MAGLEV'2002

The 17th International Conference on

Magnetically Levitated Systems and Linear Drives

Swiss Federal Institute of Technology, Lausanne, Switzerland
www.maglev2002.ch

September 3-6, 2002

MESSAGES FROM THE CHAIRMEN

International Steering Committee Chairman

After three decades of developments, the Maglev transportation systems are going to be practically utilized in Europe, U.S.A. and Japan in the forthcoming century, as the high-speed, friendly to environment and comfortable mean. MAGLEV 2002 in Lausanne is aimed to present the existing industrialization status, the marketing and social aspects, and evaluations as a high-speed transportation system on the MAGLEV system, as well as its component technologies and partially realized systems. The exchange of information, technical and sociolo gical views, and opinions on the strategies of industrialization and marketing, between worldwide specialists will promote and develop a way to introduce practical applications.
As the first MAGLEV conference in the 21st century, I strongly expect participation of experts from authorities and operating companies of transportation systems, as well as specialists who have been engaged with the MAGLEV technology and its developments, to MAGLEV 2002 for the animated discussion on practical utilization.

Prof. E. Masada
Science University, Tokyo, Japan

Conference Chairmen

After Germany MAGLEV 1995, Japan MAGLEV 1998 and Brazil MAGLEV 2000, Europe and more particularly, Lausanne on the Geneva Lake is proud to organize MAGLEV 2002, which will be held at the Swiss Federal Institute of Technology.
Approximately 4700 students, including more than 600 doctoral candidates and over 300 participants in postgraduate courses, are studying at the Swiss

Federal Institute of Technology. 210 professors and 2400 scientific, technical and administrative staff are committed to 12 teaching and research disciplines: civil engineering, rural engineering, mechanical engineering, electrical engineering, physics, chemistry, mathematics, material sciences and engineering, architecture, computer science, micro-engineering and communication systems. The Swiss Federal Institute can offer facilities to organize symposium up to 1000 people.
Lausanne, city of Europe, town of culture and leisure, has many assets to attract the visitor. We are thus delighted to welcome you in Lausanne and make you discover its attraction. We are sure that you will let yourselves conquer by its charm and its beauty and that you will like it as we like it more each day.
We are looking forward to see you at the MAGLEV 2002 conference and we shall hope you will enjoy the conference and the country encouraging you to stay some time longer.

Prof. M. Jufer, Vice President Prof. A. Rufer
Swiss Federal Institute of Technology, Lausanne

Scientific Conference and Logistic Chairmen

The objectives of "MAGLEV'2002 - The 17th International Conference on Magnetically Levitated Systems and Linear Drives" are to present and discuss the state of the art of the social, environment, economical, scientific and technical aspects of high speed MAGLEV and urban passenger transportation systems and the latest developments on magnetic levitation, linear motors, as well as electromagnetic propellers and industrial applications. MAGLEV'2002 will consist of two major parts:
MAGLEV'2002 Conference: Presentation of the papers, dedicated to specialists of the different concerned fields;
EPFL - CERN Visit Day: Visits of EPFL laboratories and CERN in Geneva is proposed.

Dr. A. Cassat P. Germano
Scientific Conference Chairman Logistic Chairman
Swiss Federal Institute of Technology, Lausanne

CONFERENCE ORGANIZING COMMITTEE

Conference Chairmen

M. Jufer (*), A. Rufer (*)

Scientific Program Chairman

A. Cassat (*)

Conference Logistic Chairmen

A. Cassat (*), P. Germano (*)

(*) Swiss Federal Institute of Technology, Department of Electrical Engineering, Lausanne, Switzerland

Conference Scientific Committee

V. Bourquin	Swiss Federal Institute of Technology
A. Cassat	Swiss Federal Institute of Technology
T. Chevroulet	Swiss Federal Institute of Technology
S. Colombi	Invertomatic Technology SA, Switzerland
F. Gaille	Les Electriciens Romands, Switzerland
B. Kawkabani	Swiss Federal Institute of Technology
N. Macabrey	GESTE SA, Switzerland
R. Mantilleri	GESTE SA, Switzerland
M. Mossi	GESTE SA, Switzerland
M. Rosenmayr	Hella KG Hueck & Co, Germany
P. Rossel	Swiss Federal Institute of Technology
J. Sandtner	Swiss Federal Institute of Technology
A. Schammass	Swiss Federal Institute of Technology
Y. Trottet	Bonnard & Gardel SA, Switzerland
D. Vernez	University of Lausanne, Switzerland
R. Wetter	Swiss Federal Institute of Technology

Secretariat Staff

N. Germano	Swiss Federal Institute of Technology
N. Jufer	University of Lausanne, Switzerland
M. Refondini	Swiss Federal Institute of Technology
F. Vionnet	Swiss Federal Institute of Technology

Web-Site Manager

R. Zoia	Swiss Federal Institute of Technology

INTERNATIONAL STEERING COMMITTEE

International Steering Committee Chairman

E. Masada — University of Tokyo, Faculty of Science & Technology, Department of Electrical Engineering

Members

Brazil	R. Nicolsky
Canada	K. Vollenwyder
England	R. Goodall
France	G. Coquery
Germany	D. Rogg
	U. Henning
	W. Rothengatter
	M. Wackers
	M. Witt
Japan	A. Seki
	M. Fujino
	K.-I. Kaminishi
	D. Ebihara
Hong Kong	T. Eastham
Italy	A. Morini
Switzerland	H. Bleuler
	A. Cassat
	M. Jufer
	P. Keller
	R. Nieth
	M. Mossi
USA	M.R. Dysart
	R. Krishnan
	E. Leung
	R. F. Post
	D. M. Rote
	P. Wilkins

Secretariat

MAGLEV'2002
Swiss Federal Institute of Technology
Department of Electrical Engineering
EPFL-STI-IPR-LAI (Old EPFL-DE-LEME)
CH-1015 Lausanne
Phone: ++41 21 693 26 91 Fax: ++41 21 693 26 87
E-mail: maglev2002@epfl.ch

Web-Sites

Conference Site:	http://www.maglev2002.ch
Swiss Federal Institute of Technology:	http://www.epfl.ch
Lausanne Tourism Office:	http://www.lausanne-tourisme.ch

THE CITY OF LAUSANNE

Overlooking lake Geneva and facing the majestic splendor of the snow-capped Alps, the city of Lausanne boasts a backdrop of scenic beauty that is truly breathtaking.

With a population of 120.000 and being the center of a metropolitan area of 280'000 including 80'000 international residents, Lausanne disposes of business, cultural, sports and educational facilities that are truly remarkable for a city of its size.

Only 45 minutes from Geneva-Cointrin Airport (by train or car), Lausanne is at the junction of major motorway and rail arteries. Every 30 minutes, for example, trains depart for all of Switzerland's major cities -with easy connections to more remote areas. It takes less than 4 hours to go to Paris or Milan, and trains leave 3 to 8 times a day.

A superb transportation system, state-of-the-art facilities and professional meeting services draw numerous seminars and conventions to Lausanne each year.

Lausanne was officially named Olympic Capital in June 1994, a unique and prestigious title awarded by the International Olympic Committee (IOC), headquartered in Lausanne since 1915. Each year, the city hosts the world's top athletes during international competitions.

Lausanne is very popular among students, with its numerous private schools and the country's largest university campus of the Swiss Federal Institute of Technology (EPFL) and the University of Lausanne. The excellent reputation of postgraduate institutions such as the Institute for Management Development (IMD) extends far beyond national borders.

The 16 museums and collections stage more than 50 exhibitions a year, from dinosaurs to contemporary art. Each month, more than 100 stage and opera productions, concerts and variety shows fill theatres and auditoriums across the city.

Lausanne is a city that has managed to preserve its human scale. Its warmth has enabled it to combine what otherwise would be irreconcilable: variety and intimacy.

Sightseeing in Lausanne and Surroundings

The Lake Geneva (or Lake Leman) region is characterized by a great geographical diversity. It deserves the reputation of being 'Switzerland in miniature". Indeed, it offers the peaceful shores of the Lake Geneva, the gentle wooded slopes of the Jura, the lush green fields of the countryside as well as the snow-capped peaks of the Alps.

From Coppet to Villeneuve, the gentle landscape and mild climate attracts the traveler.

The aristocratic charm of Coppet Main Street is enchanting while the sight of the castle takes one back to the age when Madame de Stael received the intellectual elite at that time.

Nyon has many cultural events to offer as well as its remarkable History and Porcelain Museum, which displays some of the splendid tiles produced by its erstwhile works.

The "pintes" -or country pubs -discretely scattered among the vineyards of the lakeside slopes known as 'La Côte", are waiting to welcome the traveler with many local specialties in a typical setting. Rolle and Morges have the shadow of their castles to offer, bearing witness to a noble past. Just a few miles from Lausanne, beyond the "côteaux de Lavaux" of wine-producing fame, lie Vevey and Montreux, festival towns which are really worth a visit for their mild climate and the reputation of their international events. In 1999, as every 25 years, a. special "Fête des Vignerons" will take place in Vevey, a celebration of the wine and of the men who work at the vineyards. Near Montreux, the traveler has to cast an admiring glance over the towering ramparts of the Château de Chillon" which was made a legend by the poem "The Prisoner of Chillon" written by Lord Byron in 1816.

While the Alpine and Rural resorts have the most modern facilities, they have also managed to preserve their traditional architecture so that, just a few minutes from the main European highway network, they can offer the visitor a chance to "escape" to a most agreeable mountain village atmosphere.

The countryside between the Jura and the Alps provides a setting for some truly rural tourism. There, the visitor will discover villages with typical farms as well as many museums that reflect the multiple facets of local craft trade. The southern shores of the lake of Neuchâtel will fascinate the nature lover with is natural reserve at "Chateau de Champittet", its signposted hiking paths and its study programs.

One might also visit the thermal baths at Yverdon-les-Bains and benefit from its sulfur baths and their curative effects.

The "Vallee de Joux", with its cozy atmosphere, varied landscape and its temperate climate is ideal for practicing water sports and observing the protected flora and fauna. So, combined in a relatively small area, these various venues are calm, harmonious and well balanced, That is why the local people like living here and visitors enjoy their stay,

For more information, do not hesitate to contact the Lausanne Tourist Office and Convention Bureau. Phone: +(41)-21-613-7321.

Weather

The climate in Lausanne should be very pleasant at the time the conference takes place (September), We expect rather warm days with a temperature in the range of 22-28°C; however rain could occur at this time of the year.

Travel

Train

It is the most efficient way of transportation to travel across the country (in 3-4 hours, you can reach almost any part of Switzerland). The major train transport authority in Switzerland is the CFF (Chemin de Fer Fédéraux). Most Swiss train stations have information counters where the traveler can find all the help he needs regarding the train schedule and special discount information. There are many regional trains that may be used for local transportation In the vicinity of Lausanne; Just check for details at Lausanne main train station.

Metro in Lausanne

Two lines :

From downtown to the train station and to Ouchy (Lausanne harbor on lake Geneva);

From downtown to Renens (town west of Lausanne) train station, taking you across the University of Lausanne and EPFL campus. This means of transportation is the most efficient way to get to the conference location. Metro trains are normally scheduled every 10 minutes.

TL: Public Transportation in Lausanne (bus)

A pass for the whole week is available at the desk of the conference (included in the full registration fees). To travel with TL transportation and metro lines before being registered at the conference desk, please use your confirmation of registration as ticket (valid for your first trip to the conference).

Taxi

Current day time is 5.40 to 6.20 CHF (initial charge) + 2.- to 2.60 CHF/km, inside the city limits and 3.- to 3.20, outside the city limits. Some extra charge may apply for night or weekend transportation.

Accommodation

Room will be allocated on a first come, first served basis. We therefore strongly recommend you to register as early as possible. Reservations have been made for the conference period. If you would like to extend your reservation we will do our best to help you. Please note: The registration deadline for hotel reservations is July 19, 2002. After this date we are only able to confirm hotel accommodation on an availability basis due to the

strong demand in Lausanne. Please note that we cannot guarantee hotel accommodation after this deadline.
Reservations must be guaranteed by a credit card. In case of no show etc. without prior notice to the Secretariat, you will be charged for one night. Further information will be enclosed with the letter of confirmation of the registration.

CONFERENCE INFORMATION

Language

The working language of the Conference is English, which will be used for all printed material, presentation and discussion.

Proceedings

Proceedings on CD-Rom will be published and handed out to the participants at the conference. Proceedings are included in the full registration fee. Participants will be able to consult the CD-ROM on site in the EPFL. A special computer room will be opened for this activity. In order to prepare the conference, the participants will be able to read the abstracts of the conference on our web site some weeks beforehand.

E-mail Connection

To be able to consult your E-mail during the conference, you will have the possibility to connect to the net and read or send E-mail. Please note that your POP Account and your Password are needed if you want to use this tool.

Personal Invitation

If a personal invitation to attend the conference is required, please contact the Conference Secretariat.

Lunches

Lunches will be served each day at the times shown in the programme. One lunch ticket for each day is included in the full registration fee. Tickets will be provided at registration and must be presented for service.

Registration Information

The registration form can be obtained on the conference web-site http://www.maglev2002.ch

Registration Desk

The Registration Desk and Conference Secretariat in EPFL will open as indicated in the MAGLEV'2002 - Time Table.
The Registration Desk will be situated at: EPFL - La Coupole, front of CO2 Auditorium.

Registration Fees

The full registration fee includes admittance to all sessions, one CDROM, lunches and coffee during the conference, the Get Acquainted Party and the Conference Banquet.
The full registration fee is CHF 760.- before July 8, 2002, CHF 820.- before August 15, 2002 and 930.- CHF on the Conference Site.
Please observe that both the registration form and the fee must be received by the Conference Secretariat before 8 July 2002 to obtain the lowest fee. For all payments received after this date, including on-site registration, the higher fees apply. For accompanying persons and students additional tickets for the reception and the conference banquet can be ordered with the registration form. Lunch tickets for accompanying can be bought at the conference site.
Please note: The registration deadline for hotel reservations is July 19, 2002. After this date we are only able to confirm hotel accommodation on an availability basis. We therefore strongly recommend you to register as early as possible.

Payment

Payment should be remitted in Swiss Francs (CHF). Bank, currency and transfer charges are the responsibility of the payee. Please ensure the organizer is paid the full amount due, and state the name(s) of the participant(s) clearly on all payment.

Bank Transfer

Payment can also be made using credit cards. Please fill in the requested information on the registration form.

Cancellation

Cancellation must be sent in writing by the conference secretariat. Cancellations received prior to July 8, 2002 will be subject to CHF 100.- administration charge. For cancellations received after this date the registration fees are non-refundable. Substitutes will be accepted at any time.

Cancellation terms for the pre-conference tours:
No cancellation fee for cancellations received before July 8, 2002. Cancellations received after this date will not be refunded.
All tours are based on a minimum number of participants. If a tour has to be cancelled due to low numbers of participants, the tour fee will be refunded in full.

Refunds will be processed immediately after the conference.

Confirmation of registration

Confirmation of your registration, including hotel and other reservations, registration details, information regarding transport to and from the airport etc. will be sent to all registered participants at the end of July/beginning of August 2002 and then as registrations arrive.

SOCIAL PROGRAMME

Get Acquainted Party at the CIO Museum (International Olympic Committee) September 3, evening

To welcome you at MAGLEV'2002 Conference, we invite you to a cocktail at the CIO Museum, location of the International Olympic Committee. The Authority of the city of Lausanne will offer the city wine at this reception. Participants will have the opportunity to visit the Museum during the cocktail.

Gala Dinner, September 4, evening

May we recommend you the Conference Gala Dinner at the Hotel Beau-Rivage Palace, located in Lausanne-Ouchy on the banks of Geneva Lake. The hotel is one of the world's most prestigious hotels. A jazz orchestra will accompany us. Everything will be prepared for you to enjoy yourself in good company and a cheerful atmosphere.

Visits and Sightseeing

A Visit and Sightseeing Programme is presented on the MAGLEV'2002 Web-site: www.maglev2002.ch

Topic 1 MAGLEV - World Wide High Speed Industrial Developments and Projects

1.1 Scientific, Technical And Industrialization Status
1.2 Social, Environmental And Ecological Aspects - Eco Balances
1.3 Comparisons: Evaluations Of High Speed Systems (MAGLEV versus TGV, Air Traffic)

Topic 2 MAGLEV - New Ideas

2.1 Scientific, Technical And Industrialization Status
2.2 Marketing, Political And Financial Aspects

Topic 3 URBAN TRANSPORTS (Linear Propulsion) - Industrial Developments and Projects

3.1 Scientific, Technical And Industrialization Status
3.2 Marketing, Political And Financial Aspects
3.3 Environmental And Ecological Aspects - Eco Balances
3.4 Comparisons: Evaluations With Classical Systems

Topic 4 MAGLEV - Power Supply Strategy

4.1 Ground Power Supply Network to Local Power Network
4.2 Power Transformation Station
4.3 Power Supply for Propulsion
4.4 Energy Balance

Topic 5 MAGLEV - Vehicle - Guide way - Infrastructure

5.1 Vehicle and Spatial Integration Designs
5.2 Aerodynamic Behavior And Aerodynamic Impacts On Design Constraints
5.3 Dynamic Mechanical Resonance And Vibrations, Speed And Frequency Limits

Topic 6 MAGLEV And HSTS - Safety And Operation Control

Topic 7 Propulsion And Linear Motors: Motors And Controls

7.1 Scientific and Technical Developments
7.2 Transport System Applications
7.3 Industrial Applications
7.4 Propulsion: Magnetic Hydrodynamic

Topic 8 Magnetic Levitation and Guidance: Transducers And Controls

8.1 Electromagnetic Levitation (EML or EMS) and Guidance
8.2 Electrodynamics Levitation (EDL or EDS) and Guidance
8.3 Super Conducting Quantum Levitation (SQL)

Topic 9 Transfer Of Energy To A Vehicle And On Board Energy Supply

9.1 Scientific and Technical Developments
*9.2 High Speed Transport System Applications (Transfer **With And Without** Mechanical Contacts)*
*9.3 Low Speed Transport System Applications (Transfer **Without** Mechanical Contacts)*
*9.4 Industrial Applications (Transfer **Without** Mechanical Contacts)*
9.5 Fuel Cells, Super Condensators

Topic 10 Magnetic Bearings - Typical Industrial Applications

10.1 Passive Magnetic Bearings
10.2 Active Magnetic Bearings
10.3 Super Conducting Magnetic Bearing (SMB)

Indentification of the papers: PPTTsnn

TT	topic number 01 to 10
s	subtopic (.1 to .5)
nn	paper number (01 to 99)

PLENARY SESSION 1 - TOPIC 1 - 08.20

Chairmen: M. Jufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

R. Nieth, Swissmetro SA, Geneva, Switzerland

E. Masada, Science University of Tokyo, Japan

PP01109 The Status of the Development and the Running tests of the JR-MAGLEV

Akio SEKI, Hitoshi TSURUGA, Akihiko INOUE, Kan-ichiro KAMINISHI, Haruo IKEDA, Tsutomu FURUKI

Central Japan Railway Company, Tokyo, Japan and Railway Technical Research Institute, Tokyo, Japan

The running test of the JR-MAGLEV has been conducted for six years in order to confirm long-term reliability and durability. In addition, the developments of technologies for cost reduction and improvement of aerodynamic characteristics have been carrying on. New type vehicles, which are adopted the results of the developments to improve these technical subjects, will be introduced to the Yamanashi MAGLEV Test line in this summer. New shape sidewalls with improved ground coils and high efficient power converters for cost reduction, will be introduced to the test line in this autumn. This paper deals with the status of the running tests on the test line and the developments of technology to be carried out.

Keywords: High speed, MAGLEV, running tests, super conducting.

PP01201 Transrapid Super Speed MAGLEV Technology

Manfred Wackers

Transrapid International GmbH & Co. KG, Berlin, Germany

It is widely recognized in industrialized nations that only modern, fast, attractive, track– bound transportation is capable of alleviating the pressure on existing transportation networks. Ever increasing globalization and urbanization tendencies demand transportation solutions which are capable both of relieving traffic density between metropolitan areas and of reducing existing and potential environmental damage. The Magnetic Levitation rail technology developed by Transrapid International offers a solution to the manifold challenges presented by urban development and population sprawl.

PP01112 On the Development Strategy of the High-Speed MAGLEV in China

Yan Luguang

Institute of Electrical Engineering, The Chinese Academy of Sciences, Beijing, China

High-speed MAGLEV with 500km/h operational velocity can be used for practical passenger transport in the first part of 21st century. Based on the detailed analysis of the international progress and serious discussion, a development strategy in China was suggested. The paper describes the main past achievements and future work from the point of view of the development strategy.

Keywords: Development Strategy, High-speed MAGLEV, Long Distance Line Feasibility, Shanghai demonstration line.

PP01205 Swissmetro : Strategy and Development Stages

Michele Mossi

GESTE Engineering SA, Lausanne, Switzerland

The studies carried out these last 10 years show that Swissmetro has all the potential to become a technological product fully satisfying the expectations of the new markets of high-speed passengers' transportation. It appears to be the only transportation system capable to offer both high performance and significant sustainability. Swissmetro still being in a stage of project, the operational start-up of a first line necessitates proceeding to a series of development stages. After a brief description of the project, these stages are presented in this document, and in particular the ones including two new experimental test facilities: the aerodynamic test center HISTAR (High-Speed Train Aerodynamic Rig); the test center for mastership of the partial air vacuum SETUP (Safety, Equipment and Tunnel Under Partial Pressure).

Keywords: HISTAR, Planning, SETUP, Strategy, Swissmetro.

PLENARY SESSION 2 - TOPICS 1, 2, 3 - 08.00

Chairmen: ***A. Rufer, Swiss Federal Institute of Technology, Lausanne, Switzerland***

M. Jufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

E. Masada, Science University of Tokyo, Japan

Invited **High Speed and Mobility: Toward a New Frontier?**

Yves Crozet

Laboratoire d'Economie des Transports, ISH, Lyon, France

PP01206 **World Wide MAGLEV Status**

Michele Mossi, Pierre Rossel

GESTE Engineering SA, Lausanne, Switzerland; Swiss Federal Institute of Technology, Lausanne, Switzerland

PP02102 **The current State of the Brazilian Project for a Super Conducting Magnetic Levitation Train**

R. Nicolsky, R. Stephan, A.C. Ferreira, R. de Andrade Jr., M. A. Cruz Moreira, L. G. Rolim, M. A. Neves,M. A. Rosário

UFRJ, Rio de Janeiro, Brazil

The current state of the high-temperature super conducting magnetic levitation train prototype in UFRJ is described. This project has two main parts: the levitation and the traction. In this paper, the development and results of both parts are presented. Simulation and test measurements are presented. The integration of both parts will be done with a small scale laboratory prototype. These results are necessary as a convincing example for higher investments and new enrollments, necessary for the construction of a real scale prototype, the next step in our project.

Keywords: High Temperature Superconductors, Linear Synchronous Motor, MAGLEV, super conducting Quantum levitation

PP01103 MAGLEV Program in Korea

CHO Hung-Je

Korea Institute of Machinery and Materials, Yoosung-ku, Daejon, Korea

MAGLEV Project Team at KIMM has been leading development of attraction type urban transit MAGLEV for the past 10 years. In this paper current status of MAGLEV program in Korea - what has been done so far, efforts to improve technical problems we have - is reported.

PP03102 Urban MAGLEV Development In USA

Tony Yen

PLENARY SESSION 3 - TOPICS 3, 8, 9, 10 - 08.00

Chairmen: H. Bleuler, Swiss Federal Institute of Technology, Lausanne, Switzerland

A. Rufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

E. Masada, Science University of Tokyo, Japan

PP03103 Overview Of The General Atomics Low Speed Urban MAGLEV Technology Development Program

Sam Gurol, Robert Baldi, Richard F. Post

General Atomics, San Diego, USA and Lawrence Livermore National Laboratory, Livermore, USA

The overall objective of the Urban MAGLEV Program, sponsored by the Federal Transit Administration, is to develop magnetic levitation technology that offers a cost effective, reliable, and environmentally friendly option for urban mass transportation in the United States. MAGLEV is a revolutionary approach in which trains are supported by magnetic forces without any wheels contacting the rail surfaces. The program is funded under the Transportation Equity Act for the 21st Century (TEA-21). An innovative approach for the General Atomics Urban MAGLEV has emerged that involves an entirely passive, permanent magnet levitation system with an efficient linear synchronous motor powering the guide way to provide propulsion. The studies show that the Urban MAGLEV system offers many attractive benefits, including very quiet operation, the ability to operate in challenging terrain with steep grades and tight turns, all-weather operation, low maintenance, and rapid acceleration and the potential for high speed.

Keywords: EDS, MAGLEV, Urban MAGLEV

PP03107 Comparison between Short-stator and Long-stator Linear Drives of MAGLEV System for Regional Transport

Eisuke MASADA, Tony EASTHAM, Takeshi MIZUMA

University of Tokyo, Japan; University of Science and Technology, Hong Kong; China National Traffic Safety and Environment Laboratory Traffic Safety Division, Railway Section, Chofu, Japan

Assuming applications for urban and regional transportation systems with the track length of one to several tens of km, the short stator and the long stator drives for the MAGLEV system are studied and compared on the basis of existing data on HSST, Linear Metro, M-Bahn and Transrapid for a model case. Because of the limited length of route and rather high demand of the system, the maximum velocity of trains in operation should be chosen less than 300km/h. The distribution of demands along the track of these systems requires high train density under operation near the end station. The limit of drive characteristics of the short-stator linear induction motor in high velocity would be marginal against rather high investment costs of the long-stator system, considering the rather complex operation of the regional systems and the development of the demand in the region after the revenue service.

Keywords: Linear Drives, Linear Motor, MAGLEV System, Regional Transport.

PP09502 A New Design for an Auxiliary Power Unit (APU) by Associating Super Capacitors and a Proton Exchange Membrane Fuel Cell

L. Bertoni, H. Gualous, D. Hissel, D. Bouquain, M C Péra, J.M Kauffmann

Laboratoire d'Electronique, Electrotechnique et Systèmes (L2ES), UTBM, Belfort, France

This paper describes the design and control requirements of an auxiliary power unit (APU) for transportation applications. The design of the APU is based on an association of super capacitors and fuel cell. Super capacitors are incorporated to satisfy peak power demands in order to optimize performance of the APU and to reduce its size and therefore also the cost of the fuel cell. After the system description, simulations are performed to optimize the DC/DC converter between the APU components and the DC bus of the vehicle.

Keywords: Auxiliary Power Unit, Fuel Cell, Super Capacitors.

PP08302 Experimental Study and FEM Analysis of the Large-Scale Super Conducting Magnetic Gradient Levitation System

M. Kubota, T. Kashiwagi, E. Suzuki, T. Matsuda, M. Hirakawa, H. Nakasima

Central Japan Railway Company, Tokyo, Japan

We have carried out tests of levitating a ferromagnetic material (iron) by use of the large-scale experimental apparatus with magnetic gradient levitation system. As a result, we succeeded in the stable levitation of a 79 kg weight including 26 kg iron blocks in the room temperature space without active control. In addition, we analyzed the characteristics of the electromagnetic forces of a levitation model by the finite element method (FEM), and we have obtained the good agreement between the results of experiments and numerical analysis including levitation force and guidance force.

Keywords: FEM analysis, magnetic gradient levitation, super conducting screen.

PP10204 Results on Self-sensing Active Magnetic Bearings

Alexandre Schammass, Hannes Bleuler

Swiss Federal Institute of Technology, Lausanne, Switzerland

Self-sensing active magnetic bearings eliminate the position sensors and estimate the position of the levitated object position by measuring the coil current and voltage. The main interest of this approach is to reduce production costs and hardware complexity. This paper proposes a strategy for estimating the position based on a modulation approach. Experimental results from a radial magnetic bearing are presented. The quality of the estimation signal is evaluated in terms of noise and dynamic performance (bandwidth).

Keywords: Active magnetic bearings, position estimation, switching amplifier, self-sensing bearings.

LECTURE SESSION 1A - TOPIC 1 - 10.20

Chairmen: U. Henning, Siemens, Erlangen, Germany

R. Rossel, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP01101 Failure Mode and Endurance Tests of the HSST 100L System

L.K. Siu, David Chan

Kowloon-Canton Railway Corporation, Hong Kong, ChinA; Chubu HSST Development Corporation, Nagoya, Japan

PP01102 High Speed Surface Transport System : Nagoya East Hillside Line and the Operational Testing for 3-Car Vehicle Prototype

Masaaki Fujino

Chubu HSST Development Corporation, Nagoya, Japan

The East Hillside Line in Nagoya (also referred to as Tobu Kyuryo Line) is the world's first commercial application of the magnetic levitation system for HSST that is now starting its construction for the grand opening of the World Exposition, "Aichi Expo 20 05 " scheduled for March 2005. This report summarizes the development history of the HSST system and its latest status including design concept of prototype vehicles for Tobu Kyuryo Line.

Keywords: HSST, The East Hillside Line in Nagoya (also referred to as Tobu Kyuryo Line), Un -manned operation.

PP01104 Passive Damping in EDS MAGLEV Systems

Donald M. Rote

Argonne National Laboratory, Argone, USA

PP01105 TRANSRAPID SHANGHAI - Demonstration Line. German High Technology with Chinese Boundary Conditions

Eberhard Grossert

GP Dr. Grossert Planungsgesellschaft mbH, Berlin, Germany

The routing of the track, the used guide way constructions as well as their production plants are described in this report. Parts of the planning activities will be explained which are required on the German side to cover the interface between German delivery parts and Chinese planning and production activities. Information about the absolutely short realization time for the erection of the guide way constructions will be given

Keywords: TRANSRAPID Shanghai, track routing, guide way constructions, production plant, dates.

PP01108 Transrapid Operation Control System Technical Prerequisites for Short Headways

Siegfried Burkert, Peter Hamann

Siemens AG, Braunschweig, Germany; Siemens AG, Berlin, Germany

Following the decision by the German Federal Government not to implement Berlin-Hamburg Transrapid magnetic railway main-line route, a new field of application in regional traffic was sought. The Munich airport-city centre and Düsseldorf-Dortmund lines provided the solution. The Transrapid regional traffic variant was named Metrorapid. Because of the shorter distances between stations and the shorter headways in conurbations, regional traffic places different demands on the operating concept and technical equipment for Transrapid magnetic railway systems than does long-distance traffic. The preparation work that is being undertaken in parallel with the feasibility studies comprises the system-related analysis of the Metrorapid and the development of suitable control and safety procedures for regional traffic on magnetic levitation systems.

LECTURE SESSION 2A - TOPIC 1 - 13.40

Chairmen: M. Wackers, Transrapid International, Berlin, Germany

A. Seki, Central Japan Railway, Tokyo, Japan

PP01110 Risk Assessment of High Speed Transport

Jürg Liechti, Christian Leuenberger

PP01111 The Hybrid guide way Girder Development and first application in Shanghai

Jürgen Feix, Roman Brylka

Cronauer Beratung Planung, Munich, Germany

The first commercial use of the Transrapid will be realized on a 30 km track in the People's Republic of China. At present, the Chinese are building a link between Pudong Airport and Long Yang Road Station in the outskirts of Shanghai. The technology required to build this hybrid guide way is provided by the German TGC. This paper reports on the development of this new guide way type for the Transrapid MAGLEV system. Moreover, the Shanghai track will serve as an example to illustrate the technical and economic advantages of the hybrid guide way concept.

Keywords: China, Hybrid guide way Girder, Shanghai, structural engineering, Transrapid.

PP01202 DB AG Operator Requirements for High-Speed MAGLEV Railways as Regional Services

Thomas Rühl, Hartmut Albert

DB AG, Vorstandsressort Technik, Magnetschnellbahn, Berlin, Germany

The Transrapid high-speed MAGLEV railway was conceived and optimized as a means of long-distance conveyance. Its use as a fast regional carrier for population centers or airport feeder services involves different and in some respects greater demands than for long-distance workings, in respect of which DB AG has produced operator requirements. The aims DB AG is pursuing and the ensuing focus areas for further development of the high-speed MAGLEV railway are extrapolated having regard to the system's use in regional services. How these aims translate into functional requirements is set out

together with the methodological tools adopted and a Requirement Database.

Keywords: Regional Services, Operator Requirements, Market, Operation.

PP01203 Program of the Federal Government to Ensure the Future Application of MAGLEV Technology

Wolfgang DÖRRIES

Commissioner of the Federal Ministry of Transport, Building and Housing, for magnetic levitation (MAGLEV) systems, Berlin, Germany

In the spring of 2000, the German Federal Ministry for Transportation, Construction and Housing commissioned an investigation into the regional use for the MAGLEV technology in Germany for the connection between airports and city centers and conurbations.

Future application, German government, MAGLEV technology.

PP01204 Construction of Shanghai Transrapid Demonstration Line

Wu Xiangming

Shanghai MAGLEV Transportation Development Co., Ltd Pudong, Shanghai, China

While selecting a most appropriate mode of high-speed ground mass transportation system for the nation, the Chinese government decided to build a high-speed MAGLEV demonstration line in Shanghai after continual studies, with the purpose of acquiring detailed comparison data in respect of system technologies, safety concerns and economic assessments. This paper is to introduce the first-ever commercialized high-speed MAGLEV line, its construction progress and some key technical issues. The emphasis is on the technical improvements that the Shanghai MAGLEV Transportation Development Co., Ltd. (hereinafter referred as 'SMTDC') had made on the basis of the TR guide way technologies from Germany and with the considerations of the reality of China. This paper ends with discussions on the development prospect of the high-speed MAGLEV transportation technologies.

Keywords: Transrapid, Shanghai demonstration line, High-speed MAGLEV, Hybrid-girder, guide way.

PP01207 Swissmetro : Economic Viability of the Basle-Zurich Pilot Line

Michele Mossi, François Vuille

GESTE Engineering SA, Lausanne, Switzerland

In the past two years, the management of the Swissmetro project has analyzed the technical and economic feasibility of a high-speed connection between the centres of the Swiss cities Basle and Zurich. This 89.1 km long line, which could be in operation in 2020, will be ensured by a Swissmetro vehicle in only 15 minutes.

In order to put out the economic viability of this connection, a traffic analysis has been conducted, yielding passenger estimates for the years 2020 to 2040. This analysis, based on four forecasting scenarios, showed that between 19,000 and 30,000 daily passengers would be conveyed on this line in 2020 and up to 85,600 by 2040.

These traffic estimates have been used to determine the direct economic viability of the Basle-Zurich Swissmetro link. The connection will be profitable yielding a realistic internal rate of return ranging from 3.6% to 6.4%, depending on both the traffic scenario and the ticket price; this profitability would be largely increased if the Swissmetro line would also connect both Basle and Zurich airports, as well as other Swiss or European cities.

Keywords: Basle-Zurich line, Economic evaluation, Pilot line, Swissmetro, Traffic analysis.

LECTURE SESSION 3A - TOPIC 1 - 16.20

Chairmen: D. M. Rote, Argone national Laboratory, Argone, USA

K. I. Kaminishi, Railway Technical Research Institute, Tokyo, Japan

PP01208 Study on the Feasibility of Maglev Systems in Regional Transport in Bavaria and North Rhine-Westphalia

Michael Witt, Stefan Herzberg

Dornier Consulting GmbH, Friedrichshafen, Germany

In 2000, the German Ministry for Transport, Building and Housing commissioned to investigations for the regional application of Maglev in Germany for a Transrapid-connection between Munich airport and

Munich main station in Bavaria and the connection of the city centers in the Metropolitan Region of Northrhine-Westphalia (Metrorapid).

The investigations were made on the basis of an in-depth feasibility study dealing with all infrastructural, operational, ecological and economical aspects for the implementation of a new system. The economic results are presented and show that in each of the two corridors a Maglev system is economically, ecologically, technically, and operationally feasible.

PP01301 Environmental Evaluation Of Future Transport Technologies

Michael Spielmann

Umweltnatur- und Umweltsozialwissenschaften ETH Zürich, Schweiz

In this paper, based on a case study of a Swissmetro Network, a procedure for the environmental evaluation of future transport systems within the framework of Technology Assessment is presented. The environmental evaluation is performed pursuing a Life Cycle Assessment (LCA) approach. In order to incorporate the future, scenario analysis has been introduced to LCA for the first time. The main goal of the case study was then to determine and evaluate the environmental impacts of the additional traffic generated by Swissmetro Network. The environmental evaluation of these induced impacts is built on two steps. First, the volume of the induced traffic is determined for different scenarios and variants, and second the environmental impacts due to an additional person kilometer are calculated by performing an LCA. The results of the case study reveal that the conditions determining the development of mobility, which have been operational zed in scenarios, seem to have a decisive influence on the environmental performance of the future transport system.

Keywords: Environmental Evaluation, Technology Assessment, Life Cycle Assessment, Scenario Analysis, Swissmetro.

PP01302 Energetic and Environmental Assessment of a Eurometro

Jens Geisel, Christian Leuenberger

Bern University of Applied Sciences, Bern, Switzerland

NRP 41 Project F6 and ongoing research concluded that using the ecological potentials of Swissmetro technology it is possible to

develop a better ecological alternative to long distance and high speed transportation with distances around 1200 km or more. An Eurometro system could achieve efficiency gains of a factor 5 or more compared to air transport. While traveling with considerably higher velocities it could use about the same amount of operating energy or even less than that of high speed railway systems such as ICE or TGV. New data allow to update the calculations and will allow more recommendations regarding environmental key factors in the ongoing development process.

Keywords: Eurometro; High Speed Transport; Sustainable Transport; Eco Balance; Energy Balance; Environmental Assessment; Swissmetro Technology; MAGLEV; Swiss National Research Program 41: Transport and Environment, Project F6.

PP01303 Energy and Environmental Assessment of a Eurometro DEMAND and NETWORK - influential Factors

Daniel Schöbi

University of Applied Sciences, Bern, Switzerland and Vienna University of Technology, Vienna, Austria

A Eurometro-system based on Swissmetro technology could provide an ecological alternative to aviation. Ongoing research evaluates on how a Eurometro-system should be implemented, interconnected with the local, regional and international public transport system, as well as integrated into existing and future High-Speed-Traffic (HST) - infrastructures and finally integrate Switzerland in a European HST-network. In a first step we will look back to the development of HST, overview the influential factors and then focus on trends and estimated demand and network.

Keywords: Demand, Eurometro, high speed traffic, network, trends.

PP02109 New MAGLEV Transport Concept and its Acceptability to Swissmetro

Oleksander Kozoriz, Vasyl' Kozoriz, Vladimir Kristov, Vjitchelsay Baguslaev, Fjodor Muravchenko

National Technical University of Ukraine, Kyiv, Ukraine

National Air-Space University of Ukraine, Kharkiv, Ukraine

MOTOR SICH Co., Zaporizhja, Ukraine

PROGRESS Motor Design Bureau, Zaporizhja, Ukraine

The “Magnetic Potential Well” (MPW) and “One Sided Action of a Magnet” (OSAM) phenomena are explained mainly in ideas, comparisons and testing. The passive MPW-levitation as a dynamics problem of the free body equilibrium stability, and the OSAM as the core of a new method to accelerate or slow down a body is demonstrated with tests fulfilled by visitors from the worldwide companies. Inventions concerning docking in the space, Maglev transportation, inertial navigation, and super conductive bearings are represented. Acceptability of the MPW and OSAM for the modern high-tech projects, particularly for the Swissmetro is discussed.

Keywords: magnetic levitation, linear drive, superconductivity

LECTURE SESSION 1B - TOPIC 7 - 10.20

Chairmen: T. Eastham, University of Science and Technology, Hong-Kong, China

N. Macabrey, GESTE Engineering SA, Lausanne, Switzerland

PP07101 Control of a Linear Permanent Magnet Synchronous Motor using Multiple Reference Frame Theory

Jawad Faiz, B. Rezaei-Alam

Faculty of Engineering, University of Tehran, Tehran, Iran

This paper uses a multiple reference frame theory (MRF) in order to estimate and control the current harmonics of a linear synchronous motor with permanent magnet stator structure (PMLSM). This is done in such a way that the rms supply current is minimized, therefore the losses will be lower. Also relationship between the traction force and currents of the motor is studied in d-q axes. The suggested technique is robust against time-variable parameters such as inductance variation. Finally simulation results of the suggested structure are presented.

Keywords: Feeding Current Minimization, Linear Motor, Multiple Reference Frame.

PP07103 LIM: Optimization of Secondary Width Respect to the Thrust

Giovanni Zanzara, Gino D'Ovidio, Francesco Crisi, Aurelio Navarra, Marco Villani

University of L'Aquila; Science and Technology Park of Abruzzo, L'Aquila, Italy

The paper deals with the investigation of the optimal width of the secondary in a Linear Induction Motor, respect to the primary dimensions, with reference to the thrust and levitation. An experimental equipment has been designed and built that reproduces on small-scale the motion of vehicle along an electromagnetic way. Significant experimental tests have been carried out in order to characterize the circular inductor way with annulus-type secondary and evaluate the effect of several parameters on the performance. Moreover, an accurate 3-D Finite Element model has been carried out and the simulation results have been compared with the experimental

ones. This model has allowed to optimize the secondary width in order to maximize the thrust. This study should bear gradually the construction of an equipment with high-temperature super conducting materials

Keywords: Electromagnetic way, finite element analysis, levitation.

PP07104 Advanced Converter and Control Components for TRANSRAPID

U. Henning, R. Hoffmann, J. Hochleitner

Siemens AG, Erlangen, Germany

A new converter and control system for the TRANSRAPID was developed and successfully tested under realistic operating conditions, in particular in combination with double -end feeding, in the course of modernization of the TRANSRAPID test facility in Emsland. In this paper, prototypes incorporating new technologies are presented for the various subsystems and components. Above all, test results are reported. A new compact inverter module was developed and successfully equipped with 4.5 kV IGBTs and 4.5 kV hard-driven GTOs respectively.

Keywords: Control systems, converter circuits, design, linear drives, power semiconductor devices

PP07107 4 Poles 3 Degrees of Freedom Magnetic Levitation Control And Its Coordination With Two-Dimensional Linear Motor

Jiangheng LIU, Takafumi KOSEKI

The University of Tokyo, Tokyo, Japan

Electromagnetic suspension (EMS) has been widely used in many industrial fields because of various advantages in practical use. The U-type magnets are often used to generate the levitation force in the EMS system. This conventional electromagnet, however, can only control one degree-of- freedom. It cannot construct a levitation system solely by itself.

A 4-pole type yoke hybrid electromagnet is proposed instead of the usual U-type magnet and its magnetic levitation control is studied in this paper. The basic structure and characteristics of the proposed magnet are described, and the control systems are designed. The semi-zero-power controller, with a disturbance observer, is proposed to

improve the performance of the control system. Furthermore, the combination with the linear motor is discussed.

Keywords: 3 degrees of freedom, 4-pole electromagnet, magnetic levitation, two-dimensional linear motor, zero-power control.

PP07108 Development of a MAGLEV Space Transport System

C. Ham, J. Flores, R. Johnson

University of Central Florida, Orlando, USA

Access to space is becoming both more in demand and increasingly more expensive. In order to lower the cost of getting to space, MAGLEV space launch assist is considered as one of the options for a space transport system. MAGLEV as a zero stage is viewed as a safe, reliable, and inexpensive launch assist for sending payloads into orbit. This paper presents an application of MAGLEV technology for a space transport system by developing a MAGLEV Launch Facility (MLF) for the Super-Loki sounding rocket. It provides technical analysis and trade-off studies to develop an inexpensive, reliable and reusable MAGLEV launch assist system. The main result is a computer simulation framework to derive an optimal configuration of a MLF that provides necessary initial state vectors for various launch scenarios. This computer simulation was then applied to a Super Loki Rocket launch scenario and specific optimal parameters for launch were obtained. The results can also be extended to design a MLF of a full-scale expendable launch vehicle and a space shuttle replacement vehicle through scalability

Keywords: Advanced propulsion, MAGLEV assisted launch, sounding rocket, space transport system.

LECTURE SESSION 2B - TOPIC 7 - 13.40

Chairmen: K. Vollenwyder, Bombardier Transportation, Kingston, Canada

W. Mayer, Dornier Consult, Friedrichshafen, Germany

PP07109 Principle and Analysis of a Novel Linear Synchronous Motor with Half-Wave Rectified Self Excitation

Jun OYAMA, Tsuyoshi HIGUCHI, Takashi ABE, Shotaro KUBOTA, Tadashi HIRAYAMA

Nagasaki University, Nagasaki, Japan

Principle and analysis of a new type LSM are presented. The motor is based on half-wave rectified brushless excitation. The field winding is short-circuited through a diode and the armature winding is conventional 3-phase windings. As the field flux is controllable by varying armature current, field weakening operation is possible in high speed region. The experimental machine is designed and built. The characteristics are estimated theoretically and the inductance is compared with measured value.

Keywords: Linear Synchronous Motor, Half Wave Rectified Self Excitation.

PP07110 Approaching the Analysis of Linear Machines via Artificial Neural Networks

Luciana Cambraia Leite, Carlos Rodrigues de Souza, Gilio Aluisio Simone

University of Campinas, São Paulo, Brazil

Artificial neural networks are used in this study for the analysis of a sector motor with the purpose of obtaining its thrust. The sector motor is a type of rotary induction machine, which owing to its particular shape, present the end-effects usually found in the linear machines. The analysis of a sector motor via the machine equations is not convenient because the equations do not easily lead to a model that can be applied to different operating situations. This problem arises from the difficulties in incorporating the end-effects into the machine equations. On the other hand, as the artificial neural networks are convenient tools for managing the situations of difficult modeling, they can be applied as an alternative approach for the analysis of this kind of machine. In order to generate the data required by the neural network learning process, the machine is tested in the laboratory under various driving situations, which comprise transient and steady state conditions. The main purpose of this work is to obtain an artificial neural network architecture that represents the sector motor under the required operating conditions.

Keywords: Artificial neural networks, data acquisition, linear motors, thrust estimation.

PP07112 Experimental Design Method applied to the Optimization of a Linear Eddy Current Brake.

Hecquet Michel, S. Vivier, Brochet Pascal

Ecole Centrale de Lille, Villeneuve D'Ascq, France

This paper illustrates the use of experiment design technique applied to the optimization of an electromagnetic brake. This device is used in rolling stock equipment. Previous studies showed the influence of particular characteristic dimensions on the braking and attractive forces created by this device. Our aim is to determine accurately the variations of these forces especially around the optimal point using the 3D finite element method associated to the experimental designs. The advantage of the Response Surface Methodology is to determined a polynomial model for the braking and attractive forces versus studied parameters. In addition, a comparison with the experimental measurements is realized in order to validate our model.

Keywords: Eddy current brake, experimental design method, 3D finite element method, optimization, polynomial model.

PP07113 Performance Estimation of Linear Tubular Actuator

L. El Amraoui, F. Gillon, P. Brochet, M. Benrejeb

Ecole Centrale de Lille, Villeneuve d'Ascq Cedex, France; Ecole Nationale d'Ingénieurs de Tunis. Tunis, Tunisia

The paper reports on the approach applied for linear tubular switched reluctance machine sizing, design and characterization. A prototype is built in order to validate the whole design process. Comparisons show a good agreement between computed and measured results. A response surface model of force versus position and current is then derived. This model allows an accurate prediction of the actuator performances.

Keywords: Dynamic simulation, finite element model linear tubular motor, reluctance network, test bench.

PP07115 Design and Simulation of an Electromagnetic Aircraft Launch System

D J Patterson, A Monti, T Bertoncelli, C Brice, R Dougal - R. Pettus

University of South Carolina; Swearingen Center, Columbia, US; Politecnico di Milano, Milano, Italy

This paper describes the basic design, refinement and verification using finite element analysis (FEA), and operational simulation using the Virtual Test Bed (VTB), of a range of candidate linear machines for an electromagnetic aircraft launching system (EMALS) for the aircraft carrier of the future. Choices of basic machine format, and procedures for determining basic dimensions are presented. Detailed designs are presented for a permanent magnet version, and a super conducting field coil and an induction machine version are introduced. The long armature - short field geometry is discussed, and in particular the impact of this geometry on the scale of the power electronic drive system is presented.

PP07116 Demo-Track Using a Linear Induction Motor

J.-M. Strubin, M. Veenstra, A. Rufer
Swiss Federal Institute of Technology, Lausanne, Switzerland

Technical education in classical fields like electrical engineering is confronted in western countries with on one side a high demand for engineers coming from industry and on the other side by the reduced interest from younger generation, whose interest is highly polarized by information and communication technologies. A linear motor demo-track has been set up, in order to reinforce the demonstrative aspects of modern technology as a contribution to the motivation of students for the industrial world. It is also an alternative example to the too classical rotating asynchronous motor in the field of education on variable speed drive

Keywords: Demonstration drive, linear asynchronous motor, sensorless.

LECTURE SESSION 3B - TOPIC 7 - 16.20

Chairmen: G. Coquery, INRETS, Arcueil, France

N. Macabrey, GESTE Engineering SA, Lausanne, Switzerland

PP07117 Linear Electric Motors for Aerospace Launch Assist

M. Caprio, S. Pratap, W. Walls, R. Zowarka

The University of Texas at Austin, Austin, USA

This paper summarizes the results of a design study investigating the use of linear electric motors in an aerospace electromagnetic launcher

application requiring 7g's of horizontal acceleration to a velocity of 300m/s. The study initially reviews the current state of high-speed electric machines in applications similar to the one proposed. Induction and synchronous linear motors are then evaluated for suitability to the application by analyzing their characteristics in this high-speed operating regime. A detailed design approach is used to synthesize machines capable of meeting the launcher's performance requirements, since the conditions fall outside of the conventional design envelope. Realistic physical features of all electrical power system components are included to ensure the evaluated systems are physically realizable. The two motor types are compared for suitability to the application based on performance, cost, and system integration issues. Finally, a prototype demonstrator design is proposed to verify the results of the study.

Keywords: High speed motor, launch assist, linear motor design, linear propulsion, power system simulation

PP07202 Linear Motor Propulsion for Urban Transit

Kurt Vollenwyder

Bombardier Transportation Mass Transit, North America Kingston, Canada

Modern urban transit systems must provide a high level of service with short headways. The design of the route alignment must be flexible and permit steep grades to reduce system cost. Reliable precision stopping at stations under all weather conditions is essential. Linear Induction Motor (LIM) propulsion ideally meets the operating requirements, providing adhesion-independent transmission of acceleration and brake forces. The topology used is a short vehicle mounted primary and a long track mounted secondary. The effects of the LIM topology must be considered in order to design a viable transit system. Issues are the air gap, changes in reaction rail configuration, the vertical forces and the operation as a direct drive. Two generations of LIM propulsion have been developed and are described in this paper. LIM propulsion has been successfully deployed in five advanced transit systems.

Keywords: Adhesion, Advanced Rapid Transit, Linear Induction Motor, LIM Propulsion, Transit System.

PP07301 Control of a 2.4MW Linear Synchronous Motor for Launching Roller-Coasters

A. Veltman, P. van der Hulst, M.C.P. Jonker, J.P. van Gur

Eindhoven Univertsity of Technology, Eindhoven, the Netherlands; Piak Electronic Design b.v., Culemborg, the Netherlands; GTI Electroproject b.v., Zaandam, the Netherlands.

To accelerate a heavy roller-coaster train to a speed of 25m/s in less than 3 seconds requires a lot of thrust. A 2.4MW Linear Synchronous Motor is applied for this function. Optimal thrust implies optimal current control. Because of the increasing velocity along the track, the stator configuration changes continuously during a launch (sequentially switched stator). A strategy to control 3kA of current during abrupt changes in stator inductance, while maintaining thrust, is presented

Keywords: LSM, current control, sensor-less control, switched stators.

PP07302 Electrical Performance of Two Different Types of Permanent Magnet Linear Synchronous Machines with Vector Control

G. Martínez, J. Atencia, A. García Rico, J. Flórez

Escuela Superior de Ingenieros (TECNUN, Universidad de Navarra), Sebastián, Spain

There is a dilemma about employing or not employing iron in the primary core of synchronous linear actuators. To give some guidance about the convenience of using iron or ironless primary cores, two prototypes of Permanent Magnet Linear Machines (PMLSM) geometrically identical were built. The prototypes were tested in order to get reliable comparative conclusions.

The purpose of this paper is to analyze the performance of two different topologies of linear synchronous machines, using vector control techniques. Several tests were performed to determine the electromagnetic properties and the static forces of the prototypes involved. The paper concludes with a discussion of their performances and dynamics, and their suitability for different applications

Keywords: Linear Electric Drives, Linear Electric Machines, Permanent Magnet Linear Machines, Field Oriented Control.

LECTURE SESSION 4A - TOPICS 1, 2 - 10.20

Chairmen: R. F. Post, Lawrence Livermore Laboratory, Livermore, USA

P. Keller, Swiss Federal Institute of Technology, Zurich, Switzerland

PP01401 Technical And Economical Aspects Of The Transrapid Compared To Traditional HSR Systems

K. Köncke

Siemens AG Transportation Systems, Berlin, Germany

This synopses describes the technical and economical aspects of the Transrapid technology compared to the traditional HSR (High Speed Rail) systems. The approach of the outstanding Transrapid techno logy in terms of the main requirements like flexibility, efficiency, high performance and safety will be outlined in the following paper.

PP01402 Paths of Increase of Efficiency MAGLEV-Transport with the Purpose Acceleration of Implementation

Mark Umanov, Arkadij Lasher, A. Taturevich

State Technical University of Railway Transport, Dnipropetrovs'k, Ukraine

In the present moment development of MAGLEV-transport are leads up to operational use. In this connection most important problem is the definition area of effective application MAGLEV-transport systems. One of perspective directions of application MAGLEV-transport is the combined main and regional communication. The increase of large cities and agglomeration, volume of pendulous transportations, air contamination, and also overload of an existing transport system, requires considerable of changes, where MAGLEV-transport can become the important link in implementation of regional transportations. The definition of the favorable operation conditions and optimum engineering solution MAGLEV-transport systems, at which their application will be effective, is a main problem of this work.

Keywords: Electrodynamics suspension, high-speed surface transport, MAGLEV-transport, MAGLEV-transport systems, main and regional communication.

PP01404 High Speed Transport and Climate Change - a New Challenge

Walter Ernst, Renat Heuberger, Michael Jenny, Dieter Imboden

Department of Environmental Sciences ETH Zürich and University of Applied Science Bern, Switzerland

Air traffic has become the fastest growing segment of transport. Since 1950 use of commercial aviation has grown more than seventy-fold. Prospective analyses indicate that this trend is likely to continue. According to a special report on aviation by the IPCC [IPCC, 1999] in 1992 the related emissions accounted for only about 3.5% of the total climate impact of all anthropogenic emissions. However, in 2020 Swiss international air traffic's share on total anthropogenic green house gas (GHG) emissions up to a third of the total Swiss anthropogenic GHG emissions. The terrorist attacks in 2001 make an adjustment of the existing growth scenarios necessary. Starting with a sharp decline in 2001, air traffic will recover and may even grow stronger than originally predicted to finally achieve an average yearly growth of 3,5% between 2001 and 2005. The results presented in this paper indicate that the expected growth of air traffic may to a great extend offset the positive impacts of the Swiss climate protection scheme (CO2-bill).

Keywords: High speed transport, Air Traffic, CO_2- Emissions, Greenhous Gases - Emissions, Forecast, Climate Change

PP02101 Dual Mode, The AVT and MAGLEV

Frank Randak

AVT-TRAIN.COM, Inc 8 Fallen Oaks Drive, Thousand Oaks CA 91360 USA

Traffic and energy problems are worldwide. Dual Mode (DM) systems transport vehicles with their passengers automatically, quickly, safely and more efficiently than highways. The Advanced Vehicle Transport (AVT) eliminates the inherent disadvantages of typical DM designs by combining the best features of DM and high-speed MAGLEV trains. The AVT design minimizes the cost objection to MAGLEV because the AVT Train transports vehicles, passengers and freight continuously, without stopping, producing a very popular, efficient, high capacity and profitable operation. Continuous operation is accomplished by loading and unloading moving AVT Trains with AVT Shuttles that travel on a parallel track. Shuttles pickup parked

vehicles at stations, merge with a passing Train, then dock with the Train and then transfer the vehicle onto the train. Unloading vehicles is accomplished by running the operation in reverse.

Keywords: Continuous, Trains, Vehicles, Shuttles, Docking.

PP02103 A Basic Developmental Scenario For The MAGLEV Highway – MAGLEV Highway as the Future of Transport

MINAKAMI Motoyuki, M. McDonald

National Institute for Land & Infrastructure Management, Asahi, Japan; University of Southampton, United Kingdom

A MAGLEV system, in which cars sit on magnetically levitated pallets, could potentially produce substantial benefits compared to conventional car travel, particularly on long distance routes. This paper describes basic developmental scenarios applied to the future of high-speed ground transportation.

Keywords: Scenario, Hypermodal, Intermodal, Highway Mode, Pallet.

LECTURE SESSION 5A - TOPIC 2 - 13.40

Chairmen: M. Witt, Dornier Consult, Friedrichshafen, Germany
M. Fujino, Chubu HSST Development, Nagoya, Japan

PP02106 MAGLEV System Maintenance Strategy

Edmund Haindl, Klaus Wegerer, Chunguang Xu

ThyssenKrupp Transrapid GmbH, Munich, Germany

According to wear- and tearless operation of MAGLEV, realized by mechatronic means, an appropriate maintenance strategy will be presented. A systematic methodology is described for identification of maintenance activities and prognosis of respective amount of labor, tools and spare parts. A description of MAGLEV maintenance equipment and measures is given, which is based on experience with maintenance practice of the pre-series vehicle TR08.

Keywords: Diagnostic, Maintenance, Transrapid, Vehicle.

PP02108 New Development in Transrapid Vehicle Technology

Luitpold Miller, Friedrich Löser

ThyssenKrupp Transrapid GmbH, Munich, Germany

Due to the favorable characteristics application projects for shorter routes with operating speeds of 100 to 300 km/h gained momentum. These new fields of application require an adaptation of the vehicle technology. The solution is a family of vehicles, consisting of standardized modules. This paper includes a description of the system architecture as well as the concept of subsystems. The conclusion will concentrate on the various vehicle configurations for different field application.

Keywords: Application, Electromagnetic Levitation System, Investments, Maintenance, Transrapid.

PP02111 AMLEV: a New Alternative of MAGLEV

Oleg V. Tozoni

AMLEVtrans, Rockville, USA

Herein is provided a brief description of AMLEV's design and the operating principles of its self-regulating magneto-dynamic suspension and permanent magnet propulsion motor. The feasibility of self-regulation of both the magnetic suspension and the propulsion motor is proven, thus making it possible to utilize the properties and peculiarities of mechanical, magnetic and electro-dynamic processes to ensure their interaction so as to achieve self-regulation of vehicle flight.

Keywords: Linear propulsion motor, permanent magnet, self-regulation, magneto-dynamic suspension, stabilizing force.

PP02112 Swissmetro : An Engineering View to the Systems

Bourquin V., Dériaz D., Macabrey N., Weatherill A, Steybe H.

Swiss Federal Institute of Technology, Lausanne, Switzerland; Geste Engineering SA, Lausanne, Switzerland; Bonnard&Gardel Lausanne, Switzerland; Busch AG, Magden, Switzerland

This article presents a general overview of the systems engineering related to the Swissmetro project. Since 1988 more than 200 companies, laboratories and experts have contributed to the engineering of the project. The main in terms of technologies are reviewed with a focus choices on the vacuum system and the way vacuum influences the station and the vehicle design. The complexity and the magnitude of the interactions between all the components of the project have lead to the emergence of original solutions based on

the evolution of well-known particular technologies in the context of a vacuum environment.

Keywords: Swissmetro, Vacuum, Vehicle, Stations, Mechanical systems.

PP02201 Management and Decision-Making in Projects with Strong Technological Rupture - Case of High Speed Ground Transportation Systems

Guillaume de Tilière, Vincent Bourquin

Swiss Federal Institute Of Technology, Lausanne, Switzerland

MAGLEV technologies are at an historical turn, with the first commercial implementation of the Transrapid in China. This article examines what are the causes of market barriers encountered by such disruptive technologies and what are the future challenges. It underlines that behind technological rupture the real challenge stands in the management of systemic networks between manufacturers and operators.

Keywords: High-speed Transportation system, Innovation, Public - private partnership.

PP02203 Auto-Shuttle Feasibility, Financial and Environmental Analysis

Andreas Steingröver, Rasmus Krevet

Nettlingskamp 20, D-38120 Braunschweig, Germany; Bammelsburger Str. 2, D-38114 Braunschweig, Germany

The proposed transport system Auto-Shuttle integrates road and track guided traffic using and combining the specific advantages of each of these traffic modes. Conventional road vehicles are transported with their passengers and freight in individual cabins. The operational concept provides operation of the cabins without intermediate stops at almost constant traveling speed. During the journey convoys with low aerodynamic drag are formed in order to lower the energy consumption and increase traffic capacity. Approaching a station only those cabins that have reached their destination leave the convoy on a passive switch and decelerate on a brake track, while the other cabins close the gap in the convoy and travel on at the usual cruising speed. This paper describes the planning and economical aspects of a proposed commercial line along the motorway A3 in Germany between the cities of Duisburg and Cologne.

Keywords: Passive switch, motorway.

LECTURE SESSION 6A - TOPICS 2, 10 - 16.20

Chairmen: H. Bleuler, Swiss Federal Institute of Technology, Lausanne, Switzerland

J. Sandtner, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP02205 High Speed Systems and External Rate of Return Appraisal: the Case of Swissmetro and the Basle-Zurich Connection, Milestones for a Blueprint

Pierre ROSSEL

Swiss Federal Institute of Technology, Lausanne, Switzerland

PP10101 Electrodynamic Passive Magnetic Bearing Using Reluctance Forces

Jan Sandtner, Hannes Bleuler

Swiss Federal Institute of Technology, Lausanne, Switzerland

Electrodynamic passive magnetic bearings with Halbach arrays and air coils produce only moderate Lorentz restoring forces. These bearings are especially conceived for high speed applications. In order to obtain weaker drag forces and properly directed restoring forces additional inductances in series with the stationary coils are required. These inductances comprise ferromagnetic cores, which are located outside the bearing magnetic field. Therefore no radial instability occurs. In the here presented bearing version, instead of Lorentz forces, much stronger reluctance forces are used, but the laminated ferromagnetic core has to be located inside the bearing magnetic field. This introduces a very strong radial instability. Therefore, the instability has to be compensated by permanent magnet rings, usually in a repulsive mode. The axial stability is achieved by axially splitting the Halbach array. Bearings using reluctance forces operate even for relatively low speeds without the necessity for additional inductances.

Keywords: Halbach array, Inductrack, null-flux, passive magnetic bearings, reluctance force.

PP10102 Optimization of Two-Dimensional Permanent Magnet Arrays for Diamagnetic Levitation

Roland Moser, François Barrot, Hannes Bleuler

Swiss Federal Institute of Technology, Lausanne, Switzerland

This paper presents new results in the field of passive diamagnetic levitation of macroscopic objects. Two dimensional permanent magnet arrays have been analyzed and optimized in order to obtain high thrust force and stiffness for fully passive magnetic levitation at room temperature in all 6 degrees of freedom. Experimental results with strongly diamagnetic materials like pyrolytic graphite indicate that diamagnetic levitation can be an interesting alternative to active magnetic bearings. Possible applications are pointed out and functional experimental prototypes are presented.

Keywords: Contact-less levitation, Diamagnetism, Magnetic bearings, Permanent magnets, Pyrolytic graphite.

PP10203 Magnetic Levitation and Rotation of Sub-Millimetric Spherical Rotors

A. Boletis, L. Sache, H. Bleuler, S. Menot

Swiss Federal Institute of Technology, Lausanne, Switzerland

To achieve high spinning speed, spherical rotors with less than 1 mm diameter have been levitated. A small device (50 [mm] x 50 [mm]), with a magnetic actuator that controls one degree of freedom of the rotor, an optical sensing system, and a two-phase induction motor has been designed and realized to perform levitation and rotation of small spherical rotors. In order to achieve a high spinning speed, spherical rotors with less than 1 mm diameter have been levitated.

Keywords: High-speed rotation, small spherical rotors.

PP10301 Stability Suspension And Dynamics of The Rotor With Super Conducting Magnetic Bearing

Slavko Gennadiy

Kremenchug State Polytechnic University, Kremenchug, Poltava reg., Ukraine,

We investigate the dynamics of electromechanical systems of magnetic levitation based on the effect of magnetic potential well. Rotor with contactless magnetic bearings has six degrees of freedom. We have worked out mathematical models, obtained regions of rotor

equilibrium stability, investigated the dynamics, offered methods of improving suspension stiffness. New opportunities for the creation of magnetic bearings are revealed by the superconductive effect of the uncontrolled stable levitation called "magnetic potential well" (MPW).

Keywords: Stability Dynamic Magnetic Bearing Levitation.

LECTURE SESSION 4B - TOPIC 5 - 10.20

Chairmen: M. Badoux, Swiss Federal Institute of Technology, Lausanne, Switzerland

V. Bourquin, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP05102 MAGLEV Vehicle Design for Permanent Magnet Levitation Electro-Dynamic Suspension (EDS) System

Karoly Kehrer, Volus McKenna, Wesley Shumaker

Hall Industries, Inc., Pittsburgh, USA

Specific aspects of MAGLEV vehicle technology development for urban alignment are discussed. The design approach conforms to permanent magnet Halbach array levitation, guidance, and Linear Synchronous Motor (LSM) propulsion for electronically coupled consists, while meeting the requirements of urban transit. Non-dynamic service and emergency braking is performed via a half-caliper design that obtains braking force by magnetic attraction to a steel plate, thus making the braking force independent of vehicle weight. The optimal vehicle is designed for mass production, as part of a noiseless and relatively unobtrusive mass transportation system that is made possible by the selected technologies.

Keywords: Braking, Coupling, MAGLEV, Modular, Vehicle.

PP05103 New Development of Mild Steel with Improved Magnetic Properties at Low Field

Philippe Harlet, Peggy Schouller, P. Cantinieaux, Nathalie Petit

Cockerill Sambre Usinor, Arcelor Innovation, Belgium

From all the magnetic materials, iron or extra mild steel still stay the one of the most popular cause of his excellent compromise between magnetic and mechanical properties associated with low cost prices. Cockerill Sambre Arcelor has been for a long time a specialist of magnetic steel presenting very high magnetic permeability at low field coupled with very low coercitivity and high saturation induction. These steels previously developed by cold rolling and annealing up to 1,5 mm thickness, are now available from a new thermo-mechanical hot rolling process up to 10 mm. This paper gives a summary of the manufacturing process and improvements implemented as well as an

overview of the difficulties encountered during this production. Preliminary statistics obtained for the mechanical and magnetic steel properties are presented. The low-carbon steel sheet is used to manufacture yoke laminations which provide the return path for the magnetic flux and concurring to the mechanical rigidity of the LHC dipole and quadra-pole structure in the new CERN accelerator in Geneva. More over, some new applications begin to be developed for shielding effect of this steel in term of protection from the magnetic field in some industrial activities.

Keywords: Silicon free magnetic steel; Core loss Shielding; Accelerator magnets; Permeability at low field; Hot rolled steel sheet

PP05104 Overview of New Vehicles for the Yamanashi MAGLEV Test Line

Noriyuki Shirakuni, Yasukazu Endo, Kiyoshi Takahashi, Katsuya Yamamoto

Central Japan Railway Co., Ltd Railway Technical Research Institute, Tokyo, Japan

On the Yamanashi MAGLEV Test Line, five years have passed since the start of vehicle running tests in April 1997. During this period, the MLX01 train attained two world records: a single train traveling at a speed of 552 km/h, and two trains passing each other at a relative speed of 1,003 km/h. The cumulative distance covered by the trains reached 210,000 km, and the number of passengers who rode the trains in test rides exceeded 30,000 persons. Vehicle running tests for reliability and durability have been performed, and two new vehicles have been designed and constructed, with attention to reduction of total cost and improvement of comfort and aerodynamics. This paper provides an overview of these new vehicles that are scheduled to begin running on the Yamanashi MAGLEV Test Line in the summer of 2002

Keywords: MAGLEV vehicle, Yamanashi MAGLEV Test Line, superconducting magnet, magnetic levitation, aerodynamics.

PP05105 Durability Verification of the Practical Ground Coil for Propulsion

Masao Suzuki, Tsuyoshi Fujimoto, Hiromori Ishihara

Railway Technical Research Institute, Tokyo, Japan; Japan Central Japan Railway Company, Tokyo, Japan

A huge number of ground coils will be required for outdoor use over an extended period of time. The verification of the durability of coils on the assumption of actual service conditions is really important in securing the total reliability of the Magnetically Levitated transportation (MAGLEV) system. We examined the durability using the improved single layer coil for propulsion, which were laid on a part of the Yamanashi Test Line. The durability under the specified performance was confirmed for a simulated 30-year service. As a result, we could confirm the normality of the electric insulation functions and found no mechanical damages such as cracking on the molded resin.

Keywords: MAGLEV, Ground Coil, Durability, Accelerative Deterioration.

PP05106 The Development of the New-Type Guideway in the Yamanashi Test Line

Satoru KATO, Takaaki NAGAOSA, Masaaki MIYAMOTO

Central Japan Railway Company, Japan; Railway Technical Research Institute, Tokyo, Japan

On March 9 2000, the MAGLEV Technological Practicality Evaluation Committee accepted that the superconducting MAGLEV technology has the practicality for ultra-high speed mass transportation system. In this paper, the development of the new-type guideway will be presented. Its purpose is cost reduction, which is one of the subjects for the further development

Keywords: MAGLEV, new-type guideway, cost reduction.

LECTURE SESSION 5B - TOPIC 5 - 13.40

Chairmen: M. Badoux, Swiss Federal Institute of Technology, Lausanne, Switzerland

M. Mantilleri, Geste Engineering SA, Lausanne, Switzerland

PP05107 Experimental Research for the Liners of the SWISSMETRO Tunnels

M. Badoux

Swiss Federal Institute of Technology, Lausanne, Switzerland

Swissmetro is an innovative concept for a very high-speed underground passenger transportation system. One of its features is that the small diameter tunnels are under permanent partial vacuum. This paper presents the results of an experimental research program conducted on the behavior of concrete liners subjected to service conditions of Swissmetro tunnels. In one series of tests air flow was measured through cracked concrete subjected to a differential of air pressure. In a second series of tests, concrete elements were subjected to a large number of cycles of pressure variations under partial vacuum conditions to investigate possible degradation of the concrete surface properties.

Keywords: Swissmetro tunnels; concrete liners; partial vacuum; pressure variations; surface degradation.

PP05108 SWISSMETRO - Air Permeability of Cracked Concrete Plates

M. Badoux

Swiss Federal Institute of Technology, Lausanne, Switzerland

The object of this paper is the prediction of the air flow through a cracked concrete wall element. Experimental data from permeability tests on large cracked reinforced concrete plates is used. The variation of the flow with the crack opening is investigated. A new empirical expression is developed for the calculation of the friction coefficient for the flow of air through a concrete crack. It is based on the general formulation of a turbulent or laminar flow of a gas between two parallel surfaces. It is a function of the crack width and of the maximum aggregate size of the concrete aggregate.

Keywords: Air flow; crack; friction coefficient; permeability; reinforced concrete.

PP05109 Geological Aspects of Swissmetro, a Long Distance High Speed Transport System

David Estoppey, Björn Oddsson, C. Shindler, Dr Streiff

Dr. Streiff AG, Rapperswil, Switzerland

The high-capacity passenger subway Swissmetro shall connect all major cities in the northern Alpine foreland of Switzerland. In addition, the neighboring traffic systems in the European countries shall be included in the Swissmetro concept. In this project, geological, hydro-geological and geo-technical studies have been

conducted under particular consideration of technical and civil engineering related conditions and parameters. Some critical geological issues addressed in the study are presented in this paper. The results of the study show that, from a geological and geo-technical point of view, the feasibility of the Swissmetro project is favorable.

Keywords: Civil engineering, Engineering Geology, Geotechnics, Swissmetro, Tunneling.

PP05202 Swissmetro: Aerodynamic Drag and Wave Effects in Tunnels under Partial Vacuum

Michele Mossi, Stefano Sibilla

GESTE Engineering SA, Lausanne, Switzerland; Università di Pavia, Pavia, Italy

The maximum allowed train velocity for given vehicle and tunnel cross-section areas is limited by aerodynamic effects. These effects influence the train power requirement, the traction energy costs, the pressure wave amplitude and, in a second time, the temperature evolution into the tunnel. The knowledge of the unsteady aerodynamic field around the train is therefore essential to the optimum choice of a tunnel configuration, and mainly of the cross-section diameter and of the presence and position of pressure relief ducts. In this paper, the aerodynamic field generated by a high-speed train traveling under partial vacuum through the Basle-Zurich Swissmetro tunnel are analyzed by means of quasi one-dimensional numerical simulations of the induced air flow and thus of the computational domain. Several tunnel configurations at high blockage ratio are discussed, together with the positive and negative effects of pressure relief ducts and of partial air vacuum. Results suggest that configurations consisting of twin tunnels connected by pressure relief ducts near the end stations should be preferred.

Keywords: Aerodynamics, drag, partial vacuum, pressure wave, Swissmetro.

PP05203 Overview of the Aerodynamic Issues Associated with New Ground Transport Systems

Bourquin V., Monkewitz P.A., Grégoire R.

Swiss Federal Institute of Technology, Lausanne, Switzerland

New ground transport systems are being designed in many countries around the world. The safety, the saturation and the environmental

problems associated with the existing systems based on fossil energy (namely cars and planes) is a sound motivation to develop more sustainable transport system. Aerodynamics plays a key role in the sustainability of these new transportation means. After the presentation of a general scope of the categories of transport systems, the experimental facilities of the Laboratory of fluid mechanics of EPFL are described and measurements of the unsteady skin friction behind a week shock wave are presented.

Keywords: Aerodynamics, sustainability, sonic boom, pressure wave propagation.

LECTURE SESSION 6B - TOPIC 5 - 16.20

Chairmen: M. Mossi, Geste Engineering SA, Lausanne, Switzerland

V. Bourquin, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP05302 Ride Dynamics of General Atomics' Urban MAGLEV

David W. Doll, Robert D. Blevins, Dilip Bhadra

General Atomics, San Diego, USA

The dynamics and ride quality of a new concept in Urban MAGLEV design has been analyzed. The vehicles utilize permanent magnets (PM) arranged in Halbach arrays for levitation and a linear synchronous motor (LSM) for propulsion. The vehicle was modeled in one-dimension with two degrees-of-freedom (dof) using linear theory. Next, the vehicle was modeled in six dof with MSC/NASTRAN Motion, with the force input into the vehicle programmed to emulate magnetic coupling with the guideway in levitation, drag and propulsion. A control algorithm was incorporated into the propulsion that simulated damping by adjusting the velocity in a feedback loop. All six dof interacted dynamically. The results showed that the vertical accelerations could meet the 8-hour comfort limit set by the International Organization for Standardization (ISO) and that the vehicle could be operated without creating instabilities in any of the six degrees of freedom. Comparison of analytical results with test data awaits construction of a full-scale test track.

Keywords: EDS, MAGLEV, Urban MAGLEV, LSM, PM.

PP05303 Semi-active Suspension System for the Yamanashi MAGLEV Vehicles

Hideyuki TAKIZAWA, Hironori HOSHINO, Hajime TAKAMI, Ken WATANABE, Kimiaki SASAKI, Yasushi KARINO

Railway Technical Research Institute, Tokyo, Japan; Yamanashi MAGLEV Test Center, Yamanashi, Japan

In order to improve the ride comfort of the Yamanashi MAGLEV vehicles, a semi-active suspension system to control lateral vibrations of the vehicle (lateral control) was designed. In 1999, adjustable damping force dampers (adjustable dampers), accelerometers of the car body that can function properly in magnetic fields, and semi-active controller for the MAGLEV vehicle were developed. Vehicle-running tests on the Yamanashi MAGLEV Test Line confirmed an improvement of 3 dB in the lateral ride comfort. Although an improvement in the lateral ride comfort was detected by human perception, the vertical vibrations were perceived to be strong. In 2001, work commenced on the development of a semi-active suspension system to control vertical vibrations (vertical control). Characteristics of this vertical control are being confirmed in vehicle-running tests. An improvement of 2 dB was confirmed so far. This paper describes an overview of the application of the semi-active suspension system on the vehicles of the Yamanashi MAGLEV Test Line, and the results of vehicle-running tests.

Keywords: Adjustable damper, MAGLEV, ride comfort, semi-active suspension, Yamanashi MAGLEV Test Line.

PP05305 Stable Suspension of the Bodies in Dynamic Potential Wells.

Gorsky O., Dzenzersky V., Zeldina E.

Transmag Research Institute, Dniepropetrovsk, Ukraine

Dynamic potential wells have been proposed in ninetieth. The main peculiarity of the dynamics revealed is next: stable suspension of bodies but weak dependencies on geometrical parameters. Counter flux short-circuit contours used as electro-dynamical counterpart in creation of dynamic potential well do increase the sensibility of suspension of bodies to the geometrical parameters. The main features of the dynamics in such a system are extracted in the present work.

PP05306 Analysis of Dynamics and Stability of a High-Speed Vehicle with Electrodynamics Levitation and Guidance

V.A. Dzenzersky, N.M. Khatchapuridze, N.A. Radchenko, A.A. Zevin

Academy of Sciences of Ukraine, Dniepropetrovsk, Ukraine

Some methods and numerical results on dynamics and stability of a MAGLEV vehicle with discrete track structure obtained in the Institute of transport systems and technology of the National Academy of Sciences of Ukraine are discussed.

PP05309 Route Alignment and Riding Quality Considerations of Guideways for the MAGLEV TRANSRAPID

Gerd Jansen, Andreas Trunk, Hans-Jürgen Marx

Ingenieur- und Vermessungsbüro, Oberhausen, Germany

LECTURE SESSION 7A - TOPIC 3 - 10.20

Chairmen: T. Eastham, University of Science and Technology
G. Coquery, INRETS, Arcueil, France

PP03101 General Atomics Urban Maglev Technology Development

In-Kum Kim, Robert Kratz, David Doll

General Atomics, San Diego, USA; Lawrence Livermore National Laboratory, Livermore, USA

Key technical aspects of the U.S. Urban Maglev project are reported. The selected technology is based on the principle of electro-dynamic suspension (EDS) for levitation and a linear synchronous motor (LSM) for propulsion. High field permanent magnets (PM) arranged into Halbach arrays are used on the vehicle for levitation, guidance and propulsion. The U.S. Urban Maglev project is a Federal Transit Administration (FTA) sponsored program directed toward development of Maglev technology for urban mass transportation in the United States.

Keywords: Maglev, Urban Maglev, permanent magnet (PM)

PP03104 Evaluation Method Of MAGLEV For Introducing Urban Transport In Japan

Takeshi MIZUMA, Yasuhiro SATO

National Traffic Safety and Environment Laboratory, Tokyo, JAPAN

MAGLEV has many merits in introducing urban transport in Japan, for examples, low noise, comfortable riding, high performances of acceleration and etc. However, in comparison with other conventional urban transports, it is difficult to clarify and determine merits quantitatively because there are many competitive items. Therefore, in this paper, we express simulation and evaluation method for comparing with several urban transportation systems through calculating running data and evaluation items. Through this method, we can extract merits of MAGLEV quantitatively for introducing in Japan.

Keywords: Urban MAGLEV, evaluation method, simulation.

PP03105 Air Suspended And LIM Propulsion Transit System And Next Generation PRT

Ryo SHINDOH, Takeshi MIZUMA, Atsushi DEGUCHI, Manabu SUGANUMA

Nippon Otis Elevator Compan3, Japan; Japan National Traffic Safety and Environment Laboratory, Tokyo, Japan

Through this method, we can extract merits of MAGLEV quantitatively for introducing in Japan. In 2000, after the practicability evaluation with minute examinations, the system was approved to be suitable for use as a public transportation system. This paper describes its characteristic technologies and its evaluation test result which had been discussed by the committee. And at present, one new plan is prepared for putting an advanced LIM Shuttle called "Next Generation PRT" into practical use as a new public transportation system for the next future.

Keywords: Air pad, air suspension, linear induction motor (LIM).

PP03106 Booster concepts for increase of traction effort

Th. Werle, M. Hofmann, A. Binder

Darmstadt University of Technology, Darmstadt, Germany

For modern locomotives with high mechanical power it is difficult to get the traction force onto the rail in case of bad weather conditions. With additional linear drives or with DC magnets mounted beneath the bogie of the locomotives it is possible to increase the traction effort. Different types of these booster concepts are compared.

Keywords: AC- and DC-linear drives, Booster concepts, Increase of traction effort, 3D numerical calculation.

PP03108 A new Elevator System and its Implementation

Thomas Dünser-Romeo Delplazes

Swiss Federal Institute of Technology, Zurich, Switzerland; Schindler AG, Ebikon, Switzerland

To reduce the need of space of an elevator system in high-rise buildings and such with a high volume of traffic, a completely new elevator system must be developed. As a revolutionary idea, the new system lets move several cabins at the same time in one shaft, switching to another shaft if the route is blocked. Combined with the possibility to use smaller cabins by taxi rides, a major improvement of

the main aspects of an elevator system can be expected. Herein, managing the additional degrees of freedom compared with today's system will be a key issue. This study's goal is to analyze the effect of the most important elements of an elevator shaft layout on the traffic volume regarding the technical implementation.

Keywords: Economy of Space Shaft layout components Traffic performance.

LECTURE SESSION 8A - TOPICS 3, 8 - 13.40

Chairmen: A. Rufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

K. Vollenwyder, Bombardier Transportation, Kingston, Canada

PP03201 The Aesthetics of Superlight Design

Christian Harbeke, Gregor Huhn

NOSE Applied Intelligence, Zurich, Switzerland; Deutsche Bahn AG, Germany

The interior design of a magnetic levitation train has to meet exceptional technical requirements. On the other hand, it has to provide a fascinating and satisfying passenger experience. The development of two very different solutions will be explained: the interiors of the Transrapid TR08 as an example for a long distance application and the interior concepts for the Airport Express Munich and the Metrorapid in Nordrhein-Westfalen as an example for a more metropolitan solution.

Keywords: Aesthetic, Industrial Design, Interior Design, Metrorapid, Transrapid TR08.

PP03301 The Correction Of The Functional State Of Crews Of Magnitolevitative Vehicles

V.A. Dzenzersky, S.V. Plaksin, J.N. Kulikovich, I.I. Sokolovsky

Ukrainian National Academy of Science, Dnepropetrovsk, Ukraine

The complex of physio-corrective and physiotherapeutic measures including effect on an organism of the person individually fitted low-intensity (of a sub-thermal level) by electromagnetic fields of range extremely of high frequencies (30-300 GHz) and variable magnetic fields of special vector - frequency (polarization) frame, taking into

account a spatial pattern of own electromagnetic fields of the person, geomagnetic and electromagnetic fields of space is submitted. It is demonstrated, that it is possible to consider actuation of low-intensity electromagnetic fields in an arsenal of means on correction of a physiological state of the crew personal.

Keywords: Magnitolevitative transportation facilities (MTF), crew, traffic safety, cosmic physical fields, variable magnetic fields.

PP08101 Improved Magnetic Modeling of EMS MAGLEV LEVITATORS

Castelli Dezza Francesco, Di Gerlando Antonino, Foglia Gianmaria

Politecnico di Milano, Milano, Italy

The paper presents an improved model of the magnetic circuit of two kinds of EMS MAGLEV levitators (one with coils only and the other one of the hybrid kind, with coils and permanent magnets): this model allows to obtain sensible enhancements both in evaluating the operating quantities, and in the levitation control. The introduced improvements concern the evaluation of the air-gap quantities (fluxes and forces) and the estimation of the leakage parameters (coil and permanent magnet leakage fluxes):

- the evaluation of the air-gap quantities is performed by means of mathematical expressions, deduced by the analytical investigation of the fields (method of the conformal transformations, in particular the Schwartz and Christoffel transformation); the results of these mathematical expressions have been validated by FEM analyses;
- the evaluation of the leakage parameters is operated on the basis of the actual field distribution, obtained by FEM analyses.

The obtained improvements are shown:

- by evaluating fluxes and forces in different operating conditions, and comparing these values with the results obtained by the classical modeling;
- by showing some levitation tests measurements, discussing the enhancements obtained by the use of the improved modeling.

Keywords: EMS MAGLEV, magnetic circuit modeling.

PP08102 Design of Scaled Prototypes of EMS MAGLEV LEVITATORS, Based on an Improved Magnetic Modeling

Castelli Dezza Francesco, Di Gerlando Antonino, Foglia Gianmaria

Politecnico di Milano, Milano, Italy

This paper describes the design steps of two types of MAGLEV levitators, the first equipped with coils only and the other hybrid (coils + permanent magnets); the design has two features:

- the studied levitator is conceived in electromagnetic similitude with a real one;
- the design is based on an improved modeling of the quantities concerning the air-gap.

After the analysis of the criteria used for the similitude, the paper shows the design of the two levitator types.

Keywords: EMS MAGLEV, EMS MAGLEV design.

PP08103 Fuzzy Control Of A magnetic Levitation System For a Linear Drive And Comparison With a State Control

J. Van Goethem, F. Weber, G. Henneberger

Aachen Institute of Technology, Aachen, Germany

In this paper a fuzzy levitation controller for a one degree of freedom MAGLEV application is designed and its performance is compared with the performance of a state controller. The comparison is based on both simulation and measurement results. The MAGLEV application is a levitation/propulsion head of an autonomous transportation vehicle with a nominal air gap value of 2.5 mm. First a nonlinear model of the system is presented. After a short description of the state controller the design of the fuzzy controller is specified. Simulations with noisy signals indicate the noise sensitiveness of the fuzzy controller as a major drawback. Measurements acknowledge this fact. It is shown that for this application the state controller is a better choice because of its robust performance.

Keywords: Fuzzy Control, MAGLEV, State Control.

PP08104 Design of EMS-Magnetically Levitated System Based On Genetic Algorithm

Shinichi KUSAGAWA, Jumpei BABA, Katuhiko SHUTOH, Eisuke MASADA

Faculty of Science & Technology Science University of Tokyo, Japan

The primary objective of the electromagnetic suspension system is to provide stable suspension under all operating conditions. The actuator that provides the basic suspension force is an electromagnet; its design is influenced by the dynamic considerations (stability, riding comfort, etc), as well as static characteristics, e.g. power requirement and power loss in the magnet, weight of the magnet and the configuration of the magnet-guideway. In addition, the electromagnet should be capable of providing an adequate margin of safety without excessive increase in magnet weight/power input.

Then, in this paper, in order to achieve design optimization of the electromagnetic suspension sys-tem (EMS) for magnetically levitated vehicle on its dynamic performance and weight, a design scheme based on genetic algorithm is proposed. The optimum system parameters are searched by GA. Better coordination between component design and vehicle dynamics is obtained on the HSST-type system operating in the medium velocity around 200km/h.

Keywords: MAGLEV, EMS, Genetic Algorithm, static performance, dynamic performance

LECTURE SESSION 9A - TOPIC 8 - 16.20

Chairmen: H. Bleuler, Swiss Federal Institute of Technology, Lausanne, Switzerland

P. Barrade, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP08108 Magnetic Levitation Control of Thin Steel Plate with Reduced Number of Gap Sensors Using Real-Time Finite Element Vibration Analysis

Masanori Sase, Susumu Torii

Musashi Institute of Technology, Tokyo, Japan

Contact-less magnetic levitation system is required for the transportation of the thin steel plate. When the thin steel plate is

levitated by the plural electromagnets, there are interactions of supporting forces as the action points and the consideration of the dynamic vibration is therefore necessary. This paper proposes the magnetic levitation control of thin steel plates using the real-time finite element analysis of the vibration. This system aims at the stable levitation by presuming the vibration of the plate and observing the force of the electromagnet. At the time of the levitation control the thin steel plate by the plural electromagnets, it is necessary to combine the gap sensor and the electromagnet. The proposal system presumes the displacement of the other point. Therefore, this system can omit the gap sensor on other point.

Keywords: Magnetic levitation, thin steel plate, finite element method, vibration analysis, sensor-less control.

PP08109 The Magnetic Levitation System with Two Desired Values to Suppress the Elastic Vibration of the Thin Steel Sheets

Gen UCHIMIDO, Susumu TORII

Musashi Institute of Technology, Tokyo, Japan

High quality and high efficiently transfer of the manufacture process are required with thin steel sheets of the thickness 0.3-1.2mili-meters that is in demand the highest in the steel industry. The thin steel sheets should be transported without cracks on the surface and the unevenness of lubricating oil in the field of producing steel-ware. The non-contact transportation of thin steel sheets by magnetic levitation is one of the solutions. It is proposed in this paper that the levitation system with two desired values to prevent transverse waves from propagating along the plate. The system with two desired values can set up a differentiation gain highly, therefore, vibration can be controlled rather than the independent system. The system with two desired values can control progressive wave. These experiments prove the system with two desired values is more effective than the independent system.

Keywords: Thin steel sheets, PID-Control, vibration, simulation and experiment

PP08201 Improvement of the Damping Using the Active Damper Coils System in the Superconducting Magnetically Levitated Bogie

Shunsuke OHASHI

Kansai University, Osaka, Japan

Numerical simulation of the superconducting magnetically levitated bogie (JR MAGLEV) has been studied. This system, which is based on the side wall electrodynamic suspension (EDS), keeps the air-gap length at about 10 cm. Although the EDS system has the advantage of stable levitation without active control, the result of the numerical simulation shows that the damping factor of the levitation system is small. So the active damper coil system has been proposed. Copper coil is installed in front of the superconducting coil on the bogie as damper system. We have designed damper coils to increase the damping against vertical oscillation. Running simulation of the bogie considering the limitation of the power supply is undertaken. The active damper coil system decreases amplitude of the oscillation and damping factor becomes large, and its effect is confirmed by numerical analysis.

Keywords: Magnetic levitation, Electrodynamic suspension, Damping, Active damper, Numerical analysis

PP08202 Optimized design of 8-figure null-flux coils in EDS

MURAI Toshiaki, YOSHIOKA Hiroshi, IWAMATSU Masaru, SAWADA Kazuo

Railway Technical Research Institute, Tokyo, Japan

This paper describes the design of 8-figure null-flux coils to optimize not only the basic performance for levitation, guidance and propulsion but also the vibration of superconducting magnets. By using both optimization program and modal analysis, we reveal the relationship between the characteristics and the dimensions of 8-figure coils.

Keywords: Magnetic levitation, linear motor, optimization, superconducting magnet, modal analysis.

LECTURE SESSION 7B - TOPICS 4, 6 - 10.20

Chairmen: A. Rufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

D. Vernez, University of Lausanne, Switzerland

PP06101 Safety Evaluation and Assessment of Materials and Assembly Technologies for Vehicle TR08

Steinert Winfried - Keller Uwe

Institute for Software, Electronics, Railroad Technology (ISEB), Cologne, Germany

The different materials and assembling technologies used for the structure and claddings of carriage body and MAGLEV undercarriage of the TR08 will be presented. Sufficient dimensioning and verification of the mechanical structure elements will also be demonstrated, exemplified taking special consideration of the plastic, adhesive bonding, laser welding and blind joint techniques.

Keywords: Vehicle TR08, structure, assessment, tests.

PP06102 Swissmetro: Safety Aspects Related to the Low Pressure Environment

David Vernez

GESTE Engineering SA, Lausanne, Switzerland

Due to both the high travel speed and tunnel length planned in the future Swissmetro system, reducing aerodynamic constraints and excavation costs is of utmost importance. The solution chosen is to maintain a low pressure atmosphere in the tunnel. The low pressure, which will likely range between 10 kPa and 25 kPa, may be a source of health hazards for the passengers. The potential adverse effects may be direct, in case of an accidental decompression, or indirect in case of fire or vehicle stoppage inside the tunnel. A hazard analysis has been carried out during the Swissmetro Main Study in order to assess the effects of the low pressure. A review of the data available in other fields, such as aviation and diving medicine, as well as numeric simulation have been performed during this study. The results are briefly discussed in this paper.

Keywords: Hazard analysis, Low pressure, Fire, Confinement, Numeric simulations.

PP06201 Radiowave Informative - Control System For Magneto-levitation Vehicles With Electro-dynamic Suspension

V.A. Dzenzersky, I.I. Sokolovsky, S.V. Plaksin, L.M. Pogorelaya

Ukrainian National Academy of Science, Dnepropetrovsk, Ukraine

It is presented conception of the building of the radio wave informative-control system for magneto-levitation vehicles on the base of the use the electromagnetic waves of super-high-frequency (SHF) (mm-waves) range. The system includes marker-communicative magistral waveguide, established along active travel structure, having the apertures for the communication with SHF-generator, established on platform, ultra fast without contact auto-generative meters of the distance between platform, active travel structure and lateral directing. These meters solve the problem of the determination of the spatial position of the vehicle. The control system contains the auto generative meters of the magnetic field in backlash with an opportunity of transfer of the information on the radio channel as well as contains the device of an information handling and control of the active traveling structure excitation coils.

Keywords: Control radio wave system, magneto levitation, transport vehicle, spatial position, marker-communicative magistral wave guide, travel structure, meters of the distance.

PP04301 Novel Feeding System for MAGLEV Aiming at Cost Reduction

Hidenori SHIGEEDA, Hisao OHTSUKI

Central Japan Railway Company, Tokyo, Japan

We suggest replacement of the existing triplex feeding system for superconducting MAGLEV with a novel duplex system to reduce system costs. Two types of duplex feeding systems are under examination, each having a problem. This paper describes compositions and characteristics of each duplex feeding system.

Keywords: MAGLEV, linear synchronous motor (LSM), feeding system for MAGLEV.

PP04302 Propulsion System and Power Supply for TRANSRAPID Commercial Lines

Rolf Hellinger, Jürgen Nothhaft, Makus Engel

Siemens AG, Erlangen, Germany

The contract for implementing the world's first TRANSRAPID commercial line was signed in Shanghai on January 21, 2001. It is to link the new Pudong International Airport with the Long Yang Road Station on Metro line 2, situated in the Pudong financial centre, from 2003 on. A peak operating speed of 430 km/h is envisaged on this 30 km long line with 3 vehicles consisting of 6 sections each. The structure of the propulsion system including power supply developed for commercial lines - for which the Transportation Systems (TS) division of Siemens AG is responsible - is presented below. This structure fulfils the application requirements such as modular design, operation of several vehicles on one line, operation velocity and availability. In addition the derived design for the Shanghai MAGLEV Transportation Project (SMTP) is shown. A short overview of the project progress - as far as propulsion system and power supply are concerned - is given.

Keywords: Commercial Line, Propulsion System, Power Supply, Shanghai, TRANSRAPID.

LECTURE SESSION 8B – TOPICS 4, 9 - 13.40

Chairmen: A. Morini, University of Padova, Italy

M. Jufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP04303 Sensorless Control System of Superconducting MAGLEV

Shunsaku KOGA, Jun-ichi KITANO, Shikeo KAGA

Central Japan Railway Company, Tokyo, Japan; Railway Technical Research Institute, Tokyo, Japan

In this paper, we propose both driving and lateral sensorless control system using the Electromotive Force (EMF). The main purpose of these controls is reduction of the construction cost and running cost. With driving sensorless control, we can omit the cross-inductive radio system that we have to lay along the guideway accurately. The principal of the driving control system using the EMF and the

experimental results at the speed of 0km/h to 400km/h in the Yamanashi MAGLEV Test Line are reported in this paper. The new method of estimating the initial phase at the stopping point that can't be estimated from EMF is proposed too. With lateral sensorless control, we can reduce the running cost. Lateral control enhances the lateral guidance forces and the lateral dumping forces. Enhancing the lateral guidance forces allows the MAGLEV train to land stably at the low speed. With this effect we can reduce the running cost of the tier. Enhancing the lateral dumping forces improves the riding comfort. The concept of the lateral control with the deviation of both side EMF and the results of the running test are reported.

Keywords: Driving control, Electromotive Force (EMF), MAGLEV, Lateral control, Linear synchronous motor (LSM).

PP04304 The Effect Analysis of MAGLEV on the Voltage of Power System

Zhang Ruihua, Yan Luguang, Xu Shangang, Zuo Zhenyu

Chinese Academy of Sciences, Beijing, China.

As a special load in the power system, high-speed MAGLEV has an obvious impact on the power system. The effect of MAGLEV on the node voltage is studied and a new model is presented. Compared with traditional models, this model can be used to analyze the effect of MAGLEV on voltage more accurately. This paper will further the study about the MAGLEV impact on the power system.

Keywords: Active Power, Impact Load, MAGLEV, Power Supply System.

PP04401 Swissmetro: Energy Balance of the Basle-Zurich Link

Alain Cassat, Nicolas Macabrey, Vincent Bourquin

Swiss Federal Institute of Technology, Lausanne, Switzerland; GESTE Engineering SA, Lausanne, Switzerland

The idea behind Swissmetro is a public transportation system between the main cities of Switzerland, designed for a speed up to 500 [km/h] in two tubes (tunnels) under partial vacuum. Each 6 [min], a vehicle, carrying 200 passengers, would travel without contact to the infrastructure through an application of linear motor technology, magnetic levitation and guidance. The energy consumption of the system will be low, due to the reduced air resistance. This publication describes the electromechanical component consumption and more

particularly the energy balance applied to the Swissmetro Basle-Zurich link. The energy balance considers different parameters such as the vehicle length, the speed or travel time, the mechanical motor maximum power. Specific aspects such as: the motor distribution; the power supply; the energy of the stations and the vacuum pumps are parts of the evaluation.

Keywords: Aerodynamic drag force, energy balance levitation, guidance, propulsion, power supply, Swissmetro.

PP09101 Optimization of Inductive Energy Transmission Systems with an Extraordinarily Large Air Gap

Rudolf Mecke

Institut f. Automation u. Kommunikation Magdeburg, Barleben, Germany

Inductive energy transmission through a large air gap is becoming more and more attractive especially for automatic battery charging stations and for energy supply of inductively powered electric vehicles and other movable consumers. The paper investigates the influence of geometrical and electrical parameters on energy transmission through air gaps of several hundred millimeters. The investigations are carried out by means of magnetic flux simulation and measurements. The transferable electric power and the efficiency of magnetic assemblies with large air gaps can be considerably improved by using higher transmission frequencies in the range of several hundred kilohertz.

Keywords: Flux model, Magnetic devices, Power transmission, Systems engineering.

PP09201 High Speed MAGLEV Conveyor for Bulk Materials

E.G. Knolle

Knolle Magnetrans, South San Francisco, U.S.A.

In the U.S.A. today, consumer goods, especially foods, are transported on the average for about 2000 miles (3200 Km) before reaching end users. This is a ten-fold increase over what it was about 100 years ago. A similar change has occurred in the rest of the world, where likewise the population has moved from the country to the cities. This brought with it increased road and rail freight traffic and increased need for transportation fuels, which also need to come from increasingly more distant locations. However, much of the cost and energy used for long distance transportation, especially bulk materials, like crude oil, liquid

natural gas (LNG), coal and grain, can be greatly reduced by using MAGLEV freight conveyors, and it can thereby be made simpler, less intrusive, more direct and more consumer friendly. Here described is a lightweight, low cost, high capacity MAGLEV conveyor suitable for transporting 2,000,000 barrels/day of crude oil 1,500 miles (2,400 Km) from Kazakhstan to the nearest port, 100,000,000 tons/year of coal 800 miles (1,300 Km) from New Mexico to California power plants, 10,000,000 bushels/day.

Keywords: Conveyor, oil, LNG, LIM, MAGLEV.

PP09202 Development of a Distributed Type Linear Generator

Takamitsu YAMAMOTO, Hitoshi MATSUE, Shigehisa KUSADA, Hitoshi HASEGAWA, Takashi SANO, Tomoo SHIBA

Railway Technical Research Institute, Tokyo, Japan; Central Japan Railway, Co, Ltd., Tokyo, Japan; Hitachi, Co, Ltd., Japan Tokyo, Japan; Electric MFG, Co, Ltd., 3-8 Fukuura Kanazawaku Yokohamashi Kanagawa, Japan

The superconducting MAGLEV has a special feature that it has no contact with any ground object when it runs at high velocity. Therefore, we must develop a new auxiliary power system for MAGLEV, and have developed a distributed-type linear generator. This system has abilities not only to generate power but also to improve the ride comfort by generating damping force. We manufactured this system for the vehicle of Yamanashi Test Line. In this time, we introduce the construction of this generator, and the results of this system at the Yamanashi Test Line.

Keywords: Auxiliary power system, improvement of ride comfort, linear generator, PWM converter.

LECTURE SESSION 9B - TOPIC 9 - 16.20

Chairmen: A. Morini, University of Padova, Italy

M. Jufer, Swiss Federal Institute of Technology, Lausanne, Switzerland

PP09203 Swissmetro: Design Methods for Ironless Linear Transformer

Nicolas Macabrey

GESTE Engineering SA, Lausanne, Switzerland

Among the various contactless electromechanical equipments used in high speed MAGLEV systems, the function of energy transfer is, in practice, not easy to implement. The two main classes of components are the linear generators and the linear transformers. The latter have the advantage of being insensitive to the vehicle speed. They also present interesting potential for the industrial applications.

Nevertheless, if the ironless linear transformer has a particularly simple structure, its design is not trivial. This paper gives some information about the methods to use, to design and calculate a multi-primary linear transformer, considering various external constrains.

Keywords: Swissmetro, contactless energy transfer, design method, linear transformer.

PP09501 Fuel Cell Sytems for Electrical Vehicles: Solutions, Modelling and Test Benches Design

S. Hamandi, M. C. Péra, D. Hissel, J. M Kauffmann, F. Badin

UTBM-UFC-LRE T-31 INRETS, Belfort, France

This papers present the modeling of fuel cell (FC) power generator oriented toward the integration into electrical vehicle simulation. First a brief description of the FC priciples as well as the benefits of the Proton Exchange Membrane Fuel Cell (PEMFC) technology foe automotive applications are given. Next, the model of the whole fuel cell system that has been implemented in the MATLAB/Simulink environment is described. Finally, after a brief description of a test bench dedicated to PEMFC, experimental results are compared with those obtained using the proposed simulation model.

Keywords: Electrical vehicle, fuel cell system, hybrid vehicle, modeling, test bench.

PP09503 Thermal Study of Supercapacitor Serial Resistance

H. Gualous, D. Bouquain, A. Berthon, J.M. Kauffmann

Laboratoire d'Electronique, Electrotechnique et Systèmes (L2ES), UTBM-UFC- LRE T-31 INRETS, Belfort, France.

The electric serial resistance ESR of supercapacitor cell is strongly dependent on the electric resistivity of the electrolyte used and of the size of the ions from the electrolyte that diffuse into and out the pores of the microporouse electrode particles. Supercapacitor efficiency is a function of electric serial resistance (ESR). To use supercapacitor in transportation and because of supercapacitor power dissipation, it is

necessary to characterize the thermal variation of ESR. This paper discusses the thermal behavior of the supercapacitor ESR. Experimental study is reported. ESR is determined for different supercapacitor temperatures. Based on experimental results, an analytic model is proposed to be implemented with Saber software for simulation.

Keywords: Supercapacitors, supercapacitor serial resistance, thermal characterization, thermal modeling of supercapacitor.

PP09504 Considerations on the Energy Efficiency of a Supercapacitive Tank

P. Barrade, A. Rufer

Swiss Federal Institute of Technology, Lausanne, Switzerland

Supercapacitors are electrochemical double layer capacitors, dedicated for the energy storage. Even if the energy density is still lower than that one of batteries, the supercapacitors are defined with a higher power density. The main advantage of that property is the time for charging and discharging the energy that can be strongly reduced. The limitation in the reduction of that time is defined by the series resistor of the supercapacitors, which defines the energy efficiency of the component. This has to be taken into account for the sizing of a supercapacitor tank, to identify the energy efficiency of that tank and to avoid any over-sizing of the storage system. This paper presents a method for the calculation of the energy efficiency of a supercapacitive bank, together with design criterion to size a supercapacitor tank taking into account the energy efficiency

Keywords: Energy efficiency, Energy storage, Supercapacitors.