"The Tokaido Shinkansen and Superconducting Maglev"

-Contributing to a Low-Carbon Society-

Toyonori Noda

Executive Vice President, Central Japan Railway Company (JR Central), Japan

Railway is an environmentally superior mode of transportation that is more energy efficient and emits less CO_2 than both airplanes and automobiles. It, however, can perform these superior attributes only when it is used by sufficient number of passengers. From this point of view, the Tokaido Shinkansen is a highly environmentally-superior transport system used by approximately 410,000 passengers every day.

Since the establishment of JR Central in 1987, we have been working seriously on enhancement of the transport capacity and speed of the Tokaido Shinkansen. With the opening of Shinagawa Station in October 2003 and replacement of rolling stocks that enables all trains to run at the maximum speed of 270 km/h, it became possible for us to leverage 100% of the Shinkansen's capabilities. Along with increasing the speed through the development and introduction of the Series 300 and Series 700 rolling stocks, we have greatly improved energy efficiency. We put the Series N700 into service in July 2007 which has even further improved energy efficiency, and we are now implementing additional introduction of Series N700. It achieves remarkable energy efficiency; it consumes 51% of the energy used by the Series 0 at 220km/h, and consumes 68% at 270 km/h compared to the Series 0 running at 220km/h.

As a railway company, we will continue actively to develop and introduce energy saving rolling stock such as the Series N700 and others, and will provide more attractive service to gain more passengers. We consider that this will enable us to contribute to global environment conservation such as the reduction of greenhouse gases and the prevention of global warming.

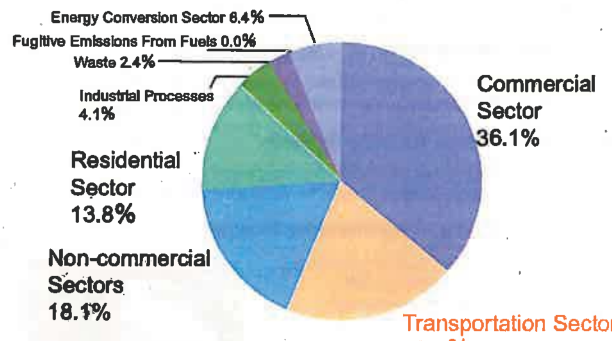
Furthermore, aiming to further development of high-speed mass transport in the 21st century, JR Central is promoting the Tokaido Shinkansen bypass project that utilizes Superconducting Maglev, which runs at an ultra high-speed of 500km/h and is also suited at the same time for global environment conservation with less CO_2 emissions compared to airplanes. The Tokaido Shinkansen, which has matured in terms of service, marks its 46th anniversary and it has become time to drastically review provisions for the future against structure-aging and large scale disasters. By realizing the bypass that utilizes Superconducting Maglev with superior energy efficiency, we will be able to contribute more to global environmental conservation as well as support Japan's major transportation artery.

In addition, JR Central is planning to promote the Series N700 and Superconducting Maglev overseas as total systems. The "N700-I Bullet" Tokaido Shinkansen system which centers on the N700-I, the international version of the Series N700, offers the maximum speed of 330km/h, high level of safety with the record of no fatal and injury accident of passengers, and superior energy saving performance. It will be designed in specification to meet specific regional needs so that it will become the solution to high-speed rail projects all over the world. Meanwhile, we consider that Superconducting Maglev will be in demand in regions with high transport density. These efforts contribute to global environmental conservation greatly as well as to the sustainable development of domestic rail-product suppliers.

The Tokaido Shinkansen and Superconducting Maglev Technology - Contributing to a Low-Carbon Society -

Central Japan Railway Company
Toyonori Noda,
Executive Vice President

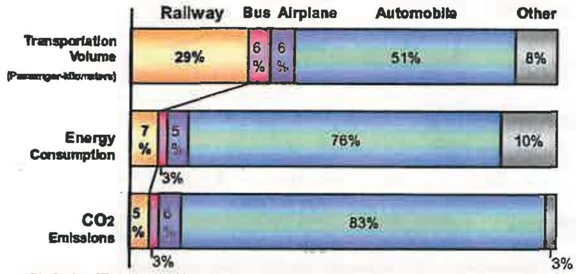
Breakdown of CO_2 Emissions by Sector in Japan (FY2007)



Source: Created based on the Ministry of the Environment data

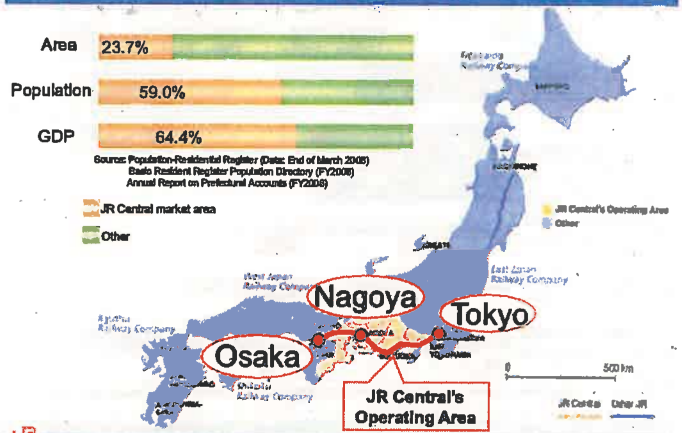
Energy Efficient Railways

Railway handles 29% of domestic passenger transport while consuming only 7% of the energy and emitting only 5% of CO2 emissions.



Distribution of Transportation Volume, Energy Consumption and CO2 Emissions for Passenger Transport (FY2007)
Source: Created based on data from Transportation Related Statistics (the Ministry of Land, Infrastructure, Transport and Tourism) and the National Institute for Environmental Studies Greenhouse Gas Inventory Office of Japan
※Energy Consumption does not total 100 due to rounding

JR Central: Operation Areas



Source: Population-Residential Register (Data: End of March 2008) Basic Resident Register Population Directory (FY2008) Annual Report on Prefectural Accounts (FY2006)

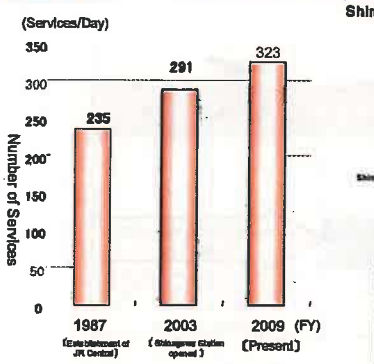
Measures following the Establishment of JR Central

1) **Tokaido Shinkansen**
-Transportation artery that links Japan's three largest cities-
- Improvements in speed, energy consumption and riding comfort through introduction of new rolling stock
- Enhancement of transport capacity and improved convenience through opening of Shinagawa Station
- Ensuring safe and reliable transport through introduction of new ATC and earthquake-resistant reinforcement of civil engineering structures

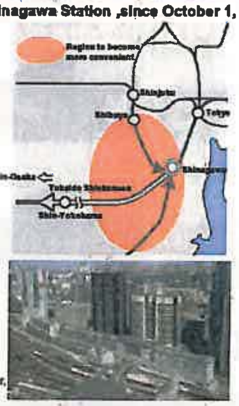
2) **Conventional Railway**
-Forming a network with the Tokaido Shinkansen-
- Improvements in speed, energy consumption and riding comfort through introduction of new rolling stock
- Ensuring safe and reliable transport through introduction of new ATS and implementation of countermeasures against natural disasters
- Contributing to regional development through the establishment of new stations and renovation of existing stations

3) **Promoting a Tokaido Shinkansen Bypass**
- Research and development for Superconducting Maglev Technology

Trends in the Number of Tokaido Shinkansen Services



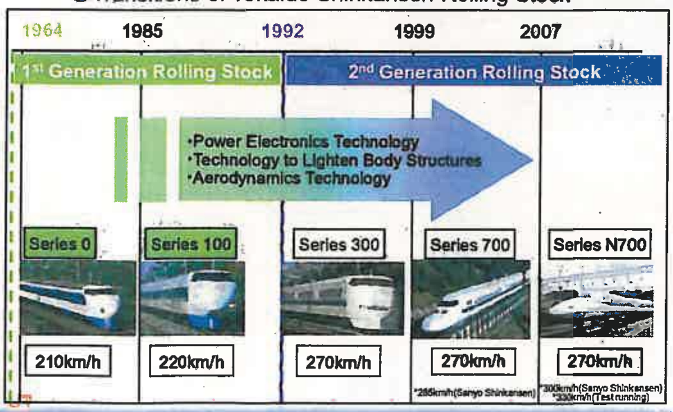
Shinagawa Station ,since October 1, 2003



※The number of services shown is as of the beginning of each fiscal year, and excludes extra services.

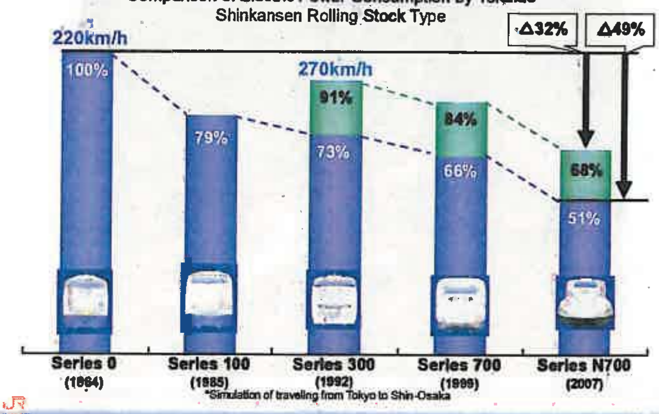
The Speed of the Tokaido Shinkansen

〇Transitions of Tokaido Shinkansen Rolling Stock



The Energy Efficiency of Shinkansen Rolling Stock

Comparison of Electric Power Consumption by Tokaido Shinkansen Rolling Stock Type



*Simulation of traveling from Tokyo to Shin-Osaka

Technology of the Series N700 that contributes to energy conservation

- Energy efficiency has been promoted by making Series 300 and Series 700 rolling stock lighter
- The Series N700 has been made even more energy efficient

1) Further reductions in running resistance

- Nose shape that has superior aerodynamic characteristics (aero-double wing)
- Smoothing of body surfaces (cover-all hood, smoothed windows)

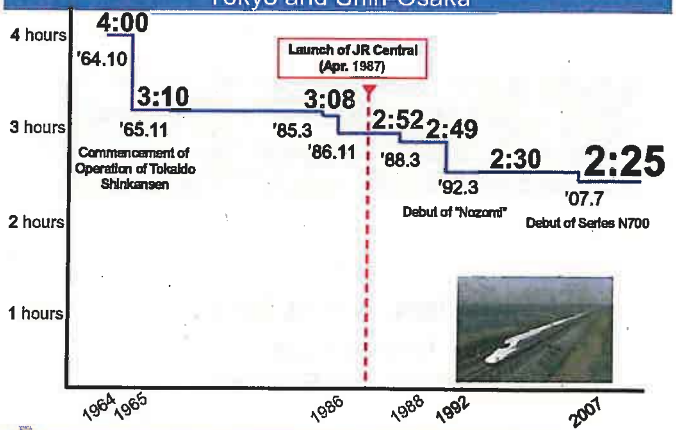
2) Introduction of Body Inclining System

- Reduces the frequency of acceleration and deceleration
  (Speed on curves with a radius of 2,500m increased from 250km/h⇒270km/h)

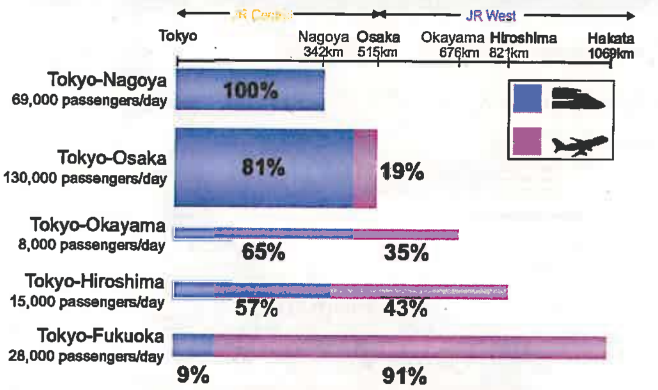
3) Augmented the use of regenerative brakes

- Effective utilization of power **regenerative brakes**
  - Energy consumption **reduced by 12%**
    (Comparison with non-regeneration)

Trends in the Time Required to Travel between Tokyo and Shin-Osaka



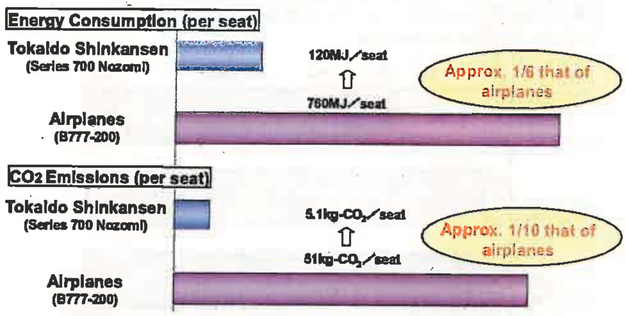
Market Share of Shinkansen and Airplanes



*Market share is the Inter-Regional Passenger Mobility Survey (FY2007) (Ministry of Land, Infrastructure, Transport and Tourism)

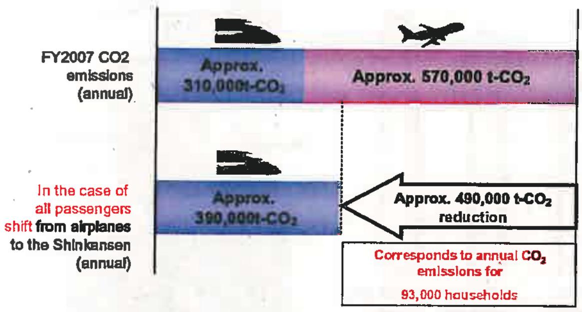
Environmental Superiority of the Tokaido Shinkansen

CO_2 Emissions of the Tokaido Shinkansen are approximately 1/10 that of airplanes



Tokaido Shinkansen: Calculation based on running performance (JR Central figures) Series 700 Nozomi (between Tokyo and Shin-Osaka)
Airplanes: Calculated by JR Central while referencing ANA's "CSR Report 2007" B777-200 (between Haneda and Itami/Kansai Airports)

Effect of Reduction in CO_2 Emissions if Airplane Users Shift to Using the Shinkansen (between Tokyo and Osaka)



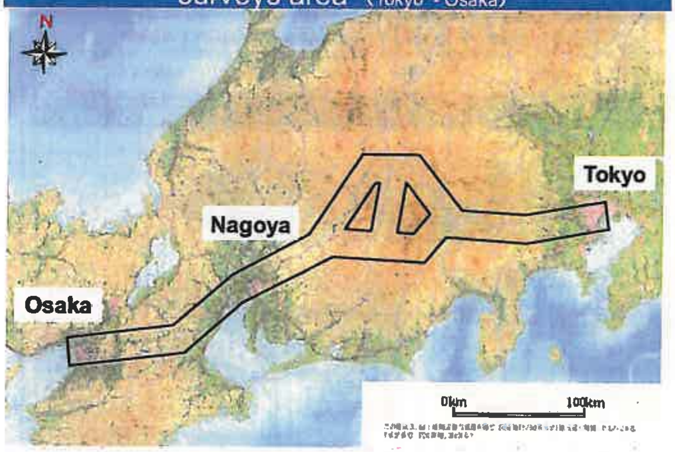
Comparison between the N700-I and other High-speed Railways

	N700-I	TGV-POS	ICE-3
Traction System	Distributed (8M)	Concentrated	Distributed (4M4T)
Speed (km/h)	330	320 (Operating speed 320)	330 (Operating speed 320)
Rolling Stock Weight at Capacity (ton)	365 (8 cars)	423 (10 cars)	465 (8 cars)
Capacity (seat/trainset)	636	357	413
Output (kW)	9760 (305 x 32)	9280 (1160 x 8)	8000 (500 x 16)
Output per seat (kW/seat)	15.3	26.0	19.4

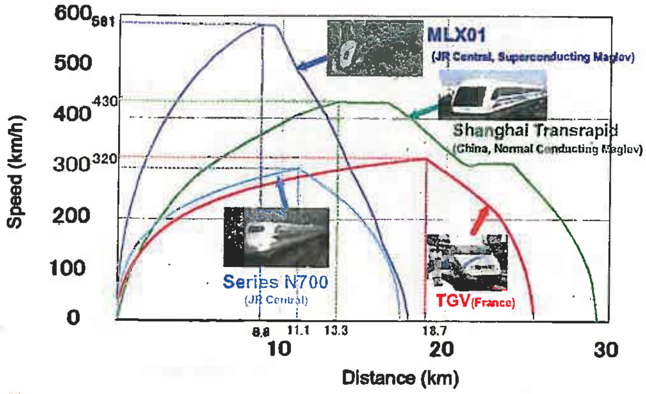
Source: N700-I data is of a hypothetical simulation based on the configuration of a 8-car train.
JR Central data and "World High Speed Rolling Stocks," UIC Website data, and calculations made using such data

Superconducting Maglev (SCMAGLEV)

Chuo Sinkansen topographical and geological surveys area (Tokyo - Osaka)



Superconducting Maglev Characteristics
(ultra high-speed / fast acceleration and deceleration)



Superconducting Maglev Characteristics
(Energy Conservation/Environmental Performance)

CO_2 Emissions for each Method of Transport
(per person) comparison [Tokyo - Osaka]

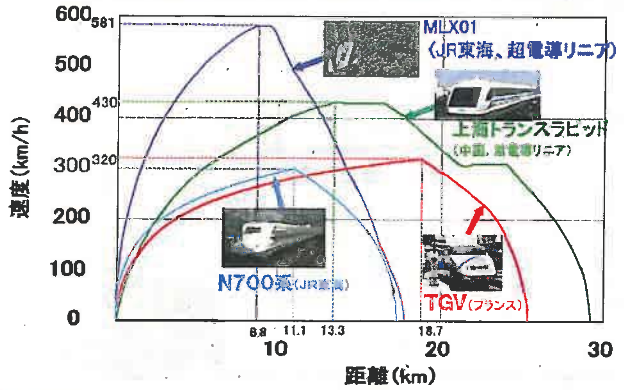
	CO_2 Emission Comparison (Superconducting Maglev= 1)
Superconducting Maglev	1
Airplanes (B777-200)	3
Household Automobile	4

*Airplanes: Calculated by JR Central while referring to ANA "CSR Report 2007" and the Annual Air Transport Statistics Report
*Automobiles: Calculated by JR Central while referring to "Transport/Transportation and the Environment" (Supervision: Ministry of Land, Infrastructure, Transport and Tourism, Issued by: Foundation for Promoting Personal Mobility and Ecological Transportation) and "Highway Navigator" (run by NEXCO)

Conclusion

- The railway is a form of mass transportation that is environmentally superior, and the Tokaido Shinkansen has dramatically improved this attribute
- Attracting more passngers to our railway service by leveraging our envrionmental superiority will enable us to contribute to global environment conservation such as further reduction of greenhouse gases and prevention of global warming
- The implementation of the Tokaido Shinkansen bypass that employs Superconducting Maglev, which has superior energy saving performance, will largely contribute to environmental conservation
- With a maximum speed of 330km/h, the N700-I Bullet provides a high seating capacity as well as high-speed, safety, energy efficiency and quietness. It can be the solution to high-speed railway projects underway all over the world.

超電導リニアの特徴（超高速・高加減速）



超電導リニアの特徴（省エネ・環境性能）

各輸送機関のCO_2排出量

（1人あたり）の比較＜東京～大阪間＞

	CO_2排出量比較（超電導リニア＝1）
超電導リニア	1
航空機（B777-200）	3
自家用自動車	4

※航空機　：ANA「CSR Report2007」および航空輸送統計年報を参考に当社算出
※自動車　：「運輸・交通と環境」（監修：国土交通省、発行：交通エコロジー・モビリティ財団）および「ハイウェイ・ナビゲーター」（東日本・中日本・西日本高速道路株式会社運営）を参考に当社算出

まとめ

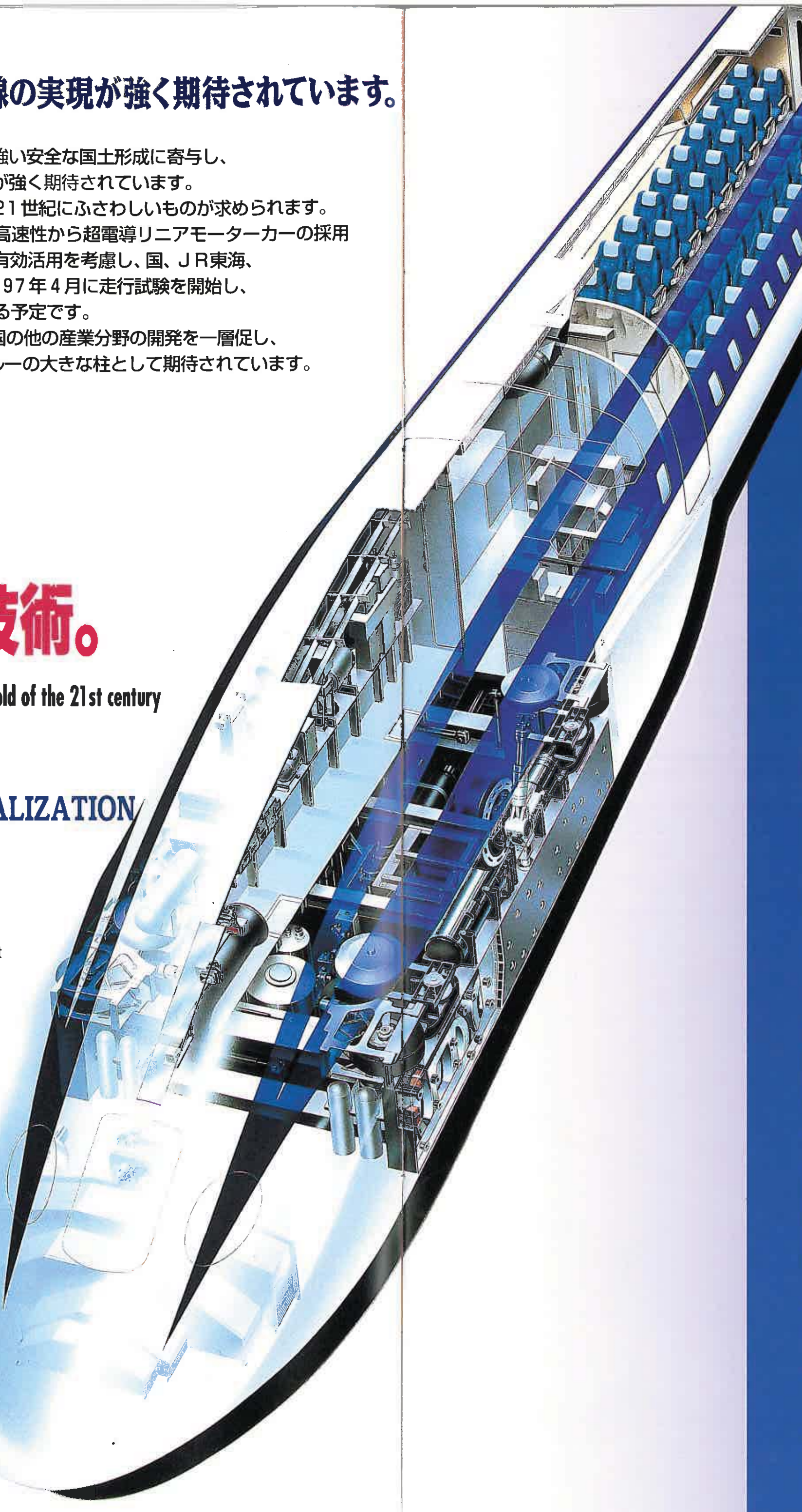
- 鉄道は環境優位性に優れた大量輸送機関であり、東海道新幹線は、その特性をさらに飛躍的に向上させている
- 鉄道の環境優位性を活かし、多くの方に鉄道をご利用いただくことで温室効果ガスの一層の削減、地球温暖化防止等の地球環境保全に貢献できる
- さらに、省エネルギー性能にも優れた超電導リニアによる東海道新幹線バイパスの実現によって、地球環境保全により一層貢献することが可能
- N700-I Bulletは最高速度330km/hの高速性、高い安全性、優れた省エネルギー性と静粛性を有しながら、大量輸送を可能としており、世界各国で進められている高速鉄道プロジェクトのソリューションとなりうる

21世紀の豊かな社会の構築に向けて中央新幹線の実現が強く期待されています。

21世紀の日本の発展を担う中央新幹線。
中央新幹線は、国際的な大競争時代における経済社会の発展を支え、災害に強い安全な国土形成に寄与し、エネルギー・地球環境保全に対応する国家的プロジェクトとして、その実現が強く期待されています。
その中央新幹線に適用されるシステムは、時代の最先端技術に支えられた、21世紀にふさわしいものが求められます。
ＪＲ東海は、将来の経営主体として、中央新幹線実現の際は、その先進性や高速性から超電導リニアモーターカーの採用がふさわしいと考え、同方式の開発を進めています。将来の中央新幹線への有効活用を考慮し、国、ＪＲ東海、鉄道総研および鉄道公団で進められている山梨リニア実験線においては、1997年4月に走行試験を開始し、3年間の走行試験を行った後、1999年度には実質的な実用化のめどをたてる予定です。
超電導リニア技術は、実用化レベルでの開発・改良を行うことにより、わが国の他の産業分野の開発を一層促し、将来の経済発展に大きな波及効果を与える、21世紀に向けてのブレークスルーの大きな柱として期待されています。

リニアテクノロジー、それは21世紀の扉を開く技術。

Superconducting Maglev Technology: technology on the threshold of the 21st century



THE CHUO SHINKANSEN—TOWARD THE REALIZATION OF AN AFFLUENT 21st CENTURY SOCIETY

The Chuo Shinkansen will play a major role in supporting Japan's development in the 21st century.
The Chuo Shinkansen will support socioeconomic development in an age of intense global competition, help strengthen the country's preparedness against natural disasters, and contribute to energy conservation and global environmental preservation. In view of the important role of the Chuo Shinkansen represented above, the implementation of the Chuo Shinkansen project is highly anticipated.
Therefore, the transportation system for the Chuo Shinkansen is required to be suitable for the next century and employ next-generation technologies.
As its future management entity, JR Central is pursuing the development of the superconducting magnetically levitated linear motor car-the Superconducting Maglev-that it believes will realize the advanced performance and speed capabilities required of a 21st century transportation system. Considering the future utilization of its facilities, the Japanese government, JR Central, the Railway Technical Research Institute, and the Japan Railway Construction Public Corporation have been promoting the Yamanashi Maglev Test Line project, commencing running tests in April 1997.
In fiscal 2000, following three years of testing, the confirmation of the practicality of using Superconductiong Maglev technology for regular operations will be given.
The development and improvement of Superconducting Maglev technology to the level of pracical application is expected to further promote technological development in other industries, having a significant spillover effect on future economic growth.
This technology is expected to play a major role in propelling Japan into the 21st century.

超電導リニアモーターカーとは。

超電導リニアモーターカー、すなわち超電導磁気浮上式鉄道は、時速500km程度の超高速での走行が可能であり、浮上走行を行うことから、従来の鉄車輪・レール系の鉄道システムに比べ、同じ速度域での騒音・振動が大幅に低減でき、高速走行時に万一地震が発生した時の安全性も高いなど、次世代の大量高速輸送機関として理想的なシステムといえます。

What is "Superconducting Maglev"?

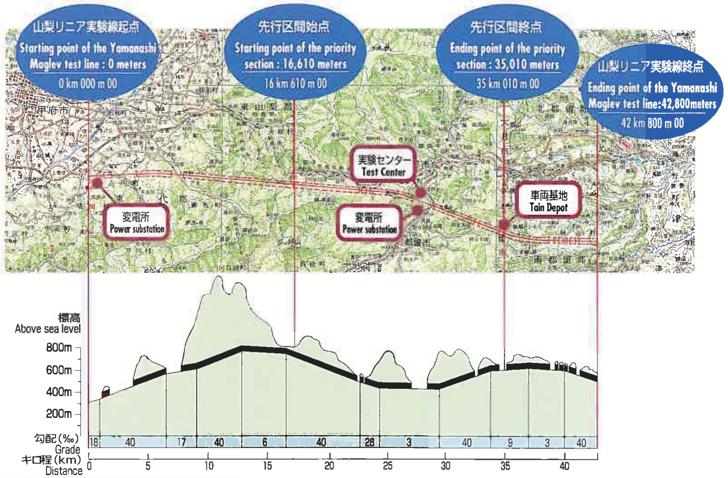
The "Superconducting Maglev" allows ultra high speeds of around 500kmph. Furthermore, because it allows contact-free levitating operation in principle, it is able to not only reduce noise and vibration in comparison with conventional iron wheel-on-rail systems at the same speed but keep a high level of safety against earthquakes at high speed traveling. This system can be said to be an ideal mode of transportation for the coming generation.

HISTORY リニアモーターカーのあゆみ

・リニアモーター推進浮上式鉄道の研究開始	1962年	・Commencement of research on a linear motor propulsion railway system
・超電導磁気浮上の基礎試験装置完成	1970年	・Completion of fundamental test equipment for superconducting magnetic levitation
・全国新幹線鉄道整備法公布		・Promulgation of the Nationwide Shinkansen Railway Development Law
・磁気浮上走行に成功	1972年	・Achievement of magnetic levitation
・中央新幹線が全国新幹線鉄道整備法に基づく基本計画路線として決定 起点　東京都　　終点　大阪市 主な経過地　甲府市付近、名古屋市付近、奈良市付近	1973年	・Determination of the Chuo Shinkansen as a Basic Plan route based on the Nationwide Shinkansen Railway Development Law Origin: Tokyo Metropolis　Destination: Osaka City Running through the neighbors of Kofu City, Nagoya City, and Nara City
・宮崎浮上式鉄道実験センター開設	1977年	・Opening of the Miyazaki Maglev Test Track
・ML−500が517km/hの世界最高速度を記録	1979年	・Achievement of a world record speed of 517kmph with ML-500
・MLU001が有人走行で400.8km/hを記録	1987年	・Achievement of manned 400.8kmph operation using MLU001
・本格的新実験線の建設、山梨県に決定	1989年	・Decision to build a new test line in Yamanashi Prefecture
・運輸大臣がＪＲ東海および鉄道公団に東京都〜大阪市間全線地形、地質等に関する調査を指示	1990年	・Direction by the Minister of Transport to JR Central and the Japan Railway Construction Public Corporation to begin topographical and geological surveys over the whole route between Tokyo Metropolis and Osaka City
・運輸大臣が「超電導磁気浮上方式鉄道に係る技術開発の円滑な推進について」通達		・Notification by the Minister of Transport of "Ministerial Memorandum on the Smooth Promotion for Technological Development of Superconducting Magnetically Levitated Train"
・運輸大臣が山梨リニア実験線の「建設計画」「技術開発基本計画」を承認		・Approval by the Minister of Transport of "Construction Plan" and "Master Plan for Technological Development" of the Yamanashi Maglev Test Line
・山梨リニア実験線着手式		・Groundbreaking ceremony for construction of the Yamanashi Maglev Test Line
・山梨リニア実験線先行区間18.4kmを発表	1992年	・Announcement of 18.4km priority section of the Yamanashi Maglev Test Line
・MLU002Nが431km/hを記録	1994年	・Achievement of 431kmph using the MLU002N
・MLU002Nが有人で411km/hの浮上式鉄道での国内最高速度を記録	1995年	・Achievement of a new Japanese record of manned 411kmph operation using the MLU002N
・山梨リニア実験線第一編成車両(MLX01 3両)車両基地に搬入		・Introduction of first trainset for the Yamanashi Maglev Test Line
・「超電導磁気浮上式鉄道山梨実験センター」発足	1996年	・Opening the Yamanashi Maglev Test Center
・山梨リニア実験線で総合調整試験開始		・Start of General courdination tests of the Yamanashi Maglev Test Line
・山梨リニア実験線先行区間完成	1997年	・Completion of the priority section of the Yamanashi Maglev Test Line
・山梨リニア実験線で走行試験開始		・Start of running tests
・速度向上試験開始		・Start of speed increasing tests

山梨リニア実験線計画のご紹介。

Introducing the Yamanashi Maglev Test Line



	全　体 Total	先行区間 Priority section
総延長 Length	42.8km	18.4km
トンネル区間 Tunnel	34.6km	16.0km
明かり区間 Above ground	8.2km	2.4km
実験センター Test Center	1箇所	1箇所
変電所 Substations	2箇所	1箇所
車両基地 Train depot	1箇所	1箇所

建設技術基準
最高速度：500km/h
最小曲線半径：8,000m
最急勾配：40‰
軌道中心間隔：5.8m

Technical standards for Construction：
Maximum speed :500kmph
Minimum curve radius :8,000m
Maximum gradient：40‰
Distance between the centers adjacent guideway：5.8m

区　間：山梨県東八代郡境川村～山梨県南都留郡秋山村
経過地：境川村・八代町・御坂町・大月市・都留市・秋山村
行　程：先行区間
平成9年4月 走行試験開始　平成11年度 実質的な実用化のめどだて

Section：Sakaigawa-village,Higashi-Yatsushiro-county,Yamanashi Pref. - Akiyama-village,Minami-Tsuru-county,Yamanashi Pref.
Areas en route：Sakaigawa-village,Yatsushiro-town,Misaka-town, Otsuki-city,Tsuru-city,Akiyama-village
Schedule：Priority section
Experiments commenced in April 1997. Confirmation of practicality of using maglev technology for regular operation to be obtained in the fiscal year biginning in 1999.

山梨リニア実験線実験項目 Tests on the Yamanashi Maglev Test Line

基本走行試験 Basic running tests

車輪走行試験、浮上走行試験、速度向上試験、最高速度確認試験（550km/h程度）

Wheel running tests, levitation running tests, speed increasing tests, maximum speed verification tests (approx. 550 kmph)

総合機能試験 General functional tests

高速すれ違い試験、変電所渡り試験、複数列車制御試験、異常時対応試験等

High-speed passing tests, substation cross-over tests, multiple-train control tests, emergency tests, etc.

信頼性確認試験 Reliability verification tests

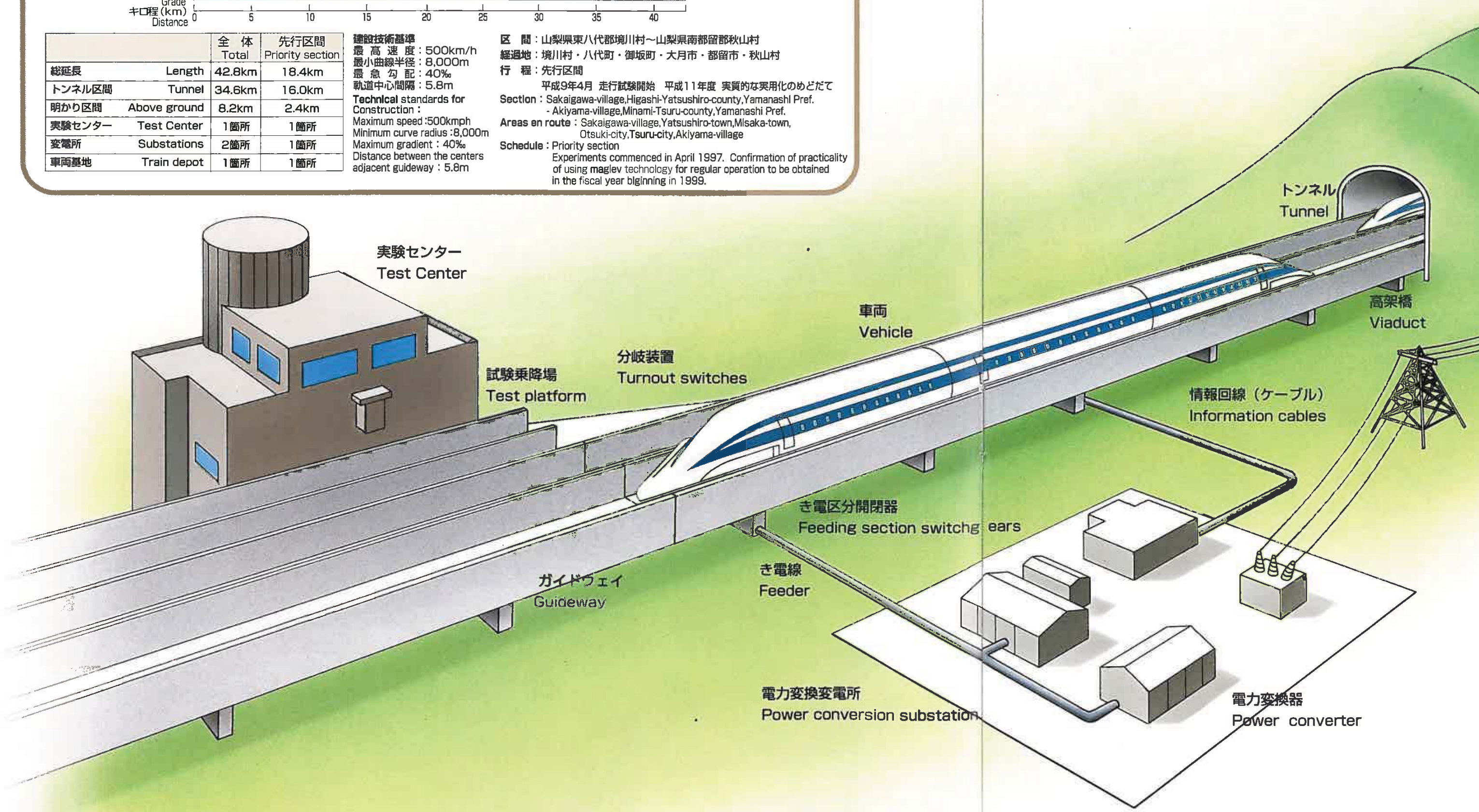
高速連続走行試験、輸送能力確認試験等

High-speed continuous running tests,transportation capability verification tests, etc.

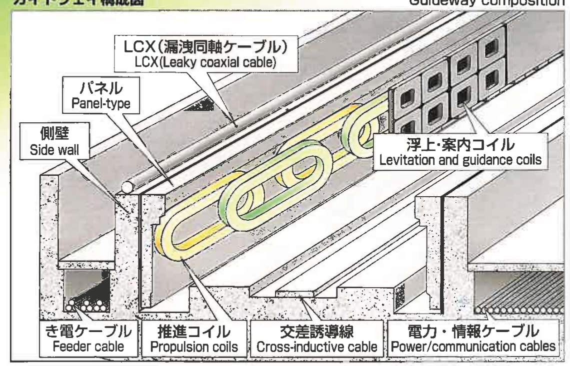
その他確認試験 Other verification tests

乗客生理確認試験、駅設備確認試験、環境影響確認試験、経済性の確認試験、保守基準等の確認試験等

Passenger physiology confirmation tests, station facilities verification tests, environmental impact verification tests, economy verification tests, maintenance standards verification tests, etc.



ガイドウェイ構成図 Guideway composition



リニアテクノロジーの全貌

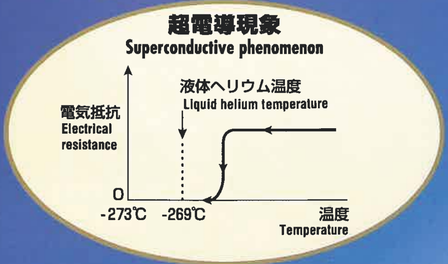
Aspects of Superconducting Maglev Technology

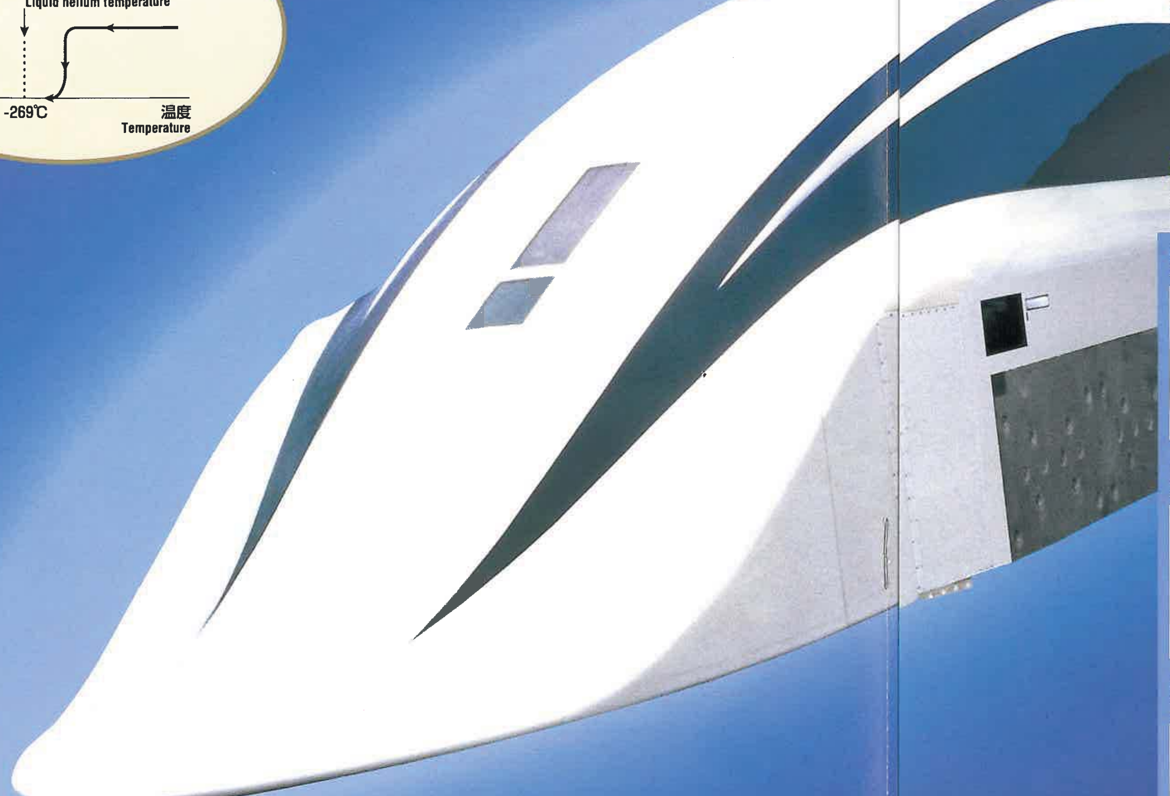
超電導とは。

ある金属物質を一定温度以下としたとき、電気抵抗がゼロになる現象を超電導現象といいます。超電導状態となった金属物質で作ったコイル（超電導コイル）に一度電流を流すと永久に流れ続け、永久磁石の数十倍もの強力な磁界が得られます。リニア車両の場合には、超電導の安定性を高めるためニオブ・チタン金属（超電導物質）の極細多芯線を銅母材中に埋め込んだ超電導線を使用し、液体ヘリウム（約−269℃）に漬けて超電導状態を作り出します。

What is Superconductivity?

When certain metals are cooled below a specific temperature, their electric resistance vanishes. This phenomenon is known as "superconductivity". Once current is applied to a coil made of superconductive metal, it continues to flow permanently and without loss. This coil can generate dozens of times stronger magnetic field than that of permanent magnets. For the Maglev, a bundle of extremely fine niobium-titanium alloy (superconductive metal) wire is embedded in a copper matrix in order to improve the stability of superconductivity. This wire is cooled with liquid helium (ca -269°C) to become a superconductive state.



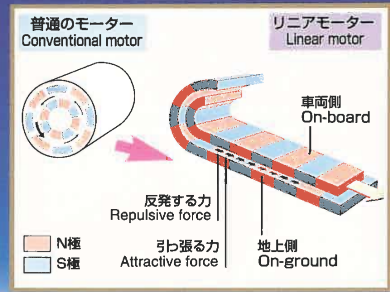


リニアモーターとは。

What is a linear motor?

リニアモーターとは、従来の鉄道車両のモーターを直線状に引きのばしたもので、このモーターの内側の回転子が車両に搭載される超電導磁石、外側の固定子が地上に設置される推進コイルに相当し、これにより地上側から推力を与える地上一次のシステムです。

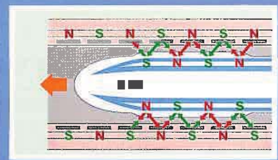
A linear motor is a motor which is unrolled and arranged in line. In the Maglev system, the superconducting magnets on-board are corresponding to the rotor inside of the rotary motor and the propulsion coils on-ground are the stator outside. This is a groundbased system where propulsion coils are powered and propulsion force is controlled on the ground.



超電導リニアモーターカーの原理

The Principles of the Maglev System.

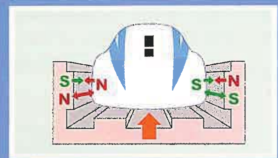
推進の原理〈Propulsion System〉



地上の推進コイルに電流を流すことにより磁界（N極、S極）が発生し、車両の超電導磁石との間で、N極とS極の引き合う力と、N極どうし・S極どうしの反発する力により車両が前進します。

By passing current through propulsion coils on the ground, a magnetic field (north and south poles) is produced, thus the train is propelled forward by the attractive force of opposite poles and the repulsive force of same poles acting between the ground coils and the superconducting magnets built into the vehicles.

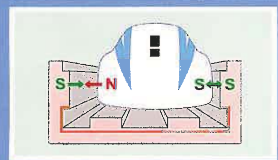
浮上の原理〈Levitation System〉



車両の超電導磁石が高速で通過すると地上の浮上・案内コイルに電流が流れ電磁石となり、車両を押し上げる力（反発力）と引き上げる力（吸引力）が発生し浮上します。

When the superconducting magnets on the vehicles pass through at high speed, current flows through levitation and guidance coils on the ground, producing electrodynamic levitating force to the vehicles.

案内の原理〈Guidance System〉



左右の浮上・案内コイルは、電力ケーブルにより結ばれ、車両が中心からどちらか一方にずれると、車両の遠ざかった側に吸引力、近づいた側に反発力が働き、車両を常に中央に戻します。

The levitation and guidance coils on either side are connected with electric power cables. They keep the vehicles in the center of the guideway at all times by exerting an attractive force on the further side of the vehicle and a repulsive force on the nearer side should the train move off center to either side.

TECHNOLOGY 車両技術 OF VEHICLE

時速500kmの超高速での安定走行を実現します。

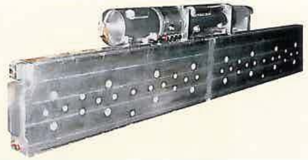
Vehicle technology for stable operation at very high speeds of 500 kmph

超電導磁石 Superconducting Magnets

超電導磁石は強力な磁界を発生し、推進コイルとの間で推進力を、8の字形浮上・案内コイルとの間で浮上力・案内力を発生させる重要な役割を担っています。超電導磁石のクエンチ（超電導状態が消滅する現象）を防止し、振動などによる内部発熱量を低減するために、スーパーコンピュータによるシミュレーションや、超電導磁石を試作して試験を行い、その結果、超電導磁石の性能や信頼性および耐久性が大幅に向上しました。

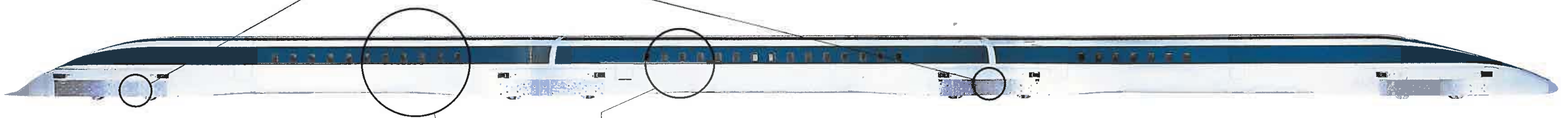
Superconducting magnets produce a strong magnetic field and have the vital role of creating propulsive force caused by interaction with propulsion coils, as well as levitation and guidance caused by interaction with figure eight levitation and guidance coils. In order to prevent quenching of superconducting state and to reduce internal heat of the magnets generated by electro-magnetic vibration and other factors, simulations have been carried out on a supercomputer and evaluation tests have been performed using test-fabricated part models of superconducting magnets. As a result, their performance, reliability, and durability has been vastly improved.

超電導磁石
Superconducting magnet



ダブルカスプ型
Double cusp type

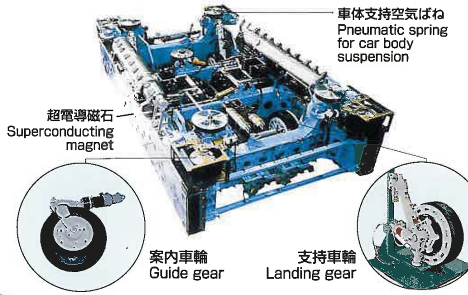
エアロウェッジ型
Aero wedge type



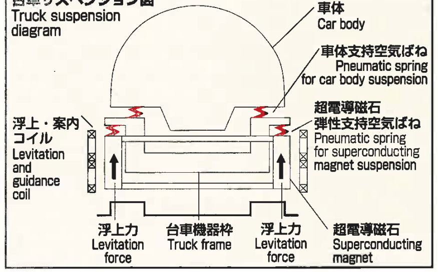
台車 Truck

リニア車両の心臓部である超電導磁石を取り付けた台車は、磁石に発生した推進力・浮上力を車体に伝達する機能をもちます。また、低速時の走行に必要な支持車輪と案内車輪を備えて、これらの車輪の上げ下げを行う油圧機器や超電導磁石用の冷凍関係機器などを搭載しています。さらに、一部車両には二重のバネで車体を支える構造とするとともに、振動制御装置を搭載するなど、乗心地向上のための種々な施策を盛り込んでいます。

台車構成図 Structural diagram of the truck



台車サスペンション図
Truck suspension diagram



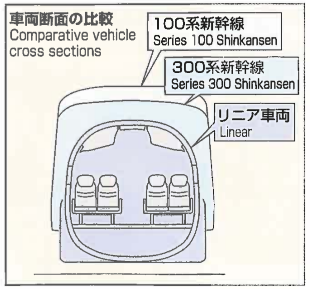
The truck on which the superconducting magnets, the heart of the Maglev Train, are mounted serves to transmit the propulsive and levitational force generated by the magnets to the vehicles. It is also fitted with landing gear and guide gear wheels needed when traveling at low speeds, and with hydraulic apparatus that raises and lowers these wheels. And apparatus for freezing the superconducting magnets are mounted. Besides, various measures to improve traveling comfort, such as the double suspension springs and the vibration control devices, are incorporated on some trucks.

車体 Car Body

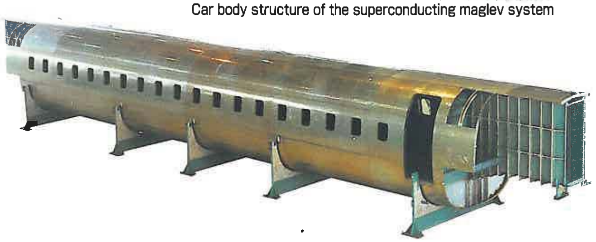
車体は、浮上走行のための軽量化を実現し、快適な車内空間を提供するよう工夫しています。車内の断面は空気抵抗低減と軽量化のため、新幹線よりスリムなものとしました。構体構造は航空機技術を応用して、軽量で、かつトンネル走行時の大きな圧力変化の繰り返しに耐えられる（営業線10年相当を検証済）ものとしています。先頭形状は「ダブルカスプ」と「エアロウェッジ」の２種類を開発し、空気抵抗や空力音を大幅に低減するようにしています。

The car body is designed to realize a weight reduction for levitating running, and to provide the comfortable interior. The cross-section of the car is slightly smaller than that of the existing Shinkansen to reduce air drag and body weight. The structure of the body using aircraft technology has light weight and enough strength to endure the repeat of large pressure fluctuations when passing through tunnels; verified about 10 years life on commercial series. Two types of the nose shapes, "Double-cusp" and "Aerowedge", were developed, which considerably reduce air drag and aerodynamic noise.

車両断面の比較
Comparative vehicle cross sections



リニア車両用構体
Car body structure of the superconducting maglev system



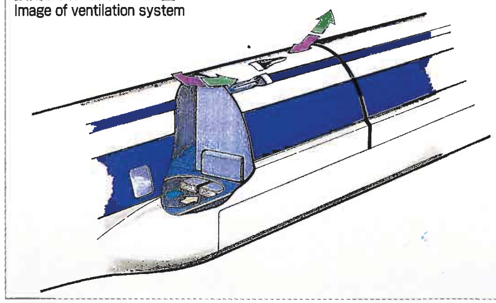
客室および車内換気 Cabin and Ventilation system

客室は十分な定員を確保しつつ、CFRP（炭素繊維強化プラスチック）を主要母材とした軽量腰掛の採用をはじめとして、快適な居住空間を実現しています。また、車内の換気は走行風を利用した省エネタイプの換気装置により行い、トンネル内の超高速走行時の気圧変動による耳ツンを防止するとともに、常に車内に新鮮な空気を供給します。

The cabin provides comfortable accommodations with ample seating capacity, using lightweight seats made of carbon-fibre-reinforced-plastic. Meanwhile, an energy-saving ventilation system that makes use of the airflow created by the motion of the train makes it possible to provide constant fresh air inside the cabin, as well as preventing discomfort caused by changes in air pressure when traveling through tunnels at very high speeds.

客室内
Passenger compartment

換気システムイメージ図
Image of ventilation system



TECHNOLOGY 電気技術 OF POWER AND CONTROL

世界最大級のインバータで、走行・停止を自動制御します。
The world's largest inverters automatically control the Maglev trains.

リニアモーターカーの制御技術 Technology of Controlling Superconducting Maglev Train

モーターの一部が地上にあるリニアでは、これまで主に人間が行っていた出発・走行・停止といった運転操作を地上から自動的に行います。ダイヤの作成や管理を行う運行管理システムから、車両のドアの開扉やホームの乗降装置の制御まで、ほとんどが自動化されています。また、保安制御システムにより列車の安全を守ります。

In the Maglev system, train operations such as starting, traveling and stopping are carried out automatically by the equipment on the ground, while conventional trains are human-controlled on the trains. Almost all stages have been automated, from the control of vehicle doors and boarding system on platform up to the traffic control system which generates and administrates running schedules. In addition, the Maglev Train Protection System assures the safety of the train.

電力変換変電所 Power Conversion Substations

リニアの変電所は従来と異なり、車両の速度や加減速度に応じて推進コイルに送る電流や周波数を変化させます。また、単に超高速で走るだけでなく、車両をホームに精度よく停止させることができます。これらは、新しく開発された世界最大級のインバータで制御されます。

電力変換変電所
Power conversion substation

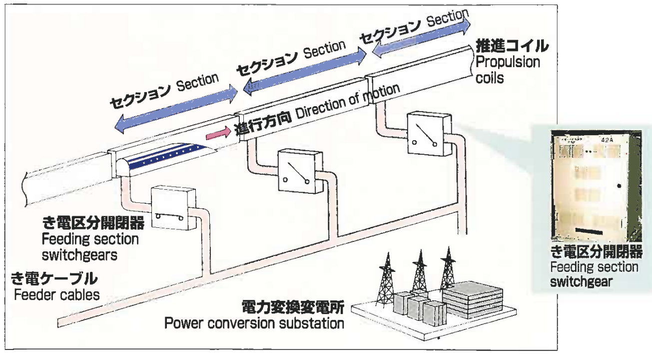
インバータ装置
Inverter equipment

Substations for the Maglev supply the electric current to the propulsion coils with the amplitude and frequency suitable for the velocity and the acceleration / deceleration of the train. They can also stop the train with high precision at the stations as well as realizing its very high speed traveling. The newly developed inverters, which are the largest in the world, realize these functions.

き電システム Feeding system

効率よく運転するために、推進コイルは一定の長さ毎のセクションに区切られており、車両の位置に応じてき電区分開閉器で切り替えて使用します。

In order to save energy, a certain number of propulsion coils are connected in series and make up a section. The sections where a train is traveling are powered through the feeding section switchgears.

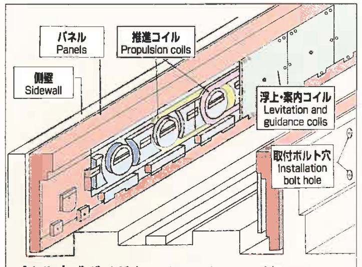


TECHNOLOGY 土木技術 OF CONSTRUCTION

超高速走行時でも、快適な乗り心地を提供します。
Construction technology provides a smooth and comfortable ride even at high speeds.

ガイドウェイ Guideways

ガイドウェイは従来の鉄道のレールや車両モーターの一部にあたる部分で、U字型の構造をしています。このガイドウェイの側壁には地上コイルが設置されます。超高速走行時の良好な乗心地を実現するため、地上コイルは、現在の新幹線のレールよりも高い精度で設置することが必要となります。このため、複数の地上コイルをあらかじめ精度良くコンクリートパネルに取りつけたものを現地で架設する「パネル方式」などを開発しました。地上コイルは、アルミニウム導体を樹脂で絶縁したもので、樹脂は電気的および機械的に強いものを用いています。



パネル方式ガイドウェイ Panel type guideway

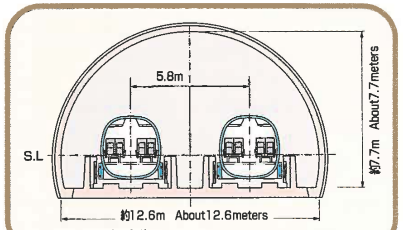
トラバーサ分岐装置 Traverse switch

Levitation and guidance coil

The U-shaped guideways correspond to the rails of a conventional railway, combined with part of an electric motor. Ground coils are installed on the side walls of these guideways. In order to achieve passenger comfort when travelling at very high speeds, the ground coils must be installed more precisely than existing Shinkansen rails. For this reason, a coil-panel method was developed: a number of ground coils are precisely attached on concrete panels at the near site, which are then installed on the guideways. The ground coils are made of aluminium conductors insulated with plastic. The plastic is strong in terms of both electric characteristics and composition.

トンネル Tunnels

山梨リニア実験線のトンネルの断面積は、走行抵抗などを考えて作られています。また列車が高速でトンネルに突入する時、圧縮波が反対側の坑口から大きな音となって放出するのを防止するため、トンネル緩衝工を設置しています。



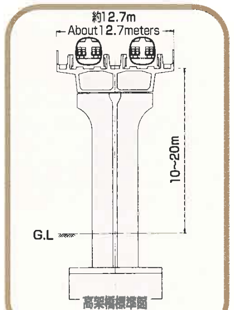
トンネル標準図 Standard tunnel diagram

The cross-section of the tunnels is decided, considering aerodynamic characteristics and reduction of air drag. Tunnel-entrance-foods are installed to prevent compression waves from generating shock noise at the opposite end of a tunnel when the train enters the tunnel at high speeds.

橋りょう Bridges

近年、土木構造物の景観への調和が求められています。山梨リニア実験線においても、中央自動車道をまたぐコーヒーブラウン色の小形山橋りょうや全長300メートルの4径間連続桁の桂川橋りょうのデザインに特に力を入れています。

小形山橋りょう Ogatayama Bridge



高架橋標準図
Elevated bridge standard diagram

Today, greater attention for harmonization with landscape is paid to the infrastructure. For the Yamanashi Maglev Test Line, particular effort has gone into the design of the coffee-colored Ogatayama Bridge over the Chuo Expressway and the 4-span continuous-girder Katsuragawa Bridge, with a total length of 300 meters.

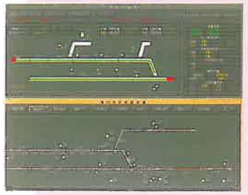
桂川橋りょう Katsuragawa Bridge

TECHNOLOGY
安全技術
FOR SAFETY

超高速から停止まで、走行中の安全を守ります。
The Maglev Train Protection System assures the safety of trains at any speed.

運転保安のしくみ　Safety Operation

信号システム
Safety Control System


保安制御画面 Safety Control Screen

信号の考え方自体は新幹線などで従来から実績のあるものを基本としており、安全で信頼性のあるものとなっています。リニアは地上で制御するため、交差誘導線を全線に設置し、数cmの精度で列車位置を正確に検知します。信号も減速による無駄な時間を減らすため、速度段方式ではなく、走行可能な速度を位置により連続的に変化させるものとなっています。

The Maglev Train Protection System is based on the principle of that of conventional railways including Shinkansen and thus realize reliability and safety. Since the Maglev Train is controlled on the ground, this system uses cross-inductive cable installed along the whole line to detect the position of the train with high precision within several centimeters. It also adopts the method in which a speed limit curve is varied continuously according to the position of trains in order to avoid unnecessary loss of time.

ブレーキ　Brakes

ブレーキシステム
Braking System

ブレーキは乗り物で最も重要なものですが、リニアでは通常は電力回生ブレーキを用います。バックアップとして発電ブレーキと車上のブレーキを併用したブレーキがあります。さらに、車上装置だけでも最高速度から安全に停止できる車上単独ブレーキがあります。

Brakes are the most important component in transportation systems. While the Maglev Train usually uses power regenerative brake, it also has a combination brake of rheostatic brake and on-board brakes as a backup. Furthermore, the on-board brake can stop the train from the maximum speed independently and safely.

地上ブレーキ　Ground-Based Brakes

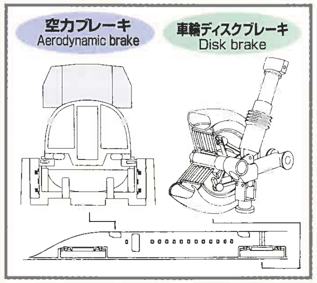
地上の設備を用いるブレーキには、通常、加速の時と逆向きの電流を流す電力回生ブレーキとバックアップとしてリニアを発電機として使用する発電ブレーキがあります。電力回生ブレーキは電力会社へ電気を返します。

Ground-Based brakes consist of regenerative brake and rheostatic brake. The former is a brake to reverse the current and to return energy to the power company. The latter is a brake to use the linear motor as a generator and to consume the kinetic energy in the resistance.

車上ブレーキ　On-Board Brakes

超高速から停止まで安定したブレーキ力を得るために、速度域に応じた車上ブレーキを装備しています。高速域では空気抵抗を利用した空力ブレーキを使用し、中低速域では車輪ディスクブレーキを使用して停止させます。

To achieve a stable braking force from very high speed to standstill, two kinds of on-board brakes are equipped corresponding to speed ranges. In high-speed range aerodynamic brakes are effective, while in middle to low-speed range the train is brought to a halt by disc brakes.



TECHNOLOGY
周辺技術
OF SUPPORTING FACILITIES

さまざまな先端設備が、リニア実験を支えます。
Various facility supports the Maglev experiments.

実験センター　Test Center

実験センターには、全線の設備監視、走行実験計画の作成、従業員への指示、電力変換変電所の操作など、実験線の中枢機能が集約されています。このほか、車上や沿線で計測されるデータが集められ、実験結果の速やかな解析、評価を容易に行う設備が設けられています。


実験センター
Test Center

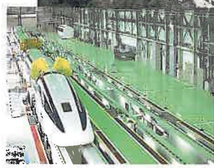

指令室
Control Room

The Test center has the core functions of the test line: monitoring over the whole line, planning running tests, issuing directions for experiments, operating the power conversion substations remotely and so on. It also compiles a lot of data obtained on the vehicles and along the guideway, and possesses equipment for speedy analysis and evaluation of the test results.

車両基地　Train Depot

リニア車両の車両基地は、日常の車両保守・点検や試験に必要な編成車両の組成などを行う検修基地であるとともに、超電導磁石を運転状態にするための予冷・注液・励消磁、および蒸発したヘリウムガスの回収精製液化なども行う極低温基地としての重要な役割を担っています。


車両基地
Train depot


建屋内
View inside the train depot

The train depot for the Maglev is the practice staging ground for daily vehicle maintenance and inspection and the place where trains are joined for the tests. It also plays an important role as the cryogenic staging ground where the superconducting magnets are pre-cooled, filled with liquid helium, and exited and demagnetized, and the place where evaporated gas helium is recovered, purified and liquefied.

試験乗降場　Test Platform

山梨リニア実験線に設置する試験乗降場は、ホームからの転落を防止するためホームを屋内化した構造とするとともに、乗降時の乗客の安全な誘導と磁気シールドを兼ねた伸縮式の乗降装置を設けています。


乗降装置
Boarding system

The test platform on the Yamanashi Maglev Test Line has been built indoors to prevent passengers from falling into the guideway.
The boarding system will align with the passenger door in order to guide the passengers during boarding and play a role in magnetic shielding.

資料協力：財団法人鉄道総合技術研究所　Contributing Source: Railway Technical Research Institute