification purposes</small>		BASE	ACCELERATOR
Specific Gravity		1.00	1.00
Consistency		Non-sag paste	Non-sag paste
Mix Ratio By Weight		100	50
		100	50
Colour		Black	Off-White
Work Life		1.5 hours minimum at 23°C	
Time to Handling Strength		4 to 6 hours at 23°C	
Time to Full Strength		7 days (test to full performance at one week)	
Shelf Life		15 months from date of despatch by 3M when stored in the original carton at 21°C (70°F) & 50 % Relative Humidity	

Performance Characteristics <small>Not for specification purposes</small>	Performance Characteristics of the Cured Adhesive.	Two cure cycles were evaluated as follows:
	Cure Cycle 1	7 days at 23°C
	Cure Cycle 2	24 hours at 23°C, 1 hour at 80°C

Date : March 1996
EPX Adhesive DP490

Storage Conditions	Store product at 15°C to 25°C for maximum storage life.
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Directions for Use /Clean Up	Place the cartridge into the 3M EPX Applicator and clip into position. Remove the resealable cap. Expel a small quantity of adhesive and ensure both components flow freely. Attach correct mixer nozzle (this should have 20 or more elements). Dispense the adhesive as required. When finished either leave the nozzle in place and store, or remove the nozzle, wipe clean the tip, and replace cap. To re-start after storage remove the old nozzle with cured adhesive and re-fit a new nozzle, or remove the cap and fit a new nozzle.	Surface Preparation: The degree of surface preparation depends on the bond strength required and the environment likely to be encountered by the bonded structure. For most plastics solvent wiping with 3M VHB surface cleaner, followed by abrasion with 3M Scotchbrite 7447, followed by a further solvent wipe until clean, will give good performance (except for acetal, polyethylene and polypropylene and some other low surface energy materials). This also applies to powder coat paints and other stoved paint systems. The same surface preparation will also give good adhesion to metal surfaces. The objective is to remove loosely attached surface films such as oils, waxes, dusts, mill-scale, loose paints and all other surface contaminants in addition to enhancing mechanical adhesion. Grit-blasting using a clean, fine grit also offers excellent adhesion on many metallic substrates. Where humid environments are likely to be encountered by metallic substrates we recommend additional priming with 3M Scotch-Weld 3901. Alternatively, chemical conversion coating techniques combined with priming can offer the best durability. Clean-Up: Excess uncured adhesive can be removed with the following solvents: 3M VHB Surface Cleaner (mild alcohol based cleaner) 3M Scotch-Grip Solvent No.2 (Ketone blend) 3M Industrial Cleaner (Aerosol).
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Additional Product Information	Please contact your 3M Salesperson for additional information on the preparation of difficult surfaces, or likely exposure to aggressive environments.
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Date : March 1996
EPX Adhesive DP490

Performance Characteristics (Cont.) Not for specification purposes	Temperature Performance in Shear and Peel.	(Etched Aluminium) Shear Strength to BS 5350 C5. Peel Strength was floating roller peel to BS5350 C9.	Tests were performed at 23°C unless otherwise stated.	
	Temperature (°C)	Shear Strength (1) (N/mm²)	Shear Strength (2) (N/mm²)	Peel Strength (N/mm)
	-55	23.7	31.8	N/A
	-25	30.2	28.7	9.24
	80	11.9	12.7	7.32
	120	2.8	3.2	N/A
	150	1.9	1.7	N/A

Adhesion to Etched Aluminium after Environmental Ageing

Ageing Condition	Shear Strength (N/mm²)
RT Control	26.2
Water at 23°C, 750 hours	25.6
50°C, 90% RH, 750 hours	22.0
120°C, 750 hours	25.3
175°C, dry heat, 120 hours	29.6
Sikadrol 500B at 23°C, 750 hours	27.6
JP4 at 23°C, 750 hours	28.7
Hydraulic Oil at 23°C, 750 hours	29.5

DP490 shows good adhesion to many plastic surfaces even by simply solvent wiping. This can be improved still further by the use of 3M Scotchbrite abrasion and/or use of the primer Scotch-Weld 3901.

Plastics	Shear Strength (N/mm²)
Carbon Fibre Reinforced Epoxy	36.1 (cohesive)
Polyester Sheet Moulding Compound	4.3 (substrate)
Glass Fibre Reinforced Phenolic	30.3 (cohesive)
ABS (filled)	3.2 (substrate)
PVC (filled)	2.9 (substrate)
Astoy (glass filled polycarbonate)	3.0 (adhesion)
Valox (glass filled PET)	1.4 (substrate)
PMMA	3.7 (adhesion)
Noryl (m XTRA) (glass filled PPO)	4.9 (adhesion)

Date : March 1996
EPX Adhesive DP490

Health & Safety Information	Precautions: Causes severe eye irritation, may cause permanent eye damage. Irritating to skin. May cause sensitisation by skin contact. Avoid contact with the skin and eyes. Wear suitable gloves and eyeface protection. Laundry contaminated clothing before re-use. Avoid prolonged breathing of vapours. Avoid inhalation of dust when grinding or cutting cured material.	First Aid: Eye Contact: Immediately flush eyes with copious amounts of water for at least 15 minutes, holding eyes open. Call a physician. Skin Contact: Wash immediately with plenty of soap and water.	For further information please contact the Toxicology Department at the Bracknell Head Office on (0344) 658000.
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3M, EPX, Duo-Pak, Scotch-Grip, Scotchbrite and Scotch-Weld are trademarks of the 3M Company.

Values presented have been determined by standard test methods and are average values not to be used for specification purposes. Our recommendations on the use of our products are based on tests believed to be reliable but we would ask that you conduct your own tests to determine their suitability for your applications. This is because 3M cannot accept any responsibility or liability direct or consequential for loss or damage caused as a result of our recommendations.



Specialty Tapes & Adhesives

3M United Kingdom PLC 3M House, 28 Great Jackson Street, Manchester, M15 4PA	Customer Service : Tel 0161 236 8500 Fax 0161 237 1105	3M Ireland 3M House, Adelphi Centre, Upper Georges Street, Dun Laoghaire, Co. Dublin, Ireland	Customer Service : Tel (01) 280 3555 Fax (01) 280 3509
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FIGURE 5 – Glue datasheet

3 Dimensions of the front bulkhead and proof of an additional diagonal

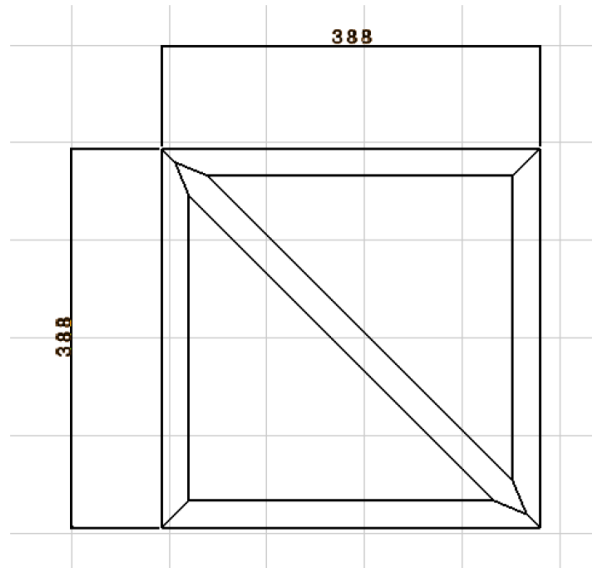


FIGURE 6 – Dimensions of the front bulkhead

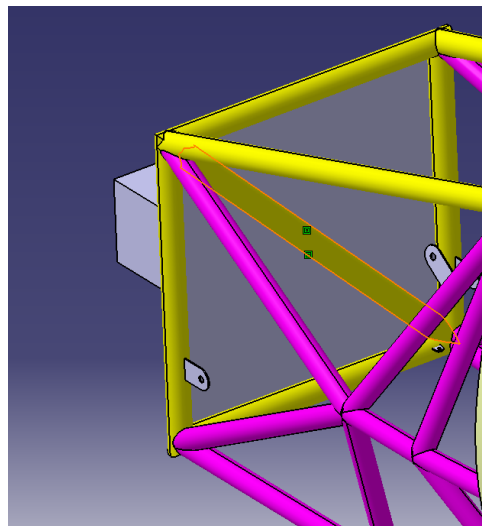


FIGURE 7 – Proof of the presence of an additional diagonal member

The front bulkhead measures $388\text{mm} \times 388\text{mm}$. The tubes have an external radius of 14mm . You can also see on a previous image the effective diagonal tube.

4 Design of the AIP

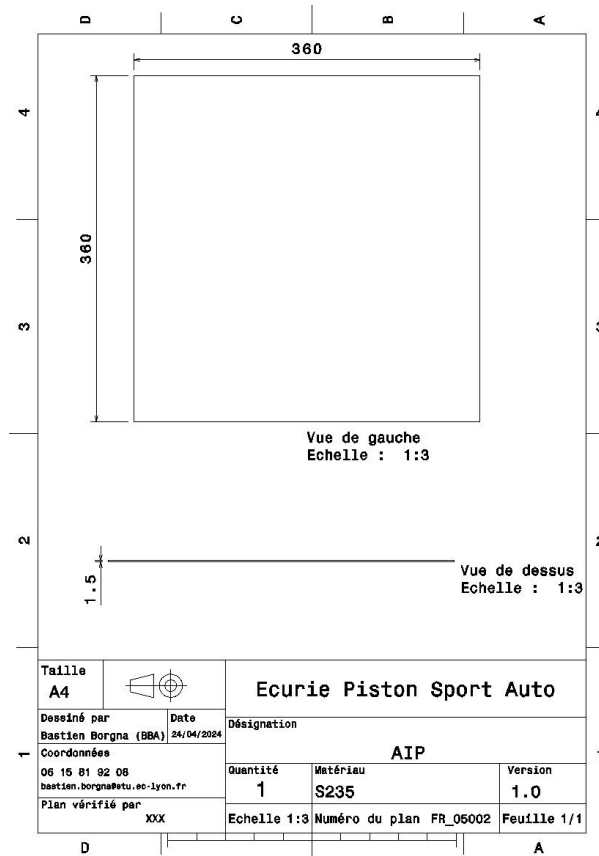


FIGURE 8 – Development plan of the AIP

The AIP is made out of S235 steel and 1.5mm thick, to show compliance with rule T 3.17.3

5 Method for attachment of the AIP to the front bulkhead

The AIP is welded along its entire perimeter to the FBH. The AIP has not been welded yet, but it will be in a few weeks. We cannot provide any photographs yet.

6 Proof of the IA material reception



Plascore GmbH & Co KG - Feldbom 6 - 55444 Waldlaubersheim

Firma
Ecole Centrale de Lyon
36 avenue Guy de Collongue
69314 ECULLY
FRANKREICH

Pro-Forma Invoice

process number 31498
Voucher Number 2023-00199
Date 25.10.2023
Customer Number D62712
Person in Charge Andreas Buir

In reply please quote these numbers!

Delivery address

Firma
Ecole Centrale de Lyon
36 avenue Guy de Collongue
69314 ECULLY
FRANKREICH

Mode of Dispatch	MBE-Online	Our VAT number	DE217658799
Terms of Delivery	FCA Waldlaubersheim (Incoterms 2020)	Our Tax number	06/206/0706/6
References	Order Confirmation 2023-41048	Foreign Tax Number	
Your Reference	Mathieu Asatneau	Your VAT number	
Your Document	Order 10/25/23		

Referring to your above mentioned order we forwarded to you:
Delivery date: after receipt of pre-payment approximately days/weeks

According to your order we request the following pre-payment:

Item	Item no.	Description	Date of Del.	Quantity/Unit	Unit Price	Total Price SC
1	50170020 (234962)	PACL-XR1-5.7-3/16-20-P-5052 200(+2/-0)x200(+5/-2)x100(+5/-2)mm Expanded Aluminum Honeycomb Core Perforated & Precrushed Dimensions in Thickness x L-Direction (Ribbon) x W-Direction Crush strength:380 PSI (± 10%) Inspection Certificate 3.1: Crush Strength tested per ASTM D 7336 Sale in sets of 2 pieces Commodity Code 75169990 Weight: 0.3800 kg / 2.2800 kg Country of Origin: Germany	01.12.2023	6 pc(s)	52,00	312,00 114
Sub-Total EUR						312,00 SC
plus lower-quantity surcharge						0,00 114
plus Freight per ship date						45,00 114
Sub-Total						357,00
plus VAT with tax-code 114 19,00 % from						67,83
Total EUR						424,83

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Christoph Denker

HRA-Nr. 3163, Bad Kreuznach
persönlich haftende Gesellschafterin
Huebner-Verwaltungs-GmbH
HRB-Nr. 4340, Bad Kreuznach

FIGURE 9 – Proof of the IA material reception

Here is the invoice of the IA.

7 Annexe : IA datasheet

The values of our IA are highlighted on Figure 11.



PAMG-XR1 5052 Aluminum Honeycomb



Description:

PAMG-XR1 5052 aerospace grade aluminum honeycomb is a lightweight core material which offers superior strength and corrosion resistance over commercial grade aluminum honeycomb. PAMG-XR1 5052 honeycomb is made from 5052 aluminum alloy foil and meets all the requirements of AMS C7438.

Applications:

PAMG-XR1 5052 honeycomb uses include aircraft floors, aircraft leading and trailing edges, missile wings, fan casings, fuel cells, fuselage components, helicopter rotor blades and navy bulkhead joiner panels, energy absorption, air/light directionalization and EMI/RFI shielding. PAMG-XR1 5052 honeycomb is suitable for applications where materials conforming to AMS C7438 are required.

Features:

- Elevated use temperatures
- High thermal conductivity
- Flame resistant
- Excellent moisture and corrosion resistance
- Fungi resistant
- Low weight / High strength
- Long shelf life. The mechanical properties referenced are maintained for 15 years minimum if not exposed to moisture, weather or any normal hazard.

Availability:

PAMG-XR1 5052 honeycomb is available in four forms: unexpanded blocks, unexpanded slices, untrimmed expanded sheets and cut to size expanded sheets. It is also available with or without cell perforations to facilitate cell venting for certain applications.

Cell Sizes:	1/8" - 3/8"
Densities:	1.0 pcf - 12.0 pcf
Sheet "Ribbon" (L):	48" typical - 72" max
Sheet "Transverse" (W):	96" typical - 200" max
Sheet Thickness (T):	20/34" max
Tolerances:	Length: + 6", - 0" Width: + 6", - 0" Thickness: ± .005" (under 4" thick) ± .062" (over 4" thick) Density: ± 10% Cell Size: ± 10%

NOTE: Special dimensions, sizes, tolerances, CNC machining and die cut to size can be provided upon request.

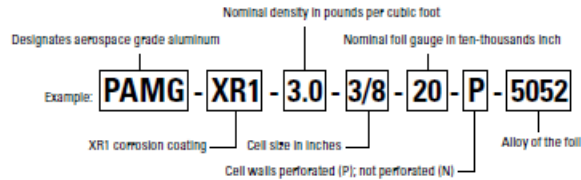
Corrosion Resistance:

The chromated XR1 coating offers excellent protection for honeycomb cores exposed to corrosive environments, meeting the requirements of AMS C7438, CL2.

FIGURE 10 – Impact Attenuator Datasheet Page 1

PAMG-XR1 5052 aluminum honeycomb is specified as follows:

Trade Name - Corrosion Coating - Density - Cell Size - Foil Gauge - Perforation - Alloy



PAMG-XR1 5052 Mechanical Properties																			
CELL SIZE		NOMINAL DENSITY		BARE COMPRESSIVE STRENGTH				PLATE SHEAR STRENGTH "L" DIRECTION				PLATE SHEAR MODULUS "L" DIRECTION		PLATE SHEAR STRENGTH "W" DIRECTION				PLATE SHEAR MODULUS "W" DIRECTION	
				Typical		Minimum		Typical		Minimum		Typical		Typical		Minimum		Typical	
in	mm	lb/Ft ³	Kg/m ³	psi	Mpa	psi	Mpa	psi	Mpa	psi	Mpa	ksi	Gpa	psi	Mpa	psi	Mpa	ksi	Gpa
1/8	3.2	3.1	50	310	2.14	215	1.48	225	1.55	155	1.07	50	0.34	123	0.85	90	0.62	26	0.18
1/8	3.2	4.5	72	600	4.14	405	2.79	372	2.56	285	1.96	70	0.48	229	1.58	168	1.16	30	0.21
1/8	3.2	6.1	98	935	6.45	680	4.69	539	3.72	455	3.14	117	0.81	340	2.34	272	1.88	45	0.31
1/8	3.2	8.1	130	1445	9.96	1100	7.58	800	5.52	670	4.62	135	0.93	445	3.07	400	2.76	57	0.39
1/8	3.2	10.0	160	1900	13.10	1500	10.34	1000	6.89	880	5.93	175	1.21	490	3.14	490	3.38	65	0.45
1/8	3.2	12.0	192	2400	16.55	1910	13.17	1920	13.24	1250	8.62	-	-	1000	6.89	750	5.17	-	-
3/16	4.8	2.0	32	187	1.29	100	0.55	150	1.03	80	0.55	34	0.23	80	0.55	46	0.32	20	0.14
3/16	4.8	3.1	50	346	2.39	215	1.07	218	1.50	155	1.07	51	0.35	127	0.88	90	0.62	27	0.19
3/16	4.8	4.4	70	580	4.00	385	1.93	320	2.21	280	1.93	72	0.50	240	1.65	160	1.10	36	0.25
3/16	4.8	5.7	91	854	5.89	600	2.83	460	3.17	410	2.83	109	0.75	300	2.07	244	1.68	46	0.32
3/16	4.8	6.9	110	1065	7.34	800	3.72	597	4.12	540	3.72	115	0.79	351	2.42	328	2.26	50	0.34
3/16	4.8	8.1	130	1550	10.69	1100	4.62	720	4.96	670	4.62	152	1.05	490	3.38	400	2.76	60	0.41
5/32	4.0	2.6	42	242	1.67	160	0.83	150	1.03	120	0.83	38	0.26	100	0.69	70	0.48	24	0.17
5/32	4.0	3.8	61	436	3.01	300	2.07	215	1.45	215	1.48	58	0.40	175	1.21	125	0.86	32	0.22
1/4	6.4	1.6	26	108	0.74	70	0.48	88	0.61	60	0.41	24	0.17	45	0.31	32	0.22	12	0.08
1/4	6.4	2.3	37	218	1.50	130	0.90	130	0.90	100	0.69	32	0.22	95	0.65	57	0.39	18	0.12
1/4	6.4	3.4	54	364	2.51	250	1.72	232	1.60	180	1.24	54	0.37	130	0.90	105	0.72	26	0.18
1/4	6.4	4.3	69	553	3.81	370	2.55	307	2.12	265	1.83	70	0.48	179	1.23	155	1.07	30	0.21
1/4	6.4	5.2	83	650	4.48	510	3.52	418	2.88	360	2.48	86	0.59	240	1.65	200	1.38	46	0.32
1/4	6.4	6.0	96	1000	6.90	660	4.55	612	4.22	445	3.07	91	0.63	310	2.14	265	1.83	57	0.39
1/4	6.4	7.9	126	1350	9.31	1050	7.24	745	5.14	650	4.48	-	-	450	3.10	390	2.69	-	-
3/8	9.6	1.0	16	52	0.36	20	0.14	45	0.31	32	0.22	10	0.07	30	0.21	20	0.14	7	0.05
3/8	9.6	2.3	37	197	1.36	130	0.90	145	1.00	100	0.69	30	0.21	77	0.53	57	0.39	16	0.11
3/8	9.6	3.0	48	314	2.17	200	1.38	209	1.44	145	1.00	44	0.30	110	0.76	85	0.59	24	0.17
3/8	9.6	3.7	59	420	2.90	290	2.00	245	1.69	205	1.41	55	0.38	125	0.86	120	0.83	26	0.18
3/8	9.6	4.2	67	582	4.01	360	2.48	320	2.21	255	1.76	70	0.48	187	1.29	150	1.03	35	0.24
3/8	9.6	5.4	86	770	5.31	540	3.72	439	3.03	380	2.62	-	-	248	1.71	228	1.57	-	-

Tested at 0.625" T per AMS STD 401 at room temperature.

The above data is based on various sample sizes and is for reference only.

Additional densities and configurations available upon request.



Plascore, Inc., employs a quality management system that is Nadcap, AS9100, ISO 9001 and ISO 14001 certified.

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FIGURE 11 – Impact Attenuator Datasheet Page 2