

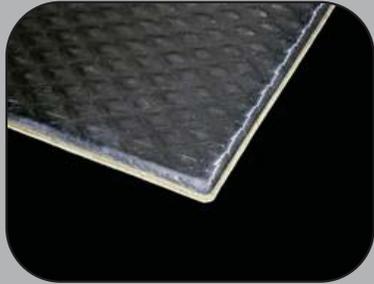


Thermal/Acoustical Group



Application Guide

Not a Controlled Document. For Reference Only



ZeroClearance

Product Attributes

- Light weight
- Very effective in limited space
- Easily formed into place
- No additional attachments required
- Low cost tooling
- Late design changes are not difficult
- Reliable processes

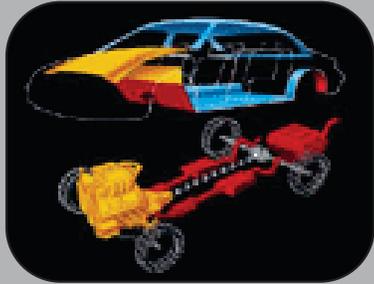
ZeroClearance

□ Composite Information

- ▶ High temperature, laminated composites
- ▶ Designed with an aggressive, high temperature Pressure Sensitive Adhesive (PSA) for attachment
- ▶ Embossed aluminum foil typically faces heat or noise source
- ▶ Available in both a glass on non-glass forms
- ▶ Available in various thickness' and weights

□ Performance Attributes

- ▶ Thermal Insulation Features
 - Reflectance from Low Emissivity Embossed Foil
 - Low Conductivity through the Core Material
 - Increased Effectiveness vs. Typical Stamping as Product Ages
- ▶ Acoustic Insulation Features
 - Transmission Loss via Aluminum Foil and Effective Decoupler
 - Absorption via Combination of Micro-Pierced Aluminum and Small Diameter Fibers in Core Material
 - Sheet Metal Damping via Viscoelastic PSA Film
- ▶ Attachment Features
 - PSA allows Permanent Attachment without Mechanical Fasteners
 - Composite and PSA Designed for Exterior Automotive Environment
 - Product Withstands High Heat, Moisture, and Common Automotive Fluids



ZeroClearance

Applications

- Undercarpet Systems
- Interior Dash
- Rear Kick-up
- Trunk Insulator
- Intake Tubes
- Evaporator
- Dog House
- Outer Dash
- Outer Wheel Well
- Wiper Motor
- Tunnel Insulator
- Chassis / Frame Insulation
- Floorpan
- Fuel Tank / System

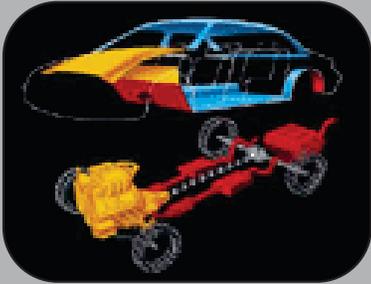
ZeroClearance

- Glass Version (ZC 112-XX)**
 - ▶ High-temp, non-woven fiberglass & PET blend into a composite matrix
 - ▶ Qualified through long-term durability at numerous OEM's
 - ▶ Standard PSA designed for painted metals and high surface energy substrates.
 - ▶ Long-term temperature resistance to 450° F (232° C) in ambient air
 - ▶ Current production styles
 - No Foil – 5.0 mm Black Fiber Blend (ZC112BLK-PSA)
 - Foil thickness' at 0.002" (0.05 mm) and 0.010" (0.25 mm)
 - Core Material thickness at 4mm

- Non-Glass Version (ZC 312, 325-XX)**
 - ▶ 100% high-temp, non-woven PET fiber matrix
 - ▶ Qualified through long-term durability at several OEM's
 - ▶ Standard PSA designed for painted metals and high surface energy substrates.
 - ▶ Long-term temperature resistance to 400° F (204° C) in ambient air
 - ▶ Current production styles
 - No Foil – 6.8 mm 100% Black Fiber w/ Water Repellant Finish (ZC350BLK-PSA)
 - Foil thickness' at 0.002" (0.05 mm) and 0.010" (0.25 mm)
 - Core Material thickness at 3.2 mm and 6.4 mm



Engineered Specialty Products
for the Automotive Market



ZeroClearance

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- Chassis / Frame Insulation
- Floorpan
- Fuel Tank / System

ZeroClearance

PolyTack Version (ZC 612, 712, 725-XX)

- ▶ PSA system designed for use on Plastics and low surface energy substrates (HDPE, PP, PA, etc.)
- ▶ Same Glass, Non-Glass constructions available as Standard PSA
- ▶ Qualified on Fuel Tanks and numerous Molded Plastic Components
- ▶ Foil thickness' at 0.002" (0.05 mm) and 0.010" (0.25 mm)

Solvent Resistant Version (ZC 812-XX)

- ▶ PSA system designed to resistant chemical solvents (e.g., diesel fuel, transmission fluid, etc.) on painted metals and other high surface energy substrates
- ▶ Same Glass, Non-Glass constructions available as Standard PSA
- ▶ Qualified on Aluminum and E-Coated Steels
- ▶ Foil thickness' at 0.002" (0.05 mm) and 0.010" (0.25 mm)

Standard PSA (ZC 112-XX, ZC312-XX, ZC325-XX, ZC212-03)

- ▶ PSA system designed for painted metals and other high surface energy substrates
- ▶ Same Glass, Non-Glass constructions available as Standard PSA
- ▶ Long-term temperature resistance to 400° F (204° C) in ambient air
- ▶ Foil thickness' at 0.002" (0.05 mm), 0.003" (0.08 mm) and 0.010" (0.25 mm)

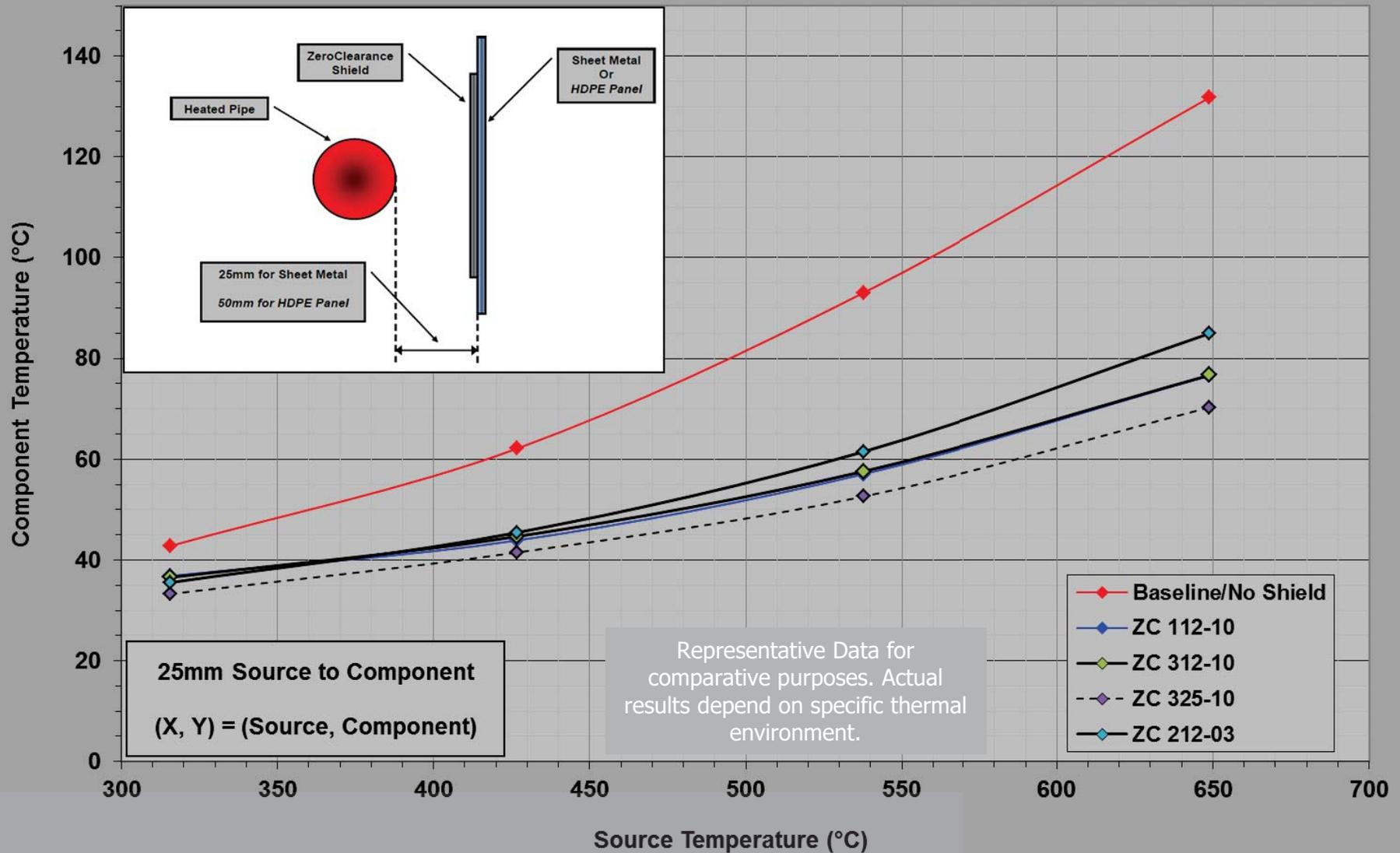


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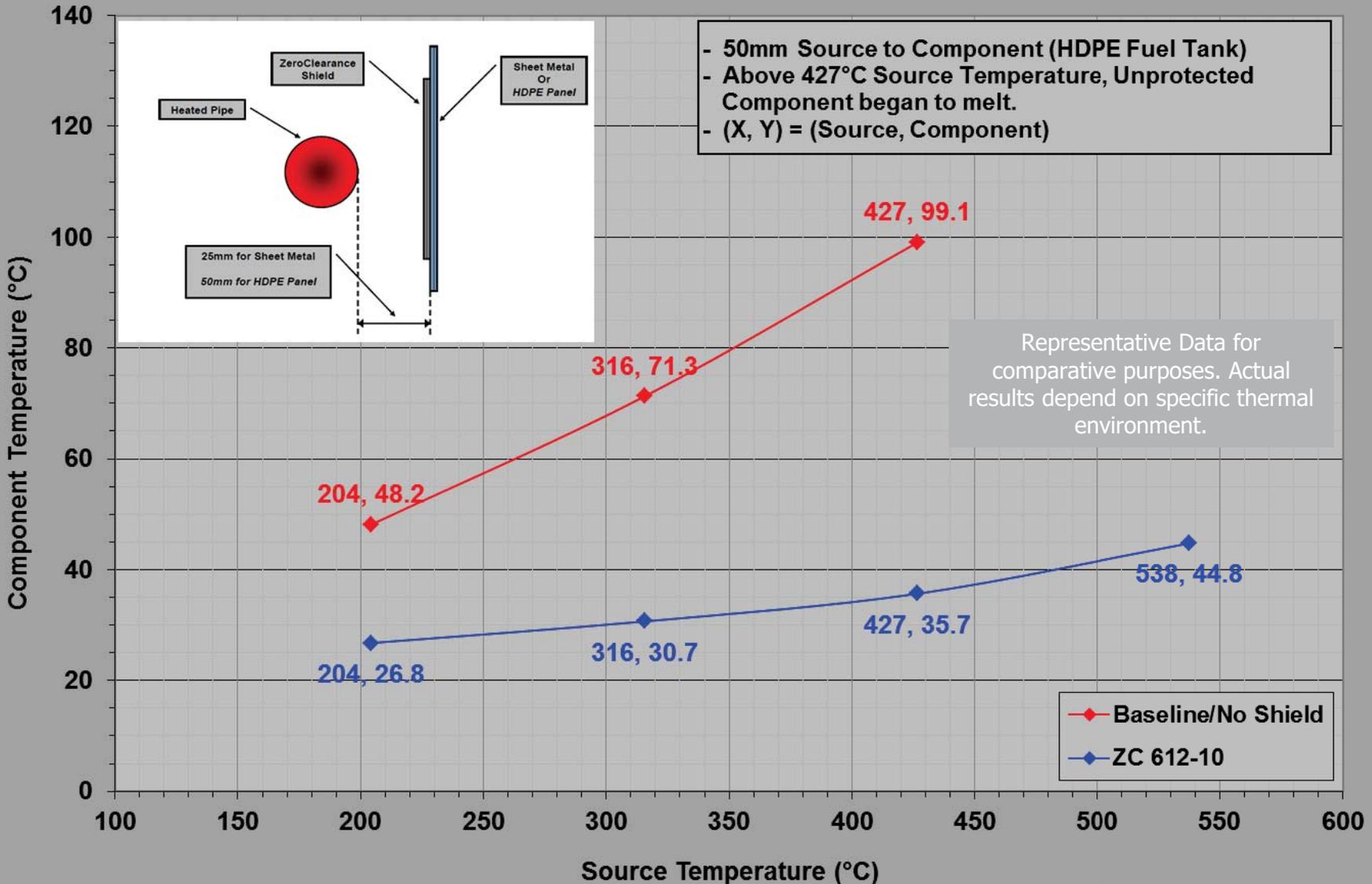
ZeroClearance Available Styles

Lydall Material Designation	Core Material	Adhesive System	Composite Thickness	Composite Thickness Tolerance	Composite Surface Mass
ZC-112-02	Fiberglass/PET	Standard	4.0 mm	+/- 1.5	816 gsm
ZC-112-10	Fiberglass/PET	Standard	4.0 mm	+/- 1.5	1339 gsm
ZL112BLK-PSA	Fiberglass/PET	Standard	5.0 mm	+/- 1.5	778 gsm
ZC 212-03	Polyester (PET)	Standard	3.2 mm	+/- 1.0	764 gsm
ZC-312-02	Polyester (PET)	Standard	3.2 mm	+/- 1.5	648 gsm
ZC-312-10	Polyester (PET)	Standard	3.2 mm	+/- 1.5	1171 gsm
ZC-325-02	Polyester (PET)	Standard	6.4 mm	+/- 2.0	1029 gsm
ZC-325-10	Polyester (PET)	Standard	6.4 mm	+/- 2.0	1553 gsm
ZC-325PERF	Polyester (PET)	Standard	6.4 mm	+/- 2.0	1018 gsm
ZL300BLK-PSA	Polyester (PET)	Standard	5.8 mm	+/- 1.5	873 gsm
ZL350BLK-PSA	Polyester (PET)	Standard	6.8 mm	+/- 1.5	1025 gsm
ZC-612-02	Fiberglass/PET	PolyTack	4.0 mm	+/- 1.5	816 gsm
ZC-612-10	Fiberglass/PET	PolyTack	4.0 mm	+/- 1.5	1339 gsm
ZC-712-02	Polyester (PET)	PolyTack	3.2 mm	+/- 1.5	648 gsm
ZC-712-10	Polyester (PET)	PolyTack	3.2 mm	+/- 1.5	1171 gsm
ZC-725-02	Polyester (PET)	PolyTack	6.4 mm	+/- 2.0	1029 gsm
ZC-725-10	Polyester (PET)	PolyTack	6.4 mm	+/- 2.0	1553 gsm
ZC-725PERF	Polyester (PET)	PolyTack	6.4 mm	+/- 2.0	1018 gsm
ZC-812-02	Fiberglass/PET	Solvent Resistant	4.0 mm	+/- 1.5	816 gsm
ZC-812-10	Fiberglass/PET	Solvent Resistant	4.0 mm	+/- 1.5	1339 gsm
ZL112BK-02	Fiberglass/PET	None	4.0 mm	+/- 1.5	825 gsm

ZeroClearance Thermal Performance - Glass & Non-Glass vs. No Shield

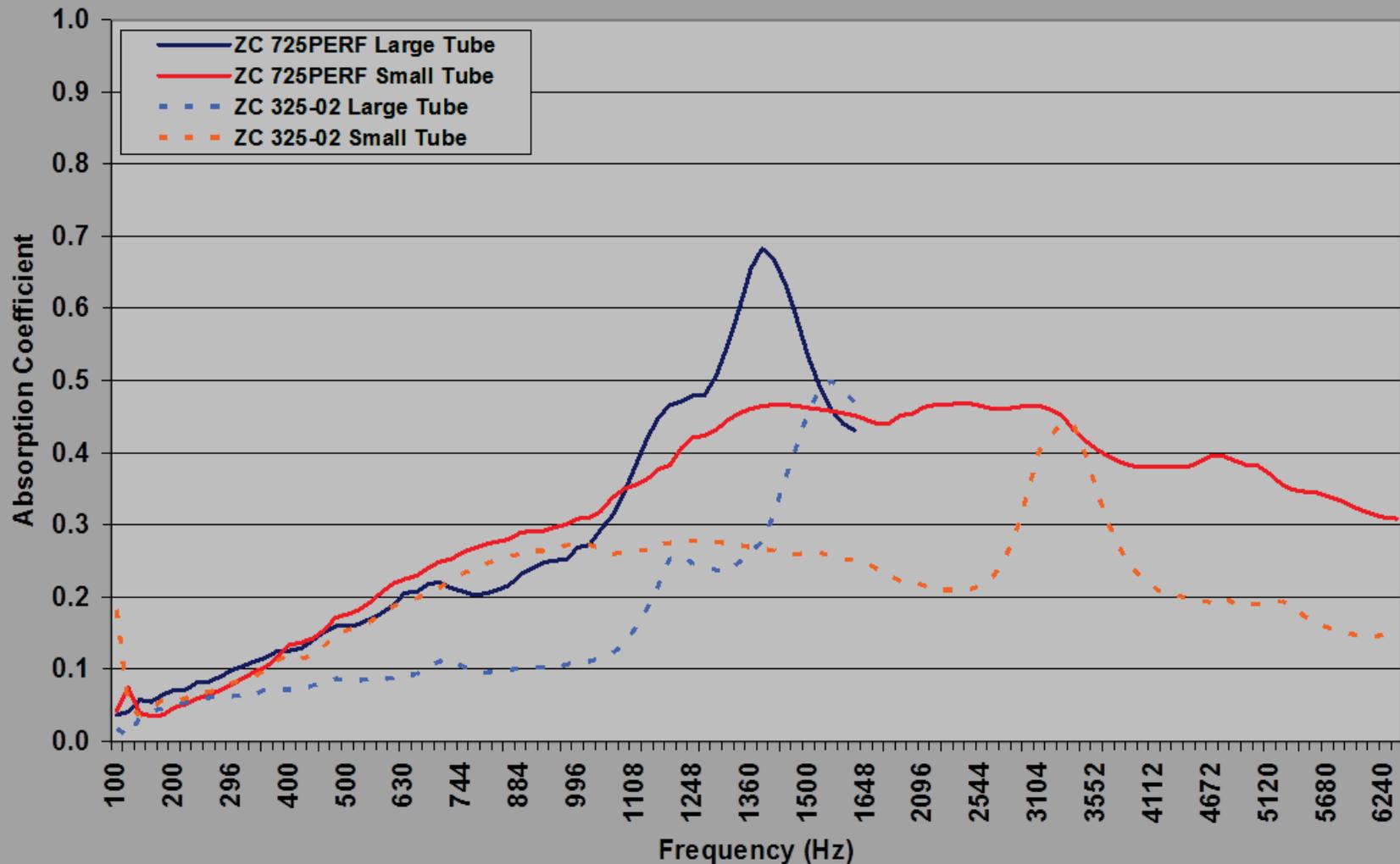


ZeroClearance Thermal Performance - ZC PolyTack (ZC 612-10) vs. No Shield



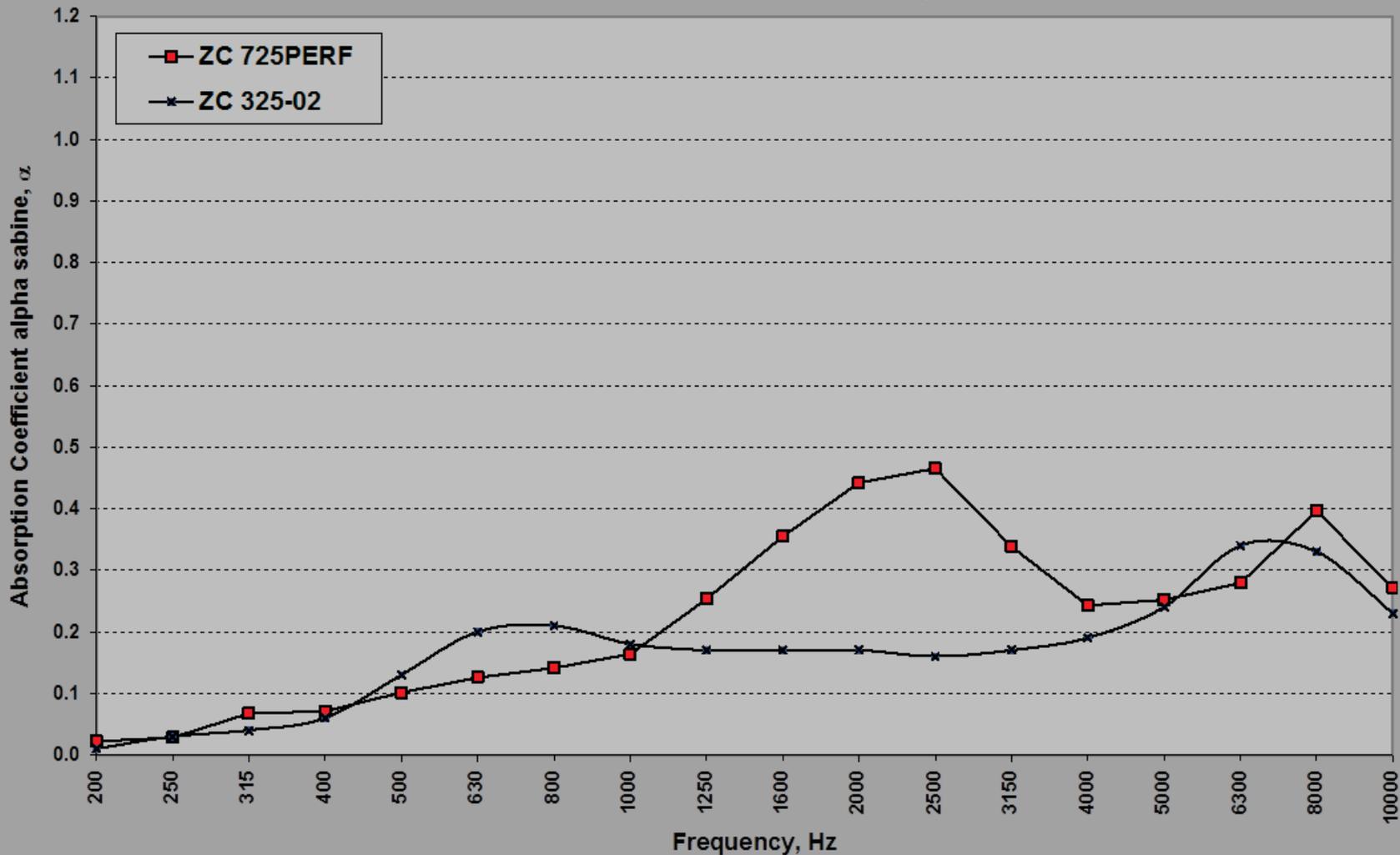
Normal Absorption Testing per ASTM E1050

ZeroClearance - ZC 725PERF & ZC 325-02

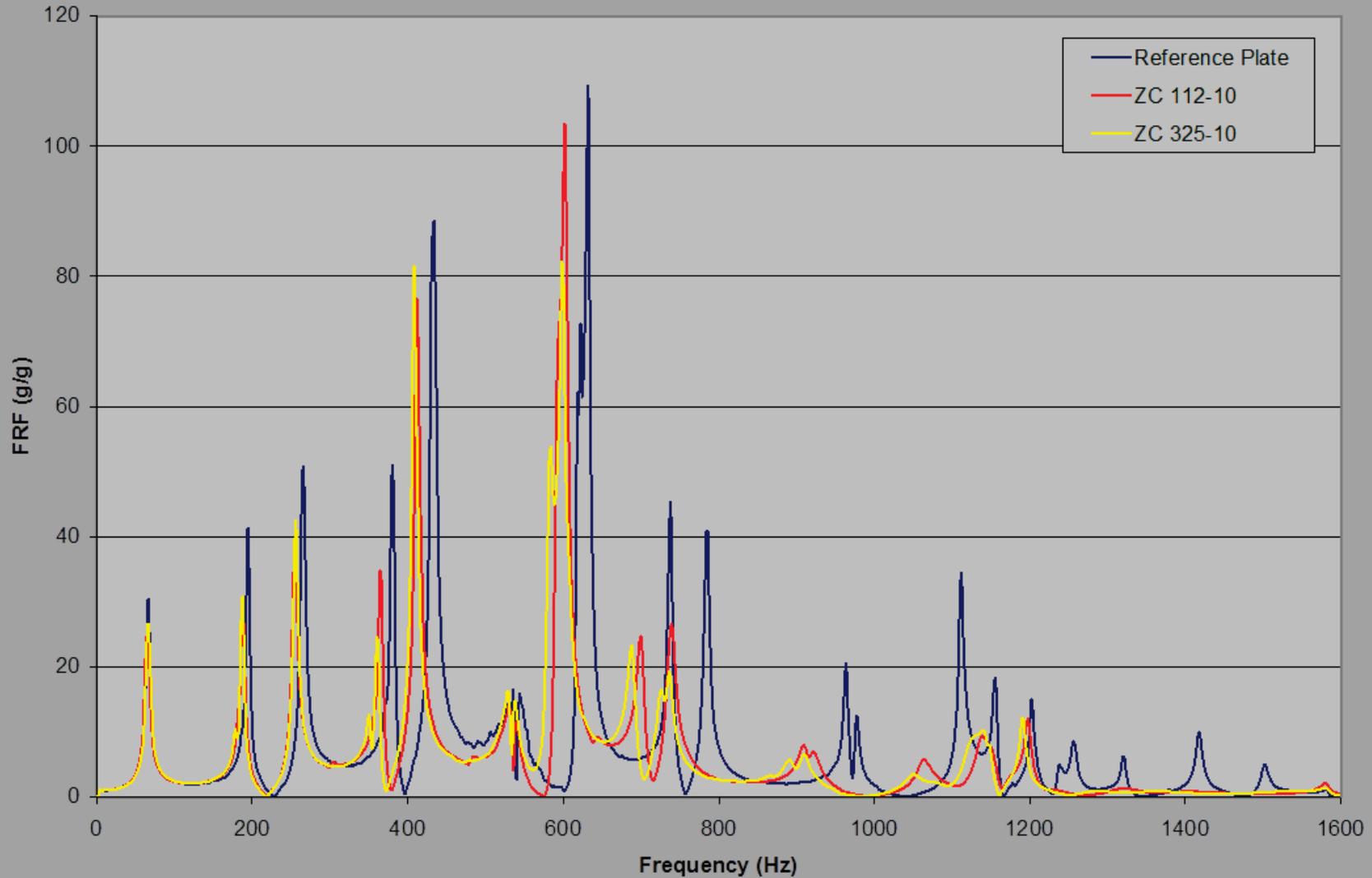


ZeroClearance

Alpha Cabin Reverberant Room Acoustic Test Random Incidence Absorption



ZC Damping Study - RTC III



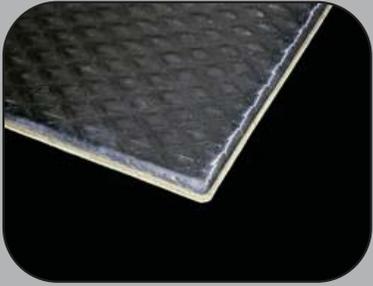
ZeroClearance

Installation and Use

- ZeroClearance is a thin profile thermal / acoustic insulator capable of attachment via a pressure sensitive adhesive.
- When applied correctly, ZeroClearance may be attached to almost any interior or exterior vehicle surface as thermal or acoustic insulation.
- An aggressive, high-temperature pressure sensitive adhesive (PSA) is used which is capable of withstanding long term temperatures in excess of 232°C (450°F).

In order to ensure proper bonding and long term adhesion, the ZeroClearance product must be applied correctly.

The following information is intended to recommend the use and application procedures to users of ZeroClearance products that will ensure long term performance. This information will also make users of ZeroClearance aware of possible factors that may reduce the bond strength of the product.



ZeroClearance

Adhesion Factors

- Substrate Material
- Surface Cleanliness
- Surface Moisture
- Surface Contamination
- Application Temperature
- Application Pressure
- Adhesive Contact Area

ZeroClearance

Surface Adhesion Fundamentals

- ▶ Adhesion is molecular attraction between unlike materials
- ▶ Strength of the attraction is determined by the surface energy of the material
 - Higher surface energy → greater attraction
 - Lower surface energy → weaker attraction
- ▶ On high surface energy materials, the adhesive can flow or 'wet out' to assure a stronger bond
- ▶ On low surface energy materials, the adhesive flows less and 'beads up', decreasing bond strength
- ▶ Unit of measure - dynes/cm
- ▶ Polytack ZeroClearance is designed for use on low surface energies



ZeroClearance

Application Surfaces

High Surface Energy

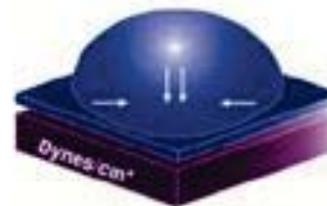
- Aluminum
- Aluminized Steel
- Galvanized Steel
- Stainless Steel
- Polyamide

Low Surface Energy

- Powder Painted Metals
- SMC
- HDPE
- Polypropylene



Metal Surfaces



High Surface Energy Plastics



Low Surface Energy Plastics

ZeroClearance

Approximate Surface Energy Values



ZeroClearance

Application Surfaces

High Surface Energy

- Aluminum
- Aluminized Steel
- Galvanized Steel
- Stainless Steel
- Polyamide

Low Surface Energy

- Powder Painted Metals
- SMC
- HDPE
- Polypropylene

Standard
ZeroClearance

PolyTack
ZeroClearance

Metals

- Copper 1103 dynes / cm
- Aluminum 840 dynes / cm
- Zinc 753 dynes / cm
- Tin 526 dynes / cm
- Lead 458 dynes / cm
- Stainless Steel 700 - 1000 dynes / cm
- Glass 250 - 500 dynes / cm

High surface energy plastics

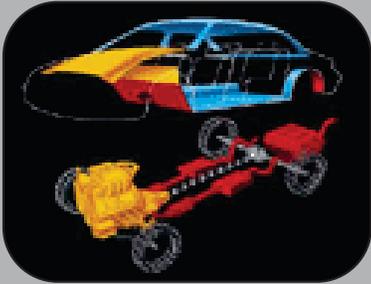
- Kapton 50 dynes / cm
- Phenolic 47 dynes / cm
- Nylon 46 dynes / cm
- Polyester 43 dynes / cm
- ABS 42 dynes / cm
- Polycarbonate 42 dynes / cm
- PVC 39 dynes / cm
- Acrylic 38 dynes / cm

Low surface energy plastics

- PVA 37 dynes / cm
- Polystyrene 36 dynes / cm
- EVA 33 dynes / cm
- Polyethylene 31 dynes / cm
- Polypropylene 29 dynes / cm
- Teflon 18 dynes / cm

* Reference Only-Contact Lydall Product Development for more information

ZeroClearance



ZeroClearance

Application Surfaces

High Surface Energy

- Aluminum
- Aluminized Steel
- Galvanized Steel
- Stainless Steel
- Polyamide

Low Surface Energy

- Powder Painted Metals
- SMC
- HDPE
- Polypropylene

Substrate Material

- The substrate that the product will be applied to should be approved by Lydall Product Development
- Approval is based on material surface energy and adhesive bond strength.
- Materials should be re-approved by Lydall after any significant material and/or process changes affecting surface characteristics

Application Surface Cleanliness

- The surface should be clean and dry prior to application of the product
- The surface should be free from any dust, dirt, or any other foreign matter that will inhibit adhesion. This includes release agents used in the molding process, oils, plasticizer migrations, or other similar surface contaminants
- Surface contamination may be removed by cleaning the area with a clean drying solvent such as VM&P naphtha or isopropyl alcohol

ZeroClearance

Application Surface Contact

- Higher surface contact between the Zero Clearance product and the bonding substrate will lead to increased adhesive bond strength
- A minimum contact area of 50% is recommended between the adhesive system and substrate for all applications. Full exterior perimeter edges of all parts should have contact with substrate.

Installation Pressure

- Manual Installation
 - Firm, even pressure should be applied across the entire surface of the product during application (palm of hand, squeegee, or metal roller are all acceptable methods)
 - To achieve optimal performance of Zero Clearance through manual application the product should be applied with adequate surface contact, consistent application pressure, and even distribution of pressure across the entire surface
- Automated Installation
 - A pressure of 6 to 10 PSI (41.4 – 68.9 kPa) & ~3 second hold time is recommended – initial tack of the adhesive is nearly instantaneous; however, surface roughness, and geometry of the final assembled condition may require you to increase the hold time to achieve the optimum wet-out.

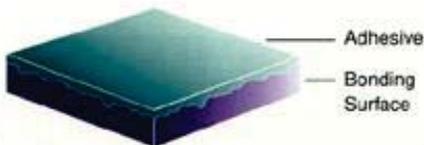
Initial Contact (Minimal Contact)



After Rubdown (More Contact)



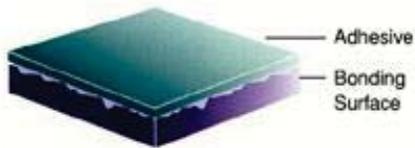
After Dwell Time (Excellent Contact)



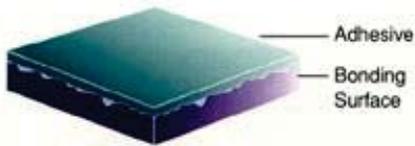
Surface Contact

ZeroClearance

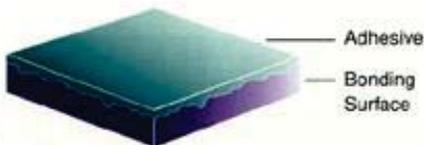
Initial Contact (Minimal Contact)



After Rubdown (More Contact)



After Dwell Time (Excellent Contact)



Surface Contact

Installation Temperature

- ▣ Decreased application temperatures can inhibit the adhesion of the product
- ▣ It is recommended to apply ZeroClearance in an ambient temperature at or above 60°F (15.5°C)
- ▣ All application substrates and ZeroClearance products should be stored at or above 60°F (15.5°C) prior to final application. Materials should be stored at this temperature long enough to ensure that the surfaces meet the above requirements during application

Installation Time

- ▣ ZeroClearance products should be applied within 5 minutes of the removal of the release liner. In extremely dirty environments, this time may need to be reduced to eliminate contamination

 **ZeroClearance**

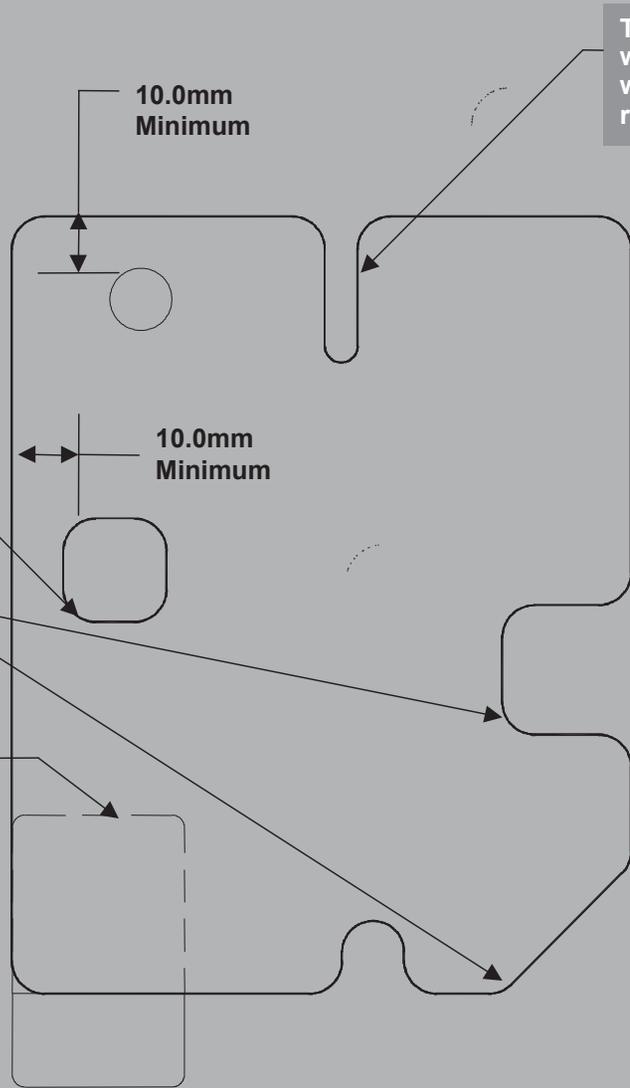
Design Guidelines

Correct Design

Minimum edge to edge distance for holes, slots or other penetrating shapes is 10mm.

All interior and exterior corners must contain a minimum radius of 6.35mm

All ZeroClearance Parts contain a "Pull-Tab" to aid in the removal of the release liner. The placement of this tab is established to facilitate manufacturing with input from our customer regarding the installation process.



The minimum slot width is 8.0mm with a 4.0mm radius at the end.

Specific Design Criteria:

- Minimum Part Size: 50.8mm X 50.8mm
- Maximum Rectangular Blank Size: 1219.2mm X 1473.2mm
- Maximum Part Size: 1143mm X 1447.8mm
- Standard Trim Tolerance: ± 3.0 mm
- Standard Hole Size Tolerance - Holes or Slots: ± 3.0 mm
- ZeroClearance can be edge coated to minimize dust out if required.
- ZeroClearance must be applied to a clean, dry and oil-free surface.

ZeroClearance

Design Guidelines

Incorrect Design

ZeroClearance should not be designed with a single slit

ZeroClearance should not be designed with sliced crosshairs

ZeroClearance should not be designed with sharp interior or exterior corners

The tab should be located to avoid tearing of the release liner upon removal as well as for ease of assembly during the manufacturing process.

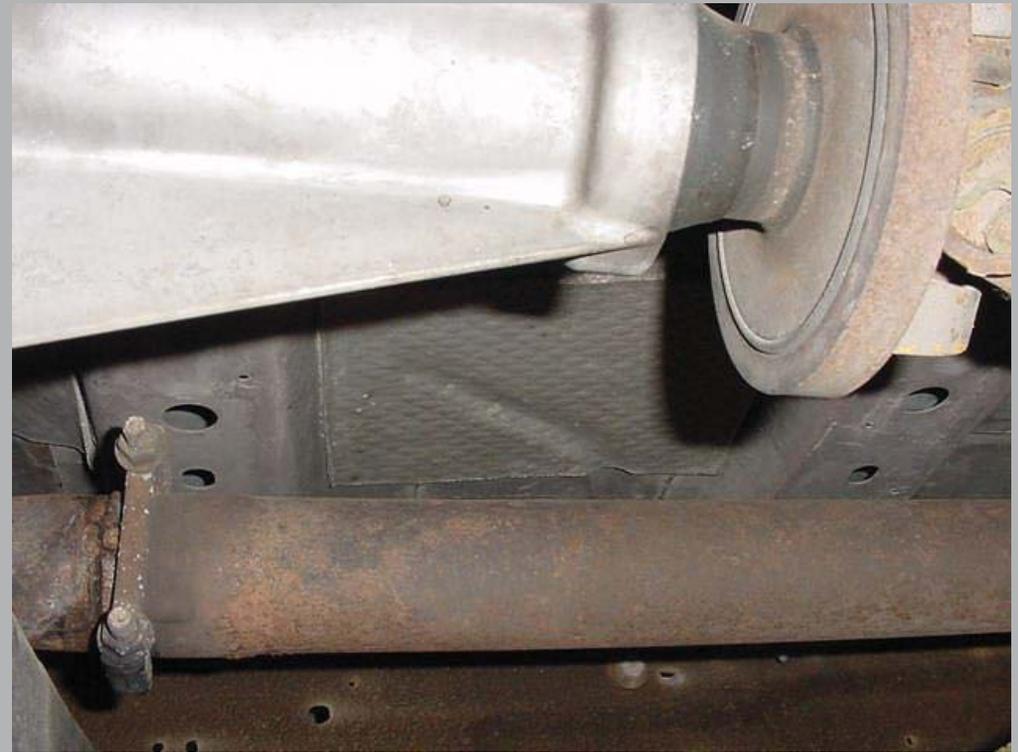
Elimination of sharp corners and slits within part design aids in part manufacturing and reduces liner tearing during installation



Engineered Specialty Products
for the Automotive Market

ZeroClearance

Durability Testing Results



Full Size Pickup Application

Results of full thermal & structural durability cycle - Pass
150K Customer Equivalent Miles



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ZeroClearance

Durability Testing Results



Sedan Fuel Tank Application

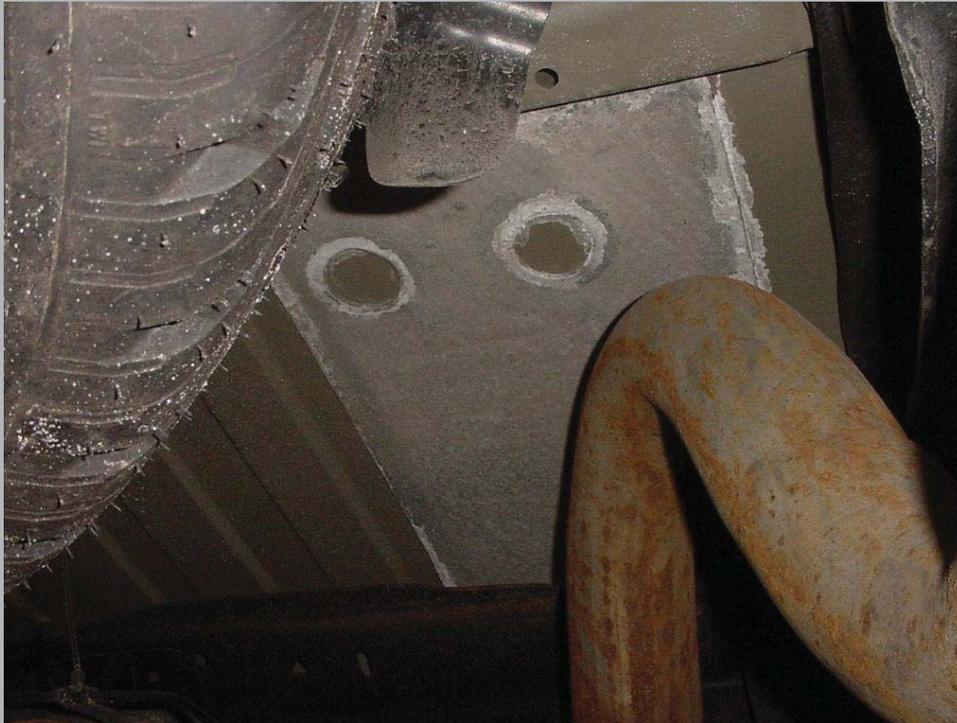
Results of full structural durability cycle - Pass
150K Customer Equivalent Miles



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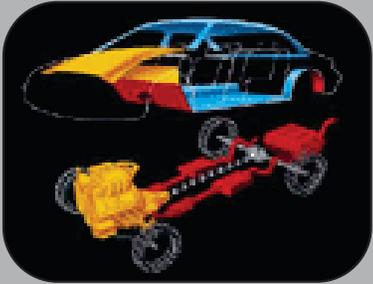
ZeroClearance

Durability Testing Results



Full Size Van Application

Results of full thermal & structural durability cycle - Pass
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ZeroClearance Applications

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- Interior Dash
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ZeroClearance

Qualified Material Specifications

- ▶ Qualified and approved to General Motors GMN10046, GMW16653
- ▶ Qualified and approved to Ford WSS M99P32-E6
- ▶ Qualified and approved to FCA (Chrysler) MS10943
- ▶ Qualified and approved to Honda specifications.
- ▶ Qualified for FMVSS302 Flammability Requirements
 - Self Extinguishing Rating [FMVSS302 & SAE J369]
 - UL-94 Vertical Burn Rating – V0 for Fiberglass Styles (ZC112-XX & ZC612-XX)

Product Validation Testing

- ▶ Adhesion Performance and Durability Measured and Qualified Through:
 - Heat Aging (Ambient up to 204°C)
 - Environmental Cycling (Heat, Humidity, Cold Cycling)
 - Salt Spray (500 Hours)
 - Fluid Immersions (Water, Salt Water, Oils, Acids, & Other Automotive Fluids)
 - Impact Cycles (From -7C to 204°C)
- ▶ Durability Qualified through Gravelometer Testing per SAE J400
- ▶ Qualified to many Interior Requirements (Odor, Fogging, Mildew, etc.)
- ▶ High Physical Strength Maintained (Tensile, Tear, Laminate Strength, etc.)
- ▶ Many other Application and OEM specific Requirements