# Articulated Low-Floor Intercity Coaches Pros and Cons


**Van Hool's AG300 articulated transit bus was recently photographed adjacent to the Van Hool factory in Belgium. It is currently being operated in several countries and is well regarded. The Lightrider research on a low-floor articulated intercity coach has used the Van Hool AG300 as a model.** VAN HOOL.

As the equipment magazine for the bus industry, we frequently get involved in new products, new concepts and suggestions. Most of these pass through our office e-mail, fax and phone on the way to our experts as well as appropriate industry people and never get into print. This time we decided to make an exception and share this discussion with our readers.

Mike Manganello from Lightrider Ministries has been working on the concept of developing a workable low-floor articulated intercity coach. He has used the Van Hool AG300 as a basis for his design and even built a model.

The logic behind an intercity low-floor articulated coach is obvious. Buses are carrying more elderly passengers than ever before and they have difficulty with the steps on high floor coaches. Lightrider's experience with using a Neoplan double-deck Skyliner has confirmed the advantage of lower entries. In his opinion, low-floor is the way to go.

However, Jan Van Eck, our columnist of "Flying Dutchman" fame has a more pragmatic approach to the concept of an articulated low-floor intercity coach. Unlike Lightrider's private ministry travels, Jan Van Eck runs a commercial bus company. Hence, he looks at this concept from the practical standpoints of costs and weight distribution.

Herewith we present Mike Manganello's thoughts on this subject followed by Jan Van Eck's comments. You will have an opportunity to read both sides. Bear in mind that each writer approaches the subject from a different point of view. We would welcome comments via mail or send an e-mail to: safety@busmag.com.

*Larry Plachno, Editor*

## Applying Today's Transit Technology to Yesterday's Motorcoach Design

by Mike Manganello
Co-Founder and Executive Director,
Lightrider Ministries

Though transit buses and motorcoaches operate generally in different venues and for different purposes, both vehicles must accomplish the same task – the safe and efficient transportation of passengers. Transit buses and motorcoaches have certainly become safer over the years. However, unlike transit buses, motorcoach efficiency has failed to keep pace with the changing demographics of our trade.

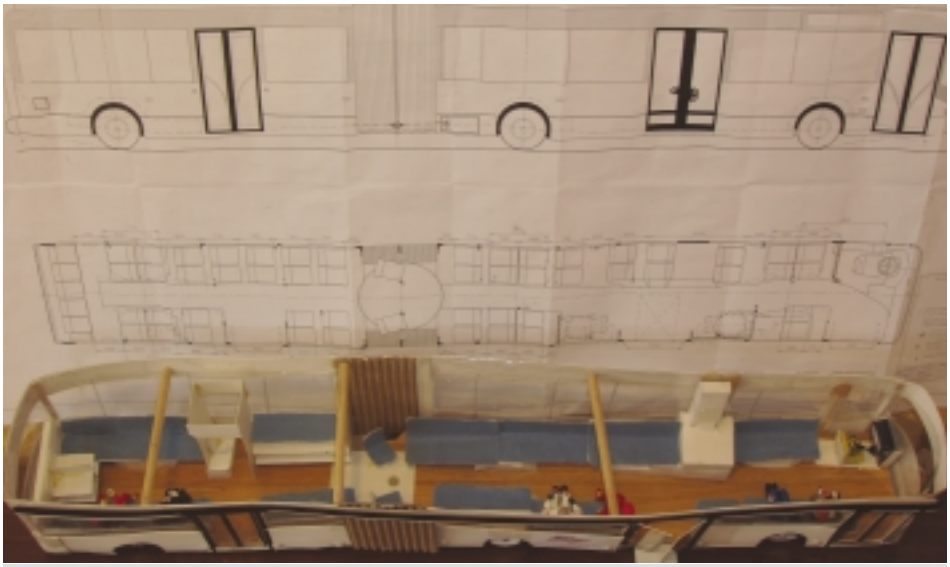
The design of virtually all motorcoaches in America requires passengers to enter the coach via a single door, then climb up five or six steps through a narrow stepwell in order to reach the passenger deck located above cargo bays – a design unchanged since the first half of the last century. Yet today's coaches must carry older passengers, and more of them, than did coaches of yesteryear. ". . . an estimated 60 percent of motorcoach passengers are elderly . . ." and or ". . . disabled," according to Ned Einstein in the March 2007 issue of NATIONAL BUS TRADER. Advocating improved stepwells, he continued, ". . . the steady trickle of boarding and alighting accidents . . . will only

worsen as our ridership ages and becomes even more frail."

A tour director from southern Indiana, timing the unloading and loading of a motorcoach full of senior adults, found that it takes 18 minutes to empty a coach and another 12 minutes to reload. Now that is world class inefficiency.

If we add a bit of modern transit bus technology to the motorcoach design equation – namely low-floor engineering – which eliminates the need for a step well, we have begun to get motorcoach design in step with the demographic needs of this new century. Put in another door or two with flip out ramps and a kneeling feature. Now you have got a vehicle that will warm the hearts and save the joints of today's aging passenger – a vehicle that will make over-the-road travel palatable and available to a far larger segment of today's market.

Of course with a 40-foot low-floor transit bus there are no cargo bays. What do you do with the luggage? Also, the intrusion into the low-floor passenger area by fender wells, the engine, the extra door ways and such, cut down on the number of passenger seats. The tough answer is to design a two-door, 45 foot low-floor coach with a mechanized luggage handling system installed above the passenger deck. This would not only provide the passenger convenience and safety of the low-floor, it would further lower the vehicle's center of gravity which is already lower than that of a standard motorcoach. People weigh more than their luggage, so putting the luggage over the people makes better sense than putting it under them.



**This shows Lightrider's model of an intercity articulated bus set up with the interior they would prefer. The little wooden dowels are used to properly space the sides of the bus since there is no roof. Behind the model are engineering drawings of the Van Hool AG300 that was used as a basis for the model.** LIGHTRIDER MINISTRIES.

Until a motorcoach friendly to elderly or disabled passengers is developed, a 60-foot, articulated, low-floor transit bus could be set up for over the road use – beef up the horsepower, add taller gears, a larger radiator, and heavier tires. The luggage of senior adults is typically wheeled these days and could be rolled up a flip out ramp, parked in the rear of the vehicle and restrained with a cargo net. Little lifting would be involved so luggage handling would actually be easier than the current under the floor system that requires our also aging drivers to do so much bending. Using the forward 38 feet of the vehicle for most of the passenger seating would place most of the weight in the forward section, or "tractor," of the 60-foot bus, aiding stability. The aft 22-foot section, or "trailer," with a lavatory and accounting for above floor intrusions of two fender wells and the fuel tank, would afford 1,252 cubic feet of space for luggage and / or more passenger seating.

With the kneeling feature, multiple doors and flip out ramps, passengers may enter and exit this vehicle without encountering even one step. The familiar gaggle of senior adults huddled in the rain or wind outside the single front door and step well of today's motorcoaches will have been transformed into happily seated, ready to roll, smiling patrons. It was just such a gaggle waiting to board their tour bus that was seen from the low-floor of Lightrider's Skyliner out front of a theater in Branson, Missouri, that inspired this idea.

Lightrider has built a scale model of an articulated (Van Hools AG300) with perimeter seating for 26 passengers plus our staff of four within the "tractor." Luggage space for 30 bags of a specified size (30"x15"x15"), a lavatory, additional "spread out seating" for 15 passengers, and a driver's bunk are fitted into the "trailer." Most of the seating converts into bunks so that all 30 aboard may sleep. Space is available for airline style overhead compartments to handle carry-on bags. The floor area under the perimeter seating will be used by Lightrider passengers for their sleeping bags and pillows.

A low-floor articulated could be designed to carry more seated passengers than Lightrider's arrangement if group dynamics and the ability to convert for sleeping were not needed. AG300s are set up to carry

**Based in Upland, Indiana, Lightrider is not a commercial operator but uses buses to assist with their ministry. Shown here is their Neoplan Skyliner double-decker that they have operated in recent years. The lower doors on the Skyliner have worked out well for elderly and handicapped passengers.** LIGHTRIDER MINISTRIES.

100 passengers plus the driver, however that is 43 seated passengers and the rest standing. So the vehicle can handle the weight of say, 43 seated passengers and their luggage. To make people and luggage fit would require engineering some kind of mechanized, overhead luggage system.

Several articulated motorcoaches have been used at highway speeds around the world. The high-decked Prevost H5-60 and the double-decker Neoplan N 138 Jumbo Cruiser are two examples. Neoplan's AN460/LF, an articulated low-floor transit bus, sold for transit or shuttle service, uses two hydraulic cylinders within the articulated joint, controlled electronically, to eliminate jackknifing. Similar systems are used by New Flyer in the D60LF and by NABI in their 60LFW for the same purpose. Hundreds of articulateds are used on intercity lines in Hungary. Neoplan articulateds ply the New Jersey Turnpike every day.

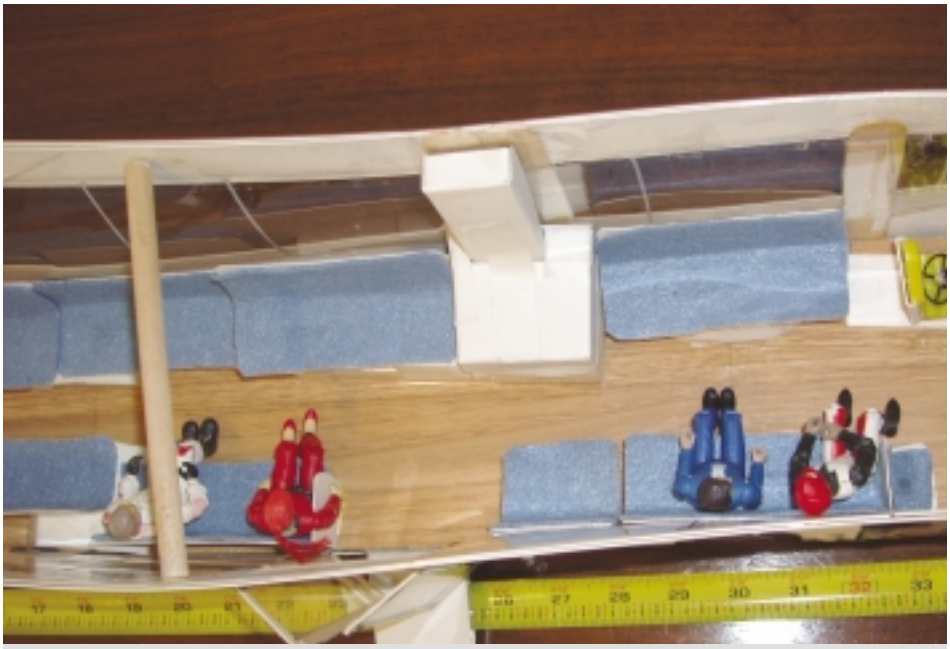
The steering geometry of rear steer and non-rear steer low-floor articulateds differs from each other and from non-articulated buses, making driver training essential in using these buses over the road. The lower driver position inherent in low-floor configurations has not been a hindrance in the 20 years of low-floor highway driving experience at Lightrider (more than a million miles).

To be sure, the view is a bit nicer from a high-decked coach, but is the sight of trees and interstate pavement worth the physical challenge that hinders stiff jointed elder citizens from entry and egress? Improved passenger amenities in coaches, like state of the art entertainment systems, are great, but do the aging 60 percent of coach travelers care more about woofers and tweeters than they do about getting on and off the bus?

Face the facts: Since the 1940s, major design improvements have transformed our two and three-lane roads into multi-lane, limited access super highways; oil dripping, smoke belching engines are cleaner, longer running, much more powerful and economical; four speed unsynchronized manual transmissions have become multi-geared, computer operated, cruise controlled automatics – like butter; bias ply, low mileage tires with inner tubes on split rims have given way to tubeless radials mounted on one piece rims with onboard pressure and temperature sensing systems; drum and Jake brakes are being left behind by all wheel disc brakes assisted by transmission retarders; even the heavy, bulky suitcase has become a light weight duffel with ball bearing wheels. Unchanged, however, is the basic motorcoach design, seemingly locked in a time warp with the likes of the venerable 1948 GM PD4151 Silversides.

Testing is the next step. Lightrider's radius of operation, North America, ideally suits us to experiment with the use of an articulated low-floor in a wide variety of travel situations. Over night ferries to Newfoundland; Small ferries (the ones we use to get to Brier Island off of Digby Neck in Nova Scotia); and campgrounds, county roads, strip mall parking lots, to name a few. We would be in and out of fast food places, through many national parks and major cities, we would climb mountains and cross deserts. We would take a low-floor articulated where no low-floor articulated has gone before – Beam me up, Scotty. Sure, this may sound like science fiction, and it will be fiction, like all innovative ideas, until it is tried.

The motorcoach travel industry, 40,000 coaches strong in the US alone, must demand that coach manufacturers design and build motorcoaches that meet the ambulatory need of the increasing majority of our passengers. Articulated, low-floor engineering is here today, let us get it into service where it belongs – on the highway.



**This shows the front of the Lightrider model of an intercity articulated bus. Lightrider would prefer perimeter seating for 26 passengers plus their staff of four. Most of the seating would convert to bunks for sleeping. The light colored assembly a few feet behind the driver is the underfloor engine and exhaust.** LIGHTRIDER MINISTRIES.

**When used as a transit bus, the Van Hool AG300 can transport as many as 100 passengers with half of them standing. Lightrider's needs call for considerably fewer passengers but they would like space for bunks and sleeping bags. This photo shows the central portion of the articulated model built by Lightrider.** LIGHTRIDER MINISTRIES.

As Ned Einstein has stated in these pages, rather eloquently, "Our future is aging baby boomers staying alive for longer and longer periods of time, and whose lives we can make richer and more meaningful by transporting them safely from their dreary parlors and nursing homes to the venues of their remaining hopes and dreams – these passengers are our living."

### The 60-Foot Articulated Low-Floor An Unworkable Charter Bus

*by Jan Van Eck*

The proposition that an articulated low-floor touring bus is going to be the "next leap forward" in bus design is, in my view, based on wishful thinking. On the surface, it looks good: the elderly, perhaps only partly mobile, passengers that the industry can be expected to see more and more of as our population ages, will avoid the slip-and-fall problems of the "conventional" tour bus. Yet, this low-floor design just has too many practical problems, overlooked or minimized by its enthusiasts. Here is why:

**Capital Cost**

To be a workable bus, there has to be space for the luggage. In a conventional tour bus, the luggage is simply stowed in cargo bays underneath. The advantage of this design is that the luggage does not have to be lifted by the driver (the average age of tour bus driver, let us remember, is now 61) and further that the luggage mass is distributed along the length of the bus.

With a "low-floor," the luggage bays disappear. The luggage has to be stowed someplace else, and the enthusiasts propose to make the bus "articulated," with the luggage stowed in the rear section (together with some seats, presumably). Yet to avoid having the older drivers strain themselves, the luggage would all have to be at "floor level," hence a large proportion of the trailing-section floor space will have to be reserved for luggage. There goes the seating space. (You also end up with a large mass concentrated at the rear, which will lead to braking stability problems.)

**This photo shows the back end of the Lightrider articulated bus model. At the top right is a driver's bunk located atop luggage shelves. The square structure immediately behind this is the restroom. Between the two couches at the rear is a shelf designed to carry six duffel bags.** LIGHTRIDER MINISTRIES.

**The Lightrider Ministries research and model for an intercity articulated bus is based on the Van Hool AG300. With four low-floor doors, the AG300 loads quickly and is friendly to the elderly and the handicapped. It is currently being operated in several different countries.** VAN HOOL.

Proponents of 60-foot articulateds respond that, "Well, we are going to install less seats, so we have level-floor space for the luggage." They envisage tour buses with only perhaps 31 seats. That articulated is going to be expensive to acquire, and expensive to operate; the hinge area will require all manner of specialized hardware, air and wiring harnesses, and the bellows coupling, all of which will have a high parts and labor cost to keep operational. Additionally, let us assume, rationally, that the 60-foot articulated is going to cost $650,000 new. If you set it up with 31 seats, then the capital cost is $21,000 per seat. Your competitor across town with a conventional 57-passenger 45-footer that he bought for $400,000 has a capital cost of only $7,000 per seat.

With so many elderly excursion trips being purchased on price, who is going to pay three times as much for the privilege of riding in the low-floor articulated? Probably, nobody. That is precisely why nobody is building such a tour bus.

If the operator attempts to reduce his per-seat costs to that of the conventional 45-foot bus, then he will have to install 92 seats. That is 23 rows of four across, and when you space this (even with an underslung, horizontal engine, so as to use the space that would otherwise go to the engine compartment), subtracting six feet for the hinge and another eight feet for the two doors, you end up with a seat pitch of less than 24 inches. This is with zero luggage space. Meanwhile your "conventional" bus with 14 rows over

41 feet calculates to a seat pitch of about 35 inches (using comparative areas).

The conclusion is obvious: there is no way that the articulated bus can ever come close to the cost-per-seat of a "conventional" bus. Either the passengers are going to pay a lot more, or the bus cannot be operated. Does anyone really think the passengers are going to pay a lot more?

**Driving Problems**

Articulateds are today being used in BRT (bus rapid transit) operations, typically on fixed routes in high-density urban areas. But remember: there are design constraints at work here. The engine size is limited, given that it is either underslung or has to be mounted in the rear section; transmissions have problems absorbing more than 470 horsepower or 1,450 lbs. ft. of torque. To compensate, the internal gearing (reduction ratio) in the drive axle is set greater – but this creates an upper limit to the top vehicle speed. These BRT buses are typically topping out at 45 mph, which is fine for transit.

Yet, tour buses are customarily run at 60 mph, and some drivers like to boot along at 70+. Can an articulated be driven at 60 to 70 mph? To do so, you will need substantially more horsepower. Automatic transmissions cannot handle this; the alternatives are to install a specialized (and expensive) automatic, or the designer has to install a clutch-manual. How many drivers can you find that are prepared to operate a 60-foot articulated with a 13-speed manual, when the employer across town will offer a nice 45-footer with an effortless automatic?

The alternative is a more sophisticated drive train, such as diesel-electric or diesel-hydraulic. This brings more complexity, more weight, more capital cost and more maintenance headaches, all of which make the bus non-competitive.

To fully appreciate how large these barriers are, we can look to the experience of operators who bought imports with MAN engines. The buses were conventional in every respect except that the engines were built in Europe. When they went to sell these buses into the used market, there were no buyers. The reason: who is going to deal with the additional complexities of an unfamiliar engine when you can buy a used bus with a Detroit or a Cummins sitting in it? Who can find the mechanics that appreciate the subtleties of these engines? Answer: nobody. So the buses were unsaleable (a sad situation, to be sure; these were truly fine engines).

The exact same pattern frustrated Neoplan with their Deutz-air-cooled twin-turbo V-8s of 13.5 liters. They were beautiful engines (I operated one and it was a rocket ship on wheels), but nobody understood the subtleties, and most important, nobody had the time or energy to devote themselves to the "learning curve." The buses became orphans.

The implication to the operator of the articulated is chilling: you can expect no resale value to the bus, so the entire capital cost of the bus has to be recouped through tour sales alone. For operators who count on resale value to generate the funds to get into their next bus, this is a serious problem. Again this is why nobody builds these buses.

**Passenger Considerations**

Unless you sell your bus as a bit like an airplane ride – e.g. designed as a metal cocoon to envelop the passengers while hurtling them through the stratosphere, with a tiny window as a sop to the unhappy – you are going to get passenger resistance from touring in a low-floor. The reason is that the passengers (at least to some extent) treat the ride as part of the experience. They want to look out of the windows and have a nice view of the scenery – and not of automobiles at eye level, fences, Jersey barriers, and associated visual clutter.

It is precisely for this reason that buses have been getting higher and higher, and windows now so big that they are "seamless," with continuous glass down the whole side of the bus.

Another problem is that, unless very small wheels and tires are going to be fitted (which poses its own problems of load capability), you have the intractable problem of "wheel humps," and in the case of the true low-floor, the axle drive-line to the wheel humps. Again, lost space, and more lost seats. All that reduces gross revenues, and drives up per-seat charges.

**This version of the AG300 is currently in operation by AC Transit in California's East Bay area. After looking at several different kinds of higher capacity transit buses, AC Transit elected to order the AG300. AC Transit also operates single unit Van Hool transit buses.** ABC COMPANIES.


**Not all articulated buses are used in conventional city service. Built by Mercedes-Benz, this three-door bus is actually a model built for longer distances and higher speeds in "suburban" type service. This bus is one of a fleet that replaced a railroad line in Germany.** DAIMLER-CHRYSLER.

**One of the obvious advantages of the low-floor bus is the ease of entry and exit. With so many bus passengers being elderly, a low-floor entrance door has obvious advantages. This photo shows how easy it is to deploy a ramp from a low-floor door for wheelchairs and other handicapped vehicles.** DAIMLERCHRYSLER.

**The Van Hool AG300 articulated buses order by AC Transit were put through a series of tests. Here, one of the articulateds is tested performance at higher speeds. The AG300 is a tractor-trailer with an underfloor engine in the front unit.** ABC COMPANIES.

The other, intractable, problem with "low-floor" is that, unless you have the floor so impossibly low that it is actually level with the curb, there is still a step up into the bus. You never really get away from it, and if you envisage loading (or unloading) into a hotel parking lot – at which, with an articulated, at least one doorway will always be away from the curb – then you still have the problem of the "step down" and the associated slip-and-fall liabilities. In reality you are not really eliminating risk; you at best substitute one risk for another risk. That does not solve either the passengers' or the operators' problems. You still end up with a footstool – and the driver standing at the footstool, for whatever good that does.

**Maneuvering**

We have to remember one basic fact about 60-foot articulates: they are built for transit properties, and in transit, buses rarely (if ever) back up. Tour buses back up all the time.

The big problem with backing up is visibility: you have to be able to see what is going on along both sides of the bus. With an articulated, that is impossible – assuming you can snake it in reverse through the obstacle course of parked cars and wandering pedestrians oblivious to their surroundings, at all. I shudder at the prospect.

The designer can put in a steering, or "floating," rear axle, but the industry has soured on these, as tag axles set up with steering systems have had the unsettling experience of coming "out of lock" at speed. You can install an intricate set of relays and switches to control the steering axle, but that again assumes that nothing ever breaks in the field, on tour. Sadly, that is exactly where everything proceeds to break. Another bad bus day coming right up, folks.

Transit garages are set up as "drive through," with big doors at both ends. Most private bus garages are one-end door, and you have to back out gently. Once again, that poses serious problems.

Inside the garage, the time-honored repair approach of simply jacking up one end and going underneath on a creeper is unworkable with an articulated. The operator will have to invest in six-station interconnected wheel lifts – probably at $39,000 in extra capital costs, assuming the garage has enough clearance height to accommodate a wheel lift system.

**Safety Considerations**

From a safety viewpoint, I am hesitant about articulateds in higher-speed open-road use, when designed as a low-floor bus. The first problem is obvious: the driver also sits at a low-floor position. Yet this is exactly where you do not want the driver; you want him higher up, with a commanding view of the road conditions ahead.

More subtly, the driver is also more exposed to collision injury when he is down low. This reality is hardly lost on drivers, and now you have an additional driver recruitment problem: who is going to want to drive the thing?

Kinetic energy that has to be absorbed and dissipated in a collision increases with the square of the speed; go twice as fast, and your collision forces go up by a factor of four. So at 60 m.p.h., if you crash a low-floor, the driver survivability is zero. Drivers may be throttle demons, but they are not stupid. It

**This Prevost H5-60 articulated coach was photographed in Brooklyn in 1995. This model has operated successfully for two decades but is more like a conventional coach because of its high-deck design. It has both a front and a rear door.** J.C. REBIS JR.

is one thing to drive a transit bus at 25 m.p.h. in the city, and quite another to be up front in a tour low-floor articulated doing 60+. Why should a driver take that risk, when he can go across town and drive a 45-footer with an elevated driver station and good driver collision protection?

Another operational problem is severe-service braking. Keeping that second section from breaking loose or fishtailing, especially in wet conditions, is going to be a substantial challenge, and requiring the most skilled drivers. Sure, the builder can install all manner of highly sophisticated anti-skid systems, but remember: all those systems need sophisticated maintenance, and that costs downtime and lost of money, plus skilled mechanics who understand the subtleties of their maintenance. Further, nothing ever breaks sitting in the garage; it always breaks on tour, at the worst possible moment. Why would any tour driver put up with this, when he can go work somewhere else?

I just do not see this bus vision as being realistic for the tour industry. It would make more sense to install a second door, and lift platforms, to bring the immobile elderly on and off the bus. We have not had much competition, or innovation, in lift-platform design, and faster-cycling lifts are certainly possible – with a lot lower capital cost than designing and building specialized articulated buses. I do see one market for really big, double-articulated buses, with luggage underneath: for substituted service for other carriers (rail and air), where they are out-of-service and need major people-hauling capacity. Those buses would typically be driven late-night on level roads at reduced speed in light traffic conditions, and the passengers would typically be quite fit. I would like such a bus; once again, the market is just too small to induce any builder to fabricate one. It remains just a dream. ❑

**The Prevost H5-60 offers underfloor luggage space and a higher deck for better passenger viewing. While a low-floor bus would provide easier entry and exit for passengers, the passengers' view would not be as nice and dealing with the luggage might present problems.** NBT PHOTO BY LARRY PLACHNO.