Proven, Reliable Technology

Straddle-type Monorails have been Refined and Improved for Over 60 Years

If transit “experts” say SkyRail is not a “proven” urban transit technology fully capable of meeting day-to-day high capacity operation, they simply must not be aware of the facts. In this context, it is very important to note that modern transportation technology has evolved tremendously through the years -- from the first private inventions to becoming the backbone of modern civilization. Cars, trucks and buses have been modernized and improved for more than 100 years since they were invented; trains have been modernized and improved over nearly 200 years since the first steam trains.

Similarly, surface light rail has been modernized and improved for over 100 years since the first trams and streetcars. And in a highly analogous manner, straddle type monorail technology has been incrementally improved and modernized for more than 60 years.

Monorail’s Steady Development Progress has paralleled that of Light Rail Transit

Straddle monorail’s steady development started with a test track in Europe and the first Disneyland Monorail in the 1950s, the initial urban systems in Japan starting in the 1960s with the Haneda Tokyo Airport line, and Walt Disney World in the 1970s. This trend of ongoing development and improvement has continued to this day.
Along the way, Monorail’s steady path toward reliable urban transit service followed very much the same path that light rail’s evolution also followed, from slow, manually operated, uni-directional streetcar and tram lines with loops at the ends of the lines -- to modern light rail and monorail lines with bi-directional trains and active track or guide beam switching.

This steady improvement included many public monorail lines being implemented through the first 50 years of monorail development (not just amusement park systems, systems that contained virtually the same basic elements as improved light rail systems) – and these lines have been operated over millions of train miles and hours. These parallel developments in light rail and monorail technology from the 1970s through the Year 2000 continued, including, but not limited to, the following key features:

- High voltage (750 VDC and 1500 VDC) electric power distribution
- Reliable AC propulsion motors and solid state motor controllers
- Bi-directional vehicles
- “Pinched loop” operation to eliminate loops through frequent switching that is fully interlocked with the train protection system
- Automatic or operator-initiated door operation using transit grade equipment
- Full standing height interiors
- Semi-permanent coupling into higher capacity trains
- Level boarding at stations (for monorails and some light rail lines)
- Proven fixed block train protection (for monorail, and for light rail lines operating in exclusive rights of way)
Unfortunately, with only one exception (in Las Vegas), improved and modernized straddle type monorail technology was not implemented in urban settings in this country over this time period, such that there are relatively few transit “experts” who are aware of these facts. At the same time, light rail systems were being implemented in many United States cities, such that by the end of this period, there were many light rail practitioners based here with first (or second) hand light rail knowledge. Now, however, as most low cost at-grade rights of way for light rail systems already have been taken, transit leaders are turning to fully grade separated options and are very seriously investigating straddle monorails for other right of way types, including freeways and high volume arterial roadways where at-grade operation can’t function, to parkways, utility corridors, and waterways.

**SkyRail Technology Development: Evolutionary to Revolutionary**

Therefore, following tens of thousands of hours of high level engineering progress and hundreds of millions of dollars of research and development, BYD’s SkyRail is being implemented around the world at a record pace. BYD’s holistic approach to the technology has not only been applied to the monorail trains – it has included all of the major elements of what is arguably the world’s most fully integrated urban transit technology.

Through this multi-year development program, BYD’s SkyRail includes all of the 1950s through the year 2000 evolutionary features of urban rail transit systems mentioned above, plus all of the following state-of-the-art features:

- Increased safety and reliability through driverless, communications based, positive train control technology, enabling operating headways as low as two minutes in each direction
• Higher speed, fully grade-separated operation, from 50 mph to 75 mph cruise speeds
• Automatic coupling into longer trains, up to 8 car trains, to meet high demand periods by providing peak capacity of at least 18,000 passengers per hour per direction (ppphpd) at American standing space specifications, not European or Asian levels of standee crowding, where the peak line capacity can reach 40,000 pphpd.
• Walk-through trains to enhance passenger boarding and de-boarding, more evenly distribute the passenger load, and facilitate emergency evacuation
• Transit-grade, state-of-the-art components throughout, such as reliable door operators, HVAC systems, variable message signs, public address systems with battery backup, facial recognition systems, closed circuit monitoring systems, smoke detection systems, etc.
• Permanent magnet synchronous AC motors, which typically have 30%-60% higher torque capacity and 30% better torque utilization with faster acceleration and deceleration, and much lower heat generation -- and as a result, these motors are showing a significantly longer life.
• Flexible seating arrangements consistent with the North American practice of maximizing seating
• Emergency evacuation walkways throughout the network that provide a safe path to code-compliant evacuation facilities located at stations and along the route
• Improved and higher speed guideway switching that provides all of the same functions as rail switches
• Code-compliant trains that minimize the potential for fires and toxic smoke
• ADA compliance, including level boarding wheelchair access resulting from automatic height adjustment, based upon passenger load
• Fully integrated, “top down” energy conservation and management, including regenerative braking and wayside energy storage
• Operation on grades up to 10% steep
• Backup on-board batteries that can move the train to the nearest station in the event of a regional power outage
• Reliable, efficient, low energy consuming LED lighting throughout
• Sleek, modern, dynamic design, both inside and out, using high quality materials (aluminum exteriors and composite interiors), large windows, and a very comfortable and quiet ride.
• Longer span structures and special structures for unique situations
• Seismic requirements fully integrated into the structural design
• Smaller, lighter weight, pre-cast columns and beams that greatly reduce costs and accelerate construction, while minimizing construction disruption
• Shorter turning radius, down to as small as 150 feet, to facilitate urban integration
SkyRail is built with transit grade components throughout, including the guide beam switches. BYD has developed or improved six types of switches that can be used in a variety of routing situations to improve operational flexibility while remaining high reliability, with operational availability greater than 99.97%.
BYD also has spent considerable time on research and development in cold climates and is delivering projects where snow and ice buildup can occur. For SkyRail, several systems including train mounted brushes, anti-frost coatings and switch and beam heating, have been developed to mitigate the effects of snow and ice during in cold environments.

![SkyRail in snowy conditions](image)

This combination of evolutionary and revolutionary technology has led to BYD becoming the world's largest supplier of urban monorail systems.

**Service Proven Technology**

BYD has over 210 miles in 22 SkyRail systems already in planning and design, construction, or operation, starting in China and the Philippines, and now expanding to systems in the detailed planning stage for several major cities in North and South America and Africa. And there are dozens of earlier generation straddle type urban transit systems provided by others in 42 cities already in full operation around the world.

BYD is the world’s only totally vertically integrated monorail system supplier. This means that BYD takes full, single point responsibility for the entire SkyRail project, thereby taking on the risks of on-time, within budget project implementation. BYD can do this because we design, manufacture, install, test and commission all of the critical elements of the SkyRail system, including:

- SkyRail trains
- Driverless train control and communications system
- High tolerance, unique, pre-cast structural guide beams
- Guide beam switches
- Traction power and distribution system, with wayside high technology battery storage
Long Term Product Support

As the world’s largest supplier of monorail systems, BYD is demonstrating its commitment and ability to provide long term support of SkyRail around the world – and especially in the United States. As a truly global, private company with 60 percent of our trading stockholders being Americans (including nearly 10% company ownership by Berkshire Hathaway under the leadership of Warren Buffett), we are here for the long run. BYD already is present in over seven North American cities, has annual revenues of $17 billion (US), global leadership in renewable energy generation and storage, and a core business led by virtue of being the world’s largest producer of zero emission vehicles. Thus, BYD obviously has the unmatched resources, engineering know-how, and advanced technology base required to provide long term, environmentally sustainable support to SkyRail cities throughout the country and the world.

BYD’s long term commitment to SkyRail technology manifests itself through our commitment to form and lead Public/Private Partnerships (P3s) that will deliver long term project financing and implement the SkyRail system with high quality, and to do so faster and at a lower cost than conventional grade-separated rail alternatives. This long term commitment provides cities with a single point of responsibility for system performance, which in and of itself is a major motivating factor for BYD to deliver highly reliable service, high quality spare parts, and support fleet and systems rehabilitation and eventual replacement many years into the future.

This long term P3 commitment is further enhanced through BYD’s demonstrated ability to form, staff, train, and lead SkyRail operations and maintenance organizations providing long term system-wide service under fixed price contracts. BYD thereby shares its primary objectives with the transit authorities with whom we partner, namely: to maintain the system diligently, and to incorporate measures and improvements over time that will ensure ongoing safe, reliable, efficient, and economical operation.
Specifically, all key elements of the SkyRail technology proposed for deployment in the United States, including the trains, systems, and switches, are fundamentally consistent with the platforms already deployed elsewhere in the world (other than local preferences such as seating, finishes, paint schemes, and so forth). This is made possible through compliance with key American and global standards and codes in all installations to the maximum extent possible. In this manner, non-recurring costs are minimized and there will be no “one-offs”, no “dead-end” applications -- such that technical know-how, spare parts, and replacement vehicles and systems will be available at fair and reasonable pricing levels for the foreseeable future.