Advance your thinking.
Experience the future – Transrapid
Floating on cloud nine – Innovation in travel

The invention of the railroad revolutionized travel more than anything that had come before. Subsequent generations brought technical developments and innovation that made rail travel even faster and more comfortable. Now Transrapid presents the first truly fundamental innovation in rail technology since the first trains were built.

Transrapid – a consortium comprising Siemens, ThyssenKrupp and Transrapid International – has no wheels, axles, transmission or overhead wires. It surpasses all previous technical and efficiency benchmarks for rail vehicles. And it is based on electronics rather than mechanics.

Instead of rolling, the Transrapid hovers over the track at speeds of up to 500 km per hour – with no vibration and no rattling. It is extremely comfortable and lightning-fast.

In today’s world, innovation means more than simply fulfilling technical requirements. True innovation must accommodate existing infrastructures and especially environmental concerns.

The Transrapid can be perfectly integrated into existing rail, road and air transportation systems, and features an outstanding environmentally-compatible design.

Transrapid sets standards.
A magic carpet ride at 500 kilometers per hour

_Sit back, relax and travel hassle-free_

For travelers, it’s often the small things that make a trip comfortable. When traveling by conventional means, many inconveniences must be tolerated – on Transrapid, just sit back and relax.

For Transrapid travelers, there’s no unpleasant pressure in the ear that comes with take-offs and landings in airplanes. There are no long lines at the check-in counter or baggage claim. And business travelers can leave their cell phones or laptops switched on.

**For all distances**

Transrapid technology lets travelers enjoy peaceful, time-saving travel over short, medium or long distances. It is especially well-suited for quick connections between downtown and the airport, from one large city to the next, as well as for long distance. The Transrapid is an excellent alternative to short flights, and perfectly complements today’s transportation networks.

**Utmost comfort**

Inside the Transrapid, passengers “hover” undisturbed to their destination. The large, comfortable seats are conveniently equipped with the latest technology, and each seat offers everything passengers need to concentrate on their work without any interruptions – or, of course, to sit back, relax and enjoy the trip.

**Custom-fitted**

Transrapid vehicles, including their interior furnishings, can be easily configured to meet a wide variety of needs. The standardized modules can be combined to create configurations that will meet any operator’s requirements for passenger and freight transportation.

*Inside view of a Transrapid passenger compartment – planned down to the very last detail*

*From Pudong Airport to downtown Shanghai – 30 km in just 7.5 minutes*
Easy on the environment

Using regenerative energy and setting new standards
Energy consumption is a critical issue for any type of transportation. With fossil fuels in limited supply, use of renewable energy is an increasing priority.

**Low CO₂ emissions**
CO₂ emissions are determined by primary energy needs and the raw materials used to create and distribute electrical energy. Since the Transrapid draws its power from the public grid, it is conceivable that it can be powered with renewable energy.

**Lower energy consumption**
The Transrapid is clearly unrivalled in its low energy requirements. For any given distance, it requires one-third as much energy as a car, and even one-fifth as much as an airplane. There are good reasons for this – low vehicle weight, minimum resistance to motion and state-of-the-art power electronics. Moreover, the Transrapid eliminates all of the processes associated with friction-based, electromechanical transformation of energy.

**Lowest magnetic field strength**
The Transrapid’s magnetic field is negligible for passengers and the environment, and is far below the field strength of common household appliances. The magnetic fields surrounding a hair dryer, a toaster or an electric sewing machine are far stronger than those in Transrapid’s passenger compartments. The values are even lower once the train is underway. Several studies, including reports from the Research Institute for Energy and Environmental Technology commissioned by Germany’s Federal Institute for Occupational Medicine, state that electromagnetic fields over Transrapid’s entire frequency spectrum are significantly lower than permissible limits set by Germany’s Federal Emissions Control Act. There are thus no adverse effects on pacemakers or magnetic cards.
Easy on the ear –
Perfectly integrated into the environment

Low noise emission, low land requirement

A big idea doesn’t necessarily need a big space, and the Transrapid shows the right way to do it. When it comes to performance, the Transrapid turns in a superior performance – but it’s very modest when it comes to the amount of space it takes up.

Comparison of noise emission test values

<table>
<thead>
<tr>
<th>Decibel (A)</th>
<th>Source Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>130 dB (A)</td>
<td>Jet plane at a distance of 200 m (650 ft)</td>
</tr>
<tr>
<td>120 dB (A)</td>
<td>Jack hammer at a distance of 5 m (16 ft)</td>
</tr>
<tr>
<td>110 dB (A)</td>
<td>Circular saw</td>
</tr>
<tr>
<td>100 dB (A)</td>
<td>Car horn</td>
</tr>
<tr>
<td>90 dB (A)</td>
<td>Truck at a distance of 5 m (16 ft)</td>
</tr>
<tr>
<td>88.5 dB (A)</td>
<td>Transrapid at a distance of 25 m (400 km/h)</td>
</tr>
<tr>
<td>73 dB (A)</td>
<td>Transrapid at a distance of 25 m (200 km/h)</td>
</tr>
<tr>
<td>70 dB (A)</td>
<td>Normal road traffic</td>
</tr>
<tr>
<td>60 dB (A)</td>
<td>Normal conversation</td>
</tr>
<tr>
<td>50 dB (A)</td>
<td>Soft music on the radio</td>
</tr>
<tr>
<td>30 dB (A)</td>
<td>Whisper</td>
</tr>
<tr>
<td>20 dB (A)</td>
<td>Ticking of a clock</td>
</tr>
<tr>
<td>10 dB (A)</td>
<td>Computer</td>
</tr>
</tbody>
</table>

An increase of 10 dB (A) is perceived as a doubling of the noise level.
The Transrapid requires only a little land when compared to other transportation systems. This not only applies to the guideway, but also to all of the other installations needed for smooth and safe operation.

Roughly just 2.1 m² per meter of track
An at-grade guideway, including technical infrastructure, requires only approximately 12 m² of land per meter of track, while an elevated guideway requires just 2.1 m². Both of these values refer to twin guideways. In addition, the Transrapid requires no access roads for safety or maintenance of the guideway.

Low noise emission
The Transrapid is exceptionally quiet compared to other means of transportation. It generates no rolling or propulsion noise, and in fact hovers almost silently at speeds up to 250 km per hour. Its 70 dB measured at a distance of 25 m is only 10 dB louder than a normal conversation. At higher speeds, air resistance increases the volume, which still remains well below the noise level of a truck. On at-grade stretches, the values are even lower.

Low air turbulence
The Transrapid’s airflow was also tested extensively at the Emsland Test Facility (TVE). No air turbulence was detected under the elevated guideway over the entire range of speeds. When the train passes by on an at-grade stretch, the slipstream feels like a normal wind. At a speed of 350 km per hour, airflow speed is barely 10 km per hour.

Minimal vibration
Vibration caused by the Transrapid is truly negligible. At a speed of 250 km per hour and a distance of 25 m, the Transrapid’s vibration is transferred to the ground and is below the level of perception of humans. At a distance of 50 m, no vibration is noticeable.

Perfectly integrated into existing transportation infrastructures – at-grade guideway

Flexible and environmentally-friendly – elevated guideway
Increased efficiency right from the start – Progress that pays off

Less is more: On track to success with reduced costs

A high proportion of the overall investment for the Transrapid goes to constructing and equipping the guideway. This investment is comparable to that required for a high-speed, wheel-on-rail track system.

![Bar chart showing energy consumption per seat-kilometer for different speeds and modes.]

*Impressively low energy consumption per seat-kilometer*
Less special construction
Construction of a Transrapid route is especially economical in difficult terrain. Small curve radii and outstanding grade climbing characteristics make expensive special construction, such as tunnels or bridges, unnecessary in most cases.

Less follow-on costs
The Transrapid’s high speed gives it an additional advantage over comparable transportation systems. It means fewer vehicles are needed to achieve the same transportation performance, which in turn requires less initial investment and follow-on costs for personnel, maintenance and energy. The Transrapid requires less in all areas – and that keeps operating costs down.

Less wear and tear
Contactless levitation technology minimizes wear and tear on the guideway and vehicles. Electronic and electromagnetic components – that are essentially wear-free – are used extensively in place of mechanical components that wear quickly.

Less time and effort
A special maintenance vehicle monitors the entire Transrapid route directly from the guideway. The built-in testing system detects changes to guideway components, reports them automatically, and promptly initiates any required corrective measures. The system’s necessary devices and mechanisms are located along the route and at stations.

There is another advantage: Damage caused by unforeseen circumstances is very rare. Track-guided transportation like the Transrapid is very rugged and operates even in the most adverse weather conditions.
Always on track –
Safety has been re-defined

*Transrapid wraps around the guideway – making derailments and collisions impossible*
Despite its extremely high speed, the Transrapid is safer than any other means of transportation.

This is because the vehicles wrap around the guideway and cannot derail. The guideway motor is activated one track section at a time and can operate in one direction only, which eliminates the possibility of collisions.

The Transrapid carries no fuel or combustible coolant on board, and is manufactured exclusively from PVC-free, flame-resistant materials. The automatic train safety system and the automatic guideway inspection system continuously provide the highest level of safety.

**Safe braking**
In the event of a power outage, batteries provide all of the required energy on board the train. The vehicle then uses the existing momentum to continue hovering, ideally to the next station. If the station is too far away, the vehicle is braked to a stop at auxiliary stopping areas specifically intended for this purpose and located at regular intervals along the guideway. These stops are always straightforward. With the backup brakes buffered by separate batteries, any power outages only affect the propulsion and not the braking system.

**Absolutely weatherproof**
The Transrapid easily masters wind and adverse weather, and hovers to its destination with absolute reliability even under extreme conditions.

**Safe and reliable operation**
All operational sequences, including the vehicle driver’s tasks, are controlled, monitored and verified by the operations control center. All operational safety equipment is integrated in the vehicle and equipment along the guideway. Data is transferred using a fully redundant radio data transmission system. The system ensures positive location of vehicles, adequate vehicle separation, setting of track switches and monitoring and controlling of vehicle speeds.

**Reliable operation at the press of a button at an operations control center**
Example – Transrapid Shanghai: Flying low from the airport to the city

On track for the future in this metropolis of 16 million

Since January 2004, the Transrapid is moving passengers at high speed between Shanghai Long Yang Road in the city and the Pudong Airport – 30 kilometers in 7.5 minutes at 430 km/h every 10 minutes.
Impressive: The high-speed link
- 30 km guideway with 2 tracks, 8 switches and a depot
- 7.5 minutes travel time
- 10 minutes train headway
- Maximum operating speed approx. 430 km/h
- 15,000 people per day and direction
- Operating hours: 18 hours per day

Exemplary: The project schedule
- January 2001: The contract to supply the Transrapid system was signed between the German Transrapid Consortium and the Shanghai Maglev Transportation Development Company (SMTDC)
- September 2002: The first vehicle was commissioned on the link between Shanghai Long Yang Road and Pudong International Airport
- December 31, 2002: VIP run
- Since January 2004: Commercial passenger operation

The know-how of Siemens is always on board

The propulsion technology: Innovation pure
The propulsion regulation and control system is the core of the Transrapid propulsion system. It ensures that the propulsion system is precisely controlled. This not only includes the vehicle guidance and control, but also the closed-loop current control according to the Transvector principle as well as the complete route control. Furthermore, 16 traction converter units, four 110/20 kV transformers, 60 switch stations, nine transformer stations as well as all of the required cabling are part of the scope of the propulsion system.

The operations control system: Twice as safe
Welcome to the brains of the Transrapid system! Here in the operations control center, automated operation has no longer been a vision for some time now. All of the operations are controlled, monitored and secured from here – including the classic tasks of the vehicle driver for instance, acceleration and braking. In addition to this central control, all of the tracks and vehicle movements are monitored in a distributed fashion.

The equipment required is located on the vehicle itself as well as in systems along the guideway. A radio data transmission system with extremely high availability ensures data transfer between the vehicle and the equipment along the guideway. In the unlikely event that a problem occurs, everything is optimally under control as three redundant communication networks form the backbone of the operating control system.

Turnkey projects: Everything from a single source
Hardly any other company combines its skillsets so consequentially in order to implement railway systems more cost effectively and efficiently – from supplying components up to the complete system. One of our strengths is to flexibly integrate solutions into the infrastructures and projects of our customers. Also when it involves working together with consortial partners as is the case for the Transrapid Shanghai project or working with you in ongoing operation "under the rolling wheel".
The Munich Transrapid project: The fastest way from the city to the airport

The Transrapid will also set new standards in Germany – as intelligent link between the Munich main railway station and the “Franz Josef Strauß” Airport.
Facts that speak for themselves

- 37.4 km route, of which, 12.7 km is elevated, 19.45 km on-grade and 7.2 km in a tunnel
- 10 minutes travel time
- 10 minutes train headway
- Maximum operating speed approx. 350 km/h
- Average speed approx. 220 km/h
- Approx. 7.86 million passengers per year

The transportation medium of the future – perfectly integrated into today’s infrastructure

Improved connections for travelers

The Munich main railway station is one of the most important travel hubs in Germany – in addition to suburban rapid transit, metro and underground trains, it also links long distance trains with regional trains. Today, passengers on their way to the Munich Airport “Franz Josef Strauß” mainly make connections here. The suburban railway takes 45 minutes to travel the 37 km between the main railway station and the airport. Transrapid will be able to reduce this travel time to just 10 minutes. In so doing, the magnetic levitation train will reach maximum speeds of 350 km/h.

Noticeably less stress for man and nature

Many travelers are missing a real alternative to their own car. The result: Stop-and-go traffic. For instance, the A9 and A92 motorways between the airport and Munich are already hopelessly overcrowded. However, continuous traffic jams, noise and pollution from exhaust gases don’t just have an impact on the travelers. The consequences of the ever increasing amount of traffic is also unacceptable, especially for those living close by these motorways. By 2015, the airport is expecting flight traffic to increase to almost 50 million passengers per year – twice as many as today. This increase in traffic could no longer be compensated even if massive roadworks were to be started – however, Transrapid can solve the problem.

Optimal link between train and airplane

A significant number of travelers complain that they have to carry around their luggage when they travel by rail and air. This is everything but relaxing, especially on vacation. The Transrapid will make traveling a lot more comfortable: Large airline companies will sell their tickets in the Munich main railway station. It will also be possible to immediately check-in for the flight and leave their luggage at the station. A seamless, integrated luggage service will then bring the bulky luggage directly to the airport from the main station and vice versa. It couldn’t be more easy and comfortable.
The best path –
An ideal solution at every level

Whether at-grade or elevated,
perfect route alignment is always ensured
Regardless of the terrain, the Transrapid’s favorable guideway parameters allow easy planning and execution.

**Elevated guideways**
An elevated guideway helps to preserve areas that are ecologically sensitive or part of a connected agricultural area. With columns up to 20 m high, the guideway can be easily adapted to any terrain, with minimal influence on plants and wildlife as well as existing roads or tracks.

**At-grade guideways**
The Transrapid moves primarily at-grade when co-located with existing transportation routes such as roads or tracks.

**Steep grades and tight curves are not a problem**
The Transrapid can easily handle tight curves and steep grades of up to 10%, resulting in fewer tunnels and other encroachment on the terrain. The Transrapid adapts to the environment – and not the other way around.

**Bendable steel switches for safety**
The bendable steel switches are a special feature. They consist of continuous steel box beams that are elastically bent for direction changes and securely locked. This control function is performed electronically with the assistance of an electromechanical actuator. Two- or three-way switches can thereby be designed for at-grade or elevated use. When traveling straight and level, the Transrapid hovers over the switch with no reduction in speed. In the turn-out position, the train travels at a speed between 100 and 200 km per hour, depending on the type of switch used.

**Exceptionally adaptable**
Expensive sub-structures are only necessary for very unfavorable soil conditions. Even when elevated, the track has no adverse impact on ground or surface water, which is another benefit for the environment.
Powerful with outstanding control characteristics

Optimal acceleration and braking – with no wheels and axles

This graphic shows the principle of the synchronous long-stator linear motor. The stator is split and extended on both sides along the bottom of the guideway, producing a magnetic traveling field. The vehicle’s support magnets correspond to the rotor of an electric motor.
No wheels, axles, transmission or overhead wires – the Transrapid’s support and guidance system functions are based on electromagnetic levitation.

The Transrapid has support magnets that pull the vehicle to the guideway from below. Guidance magnets maintain its lateral position on the track. This system extends along the entire length of the vehicle. The highly reliable, fully redundant electronic control system is modular, which means that the vehicle continues to hover over the guideway even if an individual component malfunctions.

**Propulsion and braking in a single unit**
A synchronous long-stator linear motor is used for both propulsion and braking, pulling the vehicle along with the magnetic field it creates. Speed is adjusted by varying the alternating current (AC). Braking occurs when the direction of the traveling magnetic field is reversed. This is even beneficial to the environment, since this energy can be fed back into the public utility.

**High output performance**
The Transrapid guideway is only supplied with energy at the point where the vehicle is located. The motor is not on board and therefore must not be carried along. Power input along each track section can be increased or decreased according to actual demand.
Transrapid – a joint project of Siemens, ThyssenKrupp and Transrapid International.

With its Transportation Systems (TS) Group, Siemens is one of the leading partners to the international rail industry. TS is a complete supplier and system integrator combining its expertise in areas of competence such as Automation & Power, Rolling Stock, Turnkey Systems and Integrated Services. This represents comprehensive know-how – from the operating control systems through traction power supplies up to vehicles for mass transit, regional and main line traffic. It also encompasses future-orientated service concepts and extensive experience when it comes to project management. For the Transrapid system, Siemens is supplying the propulsion system, power supply, operating control technology, communications technology and power rails.

ThyssenKrupp has many decades of experience in building locomotives and all types of carriages. It was also involved in the extremely successful development of the ICE. Based on their extensive know-how, ThyssenKrupp identified the need to extend the technical and economic limits set by wheel/rail technology. ThyssenKrupp has created the basis for the use of the Transrapid system by proving the functionality of the long-stator levitation technology and heading up the system development. ThyssenKrupp is supplying the following components to the Transrapid system: Vehicles, propulsion component, guideway equipment.

In order to be able to offer a competent partnership for the Transrapid system, Siemens and ThyssenKrupp have founded a common company – Transrapid International – for the system technology, system integration, marketing and sales.