

Optare Group

Innovative bumpers and skirts withstand high impact, keep bus looking new

Designing the Alero

Painted glass-reinforced plastic (GRP) is the standard for bumpers and skirt panels on buses—big and small—in the competitive and deregulated British bus market. Yet, when the Optare Group began designing the Alero, its first small bus for the community transport sector, the company knew that standing by convention was not an option. Instead Optare turned to a proprietary thermoplastic sheet that enabled it to achieve design, production, and performance objectives.

"We wanted something that looked more like an MPV (multi-purpose vehicle) and less like a standard transport van," explains Kevin Saville, body engineering manager for Optare, the British subsidiary of North American Bus Industries (NABI).

"We found that in the accessible vehicle sector, most products were constructed to look like ambulances," adds Neil Widdowfield, sales director for Optare's Mobility Products. "They were square vehicles, sort of boxes on wheels, and there is a stigma to traveling in that type of vehicle. We knew that if we had an attractive, stylish vehicle that people wouldn't associate with this stigma and we would have a greater chance for success."

Optare, which has been designing and constructing larger 30- to 40-seat buses since 1985, began the design of the Alero with the development of a slim-line, stainless steel drive shaft that's routed through the underframe to provide an ultra-low, flat interior floor. Normal ride height is 250mm (9.750") off the ground. Full suspension and a driver-activated ECAS system provide kneeling and lifting at both front and rear. When knelt, the entrance step is a mere 190mm (7.410") off the ground, eliminating the need for boxy lift equipment at the back of the bus.

For the structure the company wanted materials that would be anticorrosive and durable, yet stylish. To meet these requirements, the company opted for a single-piece colour-impregnated composite shell bonded to a stainless steel frame, the lower section of which is painted and undersealed for corrosion protection. All that was left to complete the look was finding the right material for the bumper and skirt system.

"Traditionally, on the larger buses we specify GRP bumpers, primarily because they can be painted to match any body colour," explains Saville. "But when it came to the Alero, because we wanted to produce something that was more car-like, we wanted a material that was coloured throughout so that if it got grazed or damaged the colour would remain."

To find the right solution, Optare worked with Paul Rhodes, business development manager for thermoformer Thompson Plastics Group (Manchester, UK). "We explained that we wanted to produce large impact-resistant components having integral colour," says Saville. "Paul Rhodes suggested a variety of materials, including several acrylic-cut PVS materials, but we all agreed that KYDEX® sheet, a proprietary thermoplastic alloy, provided what we needed all around."



The Alero's ultra-low, flat interior floor combined with kneeling and lifting capabilities at both front and rear make it ideal for riders requiring easy access. When lowered, the entrance step is a mere 190mm (7.410") off the ground.



Colour-impregnated thermoplastic sheet used on the bumpers and skirts enhances the car-like style of Optare's Alero bus.

Building in Rugged Good Looks

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**KYDEX®
Thermoplastic
Sheet Stands up
to 4-Ton Test**

The bumper and skirt panels are produced using KYDEX® 510 thermoplastic sheet with an acrylic cap, both selected in a mid-tone gray to best complement the five standard Alero body colours—Glacier White, Ardanza Red, Corn Yellow, Atlanta Blue, and Dolphin Green. A "P-1 Haircell" texture completes the overall look and feel of the product.

The curved, one-piece bumper complements the body shell very well, according to Widdowfield, who adds that Optare's customers have been "delighted with the overall appearance of the vehicle." The innovative bumper and skirt system have also proven to be much more durable than conventional bumpers, helping to reduce damage and the associated costs of repairs.

Extreme impact resistance was a deciding factor in specifying KYDEX® sheet for the vulnerable lower section of the Alero.

"Damage to bumpers and skirts is an ongoing issue in the bus market," points out Saville. "It's one that we've come to accept on our larger buses, and we send out a lot of replacements for our GRP bumpers in the field. But for the Alero, we wanted a bumper that could withstand more impact and wear than standard GRP bumpers."

"The advantage of KYDEX® sheet," explains Glenn Saint, technical director at Optare, "is its ability to withstand considerably more impact than standard GRP, and since it's through-coloured, scratches and scrapes normally visible on the panels are inconspicuous."

KYDEX® 510 sheet exhibits Notched Izod Impact Resistance of 801 J/m (15 ft-lbs/in) at 23°C (73°F), which is reportedly two- to three-times greater than ABS. "To demonstrate the durability of KYDEX® sheet components to customers, we ran over one of the side panels with a 4-ton forklift, and the panel resumed its original shape," says Saint. When put to the same test, an ABS part shattered, adds Thompson Plastics' Paul Rhodes.

"Most of the damage to buses having low ground clearance results from driving over curbs," explains Saint. "The frame structure of the Alero allows the side panels to deflect between 25 to 67 mm (1" to 3") and the KYDEX® sheet material tolerates that amount of deformation." KYDEX® 510 exhibits flexural strength of 66 N/mm² (9600 psi), modulus of elasticity of 2482 N/mm² (360,000 psi), tensile strength of 42 N/mm² (6100 psi), and Rockwell hardness of 94 (R scale).

Working from experience, Optare designed the Alero's lower panels with a quick-release system that simplifies the replacement of bumpers and side skirts. The system is comprised of 3M's Dual Lock reclosable fasteners, which hold the top of the panels to the body shell, and a quick-release fastening system from Southco that holds the bottom of the panels to the frame. The Dual Lock system uses a series of mushroom-shaped stems that when pressed together interlock with an audible snap. Though Dual Lock fasteners can be used to replace conventional bolts, screws, and clips, the interlocking pieces can be easily pulled apart when necessary, explains Saint. It's an innovative system that rarely gets used on the Alero.

"We've only had one bumper fail in the field and that was not due to material failure," says Rhodes. "The vehicle was wrecked and any material would have failed."



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The choice to use a thermoplastic sheet in place of GRP has offered advantages on the manufacturing front as well. Seventeen unique parts are being manufactured for the Alero's bumper and skirt system by Thompson Plastics. "The front bumper is interesting," points out Saville. "The overall length is more than 3.50m (approximately 12 ft), and it has a very deep draw." The bumper stretches the entire expanse between the two front wheels, bending into each wheel well.

To enhance the Alero's clean styling the front and rear bumpers were thermoformed in one piece. To meet this challenge, Thompson Plastics developed a custom forming process that is best described as a combination of drape forming and vacuum forming with a twist: the entire forming process is performed outside of the oven. It is a process that is built around the heat retention capabilities of KYDEX® sheet.

"We heat the KYDEX® sheet for about seven minutes until it becomes pliable," explains Rhodes [forming temperature for KYDEX® sheet is 163°C to 200°C (325°F to 390°F)]. "Even when pliable this material holds its own weight nicely," he adds.

Mechanical clamps are used to position the material blank, which measures 4.00m (13.100') long, 1.20m (3.900') wide, and 3.60 mm (0.140") thick, over the tool. Once the sheet is lowered and the clamps released, the clamping platform is moved into place and the vacuum is turned on. The entire process is performed in the open air and requires the sheet to retain its pliability for up to 2 minutes.

"We've tried our process with ABS and polyurethane but they cooled before we got them to the tool," Rhodes explains. "The sheer engineering involved in moving such a large sheet of material from the oven to the tool without the material tearing, thinning, or exhibiting heat distribution problems is a challenge. In the end, KYDEX® sheet is the only material we've found that can resist problems such as these while still offering the required properties for the part.

"ABS can't be substituted for KYDEX® sheet in a process like ours because in its heated state ABS is too elastic; a 3.0m (9.8') piece of ABS can easily be stretched to 4.00m (13.120'). In contrast, KYDEX® sheet becomes pliable but not stretchy.

"Using a modified forming process we can mold the bumpers in ABS," he adds, "But we don't get anywhere near the impact resistance Optare requires."

By combining the capabilities of KYDEX® sheet with its custom forming process, Thompson is able to form the deep draw corners of the bumper while maintaining a net material thickness of 3.60mm (0.140"), a 0% reduction in material thickness. Net material thickness thins down to 3.00mm (0.120") in certain areas of the bumper, which is the specified minimum threshold.



The use of colour-impregnated, impact-resistant thermoplastic on the Alero's bumpers and skirts minimizes visibility of scrapes and scratches common in low-profile buses.



Manchester Airport purchased three Aleros to transfer passengers between terminals.

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The pliability of KYDEX® sheet and its ability to maintain uniform wall thickness and minimize material shrinkage enabled Thompson to reduce both the sheet size and material gauge from its original specifications, says Rhodes. "This provided us with the opportunity to improve processing time and reduce material costs, resulting in a 12% cost reduction for Optare," he explains.

Currently, 3.60mm (0.140") KYDEX® sheet, down from 4.00mm (0.160"), is specified for the front and rear bumpers. Sheet thickness for the side panels was reduced from 3.80mm (0.150") to 3.2 mm (0.130"). Net sheet thickness for the formed side panels is 2.80mm (0.110"), exceeding the formed wall thickness minimum of 2.20mm (0.086") by 0.60mm (0.020").

Though the side panels and wheel arches aren't as challenging as the bumpers and are manufactured using traditional pressure forming techniques, one of the side panels is noteworthy due to its 2.50m (9.500') overall length, explains Rhodes. "It's a benefit that KYDEX® sheet retains its shape without curling at such a length."

Almost 300 Aleros have hit the road since the first prototype was built in 2002. With the introduction of an optional 4-speed ZF automatic transmission and growing popularity in the rural and congested urban transport sectors, Optare is hoping to quadruple yearly production of the Alero at its South Yorkshire plant to 500 vehicles/year.

The decision to introduce an automatic option was based on customer demand, says Widdowfield. "Many drivers are trained on automatics, so this should open up new markets for us," he explains, "particularly in towns and major cities including London."



More than 300 Aleros are currently in service throughout the UK in a variety of capacities

"Councils and local authorities are frequently the purchasers right now," he adds. In 2001, the British government launched the Urban Bus Challenge in an effort to encourage urban renewal and combat social exclusion. The program joined the existing Rural Bus Challenge, which was established to provide access to essentials like employment, education, and healthcare for those in remote rural communities.

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