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2012

Issue 4

RAILWAYS
A feat of engineering under the streets of Barcelona

AERONAUTICAL
London-Heathrow, ready for bad weather

R&D
Cover applications

TRANSPORT STUDIES
Modernisation of the Algerian National Transport Plan

ROADS
Phase IV of the Las Palmas de Gran Canaria ring road

ARCHITECTURE&STRUCTURES
Eight new modern stations for the 'Western Corridor' in Bogotá

Editorial

The process of internationalization

in which we have been immersed for some years now, and which has ensured our presence in over 94 countries, requires us to adopt new market strategies which will further strengthen our position: more competitive equipment, an international network, the creation of foreign alliances and new projects in emerging countries are just some of the initiatives we have recently implemented.

In addition to our extensive presence in Europe and Latin America, we should also include that recent opportunities have permitted us to expand into Africa and Asia, where our experience in the design and construction of a complete transport network in Spain has been crucial in opening doors for us.

In the following pages we hope to be able to give our readers an idea of the dedication and commitment with which we approach our projects, whether it is the high-speed train in Saudi Arabia, our work on the London-Heathrow airport, or in other cities around the world, such as Barcelona, Tallinn, Bogotá and Casablanca, all of which are featured in this edition.

We would like to share our engineering vision with you in these articles written by our engineers on the new technologies available to the transport sector, such as fibre optics, ground-breaking electrical systems, as well as exciting new tools which can be employed in airport management.

We hope you enjoy reading our magazine.

PABLO VÁZQUEZ
Chairman & CEO of Ineco

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European GNSS Service Centre

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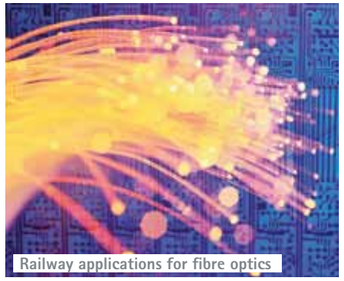
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Cover picture by Pablo Neustadt

International news

Ineco in ATC Global and Passenger Terminal 2012

Ineco participated during the months of March and April in two of the most important international trade fairs of the aeronautical sector: ATC Global, dedicated to air navigation (held in Amsterdam), and Passenger Terminal, about airport terminals (celebrated in Vienna).

Signalling on the Paris–Strasbourg high-speed line

The Italian firm Ansaldo has asked Ineco to participate in the validation of parameters of the trackside ERTMS 2 signalling system for the Paris–Strasbourg high-speed line. The 406 kilometres-line is part of the European corridor that reaches Bratislava, the capital of Slovakia. The work is focused on the RBC's (Radio Block Centres) and involves checking parameters such as slopes, maximum speeds or the position of elements. The data are checked against client documentation and using a simulation tool.

INECO TO UPDATE THE KUWAIT AIRPORT MASTER PLAN

A contract was signed on March 5 in Kuwait City with the Kuwait Civil Aviation Authority (DGCA) for an amount of €3.1 million, to update the Master Plan of the Kuwait International Airport (KIA). Ineco, in association with the consultancy firm Kuwait United Development (KUD), has been in charge of project management since March 2011 for the expansion of KIA (see itransporte English Edition, Issue 2).

[Above, Abdul-Aziz Al-Farah (first on the left), President of DGCA; Pablo Vázquez, President of Ineco; Sawsan Dashti, President of KUD, and Javier Cos, General Manager for International Business and Development of Ineco].

FIRST CONTRACT IN THIS ASIAN COUNTRY

Nepal chooses Ineco to modernise its air sector

For a three-year period, Ineco will be responsible for planning and modernising the Nepalese air sector. It will design an Airport Programme, revise aeronautical legislation to adapt it to international standards and restructure the national civil aviation authority (CAAN) into two separate entities: airports and air navigation. It will also define the technological needs of the new CAAN and create a training programme for civil aviation personnel. The sum of the contract, the first awarded to Ineco in Nepal, amounts to €2.7 million, financed by the Asian Development Bank. The Spanish bid was selected over those presented by five other groups from different countries.

SPAIN AND SWEDEN TO COLLABORATE IN UKRAINE

In the next two years, Spain and Sweden will execute a European project meant to assist Ukraine with the harmonisation of its air and airport regulations in order to adapt it to European standards. Ineco is one of the Spanish companies included in the consortium. Both countries will supply the experience of their civil aviation administrations.

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Ineco-Capita Symonds to design one section of the HS2

UK company HS2 Ltd has awarded 4 design contracts under Lot 1 of its Professional Services Framework covering civil and structural design services. The successful companies will prepare preliminary designs and work closely with HS2 Ltd, rail systems designers, environmentalists and land referencing companies. The designs will be used to inform the hybrid bill documents that are due to be submitted to Parliament by the end of 2013. A Capita Symonds-Ineco joint venture won the £11.1 million Country North contract covering approximately 78 kilometres of high-speed rail through Warwickshire and Staffordshire, and the connection to the West Coast Main Line.

MAKKAH–MADINAH HIGH-SPEED PROJECT

Pablo Vázquez, President of the Spanish consortium

The Spanish consortium for the Makkah–Madinah high-speed railway has appointed Pablo Vázquez, President & CEO of Ineco, as its top representative. Pablo Vázquez will join the Board of Administrators of the consortium as the representative of Adif, one of the 12 public and private companies of the group. The project comprises the design and construction of the railway and systems, the supply of 35 trains, as well as operation and maintenance for 12 years.

The consortium is formed by 12 Spanish companies: Adif, Cobra, Consultrans, COPASA, Dimetronic, IMATHIA, Inabensa, Ineco, Indra, OHL Internacional, Renfe and Talgo, which all together make up the Al Shoula group along with the Saudi firms Al Rosan and Al Shoula. In February 2012, the group signed the agreement (see pages 78–79) budgeted at more than €6.7 billion for the construction and startup of the high-speed railway line between Makkah and Madinah (Saudi Arabia), known as the Haramain High-Speed Railway (HHR).

NEW CONTRACT IN JAMAICA

Technical assistance for work in Sangster airport

MBJ Airports Ltd, the operator in charge of managing the Sangster International Airport in Montego Bay (Jamaica), has entrusted Ineco to provide the technical assistance for work on the runway renovation work and the new fire extinguishing services building.

This is the company's third job for Sangster, the country's main tourist airport, following the Master Plan of 2009 and the runway extension project in 2011.

.jm

FIRST AIR NAVIGATION JOB FOR NORWAY

Publication of the Bergen airport aeronautical charts

Ineco has prepared for publication aeronautical charts of the Bergen airport in Norway, for which it has also designed flight procedures.

This is the first job that Avinor, the air navigation services provider of Norway, has awarded Ineco after the framework agreement reached in 2011, which includes two more companies: the British NATS and the French CGx-AeroinSYS.

.no

International news

IMPLEMENTATION OF THE DA VINCI PLATFORM

Medellin includes buses in its traffic management system

Ineco will be in charge of supervision and technical management in the expansion of the Traffic Management System (TMS) of the Colombian city of Medellin. The system will incorporate the Metroplús, the new network of articulated buses. The fully automated TMS is based on the Da Vinci technological platform of Adif.

Spanish rail technology for Lithuania

The Baltic nation has also been implementing the Da Vinci platform since 2010 to modernise its railway traffic management. In the next 24 months, Ineco will provide technical assistance to Indra (who developed the technology) for the implementation of the cable communication systems in order to integrate interlocking management in the Regulation and Control Centre.

EUROPEAN SATELLITE NAVIGATION

→TWO MORE YEARS OF ACCEPTA

The participation of Ineco in the ACCEPTA (Accelerating EGNOS Adoption in Aviation) project has been extended to 2014. This project promotes the implementation in aviation of procedures and applications based on EGNOS, the European satellite navigation system. The company has also extended its contract with the European Space Agency (ESA) to provide systems engineering support for EGNOS (European Geostationary Navigation Overlay Service).

→INECO LEADS THE NEW EUROPEAN FILGAPP PROJECT

A consortium formed by 10 European companies and led by Ineco will carry out the new FilGAPP project (Filling the gap in GNSS Advanced Procedures and oPerations), which started in April 2012 designed to bridge the existing technological gap between current and future procedures and operations, based on the information provided by global satellite navigation systems such as GPS, EGNOS or Galileo.

Agreement with CAF

The Latin American Development Bank CAF has signed an agreement with Ineco to carry out studies on the infrastructures of all transport modes. In recent years, the company has collaborated with this financial institution, comprised of 18 countries, on various projects.

In the photo above, Enrique García, chairman of the CAF, and Pablo Vázquez, President & CEO of Ineco, at the signing of the agreement, which took place on May 29, 2012.

WORK IN ANGOLA

Safety consultancy for the Luanda airport

PHOTO BY LUKO WILLMS

Ineco is carrying out a safety and security study for Aena Internacional in the 4 de Fevereiro civilian and military airport of Luanda, the capital of Angola. Its objective is to assess the status of operations and airport safety and security, in order to identify the risks and recommend the appropriate corrective measures. This study includes diagnosing the current situation, designing operation, safety and security procedures, training airport personnel, defining procedures and tools for real-time management, and implementing a Quality Plan.

REDUCING POLLUTION IN TRANSOCEANIC FLIGHTS

Three new 'green flight' projects

Ineco, in a consortium with other aeronautical operators, airlines and air navigation companies, was awarded the projects OPTA-IN, SMART and SATISFIED, within the framework of the AIRE initiative (Atlantic Interoperability Initiative to Reduce Emissions). The company has participated in AIRE since its first campaign in 2009, a program financed jointly by the European company SESAR Joint Undertaking and the Federal Aviation Administration (FAA) of the United States. Its goal is to improve energy efficiency and reduce carbon emissions in transoceanic flights between the European continent and the United States.

Mission accomplished

A feat of engineering under the streets of Barcelona

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The tunnelling operation, through the very centre of Barcelona, passing close to architectural treasures such as Gaudí's Sagrada Familia (Holy Family) and Casa Milá, has been successfully completed. Ineco participated in this major civil-engineering project, ensuring the completion of the new rail connection to the rest of Europe.

The first Spanish railway line to be fully interoperable with the European network will be completed when the final 132 kilometres that link Barcelona to the city of Figueres are concluded. If we add the international section, the high-speed line will then total 804 kilometres, the longest such line in Europe. This is an incredible achievement, requiring a complex excavation process in which the 5.78 kilometres-long urban tunnel crossing under Barcelona's streets plays a key role.

Almost entirely excavated using an earth pressure balance (EPB) shield (the safest way of digging through clay and sandy soil), the tunnel has served to highlight the accumulated experience on similar projects undertaken by Adif and the companies that have participated in its construction. One such company is Ineco, which has provided assistance in the field of site management, among other works.

With just 365 metres of cut-and-cover tunnel to connect to Sants station, the central phase of the project posed a technical challenge that was completed on July 26, 2011, after 16 months of work.

The section excavated using the tunnelling machine runs under streets Mallorca, Diagonal and Provenza, and does not pass under any buildings. Only Torre del Fang, a medieval farmhouse located on the screened section near the future La Sagrera station, is situated above the tunnel. At the same time, it was possible to cross a densely populated city centre dotted with buildings of incalculable artistic and architectural value, such as Sagrada Familia (Holy Family) and the Casa Milá, without these being affected. Both of these Antonio Gaudí masterpieces are included on the UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage List. ✱

Auscultation

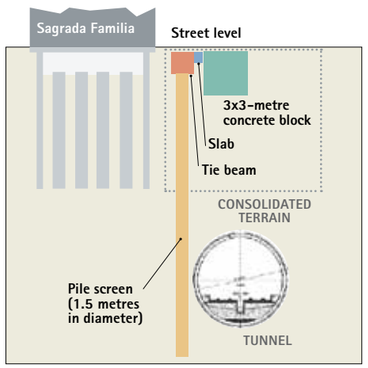
A GUARANTEE OF SAFETY. The progress of the tunnelling machine was constantly monitored, as well as the deployment of a comprehensive instrumentation system on the ground, in the tunnel and in the adjacent buildings, providing real-time online supervision. The section as a whole was divided into 150-metre long auscultation sub-sections with subsidence sections at 50-metre intervals in order to control any possible deformations of the terrain. Adif also put specific auscultation plans in place for the area's monumental buildings.

SAGRADA FAMILIA (HOLY FAMILY)
As further protection, a pile screen was added with 104 piles joined by a tie beam and a concrete block running lengthwise. The terrain was also reinforced with 2,344 consolidating injections.

A unique project

The project required two courses of action with accuracy down to the last millimetre. [1] Before the tunnelling equipment was used, protective structures were put in place between the tunnel and the monumental buildings (pile screens). [2] Both before and during excavation, exhaustive inspections, monitoring and auscultation were carried out, on the machinery, the ground and the actual tunnel itself, as well as on adjacent buildings and other structures.

The study and control phases were decisive in ensuring the success of the excavation. 7,450 auscultation devices were used to inspect 535 buildings situated on either side of the tunnel and a total of 3,730 homes. The results surpassed even the most positive forecasts: the plot subsidence after the tunnelling machine had passed showed values that were far lower than the maximum allowed levels. This was confirmed by the international committee of experts who have been supervising the work since May 2010.



The tunnel has served to highlight the accumulated experience on similar projects undertaken by Adif.

CASA MILÁ
The photo to the left shows a rotary drilling rig working on the protective screen, similar to the one installed at the Sagrada Familia (Holy Family), although smaller in size.

How Barcelona's heritage was protected

➔LA SAGRADA FAMILIA

This is one of the best-known symbols of Barcelona. Work on it began in 1882. The funding for its construction comes from donations.

- A 230-metre long pile screen consisting of 104 concrete piles measuring 1.5 metres in diameter and at a depth of 42 metres, joined by a 3x3-metre concrete block.
- Auscultation devices: 4 robotic surveying stations: 2 inside the temple and another 2 in buildings inside Mallorca street to control exterior façades. 146 survey control prisms, both in the building interiors and their facades. 3 monitoring stations used to control vibration levels, distributed throughout the surrounding area. 5 auscultation sections, consisting of 65 survey markers, 20 extensometers, 11 sliding micrometers, 17 inclinometers, 15 pressure cells on the site and 28 piezometers. 9 accelerometers in the building interior to monitor vibration levels. 39 survey markers and 2 extra rod extensometers at the tunnel axis.

➔CASA MILÁ (LA PEDRERA)

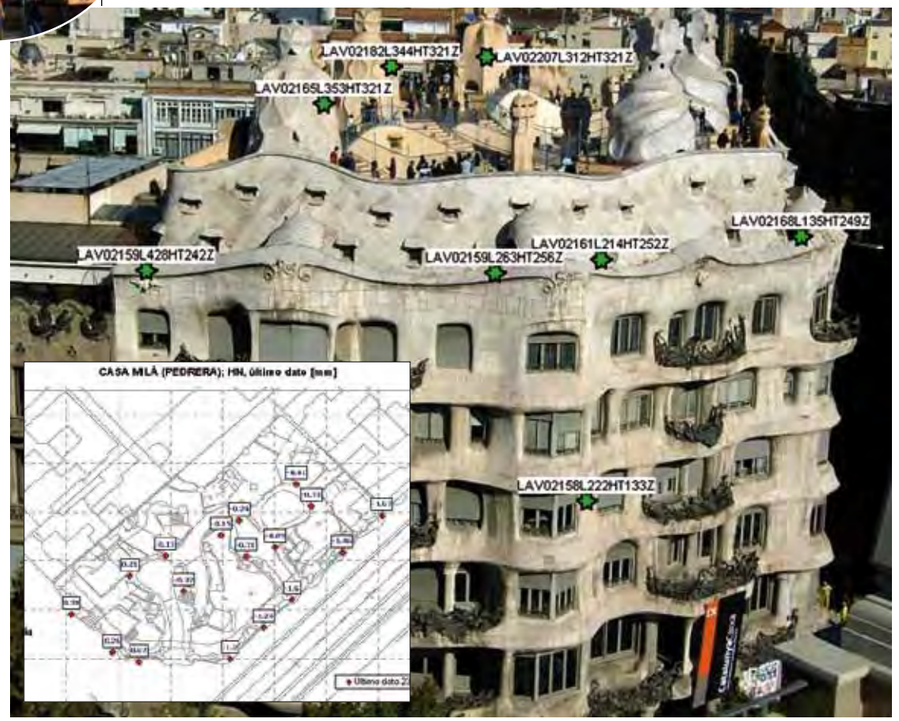
Casa Milá, popularly known as La Pedrera, was built between 1906 and 1910. It is considered as one of the best examples of Catalan modernism.

- A pile screen consisting of 33 excavated concrete piles measuring 1.2 metres in diameter, placed 1.7 metres apart and at a depth of 32 metres.
- Auscultation equipment: 2 monitored stations, 44 survey control prisms, 27 survey markers, 15 fissure meters.

➔TORRE DEL FANG

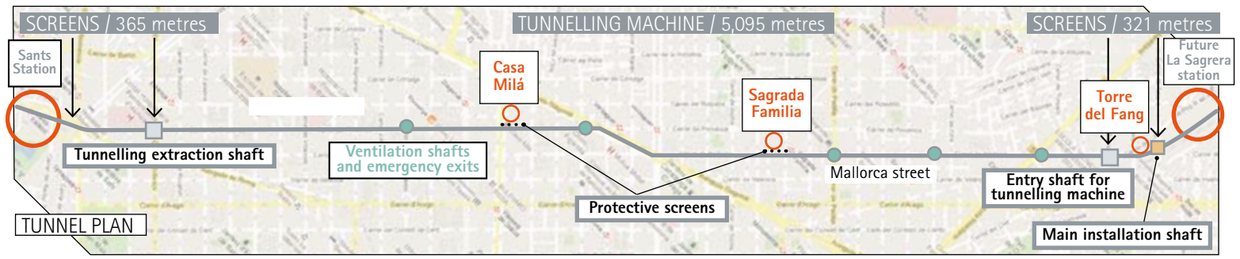
A 16th century traditional Catalan masía (farmhouse), modified in the 18th century.

- Special support for the structure of the building while the pile screens, piles and micropiles were put in place, the roof slab positioned and the tunnel excavated.
- 41 auscultation devices in total: robotic prisms, levelling screws, survey markers, vibrating wire piezometers, inclinometers and rod extensometers.



Instrumentation

Some of the graphs on pages 12 and 14 reveal the results of measurements after the tunnelling equipment had passed, with negligible subsidence (displacement). At the Sagrada Familia (see page 12), it shows the devices installed both inside and outside the building. The photo above displays control points on the façade and roof of Casa Milá.



Work completed by Ineco for Adif

Management assistance on the Madrid–Barcelona–French border, offering administrative and legal support, as well as construction supervision and liaising with UNESCO.

LINE MANAGEMENT. Via its Technical Line Management Bureau, Ineco provided valuable site monitoring, as well as drawing up reports for the Spanish High Court, UNESCO, etc.

CONSTRUCTION MANAGEMENT. Work management on the Lleida–Figueres section (including the Sants–La Sagrera tunnel), covering work such as management of the platform works, support for geotechnical experts, structures, excavation and instrumentation machinery, projects and construction works supervision in the surroundings of the La Sagrera-Nus de la Trinitat sub-section, expropriations, and the supervision and surveillance of the platform work completed between La Roca and Figueres.

DRAWING UP PROJECTS. Construction projects to adapt track installations and complementary projects: project for tunnel instrumentation, signalling and communications facilities, environmental studies, structure support and collaboration in the supervision of stations. Supervision work was also undertaken on the tunnel construction project and the shafts dug using vertical tunnelling equipment.

ENVIRONMENTAL MANAGEMENT. Review and monitoring of work to ensure compliance with the Environmental Impact Studies (EIS).

INFORMATION OFFICE. Situated alongside La Sagrera, its purpose is to provide information on the project progress; receiving visits from foreign delegations, etc. This office was the venue chosen for the meetings of the UNESCO committee.

OTHER TASKS. Construction management and technical assistance on the new La Sagrera-Meridiana commuter station, which was opened in February 2011.

INECO AND THE SANTS-SAGRERA TUNNEL
Rafael Rodríguez, Director of the Northeast High-Speed Line (in the centre), accompanied by other members of the Ineco team: Jorge Laguna, María Alfonso, Area Director José María Urgoiti, Luis Ubalde and Antoni Freixa.

Technical specifications

TOTAL LENGTH	**5.78 kilometres**
DIAMETER	**Excavation: 11.4 metres**
	Internal: 10.40 metres
DEPTH	**Between 9 and 28 metres**

CONSTRUCTION METHODS

- **Initial and final sections: cut-and-cover tunnel between concrete walls (measuring between 321 and 365 metres).**
- **EPB tunnelling machine for the rest (5,095 metres).**

SHAFTS **6 in total: 5 have been built between concrete walls and the other one using vertical tunnelling equipment.**

TRACK **Double slab track with embedded rail, international gauge (UIC) and state-of-the-art track apparatus. 2x25 Kv, 50 Hz catenary and safety systems covering ERTMS and digital ASFA circulation and control facilities, as well as fixed and mobile communications.**

‘The UIC-gauge connection to Europe is a major milestone’

Q&A

Rafael Rodríguez Gutiérrez

Director of the Northeast High-Speed Line

Spain is one of the most advanced countries in the world when it comes to high-speed rail, but one matter needed to be dealt with: the intermodal connection with the rest of continental Europe.

From a management point of view, what does it mean to oversee Spain’s longest high-speed rail line and one of the longest in the world?
It is a great honour due to the huge importance of this project, and a weighty responsibility because of the human and economic resources needed to bring it to a successful conclusion.

As far as the different technical aspects are concerned, what are the main elements that set this line apart from the rest of the rail network?
The line has two main characteristics: it connects to Europe (it is not a closed line within the Peninsula) and it allows mixed freight and passenger traffic. With these two aspects, the UIC-gauge connection to Europe is a major step forward for Spanish railways and one which is at the heart of the idea of interoperability: for the first time, it will be possible to connect the Spanish network to the European one using the same gauge, thus reducing travel time. The line is also the first to use the ERTMS communications system, as well as the first to pass from Level 1 to Level 2.

How do you think these exclusive features of the line will influence how it evolves going forward?
It will result in great benefits, both economic and environmental: it will lead to a reduction in the number of heavy vehicles using the roads; it is also highly likely that international passenger traffic –above all tourist and business travel– will increase.

How would you describe the experience of having three tunnelling machines working at the same time on one line?
In Barcelona, the feelings of local people were extremely important with respect to the tunnels as a result of other events in the past. There was also the issue of the historical monuments in the area. In Girona, it was impossible to plot the route of the tunnel without passing below 44 buildings, meaning that extra safety measures needed to be taken. Finally, regarding the third tunnelling machine at Montcada, although it didn’t pass below any building, it nevertheless ran right alongside a local commuter railway line (Cercanías), something that could have resulted in unwanted interference with other rail traffic. Despite our great responsibility, it is a great satisfaction to see the achievements made with these three tunnelling machines.

Rafael Rodríguez (above, on the left) with José María Urgoiti, Director of Ineco’s Rail Projects, Works and Maintenance Area. In the background, the Bac de Roda bridge, near the future La Sagrera station.

What do you think are the main new features that this line has introduced?
As I already mentioned, this was the first line to incorporate ERTMS. However, I would like to highlight our control over subsidence as the tunnelling equipment passed below, with a team consisting of engineers, contractors, Ineco, Adif, etc. Everything came together so that we were able to ensure exemplary behaviour in site management. ✱

A lifetime dedicated to the rail sector

Rafael Rodríguez is a civil engineer who joined Adif (the Spanish railway infrastructures administrator) in 2005. In 2007 he took charge of the Infrastructure Department for the Madrid–Barcelona–Figueres high-speed line, then he was appointed as Manager of the Northeast High-Speed Line. As we go to press, he has been named Adif’s Deputy Director of High-Speed Construction.

Ineco’s contribution

Rafael Rodríguez values Ineco’s attitude since work on the line began, both in terms of supervision and when compiling data and project engineering. ‘I understand that its work is not limited to infrastructures, but also covers the whole superstructure and all its subsystems’, he said. ‘This is of fundamental importance, because it reinforces Adif’s work (...) Ineco’s main characteristic is that it is a key tool for exporting Spanish know-how regarding the construction, maintenance and operation of a high-speed line’.

Sights set high

Ineco involved in commissioning the Ourense–Santiago section of rail

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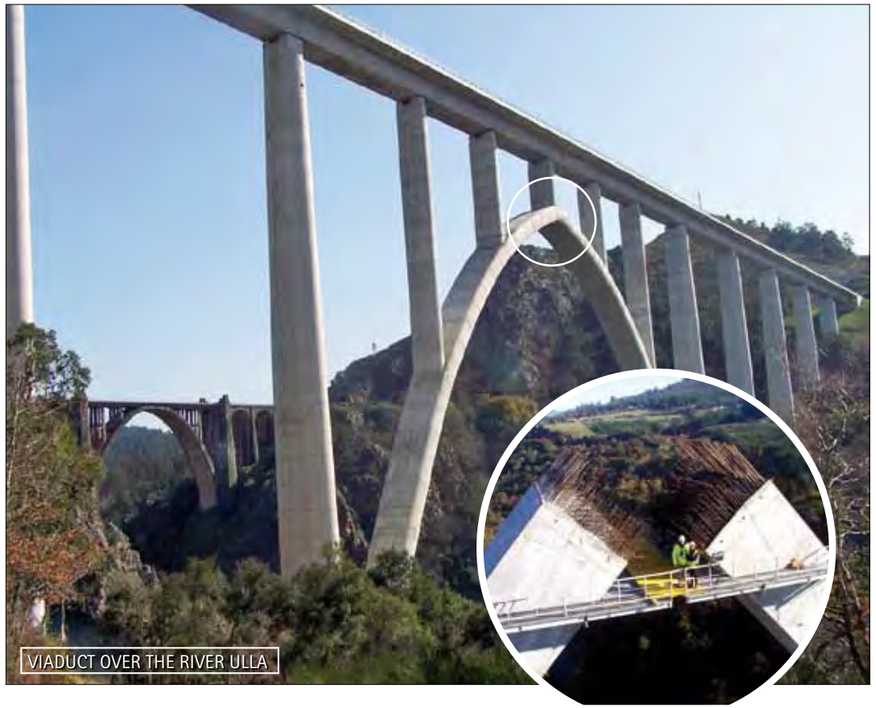
Ineco has worked alongside Adif in all the stages of development of the line: 87.1 kilometres of new track spanning rugged terrain, part of the Atlantic Axis and the forthcoming high-speed Madrid–Galicia rail corridor.

This stretch of track is a veritable feat of engineering: how best to cross the very hilly terrain, with over 30 rivers, some of which are at the heart of rich ecosystems, highways, conventional rail tracks, roads and villages, and create a track layout capable of handling high-speed trains travelling at between 200 kph (in the case of the Talgo IV) and 250 kph (CAF-Alstom's Avant 121), and up to 350 kph in the future. Such is the Ourense-Santiago section of track, which was commissioned by Adif on December 11, 2011: a brand-new 87.1 kilometre-long twin-track rail connection, fully electrified and reserved exclusively for passengers.

Ineco was involved in every stage of the project; the development, construction and implementation stages, providing site and environmental management services, technical assistance, supervision, coordination, on-site technical consultancy and maintenance.

Along with the existing stretch of track between Santiago and A Coruña (modernised in 2009), the new section represents the first high-speed rail corridor in Galicia, 150 kilometres in total (50 kilometres less than the original layout), much of which runs through tunnels and over viaducts. On the Ourense to Santiago section alone, 31 tunnels and 38 viaducts have been built (60% of the total length), halving the travel time between the two cities.

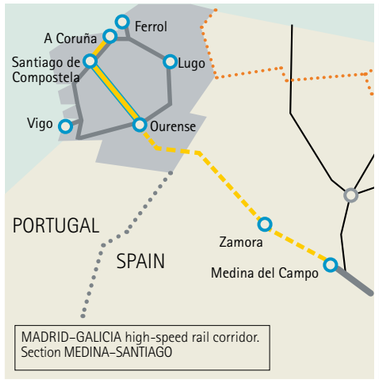
From an environmental point of view, the great height of these structures has helped to minimise the impact on the ground, although there were some temporary effects arising from the vast earth movement operations, the occupation of available spaces, site waste, noise and impact on vegetation. The Ineco team took responsibility for controlling all of these aspects and implementing the preventive, protective and corrective measures outlined in the Environmental Impact Studies (EIS). ✱



VIADUCT OVER THE RIVER ULLA

Overcoming obstacles

The entire area is criss-crossed by rivers, with the Arenteiro, Sáramo and Viñao worthy of special mention. All of these are crossed by viaducts between 1,100 and 1,400 metres long. The Rivers Deza and Ulla, which are also crossed by viaducts (the Ulla viaduct features pillars 120 metres high, the highest structure in the Spanish high-speed network), form an ecosystem that has been classified as a SCI (Site of Community Importance), with riverside vegetation of great natural beauty.



MADRID–GALICIA high-speed rail corridor. Section MEDINA–SANTIAGO

THE AVE OF THE NORTH

The Ourense–Santiago section of rail commissioned in December 2011 links up with the section of the Santiago to A Coruña line that has already been modernised, forming an axis with a total length of 150 kilometres. It is part of the 'Atlantic Axis' (to be extended to Vigo, Ferrol and Lugo) and the high-speed rail corridor that will link Galicia to the centre of the Peninsula.

Unique structures

On the A Coruña–Santiago section, almost 40% of the layout runs over viaducts or through tunnels, among which we should highlight Meirama (3,468 metres), Nemenzo (3,177 metres) and Bregua (2,993 metres). In building the Ourense–Santiago section, construction techniques rarely seen in Spain have been employed, such as the wishbone strut system used on the central arches of the O Eixo and Deza viaducts; or the viaduct over the River Ulla, with a central arch over 168 metres high, with pillars standing over 90 metres tall.

Enviromental management

Environmental restoration. The excavations for the tunnels created over 20 million cubic metres of surplus soil, which was disposed of at a number of sites in order to minimise impact on the landscape.
Once the earth-moving works had concluded, 646,822 m^2 of land were seeded, a further 2,897,844 m^2 were hydroseeded, and 160,870 trees were planted. In order to guarantee the success of the restoration work, autochthonous species were selected. The replanted areas were then monitored to check the erosive effects of rain, which has a tendency to wash away plant cover. To avoid this, fast-growing species were planted and some areas were reseeded.
The banks of 32 rivers were also restored, with 34,031.10 m^2 of land hydroseeded, 220 trees planted and another 69 transplanted into the public park in Santiago.

Water quality. Another of the tasks facing the environmental management team was the need to preserve the quality of the river water. To do so, strict control was maintained over wastewater discharges from the work on the 60 tunnel mouths of the 30 tunnels excavated, the numerous concrete-mixing plants required and the various machinery depots. The points of greatest ecological interest, such as the Ulla-Deza River System SCI (Site of Community Importance), were subject to special controls and monitoring.
With regards to the work undertaken, the building of 47 impermeable settling basins to treat water from tunnels and auxiliary facilities, featuring automatic PH correction systems and grease separation devices, as well as numerous settling basins for water overspill and runoff from the excavation should be note. The risk of landslides was prevented by installing 34,693 metres of retaining barriers made from hay bales.

Fauna protection. As far as the fauna is concerned, the measures taken consisted of fencing off the rail platform with 51,470 metres of metal railings, as well as facilitating the passage of animals to avoid what is known as the *barrier effect*, although this was minimised due to the height of the structures. Twenty-five transversal drainage systems and one overpass were prepared as fauna passageways, 995 metres of animal protection fencing were installed, as well as different escape devices and mechanisms. Compensatory steps were also adopted to counterbalance the occupation of the Ulla-Deza River System SCI.

Other environmental work. Environmental work also extended to the restoration of land temporarily expropriated for the duration of the construction work before returning it to its owners, as well as the installation of 16,420 m^2 of acoustic panels and waste management initiatives.
Environmental management was not limited to platform work, but also to other stages of the project: the O Irixo assembly base (currently used for maintenance), track assembly and electrification work, as well as other rail facilities and systems. With the line currently operational, Ineco is carrying out an inventory of environmental structures on behalf of Adif in order to offer support to maintenance teams.

Along with the existing stretch of track between Santiago and A Coruña (modernised in 2009), the new section represents the first high-speed rail corridor in Galicia.

THE O IRIXO ASSEMBLY AND MAINTENANCE BASE

CODESO CUT-AND-COVER TUNNEL

SILLEDA TRACTION SUBSTATION

RECEPTION LOAD TEST

OURENSE STATION

The Iberian gauge and multi-purpose sleepers

The original plan was to install the international gauge track with gauge switching at Santiago and Ourense stations. Later, Adif decided to install the Iberian gauge track with PR-01 multi-purpose sleepers, allowing the changeover to be made without the need to vary either the track axis or the gauge or affecting the other installations. Adif highlighted the fact that this option represented 'significant financial savings', as well as meaning it was possible to 'isolate the axis until it was definitively put into service' on the Madrid–Galicia line.

HERITAGE PROTECTION

In coordination with the Xunta de Galicia (regional Government), a programme designed to monitor protection for local historical and cultural heritage was implemented. Special mention should be made here of the archaeological finds of the 'Mámoa' (prehistoric burial mound) at Chousa Nova, near Silleda, the Castriño de Bendoiro tombs at Lalín, and the Roman remains at Santa Catalina, all in the province of Ourense.

ON-SITE WORK

➔PROJECT STAGE

PREPARING THE PLATFORM PROJECT for the FFC-COMSA joint venture, on the Ourense–Lalín section, Amoeiro–Maside and Maside–Carballiño sub-sections: includes 7 viaducts, 3 conventionally excavated tunnels and 6 cut-and-cover tunnels.

THE O IRIXO ASSEMBLY AND MAINTENANCE BASE. Basic and construction projects.

➔WORKS STAGE

TECHNICAL CONSULTANCY AND ASSISTANCE TO THE LINE MANAGEMENT TEAM. Daily monitoring of the work on site (platform, track, electrification, installations, fixed and mobile telecommunications and civil protection). Supervision of work planning.

PLATFORM. CONSTRUCTION AND INSTRUMENTATION MANAGEMENT TEAMS, assessment of structures, geotechnical engineering and tunnels. Financial monitoring of the works. Execution of an extensive instrumentation campaign covering various sections of the platform (embankments, cuttings and transition slopes).
STANDARDISATION AND COMPILATION OF DOCUMENTATION (2006-2008).

TUNNELS. CONSTRUCTION MANAGEMENT AND TECHNICAL ASSESSMENT on civil protection work in tunnels. SELF-PROTECTION PLANS. Preparation and maintenance.

VIADUCTS. RECEPTION LOAD TESTS on 8 viaducts, with lengths up to 1,176 metres and a maximum pile height of 98 metres. Work included the installation of electronic sensors, various static, dynamic and braking tests, and collation of the results.

TRACK SUPERSTRUCTURE. CONSULTANCY AND ASSISTANCE TO THE CONSTRUCTION MANAGEMENT TEAM when assembling the track. Access to Ourense (connection to the conventional line Zamora–A Coruña line, allowing access to Ourense station), linking up with the 'Atlantic Axis' (under construction). Traffic and traction service control, and final tests.
CONSTRUCTION MANAGEMENT for track-laying on the O Irixo–Santiago section.
LOGISTICS AND QUALITY CONTROL OF RAIL SUPPLIES: ballast, rails, sleepers, fastening mechanisms, track apparatus. Supervision of installation of materials. Assembly and commissioning of line switches.

SECURITY AND COMMUNICATIONS INSTALLATIONS. SUPERVISION AND SURVEILLANCE of the following works: signalling facilities, fixed telecommunications, CTC, protection and train protection systems, supply and installation of the DaVinci integration system, overhead contact line and associated systems, traction electrical substations and associated auto-transformation centres and energy remote control systems.

STATIONS. SANTIAGO: CONSULTANCY AND ASSISTANCE TO THE REMOTE MANAGEMENT TEAM regarding the modernisation of the Santiago station. Alterations to alignment to give access to the new line. OURENSE: SITE MANAGEMENT AND HEALTH & SAFETY COORDINATION of modernisation work at the Ourense station.
INSTALLATION AND MANAGEMENT OF THE ADIF INFORMATION OFFICE at the Santiago station.

➔MAINTENANCE

Once the line was in operation, maintenance from the base at O Irixo.

More efficient and eco-friendly trams

Sustainable urban transport in Tallinn

Published in itransporte 45

Ineco has worked for the public authorities of Tallinn in the modernisation of Line 4 of its tram system. In two years, trams will continue to form part of the picturesque scenery of this beautiful medieval city, but they will be more modern.

The Tram and Trolley-bus Company of Tallinn (TTTK) entrusted Ineco with the execution of the improvement and modernisation of its Line 4, which connects the neighbourhood of Tondi to the old town and Ülemiste, near the Lennart Meri airport. This project is part of the plan to develop public transport in this city. It arises from Assigned Amount Units Purchase Agreement (AAUPA) under a Greening Investment Scheme between the Spanish Ministry of the Environment and Rural and Marine Affairs, and the Estonian Ministry of the Environment, which in coming years will invest in the creation of a more environmentally friendly public transport system.

With the financing obtained from the Greening Investment Scheme, Tallinn expects to invest about €45 million in trams with a greater transport capacity, outfitted with modern technology that allows them to achieve greater energy efficiency (such as recycling braking, onboard energy storage systems, improved insulation materials, etc.).

An important improvement. In principle, 16 new trams will replace the old vehicles of Line 4, representing an important improvement for public transport users. This action is completed with the work on infrastructure, mainly on the track and power, which will be financed by European Commission Cohesion Funds.

The capital of the Republic of Estonia is the most populated city in the nation (400,000 inhabitants), and is also its financial and political centre. Due to its strategic location in the maritime route between Western Europe and Russia, its commercial seaport has always played an important role in the economic and social development of the city, particularly during the Middle Ages, the period in which its historic centre was built (recognised in 1997 by UNESCO as a World Heritage Site).

In the last 20 years (since Estonia gained independence from the Soviet Union in 1991), tourism and new technologies have driven its economy, particularly in the IT sector. The improvement in public transport will contribute to increase its use, reducing the high number of private vehicles currently in circulation and the concentration of atmospheric pollutants in the city centre.

Tallinn's four tram lines (see below) cover the entire city, connecting peripheral districts with the historic centre. This is the most convenient mode of transport for the numerous tourists who visit the city every year. The new units that will replace the current trams (Tatra KT4 and KT6) are expected to arrive in 2014. ✱

EXPERIENCE WITH TRAMS

Ineco has participated in recent years in many studies and projects for trams, metro and light metro rail, both in Spain (Madrid, Seville, Tenerife, León, Alicante and Almería, among others) and abroad (Algiers, Belgrade and Amman).

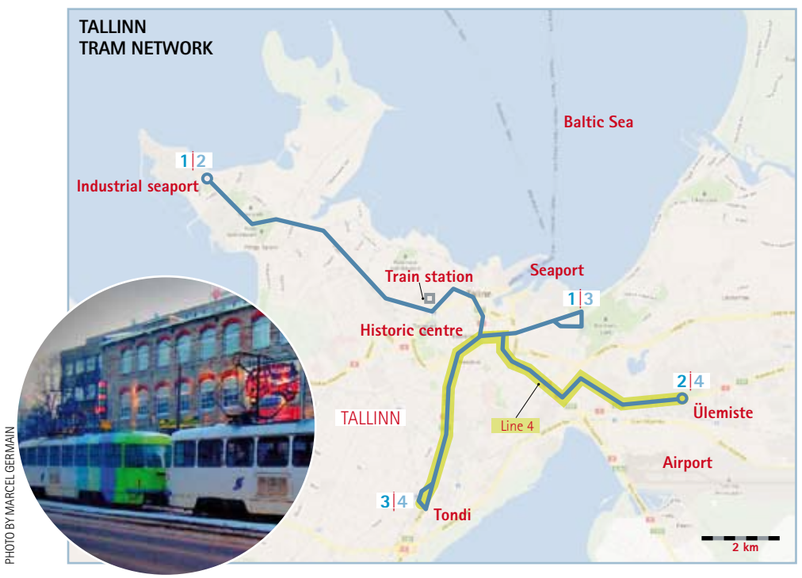


PHOTO BY MARCEL GERMAIN

THE ANALYSIS

Complete study of Line 4

➔CURRENT SITUATION

Line 4 of the Tallinn tram network passes through the central district of Kesklinn, which contains the old town and the passenger port of the city. Ineco's study includes an analysis of the current situation of the line, considering both the infrastructure and superstructure as a starting point for defining the operational problems (mainly related to the age of the rolling stock, tracks, equipment and installations), and proposing the best solutions for each case.

➔BASIS FOR THE MODERNISATION

Ineco's technical assistance has developed a full preliminary design for renewing tram tracks and the electrical substations. It also has considered the technical specifications required for the new trams and the strategy for implementing the modernisation program, which revolves around three main goals: improving the quality, the service level and the environmental aspects. As a whole, the document sets out the technical grounds for the modernisation programme.

➔ECONOMIC STUDY

Ineco's project also includes a cost-benefit analysis and a general estimate for the financing of the infrastructure actions using European Commission Cohesion Funds.

With the financing obtained from the Greening Investment Scheme, Tallinn expects to invest about €45 million in trams with a greater transport capacity.

DIAGNOSIS

Modernisation

➔FALL IN DEMAND

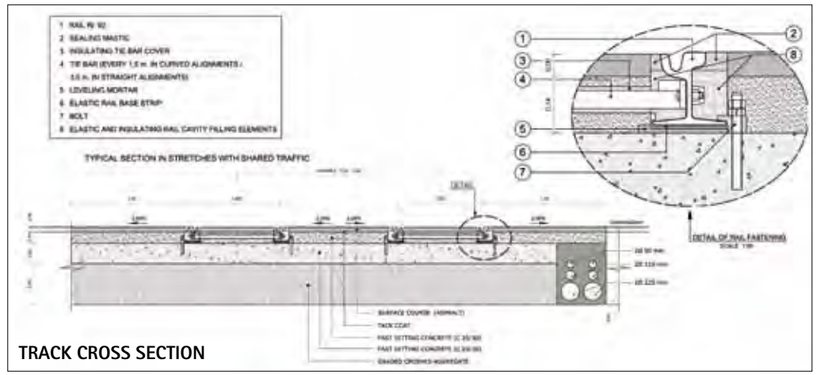
Ineco's diagnosis determined that the rolling stock, infrastructure and superstructure of the track were obsolete, and that tram demand had fallen by 75% in the last 20 years.

Line 4 is 16 kilometres long, with a gauge of 1,067 milimetres and a diverse track superstructure, including sections on ballast, slab track sections and different types of rails and sleepers (of which 60% are wood). It has 17 stops used by more than 8 million passengers per year. The line has 6 electrical traction substations that are 40 to 50 years old. In rush hours it can have up to 16 trams in service (with an average age of 30 years).

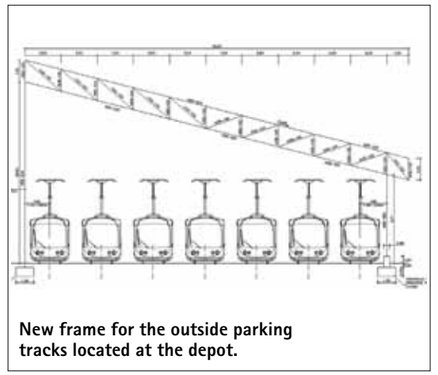
➔FULL RENEWAL

The proposal to modernise the line is to renew and completely reinforce the platform and tracks –which need to increase their load capacity per axle–, the electrical power supply equipment, the depot, accessibility at the stops, etc., using European standards as a reference and always considering the requirements of the new rolling stock.

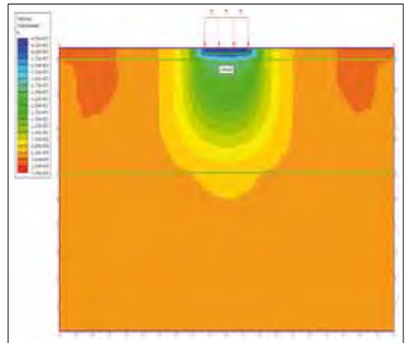
In addition, a geotechnical study has been performed to check the resistance of the ground in view of the greater axle load of the new trams, and improvement proposals have been made for the accessibility of persons with limited mobility and for the urban integration of the line.



TRACK CROSS SECTION



New frame for the outside parking tracks located at the depot.



SUBSIDENCE SIMULATION MODEL

THE NEW DESIGN IN FIGURES

- 10.86 kilometres of track to be improved on the line.
- 2 stops redesigned: Vineeri and Vadabuse Väljak.
- 21 stops with improved accessibility.
- 22 switches, 2 crossovers and 2 scissors crossings (crossings of parallel tracks in both directions) in order to improve operation.
- New cover for the outside parking tracks.
- 2 new parking tracks of 70 metres each, providing parking for 4 new trams.
- 9 kilometres of reinforcement feeder and replacement of 5 catenary posts.
- 5 new traction substations and rebuilding of an existing one.
- Refurbishment of 14 traction transformers (2,250 kVA each).
- 16 new trams with an approximate length of 33 metres each.
- 250 passengers per vehicle.
- Trams with low floors (over 70% of their total length), bidirectional traction, radiant floor heating and air conditioning.

MAIN ACTIONS

Improvements in service, tracks and rolling stock

➔PLATFORM AND TRACK

INECO HAS PRESENTED a modernisation plan that includes actions for improving traffic and service, renewing the tracks and rolling stock, and their subsequent maintenance.

FOR THE PLATFORM, the geotechnical study has shown that it is necessary to carry out a full renewal of the ground in the segments that will be renovated. For this purpose, it is considered necessary to excavate about 1 metre, filling and compacting the subsoil with better quality materials.

FOR THE TRACKS, a slab track with embedded rails will be installed, with 2 new crossovers allowing new bi-directional trams to change direction. There are different options for the surface finish: asphalt pavement in sectors shared by trams and automobiles, and tiles or grass elsewhere.

PROTECTION OF ROLLING STOCK and tracks that are damaged by automobiles passing over them. Whenever possible, it is proposed to separate the two types of traffic, prioritising the tram, as well as reinforcement treatments for the track and pavement material. It is recommended to install elastomeric elements to dampen vibrations in places where there are buildings less than 7 metres from the track.

LOW WINTER TEMPERATURES and the proximity of the Baltic Sea, which affect the state of the tram tracks and rolling stock, have also been considered. In this sense, the project considers the need to cover the train depot area to protect it from heavy snow and rain.

TO IMPROVE THE SAFETY of passengers and pedestrians, a new vertical and horizontal signalling is proposed, as well as suitable lighting at stops (which will be provided with weather protection).

BETTER ACCESSIBILITY and urban insertion in all stops and redesign of 2 stops.

➔ELECTRICAL POWER SUPPLY

With regard to power supply, Ineco considers it necessary to remodel 5 traction electrical substations and to overhaul another, renew the catenary wiring and update the energy remote control system to deal with the greater energy requirements in the renewed sections.

➔NEW TRAMS

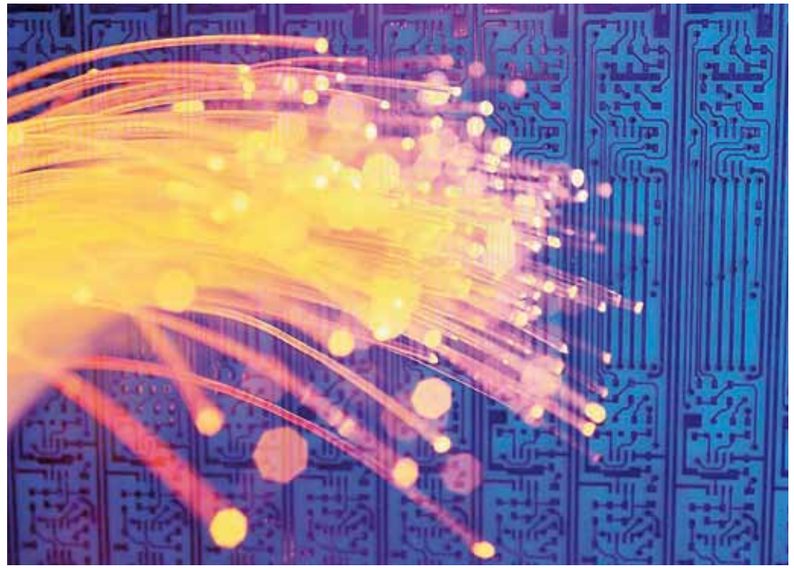
They will have greater passenger capacity and a design adapted to the new infrastructure, according to European standards and energy saving requirements. They shall have a low floor over 70% of their total length. They will also have bidirectional traction, radiant floor heating and air conditioning, and should be corrosion resistant, suitable for the extreme weather conditions. Vehicles will be provided with onboard energy storage systems and recycling braking energy systems.

The medium is the future

Railway applications for fibre optics

Published in itransporte 39

Fibre optics is the basis for the design of high-speed rail, conventional rail, tram and metro lines. It plays a key role as a conductor of information. Ineco is incorporating fibre optics as a medium for its network projects.



Fibre optics currently represents the physical medium par excellence for the transmission of large quantities of data over long distances at high speeds. Such communications are based on the transmission of information using light as a conductor.

The use of light for sending and delivering information dates back to ancient Greece, where a rudimentary but effective mirror architecture was used. The reflection allowed coded information to be sent to a receiver located some distance away. However, this system and similar methods developed in France in the mid 20th century (which made it possible to increase the distance of the link) posed a major problem: the light was transmitted through an open space, which generated large dispersions and losses of information. The solution was to design a cable to confine and guide the light transmission to its final destination.

This is how fibre optics was born, a revolutionary element that solves the problems raised by the use of electrical signals as a physical transmission medium.

The purpose of a fibre optic infrastructure deployment is to support a network technology used to transmit numerous railway communications services, such as signalling, GSM-R (Global System for Mobile Communications-Railway), passenger information systems (PIS), remote control, etc.

Network designs differ greatly depending on the type of operation, the capacity of the trains on the line and the services the railway operator wants to offer. Ineco provides consultancy services to clients, deploying the networks best suited to their needs during the project and construction phases.

Satisfying the needs of railway operators does not mean offering extremely high bandwidth capacities per service, except in certain cases, such as video transmission services for security maintenance, although there is high demand in terms of the number of fibres needed per route on a line. There are two main reasons for this. First, the generation of a large number of networks enables them to be physically independent at all levels (fibre optics and transmission equipment). This means that a large number of optical fibres must be assigned. Their design offers higher security conditions, with redundancy mechanisms for paths and equipment. Ineco prepares optical fibre allocation tables per cable in order to define occupancy status. Second, railway administrations are offering dark fibres commercially to serve as transmission media for other operators. It is very normal to rent optical fibres to mobile telephone operators and other public administrations for the development of FTTH (Fibre To The Home) projects.

To use a road construction analogy, railway operators are usually not interested in roads with large lanes for heavy vehicles, but rather in roads with a larger number of smaller lanes, so that the total number of light vehicles can be increased.

The cost of deploying a fibre optics infrastructure is high, but because it is a long-term and a scalable investment, it is sure to have a long life. Once the cable is laid, technological advances in transmission equipment and optical interfaces will allow the latter to be replaced, thus offering better conditions in terms of bandwidth and transmission distance. ✱

Use and protection

The fibre optic cables typically used in railway telecommunications projects are 16, 32, 64, 96 and 128 FO.

Adif's high-speed lines use 32 FO cables to support trunk transmission networks and 96 FO cables for the deployment of access and dedicated service networks. They use 16 FO cables to perform segregations to different sites (providing access to communications networks) to generate Fall Detector meshes and to link FOR repeaters inside tunnels to the Base Stations (BTS) for the GSM-R railway service.

If the total number of fibres to be given connectivity in a communications technical room exceeds 16, the segregation cable will be 32 FO or higher. Other lines use 64, 96 or 128 FO cables for installation on the line, providing support for operational services and network architectures.

Some cables have covers to protect them from rodents and fire. However, these are not sufficient to completely prevent service outages. Protection against a cut in the cable or a failure in the laser emitting the light is just as important as fire resistance. This is solved by using different network topology designs.The Fixed Communications personnel at Ineco's High-Speed Line Facilities business unit use different options in the network topology designs they prepare for projects.

TWO MAIN TASKS. **Ineco also ensures that these cables satisfy the regulatory, technical specifications and client demands through two main tasks: the homologation and certification procedure for optical fibre manufacturing companies, and factory acceptance of cabling orders for particular projects, including the corresponding tests.**

INECO PROJECTS

Ineco applies these network architecture designs in order to guarantee the security and protection conditions required for railway service. All of these projects are based on the deployment of a fibre optics communications network.

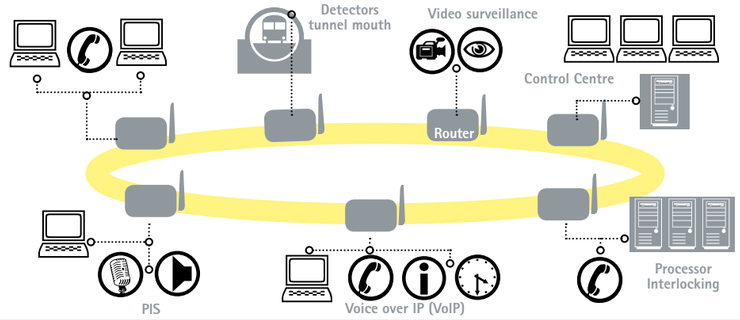
➔Project to develop the internal communications network for local FEVE (Spanish Narrow Gauge Railway Lines) networks. Orejo–Carranza line.

➔Construction project for signalling and communications facilities. Manacor–Artá (Majorca) section.

➔Construction project for signalling, fixed telecommunications, centralised traffic control, protection and security, and train protection systems for the high-speed line between Ourense and Santiago, and the Albacete–Alicante, La Encina–Valencia and Monforte del Cid–Murcia sections of the Madrid–Levante high-speed line.

Fibre optics splicing process.

COMMUNICATIONS NETWORK



Against the clock, against the mountain

Modernisation of the conventional Bobadilla–Algeciras line

Published in itransporte 32

Ineco took part in comprehensive modernisation work on the first section (59.6 kilometres), on the Bobadilla–Algeciras line, the only rail link to Spain's largest port. The work undertaken was highly complex due to the rugged hilly terrain on this stretch.

Improvements to this old, conventional single-track non-electrified railway line (it was opened in 1890) were difficult due to the rugged hilly terrain, which runs through the Guadiaro river gorge in the Serranía de Ronda mountain range, the environmental protection measures implemented and the need to carry out the work as swiftly as possible, owing to its strategic nature. With a total length of 177.5 kilometres, it is the only rail link between Algeciras and the rest of the Spanish network.

After the modernisation work carried out on the first 59.6 kilometres, the track material and new platform are now suitable for speeds up to 160 kph, with sidings at certain stations designed for large 750-metre freight trains.

Adif (Spain's railway infrastructures administrator) began work on the line in the year 2007. Since then, they have included the complete renovation of the roadbed, with the replacement of ballast, sleepers and rails, improved drainage and the installation of PR-01 multi-purpose sleepers from Ronda to the entrance to La Indiana station, and the multiple-width AM-05 sleepers from the entrance to La Indiana to the exit to San Pablo de Buceite station, making circulation compatible with both Iberian (1,668 mm) and UIC (1,435 mm) gauge.

Existing structures have been strengthened with some new additions. The signalling was also modernised and a CTC (Centralised Traffic Control) centre was added at Gaucín. Also planned (currently at the project stage) is the electrification of the whole line.

Environmental protection measures meant that restrictions had to be introduced, such as preventing access to various work areas. Staff and the material being used had to be taken right to the roadbed: 1,000 workers, 250,000 tonnes of ballast, 100,000 sleepers and more than 120 kilometres of rails. ✱

Helicopters were used in order to transport the dynamic barriers.

Specialist climbing staff were needed to position the metal mesh.

INECO'S PARTICIPATION

Ineco undertook site and environmental management and provided technical assistance, as well as monitoring two of the three sections of the line: Ronda–Cortes de la Frontera and Cortes–San Pablo de Buceite. As far as the final section (San Pablo–Algeciras) is concerned, studies of alternatives and environmental documentation have been prepared, along with the drafting of the Almoraima–Algeciras construction project, which includes a branch line between the San Roque freight station and the port. Energy studies and projects have also been prepared covering the whole line.

Work around the clock, seven days a week

Worthy of special mention among the work undertaken is the reinforcement and protection of embankments, earthworks slopes and banks to prevent the effects from flooding and the frequent landslides caused by the abundant rainfall in the area. Work on the first two sections of this stretch of the line was divided into two phases. The second and more complex section required the closure of the line to rail traffic for a period of 6 months in order to carry out major work that was incompatible with normal rail usage. Here, for example, in order to transport and install on the earthworks slopes some of the elements offering protection against landslides, it was necessary to use helicopters and specialist climbing staff. In addition to this inherently complicated labor was the added difficulty posed by the copious rainfall and the urgent need to reopen the line, meaning that work had to continue around the clock, 7 days a week.

TRACK ASSEMBLY. The existing fill was replaced with sandy ballast and new PR-01 and AM-05 multi-purpose sleepers were installed, as were 60 E1 and UIC-54 rails.

RETAINING WALLS. The construction of retaining walls and the installation of barriers and other elements is basic in order to improve safety.

REINFORCED TUNNELS. A total of 14 tunnels between Ronda and San Pablo were modernised and reinforced before lowering the tunnel invert in order to increase headroom.

CUT-AND-COVER TUNNELS. More than 200 large prefabricated concrete lintels (especially designed for this project) were used in order to construct 575 metres of cut-and-cover tunnels.

Level crossing ahead!

Since 1998, Ineco has participated in over 70 installation projects

Published in itransporte 43

A new system means it is no longer necessary to collect control data from automated level crossing equipment 'in situ', facilitating maintenance and therefore improving safety.

After automatic semi-barriers were installed in Spain at level crossings in 1987, Adif (the Spanish railway infrastructures administrator) began to install a local operation monitoring system, known as an event recorder, throughout the system. Similar to the black boxes used on aircraft, these loggers permanently record everything that happens at the installation. The equipment is installed in the level crossing cabin and features three logging levels:

- Level "0" collects all the input signals for a set time, depending on the installation type.
- Level "1" records technical incidents not related to safety.
- Level "2" logs all failures affecting safety.

Nevertheless, the system, only allows data to be collected at the level crossing in question, with the information downloaded onto a computer via a specific IT programme. Over time, it became apparent that this need to consult logs *in situ* was problematic for maintenance staff, as it was not possible to have information on breakdowns in advance. This led to the idea of accessing the information remotely and in real time via computer, in order to facilitate maintenance and ensure improved safety, both for the trains and the other vehicles using the crossing, by reducing repair times.

Technical assistance. And so, in 2009, Adif requested Ineco to provide technical assistance in concentrating the loggers and safety supervision at 263 level crossings situated on various lines in the general interest rail network. The company then took charge of the lay out works, controlling the installation of the necessary equipment and performing the various tests and commissioning. The system, known as CRYSSMA (Sistema de Centralización de Registradores y Supervisión de Seguridad y Mantenimiento), is structured on three different levels:

- "Concentration", consisting of all the equipment installed on the track, in order to obtain information on an unlimited number of level crossings
- "Centralisation", consisting of all the equipment needed for one or more stations to centralise the information received from the loggers installed at an unlimited number of level crossings
- "Operation", consisting of the elements required to represent and process the information from these central stations

This structure provides access to each of the event loggers from a terminal station and allows the relevant information to be downloaded without the need to visit the various crossings. The system gathers the information, stores it for subsequent processing and analyses it in order to detect possible exceptions. Furthermore, if any such exceptions are detected, an alarm can be sent via SMS to mobile phones, thus creating a fourth level, known as the "alert level". ✱

Ineco and level crossing protection

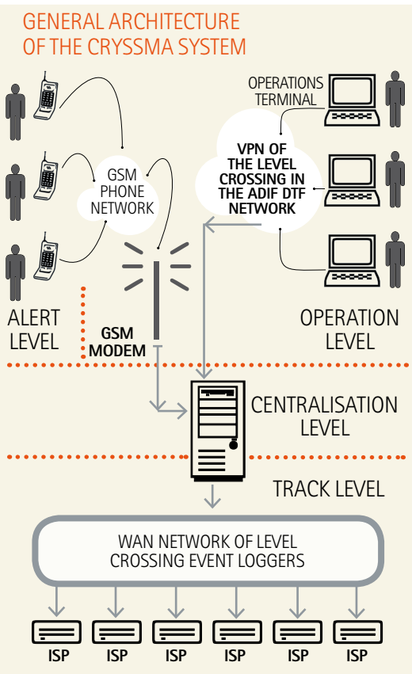
Ineco has been working with Adif's Level Crossing Department since 1998, providing technical assistance to site management. The company has participated in over 70 level crossing installation projects, such as automatic semi-barriers, acoustic and light signalling, and pedestrian protection systems. On a parallel basis, since 2007 it has collaborated on modernisation work on existing installations, both in order to bring them up to the standard required by current legislation and to replace equipment that has come to the end of its useful life (around 25 years).

DOWNLOADING LOGS. Data can be downloaded from the logger, either 'in situ' or remotely, from a terminal station.

Level crossing clasification

Level crossings can be classified according to the protection systems. Class 'A' crossings only use fixed signals. Class 'B' have acoustic and light signalling. These are the most common as a result of their proven effectiveness and the advantage they have in reducing the time that the crossing is closed due to the absence of barriers. Class 'C' level crossings are protected by semi-barriers, double semi-barriers or barriers (either automatic or interlocking) and are reserved for points where transit levels are high. Class 'D' crossings are standing instructions regiment, using manual chains, barriers and semi-barriers. Class 'E' crossings are manned systems with crossing keeper. Finally, Class 'F' are exclusively for pedestrians and/or livestock.

When installing protection, the choice between Class 'B' or 'C' depends on the visibility of the level crossing and a statistical indicator known as the 'moment of circulation' (AxT), the result of the product of average daily intensity of vehicles and the number of trains passing per day. If this is equal to or greater than 1,500, the crossing must be removed. Another protection element on Class 'B', 'C' and 'F' crossings is the 'rail signal', which informs the level crossing status to the train driver.



MAIN PURPOSES OF THE CRYSSMA SYSTEM

- To log and save any change in the status of supervised vital elements in a protective installation at a level crossing.
- To detect possible breakdowns or exceptions.
- To immediately send notification of any such exceptions and, if possible, information on the nature of the latter, to the system user terminals, and by SMS.
- To facilitate access to the saved information for analysis purposes.

Sustenance for the Spanish AVE

Transformers for the high-speed rail network

Published in itransporte 42

Ineco is responsible for technical specifications and supervision of traction substation equipment and auto-transformation centres required to supply power to new high-speed lines.

Ineco is currently involved in quality control at the 26 new electrical substations and their respective auto-transformation centres (around 130), which are responsible for supplying the electric traction energy needed to run the trains.

Adif first hired the company in 2008 to participate in drawing up the technical specifications for the equipment in the different high-speed line auto-transformation centres, as well as the traction substations. The Spanish railway infrastructures administrator also awarded Ineco consultancy and technical assistance contracts covering control of the supply, transportation, installation and commissioning of equipment at these high-speed rail network substations and auto-transformation centres.

The work basically consists of controlling, monitoring and providing organisational support for the supplies managed by Adif's Energy Department, with the point of departure being the general plans for the projects and the work schedules that apply to each supplier's contracts.

The high-speed lines for which Ineco was hired to carry out these tasks are the South, Northwest, Levante and the Madrid–Valladolid–North lines. Works on the Ourense–Santiago section of rail (on the Northwest line) are currently finished, as the line was inaugurated in December 2011. On the Albacete–Alicante section of rail, works are in their final stage.

Ineco has carried out supervision work in order to ensure the quality of supplies of 30 MVA, 405/2x27.5 kV and 220/2x27.5 traction transformers, 10 MVA and 15 MVA, 55/2x27.5 kV traction auto-transformers and 55 kV-SF6 cabinets for the electrical traction substations and auto-transformation centres associated with the high-speed lines.

The supply complies with the three technical specifications drawn up by Ineco, its additional requirements and the common reference standards. Worthy of special mention are the UNE-EN 60076 *Power Transformers set of standards* (the most recent applicable version of each), the UNE-EN 50329:2004 *Railway Applications. Fixed installations. Traction Transformers*, the UNE-EN 60694:1998 *Common Stipulations for High Voltage Switchgear and Controlgear Standards* , as well as the UNE-EN 62271 *High Voltage Switchgear and Controlgear* (the most recent applicable version of each). ✱

Transportation of equipment to an auto-transformation centre on the Ourense–Santiago section of rail.

220/2 x 27.5 kV, 30 MVA power transformers.

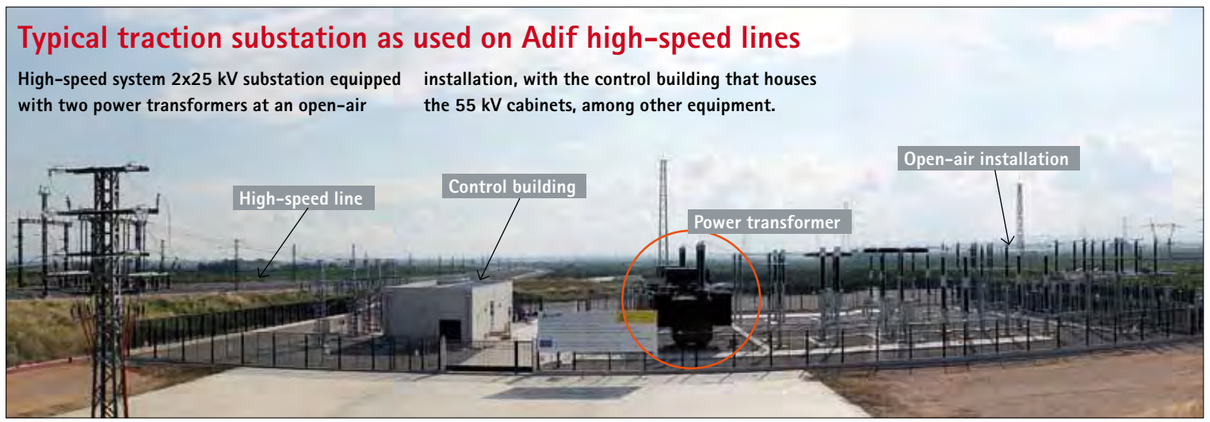
THREE TYPES OF EQUIPMENT

The equipment for which Ineco will be in charge of supervising installation and commissioning can be classified into three categories.

- POWER TRANSFORMERS for traction substations on high-speed lines, using a 2x25kV system.
- OIL-IMMERSED AUTO-TRANSFORMERS for auto-transformation centres on high-speed lines.
- REINFORCED TWO-PHASE 55kV CABINETS, insulated with SF6 gas.

Typical traction substation as used on Adif high-speed lines

High-speed system 2x25 kV substation equipped with two power transformers at an open-air installation, with the control building that houses the 55 kV cabinets, among other equipment.



Assistance schedule

The technical assistance provided by Ineco to guarantee the final quality of supply is divided into five phases.

PHASE 1. Technical validation of the prototypes. This includes a review of the manufacturer's installations, the quality control system and type tests, as well as analysis of the manufacturing procedures.

PHASE 2. Unit manufacture. This includes supervision of compliance with quality control specifications, set deadlines and assistance with Factory Acceptance Testing (FAT).

PHASE 3. Supervision of storage of the main mass and its accessories in factories, the control and management of access to centres and substations during transportation, and the unloading and assembly of equipment at its final location.

PHASE 4. Post-assembly field inspection and testing, prior to connecting the equipment to the grid and commissioning. Once the equipment arrives at its location, it is examined in order to detect any potential damage caused during transportation.

PHASE 5. Drafting of final documentation. Ineco is in charge of overseeing the maintenance manual produced by the successful bidders, which will specify all special precautions and instructions required in order to guarantee optimal equipment performance.

A Snow Plan that hits the mark

London-Heathrow, ready for bad weather

Published in itransporte 45

Implementing a procedure to put in motion 500 people in emergency situations is not an easy task. Ineco has created, in collaboration with Ferroser, the Snow Plan for Heathrow airport on the airside.

Following the snowfall of December 2010 that paralysed London-Heathrow International Airport and, to some extent, affected the main airports worldwide, BAA initiated a series of studies that gave rise to the Winter Resilience Plan, a project meant to develop the 14 recommendations that the Begg Report had defined as the keys to prevent a similar situation from occurring again at the London airport.

Ferroser, a Ferrovial subsidiary, was responsible, among other matters, for executing the Winter Plan for the Madrid-Barajas airport, a project carried out in 2009 by Ineco with great success. Aware of its experience and capacity, the company developed, in collaboration with Ferroser, the Snow Plan on the airside for London-Heathrow.

The main airport of the British capital city is also the busiest in the world in terms of international traffic volume, and handles about half of the air cargo moved in the entire UK. Its operation is much more complex than that of Madrid-Barajas, as it runs at near-full capacity for 18 hours, and continues for about 6 hours operating at night. Given this great density of traffic, a serious event affecting its operation requires cancelling flights, since its high demand prevents operating them in a different time window. *

COORDINATED RUNWAY CLEARING

Clearing of the runways is coordinated with the air traffic controllers, so that one of the runways is always operative and they can handle the air traffic generated daily at London-Heathrow.

Development of the Snow Plan

Work started in early May 2011, with four main tasks. [1] Activating and organising the Snow Plan. [2] Clearing stand areas. [3] Clearing runways and taxiways. [4] Clearing airside roads.

1 CLEARING AIRCRAFT STANDS

When working at full capacity, Heathrow has very few free aircraft stands, so they must be cleared as quickly as possible. In May 2011, the airport had 27 tractors (with a 6-metre wide and 1.5-metre high plough for removing snow), as well as 30 small vehicles (John Deere Gators) for less accessible areas. This equipment was completed by 6 spreaders.

To simplify the work, a clearing methodology was designed that allowed the snow to be cleared to both sides of the stands without having to change the plough position. A method was also created for reducing clearing times in larger spaces that allowed operating two machines in one space. This, as well as the purchase of 10 snow clearing equipment with spreaders, reduced the planned clearing time for a 10-centimetre snow fall to:

Terminal / Time (hours) for full clearing

T1	T2	T3	T4+CARGO	T5A	T5B	T5C	T5D	Ⓟ
3,8	5,9	5,9	11,7	3,5	4,6	9,3	6,8	8,8

With regards to clearing occupied aircraft stands, the planned procedure is more complex due to the risk of hitting the aircraft with the clearing equipment. Small equipment will be used to clear snow near the aircraft and large ones will be used in a second stage.

Following the snowfall of December 2010 that paralysed London-Heathrow, BAA initiated a series of studies that gave rise to the Winter Resilience Plan.

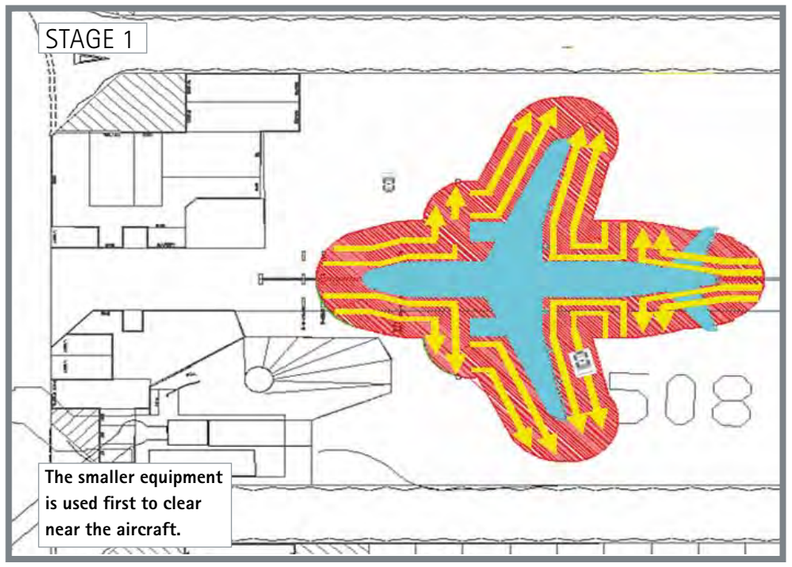
2 ORGANISING AND ACTIVATING THE PLAN

Two factors are essential for this Snow Plan to work: weather data and organisation in such a complex situation. Ineco's team visited the UK meteorology services (Met Office UK) to learn of their capacity. The team explained the importance of their forecasts for the operation of Heathrow, and a new communication protocol was designed for communication between the airport and the meteorological office in order to obtain the best available forecasts in proper time and form.

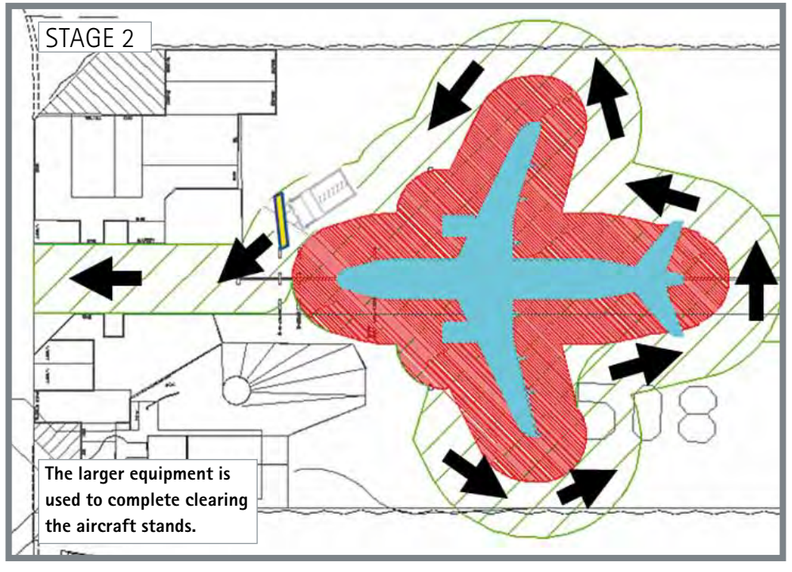
By way of example, in the years prior to the plan, the meteorological office announced the likelihood of snow 24 hours in advance, snow being one of the weather phenomena that is hardest to forecast, particularly for an area the size of an airport. Now, a methodology has been set in place that allows issuing snowfall warnings 5 days in advance, with a deadline for alerting of the likelihood of snowfall 6 hours in advance.

The flow of communications between Met Office UK and London-Heathrow increases from the time of the first alert until the snowfall occurs, and continues until it ends. The internal process of the meteorological office was also improved, so that the information would reach the appropriate persons at the right time.

In addition, the Snow Plan activation schedule was defined using a specific colour code.



The smaller equipment is used first to clear near the aircraft.



The larger equipment is used to complete clearing the aircraft stands.

Activation schedule

GREEN

Activated by a snowfall forecast within 5 days, with a likelihood greater than 30%.

ORANGE

Activated by a snowfall forecast within 2 days, with a likelihood greater than 40%.

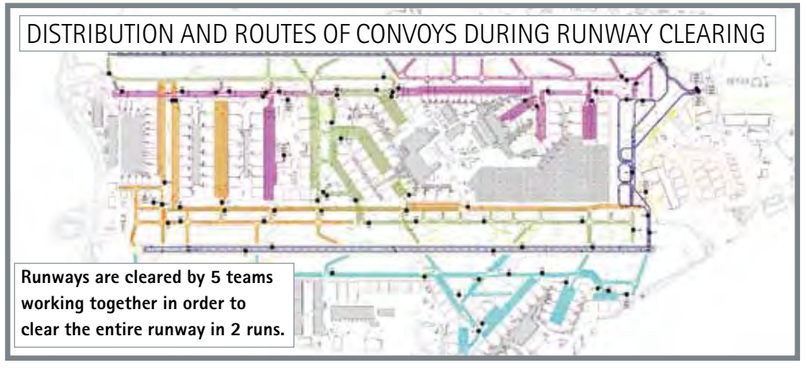
RED

Activated within 6 hours of the snowfall, when it is certain.

Organisation

The other essential factor is organisation: all persons must be aware of their roles in the Snow Plan for maximum efficiency. After analysing the organisation of the normal operation of the airside, a number of main roles were defined for coordinating the movement of the equipment with that of the aircraft to minimise their effect on airport operations. This organisation is integrated in the 'command and control' model of the London-Heathrow airport.

DISTRIBUTION AND ROUTES OF CONVOYS DURING RUNWAY CLEARING

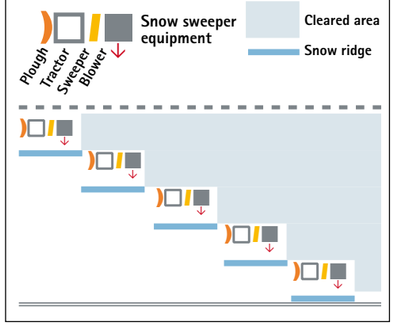


Runways are cleared by 5 teams working together in order to clear the entire runway in 2 runs.

'Command and control' model

GOLD	Strategic / Strategic Team
SILVER	Tactical Coordination / Tactical Team
BRONZE	Operation Control / Operational Team
ACTION	Airside / Operations Incident Response Teams

Runway and taxiway clearing



Training at Heathrow

Ineco, together with Ferroser, has also developed a training programme for the different roles defined in the Snow Plan. This plan includes both theoretical training and support for defining mock exercises in the London-Heathrow airport, most of which took place in the months of June, September and October. During the staff training process, the programme was also adapted to the daily operation of the airport.

20 snow sweepers, 6 snowblowers and 6 spreaders are available to clear runways and taxiways.

3
CLEARING RUNWAYS AND TAXIWAYS

Twenty snow sweepers, 6 snowblowers and 6 spreaders are available to clear runways and taxiways. As only 10 of the 20 snow sweepers are new, the procedure has been designed for using only 17, to allow for breakdowns.
The runway clearing process, coordinated with the air controllers, is characterised in that: [1] One of the runways must always be operative, together with the taxiways that service it. [2] Aircraft must be able to access the runway from any aircraft stand. [3] The minimum time for clearing the second runway must be 30 minutes, so that controllers can handle traffic.
In addition to the above considerations, the routes of snow equipment have been adapted to the normal operation areas of the airport. In order to meet these requirements, 5 convoys were defined.

After analysing airport traffic, it was decided to start clearing the north runway and the exit and access links. The programmed time needed to prepare the first runway was 30 minutes. This requires 3 convoys to be used simultaneously: 1 for the runway and 2 for the runway exits and accesses, and parallel taxiway. The fourth convoy will clear the south area between the runways, and the fifth will clear the area of Terminal 4.
This procedure should allow clearing the full manoeuvring area in less than 2.5 hours, observing at all times the simultaneous operation of the aircrafts, which in these conditions will be below normal levels. If the snowfall continues, the convoys will return to their initial stations. Coordination is essential for the simultaneous clearing of the areas next to the south runway.

4
CLEARING AIRSIDE ROADS

Airside roads must remain operative so that the handling vehicles can access the aircraft. For Heathrow, the presence of tunnels under taxiways makes the preventive treatment of their accesses and exits essential to prevent ice buildup. The solution was to establish 5 convoys comprising a single vehicle. At this time, in view of the available resources, two routes were linked to allow executing the procedure in a coordinated manner. Throughout the project, the de-icing routes were also defined for both the runways and the taxiways, and the snowdumps were identified according to the different snowfall levels.

Madrid-Barajas programme

In the winter of 2008/2009, Ineco prepared and implemented a Snow Removal Plan for the Madrid-Barajas International Airport that considered the different actions to be taken in case of snowfall and/or ice buildup. The plan represented a substantial change, with more teams, a system of routes and convoys, and a new command and coordination structure.

'Our experience with Madrid-Barajas was essential for the Heathrow plan'

Q&A

Salvador Urquía

Centre Regional and International Director of Ferroser

Salvador Urquía emphasises how the collaboration between Ferroser and Ineco was one of the keys for the satisfactory outcome of the London-Heathrow Snow Plan. He also notes that advances in weather forecasting have improved the ability to take actions in advance in case of bad weather. The prior experience of Ferroser and Ineco in preparing and executing the Winter Actions Plan at the Madrid-Barajas International Airport was a decisive factor for developing the London-Heathrow Snow Plan. His company has specialised in comprehensive maintenance of buildings and installations for over 20 years.

Have there been big changes in preventive means for bad weather conditions?
What has improved are weather forecasts, and therefore the capacity for advance action when preparing and preventing the potential consequences of bad weather. It is also true that user expectations are increasingly higher, requiring that their activities not be interrupted by weather conditions.

Ferroser has great experience with roads, buildings and, in recent years, with large airports such as Madrid-Barajas and London-Heathrow. Do these represent your greatest challenges?
In the services sector one finds and sets challenges every day. You don't stop to consider which are bigger or smaller. You always try to overcome them and once you've managed, you set yourself new challenges within those you have successfully accomplished in order to further improve the services you provide, as one does in other sectors, areas or activities.

Nowadays, all companies that wish to survive or even grow must set themselves significant challenges, such as those mentioned before, but also much smaller ones that allow accomplishing the larger ones.

Compared to your experience with the Madrid-Barajas Winter Action Plan, was the work in Heathrow very different?
Most certainly. Our experience in Madrid-Barajas for preparing and executing the Winter Action Plan, resulting from the severe snowfalls of 2009, was vital for obtaining a better result in London. In this sense, I would say that the work in Heathrow has benefited from the learning experience in Madrid-Barajas and has allowed a greater analysis of the details which, as a result of this experience, we knew could be critical due to their repercussion or to the time required to implement them.

In any case, there are always differences between working in Spain and in the United Kingdom which are intrinsic to how work is done in each country. But this is something that one must adapt to and which is part of everyday experiences in Ferrovial.

Snow, ice, rain... Which one do you fear the most?
Actually, I don't think we should fear any of them. We must respect these weather phenomena as they deserve, and plan and act in consequence. This is exactly what BAA has done in its Winter Resilience Plan, considering the 14 recommendations resulting from the Winter Resilience Enquiry, in which the airlines, the NATS, the CAA and, of course, BAA participated.

To answer the question more specifically, the combination of snow and ice is probably the hardest to manage to maintain operability in any infrastructure.

In order to obtain good results, which is Ferroser's best ally, weather forecasting or a good budget?
Without a doubt, a combination of both. In fact, an accurate weather forecast can allow saving money, so that they are complementary tools that should always be used jointly.

Now that winter is over, how would you rate the consultancy work performed by Ineco?
Ineco's work was outstanding, as expected... But I should remark that it was in the collaboration between the two companies where we have excelled, delivering a technical product with the experience of its application and start up. In short, it is a work that exceeded our client's expectations. ✱

Experts in snow removal

Ferroser's experience and technical know-how related to snow removal ranges from airports to roads. The machinery used is adapted according to the type of snow, its amount and location. This experience in integral management is complemented with Ineco's experience in airport operation, planning and coordination between the responsible parties in order to minimise incidents.

Bigger under the sun

Study on how to improve Casablanca International Airport

Published in itransporte 43

Mohammed V Airport has undergone spectacular growth over the past decade. In early 2011, Ineco was hired by the Office National Des Aéroports (ONDA) to undertake an expansion study.

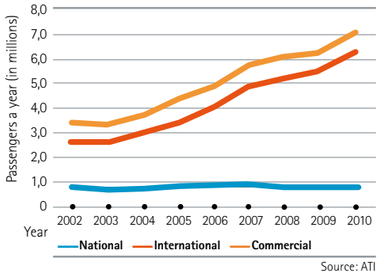
With a population of nearly 6 million people, Casablanca is Morocco's biggest city. It accounts for 50% of the country's industrial activity and is considered to be its financial capital. Mohammed V International Airport plays a key role in this economic activity.

With over 7 million passengers a year, it is the most important airport in the Maghreb region. Nearly 90% of its traffic is international, with direct flights to the Middle East, North America, Africa and virtually all the European capitals. The most popular routes are to Paris and Madrid. It is worth highlighting the large number of passengers who use the airport as a hub, mainly between Europe or America and Africa.

There are three terminal buildings. Terminal 1 (T1) has a total floor area of 66,000 m², although the majority of this space is temporarily closed due to extension work. Terminal 2 (T2) covers 40,000 m², with 36 check-in desks, 26 passport controls in departures and 28 in arrivals, 9 baggage-reclaim belts and a departures lounge. Terminal 3 (T3) has a total floor area of 4,000 m² and has been used for passengers during the Hajj pilgrimages to Makkah.

In early 2011, the Office National Des Aéroports (ONDA), the body in charge of managing Moroccan airports and air navigation services, announced a public tender for a study to identify the issues currently affecting the airport and define the dimensions and design of the infrastructures required in order to meet future traffic needs. Ineco was awarded the tender. *

PROSPECTS FOR THE PROJECT
When the work is complete, Mohammed V airport facilities will be fully in line with future demand.

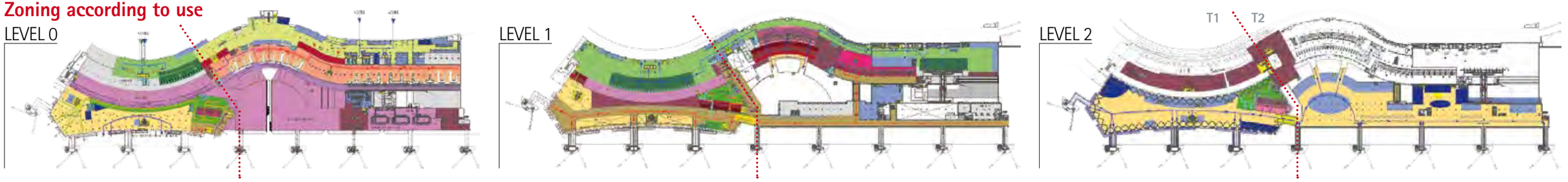


Source: ATI

High growth

Casablanca airport has undergone rapid growth in recent years. Since 2002, the number of passengers has doubled. As a consequence of this increase in traffic, the current facilities will not be sufficient to meet future passenger and aircraft demand.

Zoning according to use



Phases in the study undertaken by Ineco

→PHASE I

ANALYSIS AND DIAGNOSIS

All infrastructures, both those intended for use by passengers and those that are devoted to baggage, airlines and commercial, administrative and technical areas, were analysed. Passenger and aircraft traffic was also defined. A number of days were spent measuring the time required to process passengers at check-in, security checks, passport control, connecting flights, as well as for outgoing and incoming baggage. On the basis of this information, a diagnosis of the airport facilities and its operations was prepared, identifying the flows and processes that were liable for improvement. An architectural diagnosis of the building was also drawn up, from a structural point of view and in terms of the quality of the surroundings offered to passengers.

→PHASE II

DETERMINING NEEDS

Infrastructure needs were calculated on the basis of future passenger demand. To this end, design parameters ensuring high levels of service were defined.

→PHASE III

GENERATING AND SELECTING ALTERNATIVES

A number of design specifications were established during this phase.

- The functional and architectural integration of the terminal buildings should be such that the final result takes the form of a single building. This minimises operating costs and optimises flexibility.
- The new development should allow passengers and their baggage to make their flight connections quickly and easily.
- The new facilities should enable the installation of an Automated Baggage Handling System (ABHS).
- The architectural solution should ensure high standards of comfort in passenger areas, with special attention being paid to heights and lighting.
- The location of commercial areas will be optimised for better adaptation to passenger flow without hindering operations. When selecting the best development alternative, the emphasis was placed on efficiency, which is understood to mean optimising targets and cost.

→PHASE IV

IMPACT ON OTHER PROJECTS

Parallel to preparing and selecting alternatives, ongoing projects were analysed to determine the impact to be expected from the new proposed development. Special importance was placed on the T1 extension project, where work was already underway. At the time that the study was undertaken, this work had been temporarily suspended, pending the solution proposed by Ineco. After the study was concluded and submitted to ONDA and the Moroccan Ministry of Transport, Ineco was hired to take over responsibility for the Technical Engineering Support Office for the T1 and T2 extensions. Management teams from Ineco's Aeronautical Consultancy, Airport Projects and Architecture, Structures and Instrumentation departments will be participating in this contract.

To control lights

Control and Display System for Visual Aids

Published in itransporte 45

Ineco is in charge of technical assistance for the installation and maintenance of the Control and Display computer system (SMP) that controls and manages visual aids in Aena's airports and heliports.

Watching an aircraft land, getting closer and closer to the ground, is always a special moment. But at night, it is quite spectacular: lights are used to welcome and show the pilot which way to go to meet the runway and guide the aircraft to the end point of its path.

How many lights does an average airport have? How are they turned on and off? What would happen if they suddenly went out? There is a system that is as simple to use as essential in its function, which is used to control the entire illumination of the airfield. The different visual aids can be turned on and off, as well as given different brightness depending on the visibility conditions at the time, thereby preventing both insufficient light and excessive glare.

As important as turning on the visual aids is being able to turn them off in order to show the aircraft which way to go and where not to cross. The objective is to provide assistance in guiding the aircraft, as well as saving energy, a matter particularly relevant nowadays for environmental and economic concerns.

This system is known by the initials SMP (Sistema de Mando y Presentación or Control and Display System). Understanding the term "control" seems simple. But what about "display"? It is refered to this way because its main function, in addition to controlling the lights, is to view their status so that the airfield illumination situation can be known at all times, with little delay.

Technical standards. Spanish Royal Decree 862/09 (on the technical standards for designing and operating airfields of public use) establishes that, whenever there is a change of operation of the lights, an indication must be provided in less than 2 seconds for the stop bar, and in less than 5 seconds for the other types of visual aids: the SMP system was designed within this framework. In compliance with this standard, Aena (the Spanish operator of airport services and air navigation) has gradually installed the system since 1999. It is currently implemented in almost all the airports and heliports of its network.

It is a simple system to use, and although it has evolved over time, it has maintained the same characteristics and interfaces, so that an operator can use it in any airport of the network without encountering significant differences nor requiring specific training.

This standardisation strategy was also applied to the programming, in order for Aena to have a proprietary corporate software, a tool that would provide an open system. For this purpose, it was decided that all SMP systems would be developed on the Industrial Application Server (IAS) platform of Wonderware. This has led to a system that is easier to understand, modify and, therefore, maintain by any integrator, even those who were not responsible for the initial development. It also provides Aena with greater knowledge and control, and simplifies upgrades and future work. ✱

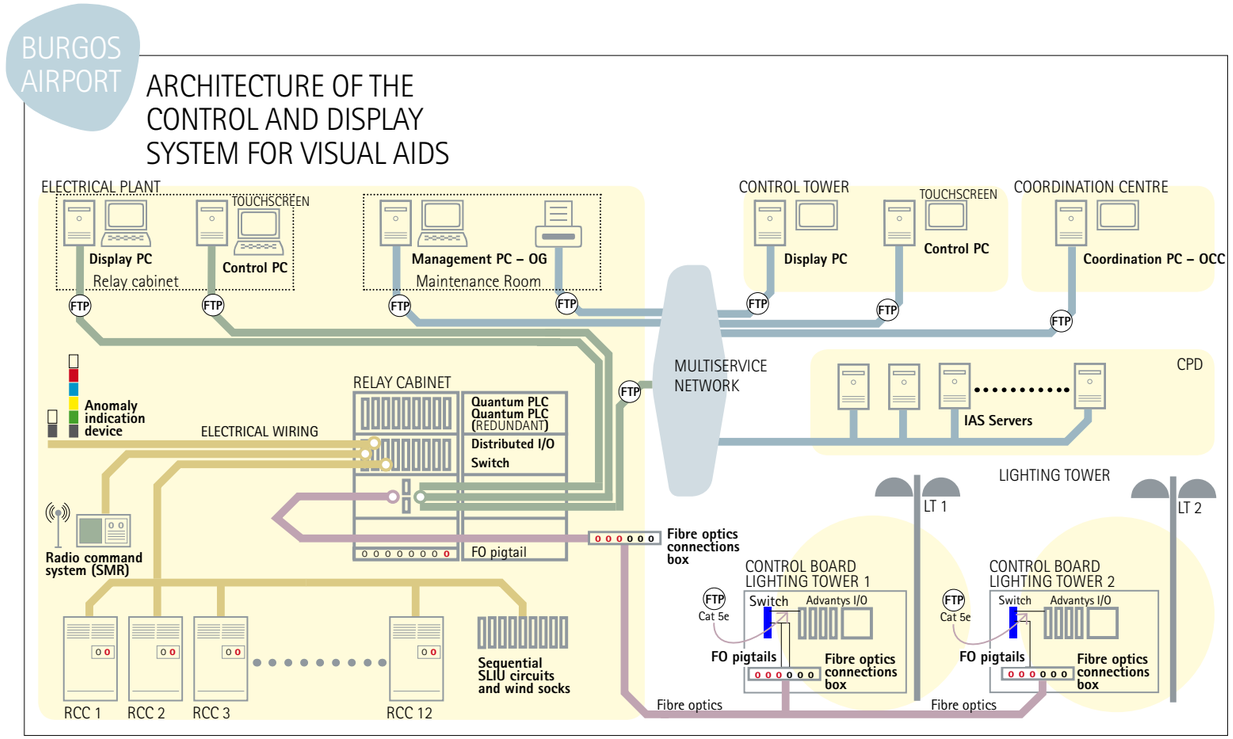
Classification

These systems can be classified in two groups. [1] A traditional system with a central computer as the 'brain'. [2] An exclusive local network, IAS system whose application resides in the SCADA (Supervisory Control And Data Acquisition) servers of Aena. Communication is established using the airport's Multiservice Network. The servers are standardised under the guidelines of the DSI (Information Systems Division) of Aena, which also defines the architecture according to its regulations for the SCADA and participates in maintenance tasks.

PHOTO BY JUAN LUIS SÁNCHEZ (INECO)

AN ONGOING TASK

Ineco provides technical assistance in the installation and comprehensive maintenance of the SMP. Due to its critical nature, it is a continuous and ongoing task, as any work, transfer or expansion of any airport elements requires the system (hardware and software) to be modified. It is also a multidisciplinary task that requires coordination between the persons in charge of implementation, maintenance and the system users.



Components of the Control and Display System

The control and display operations are performed from several stations, as in all SMP systems:

- **CONTROL TOWER STATION. A touchscreen to enter the commands to turn on the runway and taxiway visual aid systems, and a display monitor that shows their status.**
- **ELECTRICAL PLANT STATION. Located in the regulator room, identical to the tower station.**
- **COORDINATION STATION. Desktop PC in the technical block, in charge of controlling the platform illumination towers and the display of the set of aids and towers.**
- **MANAGEMENT COMPUTER. Desktop PC with a printer for the control room of the electrical plant, which can act on the entire illumination of the airfield, viewing its state and the alarms that can be triggered. This station is also used for maintenance, enabling generation of reports, modification of configurations, etc.**
- **The command given from the control station is processed by the central computer or the servers, as applicable. The automata deal with messages received from the installation brain and activate relays that turn the circuits off or on at the desired brightness. The status is displayed using the same process, in the opposite sense.**

A control alternative used, for example, when the airport is closed, is Radio Control, in which a receiver can enable activation of various visual aids using the airport aerial frequency band, so that the pilot can turn on some systems using radio pulses.

The point-to-point system should also be mentioned, which is based on the SMP system, but has the advantage of knowing the status of each of the beacons in the system.

The brains behind the airport

Changes to real-time management

Published in itransporte 42

The activities of the main airports in the Aena network are overseen from the Airport Management Centres. Ineco has collaborated with Aena's Operational Readiness and Transfers (ORAT) department in implementing these new horizontal management models which are groundbreaking in the sector.

Aena's Airport Management Centres are the forerunners of a more effective model that is fully geared towards the customer, one that leaves the traditional and vertical models behind. We find ourselves in a globalised and increasingly competitive world, where cost reduction is a priority for all companies and where the competitive edge is increasingly defined by the ability to meet customer expectations, in open, dynamic environments. The airport business is aware of this situation, as demonstrated by the important changes already underway at Aena's main airports.

Madrid-Barajas was the first major Aena airport in Spain to respond to this need to change, implementing real-time management in the year 2002. The passenger terminal T4 extension, inaugurated in 2006, posed a challenge that was hard to meet with the traditional model and therefore Aena decided to set up an Airport Management Centre (AMC) at Madrid-Barajas, from which monitoring and control for the whole airport could be coordinated.

PHOTOS BY AENA'S IMAGE BANK (AGAENA)

The Madrid-Barajas AMC.

The AMC comprises a set of units occupying a surface area of over 3,000 m², including a main operations room with 96 workstations (300 people providing service 24 hours a day), a crisis room and space set aside for technical matters, training, administration, etc. All of these facilities are equipped with the very latest technology (videowalls, integrated systems, IT tools...), as well as being clearly process-oriented: monitoring of main process indicators, control panels for general airport supervision, automatic incident detection systems, the tools and procedures required to deal with these exceptions, real-time recording of incidents with facilities for subsequent analysis, etc. The Madrid-Barajas AMC is a pioneering airport management project, not only for Aena, but on a worldwide level.

Barcelona-El Prat International Airport, extended in 2009, also saw the creation of an AMC at the new T1 terminal, applying the same concept of unified airport management. Other Aena airports (Málaga in 2010, Alicante and La Palma in 2011, as well as others currently being extended) have redesigned their real-time management model. ✱

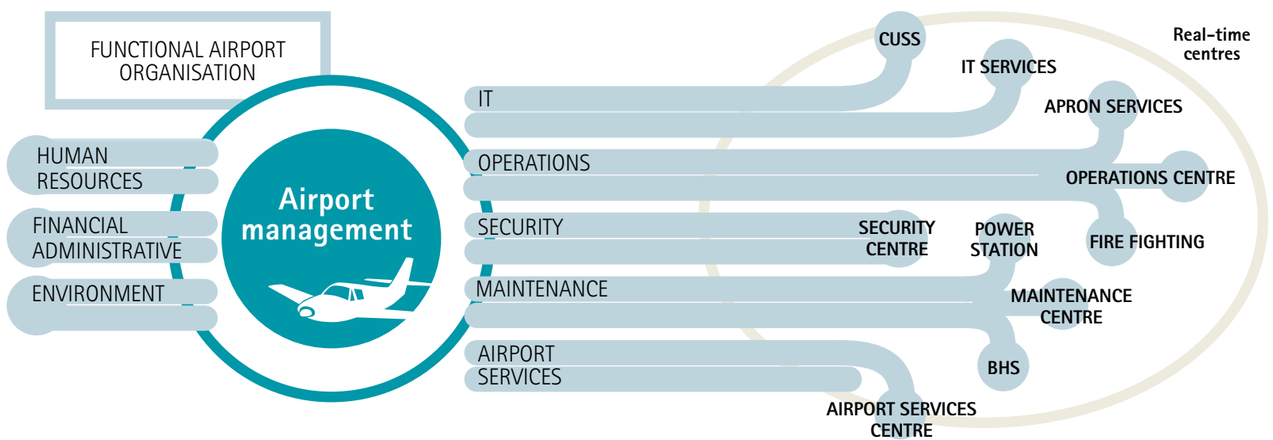
Process-oriented management

The implementation of this form of management is one of the most effective improvements.

Airport organisational models have traditionally been based on strong functional specialisation, leading to situations whereby each department operates on an isolated basis, with very little integration with the rest of the organisation. As in most companies, this phenomenon has important consequences: transversal activities tend to become blurred, interface responsibilities are less clearly defined, activities involving various organisational units are affected by unbending departmental barriers that lengthen the time required for the process, cause errors, create confusion and increase costs. All of these matters have been extensively studied in published works focusing on business organisation.

Most of an airport's activities (around 70%) take place in real time (understood to be the set of interactions with the surroundings subject to temporal restrictions). Real time has particular characteristics which make the limitations of traditional organisation more critical:

- **Resources are grouped into 24-hour centres that reproduce and multiply negative effects (multiple centres in each department).**
- **It functions as a complex, unpredictable system (the exceptions, breakdowns and circumstances that occur mean that no two days are alike).**
- **There is an impact on the quality perceived by airport customers, meaning that real time is particularly sensitive.**



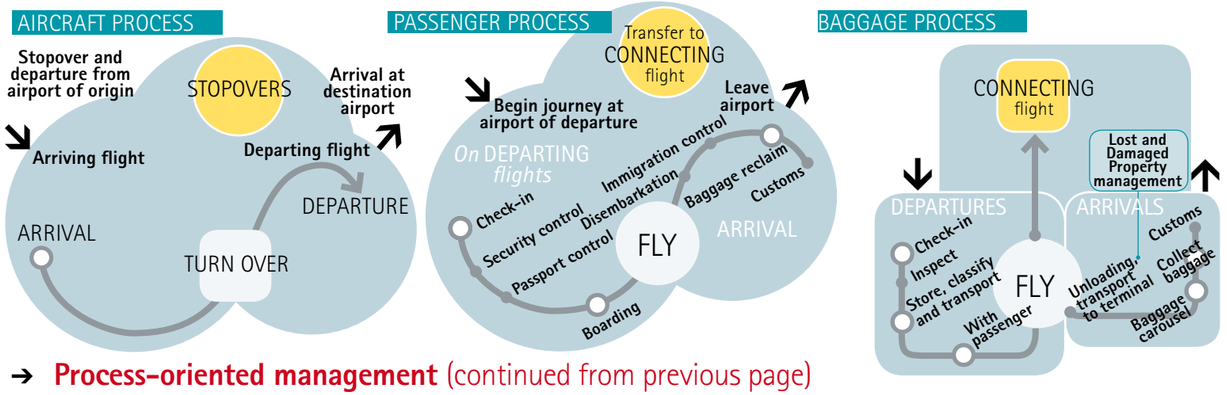
The Madrid-Barajas AMC is a pioneering airport management project, not only for Aena, but on a worldwide level.

Experience in Aena. Customer-oriented processes

In an airport, the main external customers are the passengers and the airlines, although other airport users may also be considered as such. In simple terms, the aim of the airport business can be understood to be providing the resources required to ensure that each passenger, generally carrying their baggage, can catch a specific flight (or, in other words, to ensure that each airline is able to collect passengers and their baggage to take them to their destination airport). Therefore, there are three key airport processes: aircraft, passengers and baggage (see diagrams below).

As may be seen in the Airport Process map, the key processes are undertaken almost exclusively in real time, and it is through these processes that the desired interaction with customers occurs. Similarly, support processes play a significant role in real time. The process perspective provides a better understanding of the critical nature of appropriate organisation in order to carry out activities in real time. This is the philosophy at a number of Aena's main airports, which, taking advantage of recent extension work on its airports, have reorganized their real-time resources by implementing variations on the process-oriented model.

As far as Aena is concerned, the trend seems clear: process orientation has proven to be an effective real-time management model. Nonetheless, this is very much a groundbreaking experience, one of which many airports are still unaware.



→ Process-oriented management (continued from previous page)

Process-focused management, a basic principle of Total Quality Management (9000:2000 ISO standards), has proven itself to be a new form of business administration. It implies an orientation toward the external customer and allows market expectations to be balanced with the company's in-house activities. In order to adopt a process-based focus, the organisation needs to identify each of the activities it undertakes.

Graphic, ordered, sequential representations of all activities, with their corresponding interactions, are called process maps. Organisational activities are generally horizontal and affect various departments. This 'horizontal' concept (process and activities) is juxtaposed to the traditional 'vertical' organisation (departments and functions). This however does not mean that processes replace or cancel out these functions.

The sum of the independent targets and activities from each department should result in attaining the organisation's overall targets. An organisation's processes tend to fall into one of three groups: strategic, key and support processes.

- **Strategic processes are responsible for ensuring a suitable response to the company's needs and conditioning factors: marketing, human resources, quality control, etc.**
- **Key processes involve direct contact with the customer and are related to business targets.**
- **Support processes (maintenance, IT, security) provide the resources required in order to undertake the key processes.**

AERONAUTICAL | **SPAIN** | Airport enlargement

At the end of the way

Design and construction for the new terminal of León airport

Expansion project

Published in itransporte 35

Improvements at León airport include a stunning new terminal building and larger aircraft parking bays, car park and access areas. Ineco has worked alongside Aena in the preparation of the projects and supervision of the work.

The final stage of the enlargement work at León airport was officially inaugurated in October 2010. The metal framework of the new 4,840 m² terminal building is the most recognisable element. Designed by Ineco for Aena, in collaboration with the Francisco Benítez architecture studio, the project tripled the available surface area, increasing its capacity to 520 passengers per hour.

The new terminal and extension work included the installation of a new Automated Baggage Handling System (BHS), 7 check-in desks, 3 departure gates and 3 baggage reclaim belts (one of which will handle special baggage), as well as the construction of new retail areas. The access roads and a new car park (with space for 295 vehicles and 4 parking bays for coaches) were also extended and remodelled, as well as the various mechanical and electronic systems.

The airport, which has been named *Virgen del Camino* (*Virgin of the Way*, in reference to the St. James' Way) is situated near the small town by the same name, 6 kilometres from the city of León. Built in 1929 as a military base, it was opened for civilian air traffic in 1999. ✱

ADAPTED TO THE 21st CENTURY. The growth the airport has experienced in recent years has seen the construction of new facilities and infrastructures.

PHOTOS BY AENA'S IMAGE BANK (AGAENA)

Further details

- **New terminal building: 110x44 metres on two floors, with a surface area of 5,276.73 m² on the ground floor and 2,689.74 m² on the upper floor.**
- **New car park: 295 parking spaces, in addition to the current 191 spaces.**
- **Service roads, landscaped areas and further parking spaces: 2,950.8 m².**
- **Aircraft parking bays: these have been enlarged by some 23,000 m², with the total surface area now covering 46,000 m².**
- **Taxiway: width increased to 5 metres, with a further 10-metre margin.**

WORK BY INECO AT LEÓN

Ineco prepared the designs for the new terminal building, urban development, extensions to the airport parking bays, its car park, an electricity generation plant, drainage work and service roads.
Ineco was also responsible for on-site monitoring and surveillance. Prior to this, the company took part in both of the previous extension projects, which concluded in 2005 and 2007. In 2001, it drew up the Planning Study (equivalent to a Master Plan) on behalf of Aena.

Covering the world

Cover applications

Published in itransporte 43

CoverNav began to take shape in 2005, an Ineco RDI project offering extremely accurate air navigation simulations. This continuously evolving set of applications is now world-renowned and is used in large-scale projects.

All the RNAV air navigation procedures in the world are evaluated and validated by checking the features provided by the navigation systems: DME and VOR.

Validation of the suitability of this terrestrial infrastructure to support provisions required by these procedures cannot be carried out solely by calibration flights, as, in addition to being costly, it is not possible to undertake comprehensive checks in any condition. For this reason, powerful calculation tools enabling coverage simulations are required, ensuring the accuracy and continuity of the services provided in any condition. Based on this idea, a proposal was put forward in 2005 for an Ineco innovation project to meet these air navigation needs.

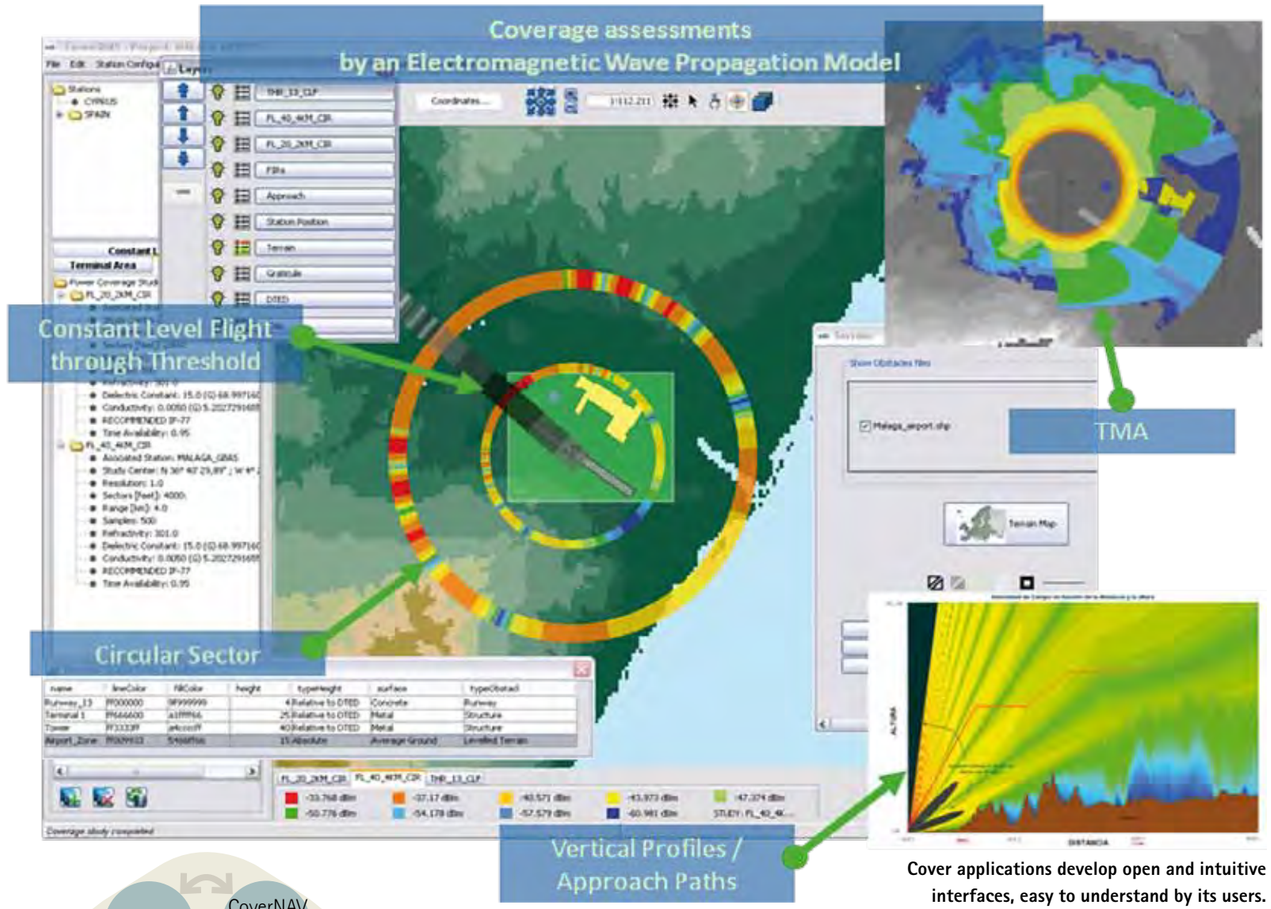
A development team set out the premises for an efficient line-of-sight calculation algorithm to simulate radio-assistance coverage on these systems. Interest quickly grew in this new application, developed as a desktop application backed by a geographic information system (GIS). This first innovation project designed by Ineco was very well received by our customer, who validated the results provided by the application by comparing them with data registered on calibration flights.

CoverNAV gained fame in subsequent years. New needs began to emerge and were in time covered by new Cover applications. Given the interest of Aena in this first programme and as the CoverNAV functions and graphic capabilities were being improved, the knowledge acquired in this project was used to commence work on new developments.

In order to include radio communication systems, a sight-line calculation algorithm was complemented by a radio wave propagation algorithm, through which the power loss associated with voice communications between the pilot and the control tower could be calculated. This idea, together with the inclusion of more functions, gave rise to a new member of the family: CoverCOM. At the same time, another innovation project turned its gaze skyward. The GPS constellation is considered the navigation system of the future. It was therefore decided to simulate the characteristics of the availability and continuity of this system, calling it CoverSAT.

CoverGBAS was born after renewed interest by Aena and Ineco in the Cover family of applications. The programme was improved and the GBAS system was added to the coverage simulations. Aena sought to increase the algorithms and it was decided to include one that would be able to search for the optimum location for CNS system antennas based on the restrictions to be set.

Impulse was created last year, a new innovation project which has revolutionised the premises for and scope of Cover applications. On the one hand, the simulator systems were extended with new pulse signal systems, and, on the other, a new group of analysis algorithms focusing on the problems associated with various phenomena were added. ✱



Cover applications develop open and intuitive interfaces, easy to understand by its users.

Continuous growth

The Cover applications make up a growing range of products. Communication within the development team and coordination with experts make it possible to develop applications that are increasingly compact.

CoverNAV. Line-of-sight coverage studies to ensure the optimisation of terrestrial infrastructure in assisting air navigation. It is used in RNAv analysis to ensure accuracy and continuity.

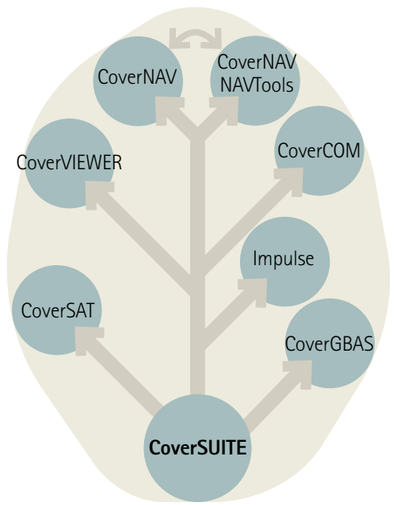
CoverCOM. Radio-electric coverage studies for voice communication systems. Studies focusing on blocks of air space and sectors, providing information on minimum flight levels and sector power coverage.

CoverSAT. GPS and integrity availability and continuity studies based on RAIM.

CoverViewer. Comparison of results from different air navigation systems.

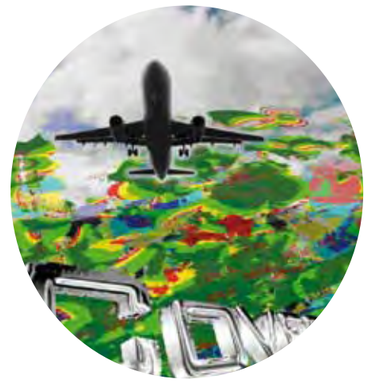
CoverGBAS. Studies focusing on the GBAS satellite systems: location of the best VHF transmitter position, compliance with restrictions, etc.

Impulse. Studies to predict the effect of new obstacles on the quality of pulse-system signals.



The sky is not the limit

All Cover applications have been presented at various international congresses from the outset. Cover has had a continuous presence in ATC Global and attracted the interest of other companies. It is worth mentioning the interest and collaboration of the French Directorate-General for Civil Aviation in CoverNAV: they acquired in 2007 the necessary licences to incorporate it into their work of evaluating and validating air navigation procedures. Some of the tasks for which these applications are used are as follows:



- **Generation of coverage and navigation reports to evaluate and validate RNAV procedures published every month.**
- **A report covering the Spanish territory, verifying radio coverage for all the communications stations.**
- **Aena installed the first GBAS system in Málaga. Cover applications were used to validate the location.**
- **The pulse system algorithms are continuously being verified through simulations to evaluate new obstacles. The Cover tools are used to simulate the effect on signal quality.**

From Madrid to the sky

A major aerospace engineering project

Published in itransporte 44

The new European Satellite Navigation Service Centre in the town of Torrejón de Ardoz (near Madrid), which will come into operation in 2014, will be a benchmark for technical excellence in satellite navigation systems without precedent in Europe. Ineco is coordinating the definition study for this key part of the Galileo project.

Antonio Tajani, Vice-President of the European Commission, signed a historic Memorandum of Understanding in 2011 with the Spanish Ministry of Transport, which established the site of the GSC (the European GNSS Service Centre) at the town of Torrejón de Ardoz, near Madrid. The centre will form part of the European satellite navigation infrastructure and will act as the sole interface with users of Open Galileo services (OS), as well as for critical (SoL) and commercial (CS) applications.

The study, which Ineco is leading under the supervision of the Ministry of Transport, with the financing of Aena and the support of the National Institute for Aerospace Technology (INTA), will define the scope of the GSC. The following leading Spanish aerospace engineering companies are also taking part: Indra, GMV, Deimos, Hispasat, INSA and the aforementioned INTA.

Satellite navigation systems have support centres that provide information on maintenance plans, navigation performance and interface and algorithm specifications. It is hoped that this centre will include functions for Galileo and EGNOS, as well as other multi-constellation solutions.

GSC development will follow the Galileo deployment schedule, whose two first satellites are already in orbit. Having ensured the initial operational capability (IOC) of the system, operations will begin on the first version of the centre. All services will be on stream when the constellation with 30 satellites is completed (full operational capability - FOC) and will potentially include the EGNOS services that are already offered from Madrid. ✱

Interfaces

The GSC will maintain interfaces with the following: [1] Galileo Control Centres in Germany and Italy. [2] Time, geodesy and independent performance analysis provision facilities. [3] With the Galileo Security Monitoring Centre (GSMC). [4] External commercial service data providers. [5] Communities of users of regulated and non-regulated OS, CS and SoL services. [6] The EGNOS Service Centre and GNSS systems service centres. [7] Any current or future elements within the Galileo infrastructure.

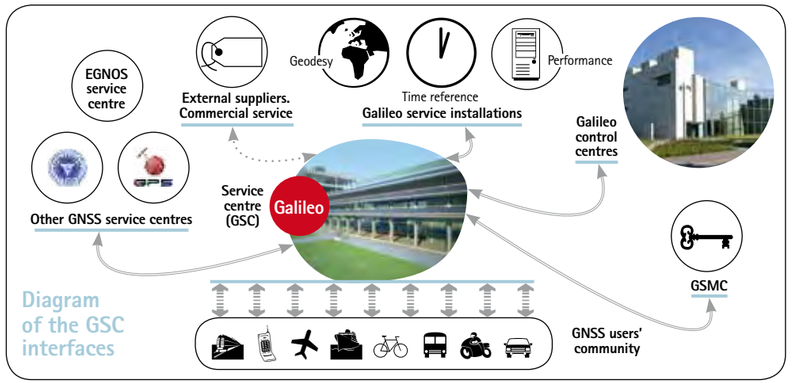
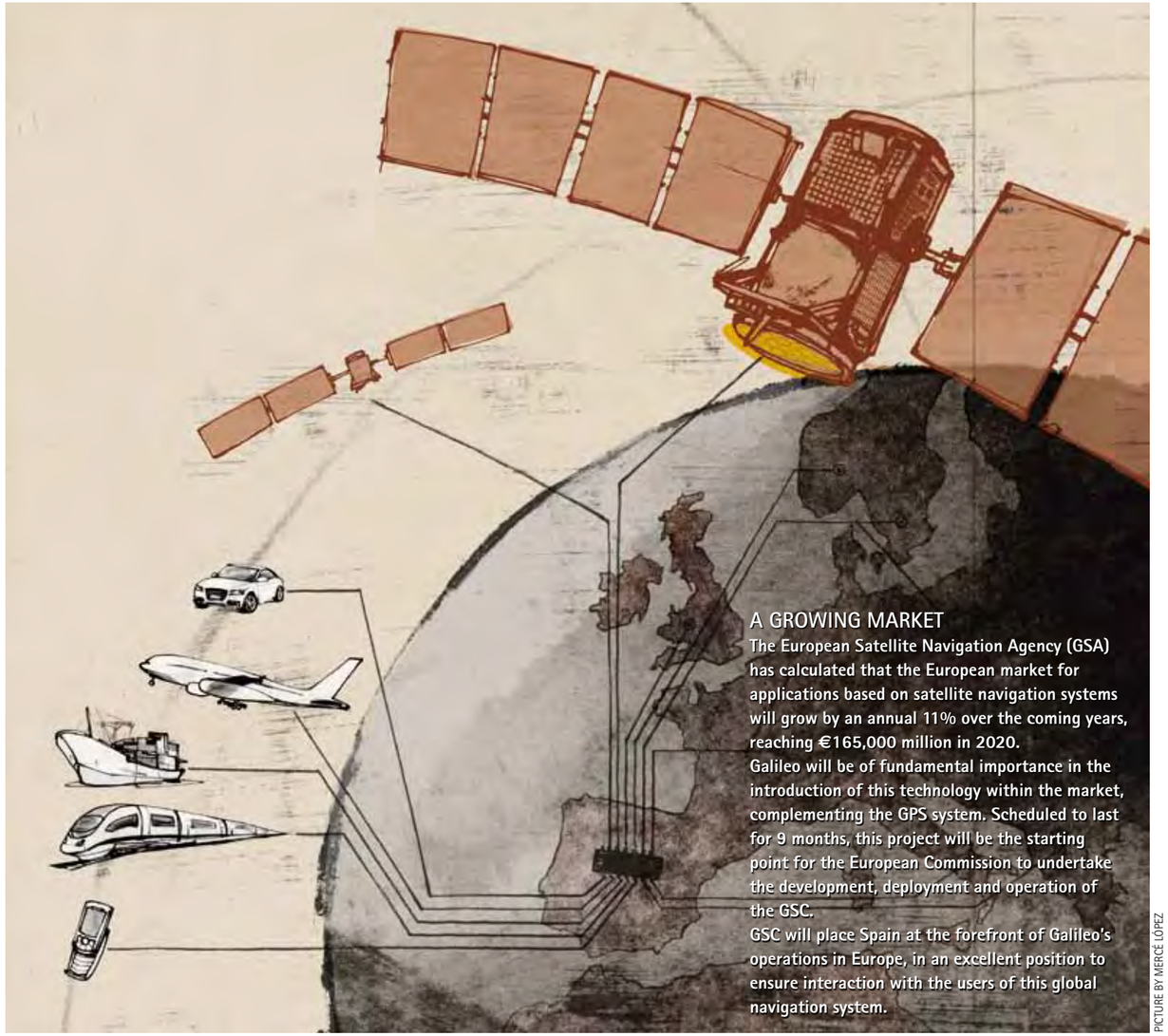


Diagram of the GSC interfaces

GSC missions

Among the GSC's most important missions are the following:

- **Provision of interfaces between the Galileo system and the users of 'open', 'commercial' and 'critical application' services.**
- **Website, user helpdesk, virtual distribution platform for GNSS products, etc.**
- **Support for the validation and certification of applications.**
- **A centre of technical excellence for OS, CS and SoL services.**
- **Provision of SoL and CS users' service performance assessment, customized performance forecasts, notice to users, etc.**
- **Support for the provision of added-value services required by GNSS users.**
- **Recording of data as a legal support in the case of regulated applications or to assist Service Level Agreements (SLA).**
- **Support for the development of applications and services for the multi-modal transport industry.**
- **The management of use of private data and the observance of privacy.**
- **The Galileo 'seal of quality'.**



A GROWING MARKET

The European Satellite Navigation Agency (GSA) has calculated that the European market for applications based on satellite navigation systems will grow by an annual 11% over the coming years, reaching €165,000 million in 2020.

Galileo will be of fundamental importance in the introduction of this technology within the market, complementing the GPS system. Scheduled to last for 9 months, this project will be the starting point for the European Commission to undertake the development, deployment and operation of the GSC.

GSC will place Spain at the forefront of Galileo's operations in Europe, in an excellent position to ensure interaction with the users of this global navigation system.

PICTURE BY MERCE LÓPEZ

In pursuit of excellence

Groundbreaking Spanish research centre

Published in itransporte 44

Just two years after its inauguration, the Rail Technology Centre (CTF in Spanish) has already attracted about 30 international companies. The high level of specialisation and the broad-ranging, cross-disciplinary ethos of the facility have drawn in experts in railway technologies from all over the world.

The consolidation of the leading role of the Spanish rail sector on the international stage was one of the main sources of motivation for the country's engineering firms, industries and administrative bodies in recent years. Therefore, in a bid to optimise research and innovation initiatives in this field, Adif (the Spanish railway infrastructures administrator) set up a technological centre in the province of Málaga (southern Spain) as a hub for excellence in research: the Centro de Tecnologías Ferroviarias (CTF), as it is known in Spanish, or Rail Technology Centre.

The centre will handle the development of Adif's key leading-edge technological activities, as well as those pertaining to the majority of the other centre members, thanks to the stable presence of multinational research groups. The CTF is therefore intended as a cluster, a hub to bring several companies together (large companies, small and medium-sized enterprises, research centres, etc.) in order to foster collaboration and facilitate complementarity in different areas of research. ✱

THE 32 COMPANIES

•Abengoa •Acciona •Aldesa
•Alcatel-Lucent •Alstom •Andel
•Ayesa •Azvi •Bombardier
•Cetren •CIAC •Comsa Emte
•Invensys Rail Dimetronic
•Elecnor Deimos •FCC •Ferrovial
•Huawei •Idom •Isolux Corsán
•Sando •Sener •Sice •Schneider
•Ineco •Indra •Talgo •Teams
•Technosite •Thales •TJH2B
•Tria Railway •Windinertia

Ineco's activities at the CTF

1. Projects focusing on the DaVinci environment and the Information and Communication Technologies Laboratory.
2. Projects related to the ERTMS and GSM-R Laboratory, as well as new communications technologies.
3. Aerodynamics in tunnels. Instrumentation and measurement.
4. Projects related to traffic management systems and the protection of low-cost trains through the use of new technologies.

Ongoing projects funded by Ineco

iCECOF

→Project co-funded by Adif and Ineco to develop a system to aid supervision and ensure control over compliance with rail punctuality commitments.

ELARA

→This project seeks to develop a new IT application to facilitate distribution planning and the use of fixed 'Eurobalise' transceivers.

PICTURE BY MERCÈ LÓPEZ

No fear of the dark

Solving blackouts in airport electrical system

Published in itransporte 44

In order to prevent possible electrical breakdowns and power outs in airports, Ineco has developed the SILA and SIENA simulators (Spanish acronyms for 'Airport Electrical Facility Simulator' and 'Air Navigation Electrical Facility Simulator', respectively). These two innovative applications are important tools in training operators.

In August 2009, the brand new passenger Terminal T4 and its satellite building T4S at Madrid–Barajas International Airport were plunged into complete darkness for about an hour due basically to a fault occurring in a medium-voltage (MV) switchgear. In January 2010, a 25-minute outage at the Area Control Centre (ACC) grounded flights at eight airports in the Canary Islands. In order to prevent this type of exceptions, it is essential for technicians to be fully trained in and to have extensive knowledge of all the airport's electrical facilities.

Ineco developed in 2005 its first airport electrical facility simulator, SILA. This application reproduces all the high-voltage (HV) facilities at a typical airport and has been used to train Aena (the Spanish operator of airport services and air navigation) technicians since 2006. SIENA, a continuation of SILA, simulates the installations that are not included within the scope of SILA, focusing on air navigation facilities, and principally on low-voltage (LV) equipment. Both simulators cover all the possible electrical installations in the Aena network.

SIENA reproduces the control rooms and the panels showing the airport's electrical equipment: high-voltage (HV) switchgear, emergency generators, low-voltage (LV) switchboards, Uninterrupted Power Systems (UPS) and rectifiers. All of the different electrical remote controls, pushbutton panels and levers that are required in real-life operations are reproduced on the simulator and may be operated via SIENA's 70-inch touch-screen displays. The sense of reality is furthered through the system's sound effects, which respond to each action. *

Issues

Faced with a breakdown or power outage, a control system will automatically start up the emergency generators and turn on or shut off the switches required to restart the service. If this automatic system fails, these operations should be performed manually by maintenance staff. Fortunately, such incidents are rare. As operators are not used to such procedures, a longer reaction time is required.
Electrical facilities are spread out at airports; they are complex and, in most cases, automated. Switching operations are infrequent and the few that are carried out are critical to the airport's operations. In emergency situations, where reaction time is critical, knowledge of the electrical facilities is even more important to ensure correct local and remote operation of electrical equipment.

Solution

A simulator is a set of items of equipment that reproduces the real performance of a system and recreates the real-life sensations that an operator experiences. The aim is to provide a tool to train the maintenance staff to correctly use and run the airport's electrical facilities. Additionally, it can be used to validate the different operational procedures and help improve its installations. This tool allows safety levels to be maximised in emergency situations and during routine maintenance, increasing the effectiveness of operations and streamlining the operation.

The training time required for new staff is also optimised, as is the retraining of experienced personnel, thus offering the best solution in terms of the cost/profit ratio.
Simulation is the only way to provide practical training on how an airport's electrical system operates without affecting its day-to-day functioning. With the SIENA simulator it is also possible to experience changes in operating procedures prior to their implementation, in order to achieve continuous improvement.

A TEAM OF 10 ENGINEERS

The stages in which any simulator is made are definition, design, development and integration. Ineco was entrusted with developing all of these stages for SIENA. To this end, a team of 10 engineers was organised and spread across the various tasks: developing models and the graphic interface, stimulating the Supervisory Control and Data Acquisition (SCADA) system and drafting operational procedures and manuals.

PICTURE BY MERCE LOPEZ

The stages in which any simulator is made are definition, design, development and integration. Ineco was entrusted with developing all of these stages for SIENA.

SIENA

The electrical installations used as the point of reference for the SIENA simulator are those at the Gavà Area Control Centre (ACC) in Barcelona, the north control tower at Madrid-Barajas airport and the flight path radar at Valladolid-Villanubla airport. These facilities are representative and have the required levels of complexity in order to train new staff and offer refresher training to experienced maintenance staff.

➔DEVELOPMENT

STAGE 1 (DEFINITION). Data was gathered at the benchmark installations; electrical diagrams were drawn for each item of equipment, including descriptions of their systems and components; user manuals for the SCADA systems and the instrumentation used in each one; analogue and digital input/output signals; loads and consumption lists; operating manuals, etc.

STAGE 2 (DESIGN). The information obtained, together with the training needs defined by Aena, were used to generate a technical specification for each of the installations to be simulated and to define the breakdown data base to be modelled. The modelling software and hardware platforms were selected, as well as the graphic navigation system, both in 2D and 3D.

STAGE 3 (DEVELOPMENT). Over a 12-month period, all the logical and dynamic models were developed, as were the graphic and audio interfaces, with more than 7,400 possible breakdown scenarios programmed.

STAGE 4 (INTEGRATION). During this final stage, all of the software developed was integrated onto the hardware platform and the Supervisory Control and Data Acquisition (SCADA) systems were connected and stimulated. The system as a whole was also run in order to debug it in the functional tests. Finally, over a four-month period, functional tests were carried out before being accepted by Aena, with over 750 problems being solved.

➔STRUCTURE

SIENA is designed to allow two places for mainteinance staff and one for the instructor. The first student place features two screens for the SCADA system, a projector for the synoptic diagram of the installation and a 70-inch touch screen. The second place has a similar touch screen. Both screens allow any electrical L.V. switchboard, generator control pannel, H.V. switchgear, to be operated all on a real scale. The navigation system allows the user to go on virtual tours through the installations in 2D and 3D, although they can only be enabled in 2D. The instructor's place is designed to be able to control each student's session with ease. It is equipped with two replica SCADA screens and three screens to control the training sessions: via the installation upload panel, the simulation control console and the control room and local panels.

Used to train and retrain over 1,500 technicians

FACTS AND FIGURES. The SIENA simulator has over 10,000 linked variables. A total of 2,047 items of equipment of 155 different types were simulated. Facilities are represented through over 500 different screens, with around 1,680 image files and 66 audio files. To ensure even better prevention, more than 7,400 possible breakdowns were programmed.

USE. This application allows operators to be trained in the use of electrical systems and reduces response times in degraded or emergency situations, as well as ensuring that new and existing staff are duly qualified to correctly and safely operate facilities, evaluating the ability of staff who will be operating electrical systems, validating the operating manuals for the airport power systems and checking changes to the design of the electrical system during the project phase.
The SILA simulator was installed at Madrid-Barajas. SIENA was installed at the old Paracuellos del Jarama control centre (Madrid) and commissioned at the beginning of this year. Aena will use these simulators to train and retrain over 1,500 technicians specialised in the maintenance of airport electrical installations.

TEAMWORK. A team of 10 engineers and experts in various areas (installations, programming, networks, photography, training, etc.) were responsible for developing SIENA. For four months, this team, along with six other Aena representatives, carried out the functional tests on the simulator.

Down to the last drop

How to recover regenerative braking energy

Published in itransporte 44

Work has now concluded on the installation of a direct to alternating current converter at the La Comba (Málaga) traction substation, which will allow an increase in train efficiency through the use of the regenerated energy. Adif requested Ineco to draft this project.

The energy a train takes from the overhead contact line is transformed in three ways: approximately 15% is used in the train's auxiliary services (air-conditioning, lighting, etc.), 35% is lost in the form of heat due to leakages in the train's equipment and in the friction with the air and the ground, while the remaining 50% –the kinetic energy stored by the train depending on its mass and speed– is lost in the form of heat when the train brakes. Therefore, in order to optimise the train's energy consumption, it is necessary to improve traction performance, auxiliary equipment consumption and –the most efficient measure– make better use of the train's kinetic energy.

Eco-driving modes are based on slowing and stopping the vehicle without using the brakes, transforming kinetic energy into speed loss through friction. This method is effective in vehicles with pneumatic wheels, as friction loss is higher. On trains, however, where such losses are lower, this system may mean considerable increases in detection times.

Regenerative braking. Electrical traction vehicles use electrical brakes; the traction motor –a reversible machine– functions as a generator that converts kinetic energy into electrical energy, which can either be burnt off in friction or returned to the overhead contact line. This is known as regenerative braking, and is the best method for increasing train efficiency. In the case of AC-current traction systems, such as those used on Spanish high-speed rail lines, this regenerated energy can be consumed by other trains on the same electrical section, or reverted back to the grid at the traction substations. This is possible because the equipment at these substations is also reversible.

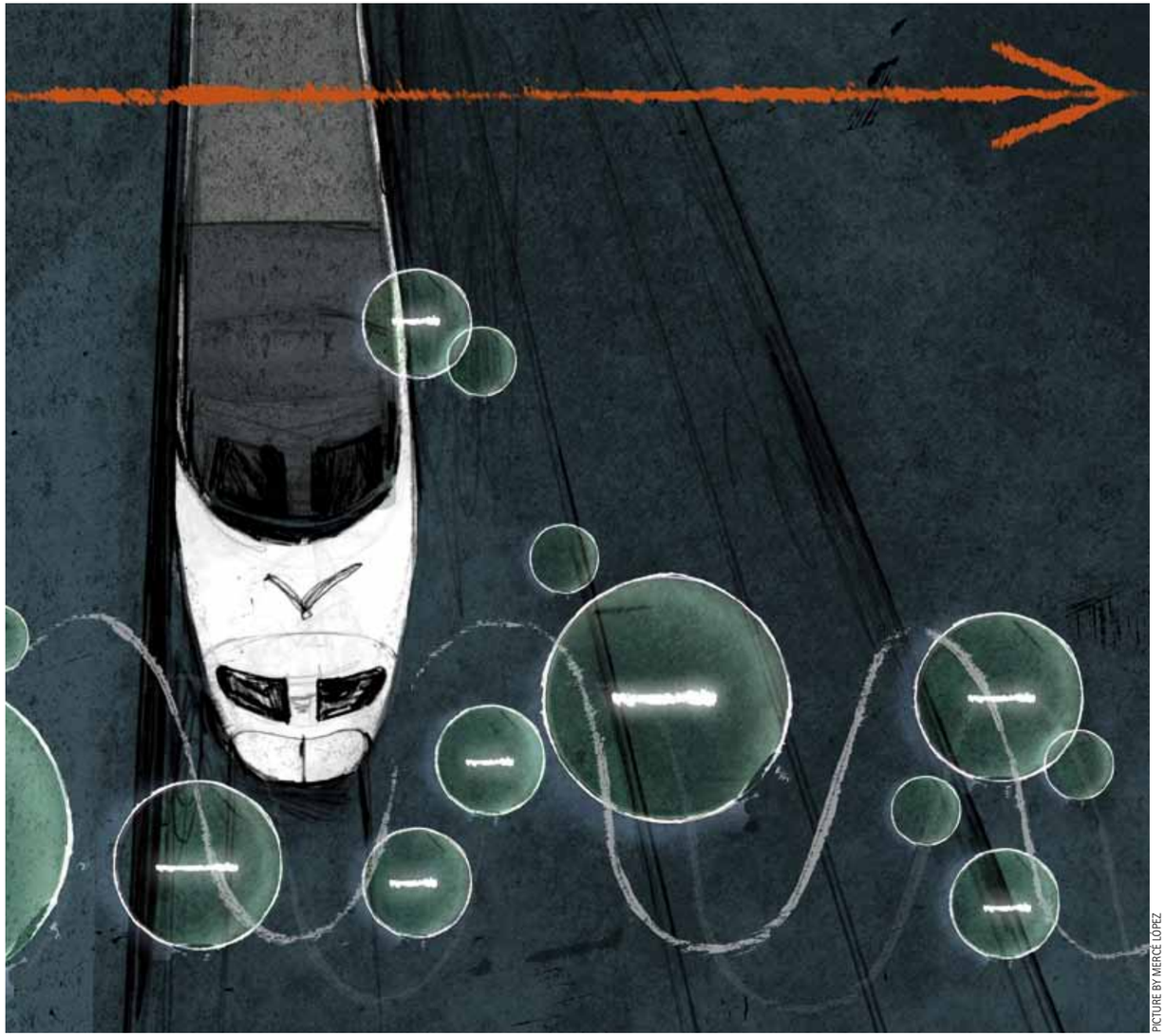
However, in direct current systems –such as those used on most underground systems, trams, the conventional train network and almost all Spanish regional railway lines–, the substation rectifier is not reversible, meaning that energy cannot be returned to the network. Regenerated energy can only be used by other trains on the same electrical section as the train that is regenerating. The rest of the energy must be burned off as friction as the train brakes. *

SUB-HEADINGS

In order to optimise the train's energy consumption it is necessary to improve traction performance, auxiliary equipment consumption and make better use of the train's kinetic energy. At La Comba, Adif and Ineco have worked on a unidirectional inverter mounted in parallel to the rectifier, allowing disconnection without affecting the substation's operations.

Alternatives to storing the excess energy

There are alternatives in which the 'excess' energy may be stored, either on flywheels or on high-capacity accumulators, and returned when required. These systems have high associated losses and control is complicated. THE MOST FAVOURABLE option is to return the regenerated energy not used by other trains to the grid. In order to achieve this, it is necessary to convert substation rectifiers into reversible machines. There are two alternatives. [1] Developing a reversible rectifier that converts AC to DC when the trains are in 'traction' mode, and from DC to AC when they are regenerating. The disadvantage is that the current rectifiers have to be removed and replaced by the new models, at a high cost. This is a viable solution for new installations. [2] Installing an inverter connected in parallel to the rectifier, enabling this to convert AC to DC and the inverter from DC to AC. BEFORE MAKING THE DECISION to install equipment of this kind, it is necessary to carry out a specific feasibility study for each line, as the amount of energy liable to be recovered depends on the coincidence of trains braking and trains in traction mode, as well as losses on the overhead contact line and on the converter. In order to carry out this type of study, simulation programmes like the ones that Ineco uses are needed. After the decision to install a new pilot inverter system on the Málaga–Fuengirola suburban line, a feasibility study was undertaken (in collaboration with Ingeteam) to confirm that the best option would be the La Comba traction substation. Ineco was entrusted with the task of defining the technological equipment and the project for installation at the substation.



PICTURE BY MERCE LÓPEZ

The La Comba traction substation in Málaga is an operational installation on a high-performance line, meaning that reliability needs to be high.

SOLUTION ADOPTED

LA COMBA SUBSTATION

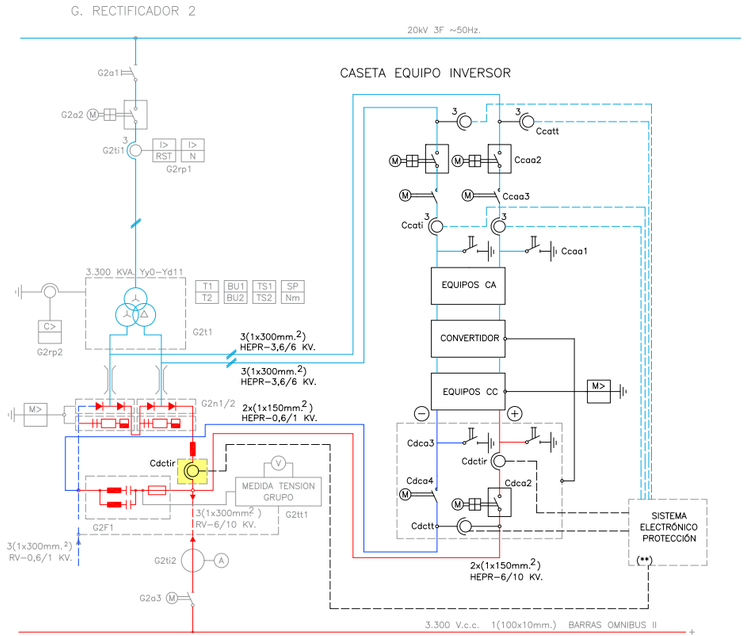
The La Comba traction substation in Málaga is an operational installation on a high-performance line, meaning that reliability needs to be high. For this reason, the option to install a reversible rectifier was ruled out. The decision was made to install independent equipment at the existing substation, which could be disconnected and allow the substation to resume normal service if the energy recovery equipment shows signs of an operational problem. Finally, Adif and Ineco worked on the option of installing a unidirectional inverter in parallel with the rectifier in the installation, due to the advantages provided by an element that is independent from the rest of the installation.

PLANNED INSTALLATION AT THE LA COMBA TRACTION SUBSTATION

Due to the lack of available space inside the La Comba substation building, the solution that was finally adopted for the construction project was to install energy recovery equipment in two prefabricated buildings on land within the fenced-off area. This energy recovery equipment consists of various elements: an AC and DC control cabinet, a second cabinet containing the AC/DC equipment/filter, a power converter, and auxiliary equipment in a local control station and a recirculation intensity transducer in the rectifier generator cell.

DESIGN OF THE INSTALLATION

In designing the installation, the fact that the equipment that was connected to direct current would be mounted on an earthed rack was taken into account. The design of the equipment also ensures that energy injected into the AC connection area is not recycled back to the rectifier; in other words, the recovered energy should only be directed toward its discharge into the transport grid. This is achieved through a specific feature in the control system for the equipment. The design also considers that the normal operation of the traction substation cannot be hindered. If there is a fault in the direct current area of the recovery equipment, this will result in the automatic disconnection of the converter and the associated rectifier. Additionally, the power electronic equipment generates a great amount of heat during its operation, meaning that the design includes refrigeration systems for the control cabinets and huts.



SELECTING THE UNIDIRECTIONAL INVERTER EQUIPMENT

Once the type of power electronic equipment to be installed has been chosen, its topology must be defined. Depending on the number of AC-to-DC conversions, this equipment may be one or two-stage. Control is simpler with two-stage equipment, although it is noisier, less reliable and with greater losses.

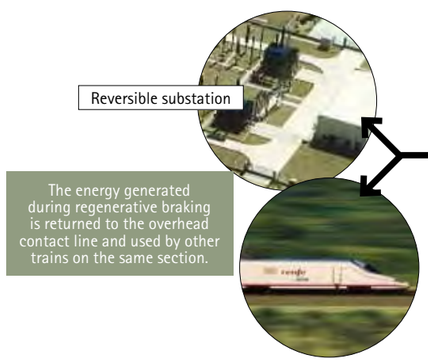
As reliability is an important factor, it was decided to install one-stage equipment. Depending on the voltage levels that the equipment is capable of generating in order to make up the sine wave, the inverter may have two or three levels. The difference is both constructional and functional: the three-level inverter represents a more efficient solution from an energy point of view as well as a better response to the output wave form. On the other hand, it requires a more complex control system, which therefore implies less reliability.

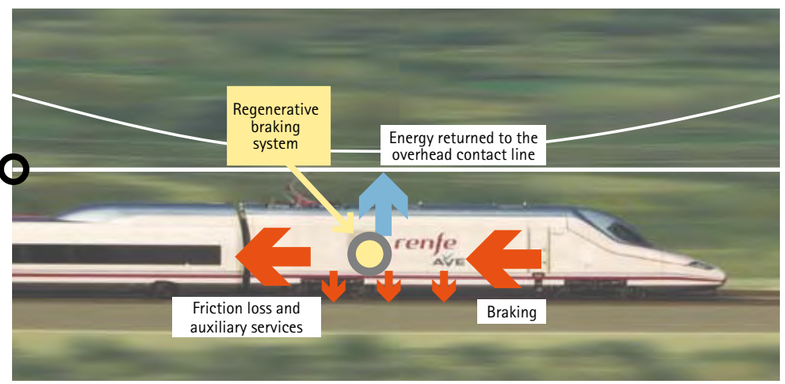
How the equipment works

The system is connected at both the AC and DC sides. In this state, the system remains on standby, measuring the voltage at the entry and the exit of the equipment. If the output voltage is higher than it should be, it means that energy is being produced by regenerative braking, which activates the system.

➔There is a direct link between the AC voltage entering the rectifier and the outgoing DC voltage generated. For this reason, the equipment detects if one or more trains are in regenerative braking when this link is not confirmed. In this case, the control system will order the inverter to come into service and the process of transferring the recovered energy to the grid will begin.

➔The converter injects the energy extracted from the overhead power cable into the distribution grid and ensures there is no recycling of current back to the inverter through a recirculation transducer. The energy is injected into the low voltage terminal blocks on the substation's traction transformer.





Transforming energy

In order to optimise the train's energy consumption, full use should be made of its kinetic energy. To avoid increased detection times, regenerative braking converts this energy into electricity which is then returned to the overhead contact line, or, as a last resort, 'burnt off' in braking friction.

Information with coordinates

Proprietary GIS for Aena airports

Published in itransporte 44

From locating a breakdown to finding out a shop's turnover; applications based on geo-referenced information are bringing about a revolution in technical and economic airport management. Ineco has been working alongside Aena since 2005 on the development and implementation of this technology.

Querying geo-referenced information has become commonplace all over the world in recent years. As well as the countless up-to-the-minute digital maps that are available, there are also new IT applications based on the intensive use of this technology, allowing multiple tasks to be carried out on all types of devices and a wide range of environments: from searching for a simple street address to developing optimum travel routes, from finding users on social networks to locating services using price-based criteria, etc.

All of these state-of-the-art applications are based on Geographic Information Systems (GIS). While other IT systems, for example a bank's databases, only contain alphanumerical data (names, addresses, account numbers, etc.), GIS databases associate the graphic representation of the location and shape of an element (what is known as *geo-referencing*) to the relevant alphanumerical data.

In just 20 years, since this new technology began to emerge, GIS applications have proven to be very effective when studying, planning, constructing and managing all kinds of infrastructures, including airports. In fact, GIS technologies enable an effective management of geographical and aeronautical information, which is extremely useful to aid decision-making.

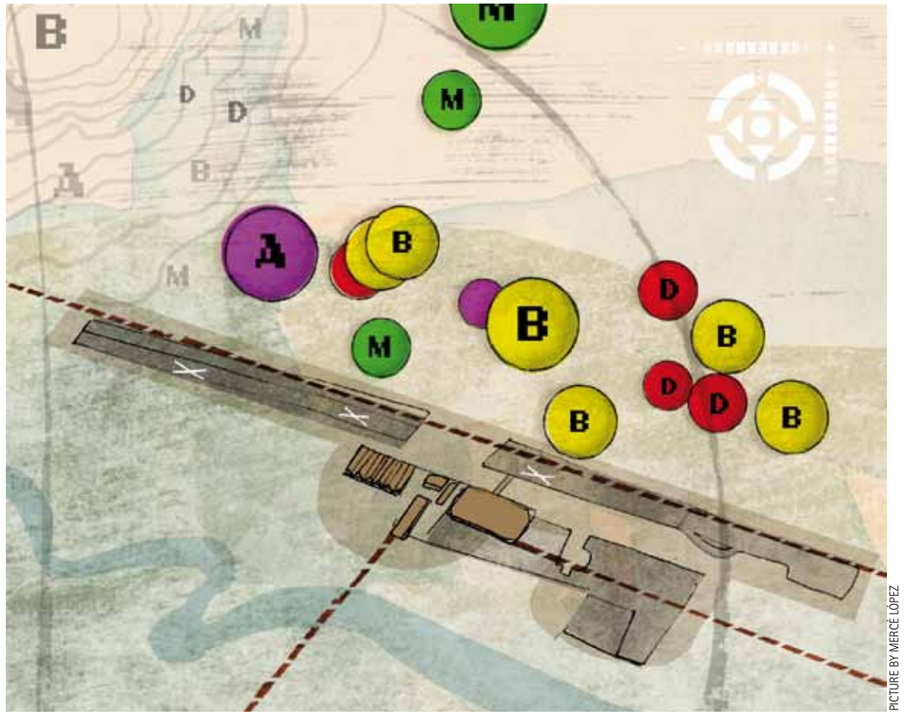
Since 2005 at Madrid-Barajas International Airport, and since 2009 at Barcelona-El Prat, two Ineco teams have been collaborating with Aena (the Spanish operator of airport services and air navigation) on the development, implementation, maintenance and administration of a proprietary corporate GIS for Aena, which currently consists of the following modules:

- **Commercial Module.** Includes basically shop management, premises and plot rental, car parks, VIP lounges, meeting-rooms and vending-machines. This module can be used to monitor commercial management and budget analysis of the various concessions at airports.
- **Asset Module.** Connected to Aena's SAP database, this module provides assistance with the financial management of the airport's assets.
- **Advertising Module.** A specific module that helps to manage advertising at the airport, covering the location of advertising resources, advertising contracts, invoicing, control over items that are out of order, etc.
- **Engineering and Maintenance Module.** This module focuses on the optimisation and monitoring of airport infrastructures based on connecting the airport facilities to the information on them contained in the MÁXIMO database.
- **Environmental Module.** The aim here is to offer streamlined access to all data associated to this monitoring: noise levels, water tables, waste management, etc.

The following modules are currently under development:

- **Signposting Module.** This module will be used to manage the various informative signs at airport terminals and in the accesses to the airport.
- **Land Registry Module.** Together with the Commercial Module, this module will provide the data that must be submitted to the Directorate-General of the Land Registry regarding the plots and premises under concession and the shops and companies or private individuals occupying them.

As well as these specific modules, GIS has proven to be a very useful tool in airport design, analysis and operation. ✱



PICTURE BY MERCÉ LÓPEZ

ADVANTAGES OF USING GIS IN AIRPORTS

- Ongoing updates, ease of access and streamlining of information in a single database.
- Drafting of more comprehensive reports and plans.
- Improved day-to-day maintenance and management.
- Faster data retrieval.
- Improved financial management.

Other GIS applications used in airport infrastructures

NEW INFRASTRUCTURE PROJECTS

→The versatility of GIS applications enables simultaneous use of different data sources. These include digital terrain models, as well as vector information pertaining to installations and civil engineering. For example, this allows earth movements to be calculated and rainwater run-off to be analysed in order to optimise the positioning of elements in a drainage network, simulating and calculating fluid distribution networks.

→If we add a digital surface model that shows the heights of obstacle limitation surfaces, it is possible to analyse any potential encroachment on this terrain by new structures at the planning stage.

ANALYSIS AND OPTIMISATION OF EXISTING INFRASTRUCTURES

→Topological analysis tools that can be applied to GIS data have made the huge task of checking that airport infrastructures comply with the regulations and recommendations contained in Spanish Royal Decree 862/09. This law regulates the obligations placed on the management of airfields, airports and other airport installations regarding operational safety and security.

→Adapting to the terms of this regulation is an essential requirement in order to obtain certification from the Spanish Aviation Safety Agency (AESA). Based on GIS information, extensive analysis of topographical requirements and of the location and design of airport systems has been carried out, resulting in the detection of those elements that are in breach of the established regulations and recommendations, so that they could then be corrected.

→GIS applications are also used to analyse and calculate routes, allowing aircraft movement to be simulated in order to simulate and optimise taxiway routing.

MAINTENANCE AND MANAGEMENT

→GIS applications also enable the creation of plot inventories, which include the purpose of each land and allows the main user to be identified. This simple approach means it is easy to check that all developments comply with the terms of the applicable planning and ordinance documents, such as the 'Plan Director' ('Steering Plan'), the 'Plan Especial del Sistema General Aeroportuario' ('Special Plan for the General Airport System') and all applicable urban-planning legislation.

→GIS is also used in obstacle surveillance, grouping together all data pertaining to geographical, alphanumerical and documental information required to detect any such obstacles, keep historical control and monitoring records, as well as AESA resolutions concerning new buildings.

Good perspectives for 2025

Modernisation of the Algerian National Transport Plan

Published in itransporte 44

Stimulating the economy and promoting social development are the priority objectives for the Algerian government's new 2025 National Transport Plan. Undertaken by a consortium led by Ineco, the plan examines all modes of transport in depth in order to improve connections between the country's cities and centres of production.

Algeria, the world's leading producer of natural gas and Africa's third largest oil producer, has an unbalanced demography (91% of the population live in 12% of its territory), as well as a transport system with problems in terms of responding to its economic and social development needs. The current challenge facing the country is that of improving connections between its people and its industrial and production centres.

The 2025 National Transport Plan is an ambitious project that covers all modes of transport with the aim of meeting Algeria's mobility needs, both in terms of passengers and freight. This plan establishes the strategy to follow over the coming 14 years, in line with the general objectives of the National Territorial Development Scheme (SNAT in French), the regional strategic framework developed by the Ministry of Spatial Planning, Environment and Tourism, in conjunction with other agents within the Algerian public administration.

According to the SNAT, the Algerian population will grow 20% by 2025 (up to 42 million inhabitants). After its independence in 1962, there was a significant migration from the south and centre to the north, a phenomenon that led to the demographic imbalance.

The government now wishes to reduce the concentration of the population on the coast, mainly in the metropolitan areas of the large cities. One in ten Algerians live in a suburb of Algiers, Oran, Constantine or Annaba. The aim is to get 45% of the population to live in the south, compared to the current 35%. In order to achieve this, the new transport system will have to overcome the difficult geography that separates the north of the country from the centre and south.

Algeria has undertaken major infrastructure improvement work in recent years on the least populated areas. In 2010, 2,900 investment projects were carried out in all sectors in central and southern regions in order to stimulate employment, such as:

- The new city of Boughzoul, based on the Brasilia model.
- The Hauts Plateaux highway, with a total length of 1,300 kilometres.
- A 700-kilometre water diversion project taking water to the south, from In Salah to Tamanrasset, aiding in the agricultural development of the Sahara.
- The new railway line between Relizane, Tiaret and Tissemsilt, included in the Transport Plan.

The Algerian Transport Minister, Amar Tou, believes that with the new plan, "transport will be fully recognized as a catalyst for supporting economic and social development, a necessary condition in ensuring Algeria's progress". The country is seeking to diversify its economy by reducing its dependence on fossil fuels, opening up markets, creating a new industrial network and improving the tourist sector. ✱

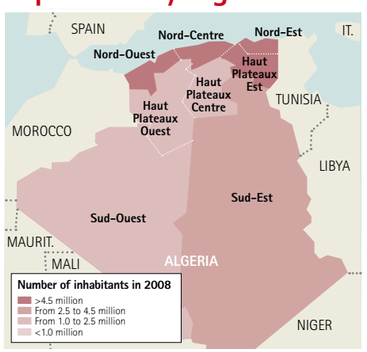
Evolution of the population

Forecasts indicate that Algeria will have a population of 42 million people by 2025 and around 50 million by 2050. Population density in the north of the country is 235 inhabitants per km², whilst in the south it is 1.35 inhabitants per km².

Year	Population (millions of people)
2010	35,3
2015	37,7
2020	40,2
2025	42,5
2030	44,4

Source: SNAT 2025 / Algerian National Institute of Statistics

Population by region



Strategies and financing

→EUROPEAN FINANCING

The National Transport Plan, developed by a consortium made up of Ineco, Consultrans, Imathia and FIIAPP, has received financing from the EU within the framework of the Transport Sector Support Programme in Algeria. Ineco has acted as project leader, given its experience both within Algeria (with the study examining the reorganisation of urban transport networks in Algiers), and other national plans prepared for Costa Rica and Ecuador, as well as for Spain, and sector plans for Panama and Kuwait.

→THE PROPOSED FOCUS FOR FUTURE STRATEGIC PLANNING

The Plan was developed based on strategic planning arising from the contrast between the results of the diagnosis of the country's transport sector and the vision of the future agreed upon with the Algerian Ministry of Transport. The final aim is for the various modes of transport to complement each other in order to ensure a modern, efficient transport system by 2025 for both passengers and freight.

→SUPPORT FOR THE TRANSPORT SECTOR

As well as the aforementioned National Transport Plan, the team led by Ineco has also drawn up a general study of costs and fares for all modes of transport in the African country. It has also prepared and implemented a Transport Sector Information System for the Algerian Ministry of Transport, through a global IT solution that allows centralised management of the systems in place in the various transport subsectors.

→MAIN FOCAL POINTS OF THE NATIONAL TRANSPORT PLAN

The Plan is based on four key areas: reinforcing the political framework, developing infrastructures and modernising equipment, establishing economic and technical regulations and encouraging competition. These are also accompanied by four main complementary components: the development of multi-modal transport; facilitating transport; guaranteeing safety and security and limiting the impact on the environment.

Algeria is seeking to diversify its economy by reducing its dependence on fossil fuels, opening up markets, creating a new industrial network and improving the tourist sector.

SOME OF THE KEY AREAS OF THE PLAN BY TRANSPORT MODE

AIR TRANSPORT
Need for modernisation to cover demand

Given Algeria's foreseeable socio-economic evolution, forecasts for air traffic suggest that around 15 million passengers will be using this mode of transport by 2025. International airports at the cities of Algiers, Oran and Constantine will need to undertake modernisation work to meet this demand.
Among the objectives is that of completing the Euromed route map (an EU project promoting cooperation in air traffic between Mediterranean countries) and the adaption of the legal and institutional framework in order to respond to rapid growth in demand and requirements set by the International Civil Aviation Organisation (ICAO).

➔Expected investment includes:
- A new international airport in the new city of Boughzoul.
- A freight cargo terminal at Algiers International Airport.
- Extra aprons for aircraft at 15 airports.
- Improvements to the infrastructure at 31 airport 'hubs' (Oran, Hassi-Messaoud, Constantine, Algiers, Tiaret, Annaba, Tremecen, Setif and Chlef, among others).

RAIL
Significant growth

Forecasts show a growth in demand, especially in inter-regional passenger traffic, handling 45 million passengers in 2025 (just 1 million passengers used the network in 2008). Freight transport will increase four-fold.
The National Plan provides for the creation of a National Agency for Rail Safety (locally known as ANSF) and the restructuring of the Algerian rail group. In parallel, an investment plan for rolling stock and improvements to maintenance centres has been prepared. Conventional lines will connect the regions in the country's high plateaus and the so-called 'big south' to the coast. Links between the various modes of transport at urban stations will be improved.

➔The main courses of action are:
- Track duplication, electrification and signalling on the coastal rail network.
- Improvements to the eastern mining line.
- Modernisation and development of suburban lines and networks in Algiers, Oran, Constantine and Annaba.
- New beltway lines for the plateau with connections to the coastal beltway.
- Improvements to the intermodality of stations and terminals. Removal of level crossings.
- High-speed line running east-west along the coast (1,200 kilometres).

NEW MODELLING PROGRAMMES

Over 3,000 kilometres of rail lines and 23,700 kilometres of roads have been modelled in order to respond to passenger and freight demand forecasts for 2025. Overland transport will be one of the key areas in the future transport network, designed to meet the needs arising from economic development.

SEA TRANSPORT
A new international port

Maritime traffic is expected to increase significantly: annual exports will rise from 15 million tonnes in 2010 to 30 million in 2025. Imports will increase five-fold, reaching 10 million tonnes by 2025. The export of oil and cereals will also grow. Less pronounced will be the evolution of passenger transport, with a 30% growth compared to 2005 figures.
By 2025, ferries will be carrying 1.2 million passengers and 390,000 vehicles per year. Expansion of the port sector will involve the private sector. Its role as receiver and distributor of goods from the Algerian interior is key. The planned strategy foresees the concentration of activities in a new international 'hub' port to free up traffic in the current port of Algiers.

➔The following courses of action should be mentioned:
- The creation of a new main international 'hub' port.
- The establishment of the port at Djen Djen as a specialist 'hub' centre.
- Rail access and logistics platforms in the ports.
- Modernisation of the port of Algiers as a major passenger port.
- Improvements to infrastructures and installations in other ports.

PORT STRUCTURE

The sea transport mode will play an important role in international freight transport. The plan proposes a major central port, a specialist 'hub' at Djen Djen and two regional ports in Oran and Annaba for containers and other freight. Two further hubs dedicated to oil transport are also planned.

ROADS
Connections to cities in the centre and south of Algeria

Roads are the main element of cohesion and structuring in the country. According to data supplied by the SNAT, annual growth of 5.14% is expected for passenger transport and 6.3% for goods by 2025.
The main strategic lines of the plan cover the development of urban public transport, connections to Algeria's four largest cities and its major ports, the construction of highways and trunk roads on the coast and to the cities in the south, where the country's natural gas and oil production is centred.
Another key objective is the integration of the network with those of neighbouring countries, in particular with the multimodal Trans-Maghreb corridor, which runs for 7,000 kilometres between Nouakchott (Mauritania) and Tobruk (Libya).
Road transport will be improved in terms of its quality, efficiency and safety, which will require an adapted legal and institutional framework, as well as a restructuring of the private transport sector, among other developments.

➔Among the planned infrastructures, the following should be highlighted:
- The 'Rocade des Hauts Plateaux' highway.
- Road links between the coast and the east-west highway.
- The 'Transaharienne' north-south highway.
- The fourth Algiers ring road. Ring roads and access to main Algerian cities.

Between ravines

Phase IV of the Las Palmas de Gran Canaria ring road

Published in itransporte 42

The UTE Arucas (joint venture), of which Ineco is a partner, is responsible for controlling and monitoring Phase IV in the construction of the Las Palmas de Gran Canaria ring road, featuring 8 viaducts running over 4 different ravines. Some 40,000 vehicles are expected to use this new section every day.

Work on Phase IV of the Las Palmas de Gran Canaria ring road is progressing fast, having begun in December 2007. The construction work in this phase, which runs between the district of Tamaraceite and the Tenoya–Arucas Coast, will connect Phase I to the regional road GC-2, at the current Arucas link, providing an inland connection between Las Palmas de Gran Canaria and the town of Arucas, and a double access to the north-east of the island's capital.

The completion of Phase IV (part of a road-building agreement between the Canary Islands Regional Government and Spain's Ministry of Transport) will conclude the Las Palmas beltway, which began in 1997 and which has helped to free up traffic in the city. This latest section will close the Las Palmas ring road, improving traffic flow in the city and its connections to other points on the island, as well as accessibility in general, giving Las Palmas two entrance points to the north-east.

The Canary Islands Regional Government's Public Works department has calculated that some 40,000 vehicles will use this new section every day, easing traffic congestion at key points in the city, such as the Plaza de América, the Julio Luengo tunnels and the Torre Las Palmas junction. It will also improve traffic flow in the outskirts of the capital, with a reduction in journey distances, waiting times and pollution –a positive effect similar to that which has been experienced with the opening of the first three phases of the ring road already in use.

The highway runs through a semi-urban environment, whilst also crossing deep, wide ravines, typical of the island's rugged terrain. The section under construction will connect Phase I of the ring road to the Tenoya district, Tamaraceite, the villages of Arucas and Santidad, joining up with the GC-2, the road that runs around the island.

Viaducts and overpasses. The works consist of 8 viaducts: 4 in the first half of the new highway section, 3 over the Barranco (ravine) de Cardones and 1 where it meets the GC-2. Of these, the V-1.7 viaduct over the Barranquillo (gorge) de Tenoya has already been built. Viaducts V-2.1 (over the Barranco de Tenoya), V-3.1 (over Barranquillo de La Dehesa) and V-4.1 (over Barranco de Arucas) are all considerably advanced.

Special mention should be made about the viaduct over the Barranco de Tenoya, because of its dimensions: a total length of 528 metres running over 5 spans, and a height of more than 100 metres above the ground.

The project also includes 4 overpasses, 5 underpasses, a 207 metre-long cut-and-cover tunnel (comprised of 2 reinforced concrete arches) and a conventional 94 metre-long excavated tunnel, drainage and lighting systems, reinstatement of services, signposting, side marker and clearance lights and containment systems, as well as earth-moving and compacting operations.

Ineco has been providing control and supervision services for the construction work on the highway section and its connecting roads, offering a wide range of duties: geometric control over project work, qualitative control over materials and construction units, budget control, environmental monitoring, review of the contractor Quality Control Plan and the preparation of reports, among other tasks.

The entire work is supervised by the UTE Arucas, in which Spanish companies Grusamar and Inastecán participate alongside Ineco. This joint venture is also responsible for coordinating health and safety matters, among other tasks.

The geometric characteristics of the main section layout correspond to a road where the maximum speed is 100 kph, with 7 metres carriageways, 2.5 metres hard shoulders and 1 metre inner verges, as well as a 1 metre outer berm on either side of the section. As far as the horizontal alignment of the main section is concerned, it was designed to have a minimum radius of 500 metres and a maximum of 5,000 metres. Roadbed works were also carried out on the main section corresponding to section 032. ✱

Technical specifications

TOTAL LENGTH

18.1 kilometres: 6.8 kilometres correspond to the main highway section and with the remaining 11.3 kilometres to slip roads and service roads.

EXPECTED TRAFFIC**: 40,000 vehicles per day.**

JUNCTIONS

- **JUNCTION 1 (Tenoya). A revolving system with a central roundabout above the highway, 4 direct slip roads, 1 link road and 2 relief roads.**
- **SEMI-JUNCTION 2 (Cardones–Santidad). A dumbbell interchange, with 2 direct slip roads, 2 roundabouts (one on either side of the highway) and a link road underneath the main highway section.**
- **JUNCTION 3 (Arucas–GC-20). A trumpet interchange, allowing movement from the main highway section with respect to Arucas.**
- **JUNCTION 4 (GC 301–Cardones). A revolving system, with an off-centre roundabout under the main section and 2 direct slip roads that connect it to the northbound lanes of the highway.**
- **JUNCTION 5. Connects Phase IV to GC-2. The project includes 4 overpasses, 5 underpasses and 26 transversal drainage installations (of which 7 pertain to the main section of the highway and 19 to slip or link roads).**

TUNNELS

One 94 metres tunnel parallel to the existing Tenoya tunnel (which will be used by pedestrians) and one 207 metres long cut-and-cover tunnel.

VIADUCTS

- **BARRANQUILLO DE TENOYA: 150 metres.**
- **BARRANCO DE TENOYA: 528 metres.**
- **BARRANQUILLO DE LA DEHESA: 370 metres.**
- **BARRANCO DE ARUCAS: 150 metres.**
- **GC-2 ROAD: 27 metres.**
- **BARRANCO DE CARDONES: 3 in total, one 79 metres long, another 160 metres long and a third 25 metres long.**

A custom-made ring

Expansion of the Madrid M-40 ring road

Published in itransporte 45

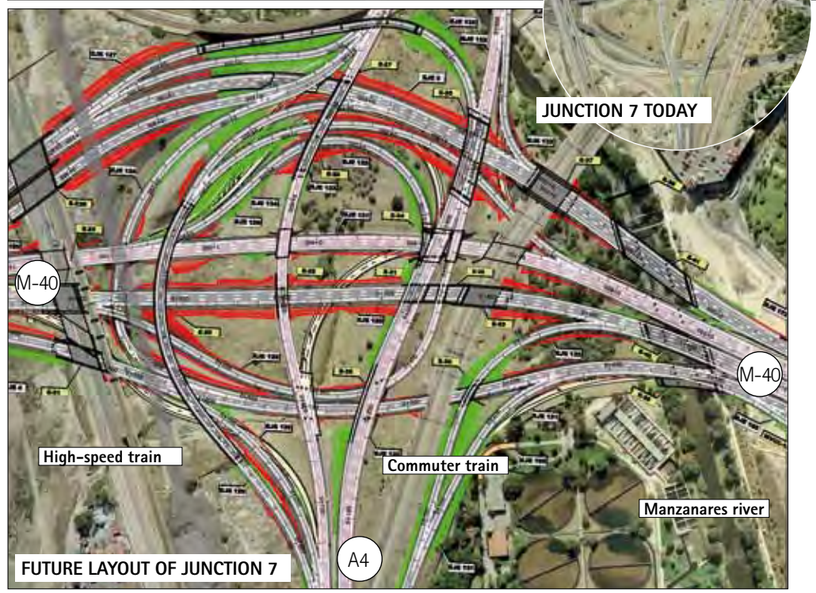
The M-40 is one of the most used urban ring roads in Spain: over 159,000 vehicles use it every day. Ineco has prepared a layout project with a view to increasing its capacity and reducing its environmental impact, mainly noise.

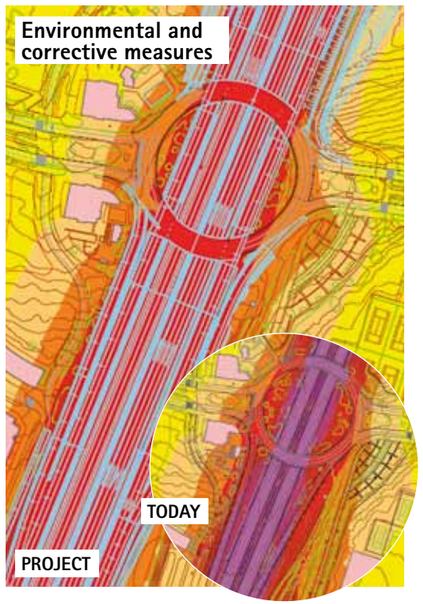
The capital city of Spain has two ring roads, the M-30 (renamed Calle 30) and the M-40, as well as two half-rings, the M-45 and M-50. The M-40 is considered to be the second ring road of Madrid. An average of 159,175 vehicles travel over its 62 kilometres every day, making it one of the roads with the highest traffic intensity in Spain. For this reason, the Ministry of Transport undertook the improvement and expansion of the road in 2008.

Ineco developed the layout and environmental measures project for one of its segments: a total of 10,700 metres. The project considers two areas of action. [1] Increasing the capacity, improving service levels and traffic safety. [2] Corrective measures for reducing environmental impact, mainly noise. ✱

TRAFFIC ANALYSIS

Nearly 160,000 vehicles use the M-40 every day. A forecast has been made until 2032 that shows a traffic estimate for the north trunk carriageway and north collection/distribution road of 85,413 and 66,468 vehicles per day, respectively. For the south trunk carriageway and the south collection/distribution road, the calculated values are 96,543 and 49,299 vehicles per day.





THE PROJECT

➔THE M-40 NOW

The M-40 consists of independent carriageways with 3 to 4 lanes in each direction, connecting the junctions to the radial roads and in some cases segments of collection roads.

➔LAYOUT PROJECT

Short and long distance traffic has been separated, designing collection/distribution carriageways with 2 to 4 lanes on both sides in order to collect all short-distance urban traffic, and for connection with the trunk road in junctions to the main radial roads that leave Madrid: A3, M-31 (which in turn connects to the M-45 and M-50) and A4 ('Supersur' node).

The projected speed is 100 kph for the M-40 trunk road and 80 kph for the collection/distribution carriageways.

➔JUNCTIONS

- JUNCTION 1. Avenida de Canillejas to Vicálvaro. Overhead traffic circle.
- JUNCTION 2. M-23 / R3. Windmill type.
- JUNCTION 3. A3. Full cloverleaf type.
- JUNCTION 4. Avenida de la Albufera. Inverted diamond with dumbbells type.
- JUNCTION 5. M-31. Trumpet type.
- JUNCTION 6. M-602 to Embajadores street. Diamond with dumbbells type, plus a direct branch (U turn).
- JUNCTION 7. Mercamadrid. Partial trumpet type. This junction stands out for its complexity, since it is located at a point where the A4 (Andalucía) highway and the high-speed and commuter train (Cercanías) lines meet, on loose ground with a slope on the edge of the Manzanares river, with 2 high-voltage transmission lines crossing it. It includes a total of 22 structures.
- JUNCTION 8. 'Supersur' node / A4. Windmill type.
- JUNCTION 9. San Fermín. Depressed racetrack type.

➔SINGULAR STRUCTURES

A total of 45 structures have been designed for the entire segment. Among the most noteworthy structures are 3 covers for collection roads (meant to correct their environmental impact) and the relocation of 2 pedestrian bridges.

Different types of walls have been designed, made of reinforced concrete and reinforced floor. Among these are panel walls with metal strips, 'green' or ecological walls reinforced with highly durable geotextile fabric, and prefabricated landscaping walls made of reinforced concrete pieces.

➔ENVIROMENTAL AND CORRECTIVE MEASURES

NOISE

- Collection road covers.
- Noise study, determining that the most sensitive area is potentially the area between the junction of Doctor García Tapia street and the A3 highway.
- Installation of noise screens and sound absorption panels.

VEGETATION AND VISUAL IMPACT

- Tree inventory to identify trees that are directly or indirectly affected, proposing their transplantation and/or replacement.
- Landscaping integration measures.

Pillars in the earth

Treatment of an embankment built on soft soil

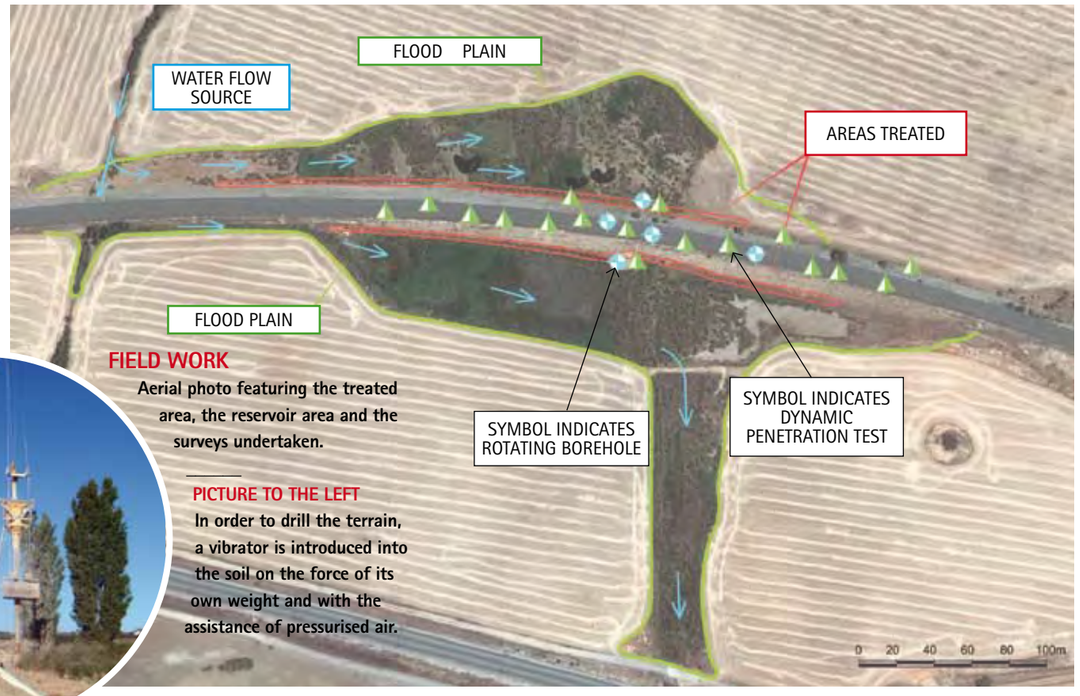
Published in itransporte 43

Work carried out on a defective embankment in order to restore stability to the structure and prop up a new track supporting layer is a clear example of the solutions that geological-geotechnical studies provide in civil engineering projects. Ineco experts worked to find the best possible solution to ensure strong foundations.

The defective embankment is located on the Villar de Chinchilla-Alpera-Almansa section of the Madrid-Albacete-Alicante conventional railway line, on which Ineco is responsible for controlling the intervention on the track supporting layer, the track and the overhead cable assembly, as well as the installation of electrical equipment and the safety, security and communications facilities.

After a number of years in use, the foundations of the embankment were in poor condition because it was supported by very soft Quaternary deposits and in a sunken area with inadequate drainage, causing superficial subsidence and depressions in the embankment body. In order to analyse this issue and look into construction solutions, Adif (the Spanish railway infrastructures administrator) requested Ineco to draw up a ground improvement study: the answer consisted of adding reinforcements by installing stone columns which ensure an appropiate performance of the fill below the track platform.

The first step was to implement a soil testing programme which detected a water channel that the embankment had cut off, producing a significant barrier effect and leading to water accumulating upstream. The study included the characterisation of the various lithological horizons associated to the floodplain in question. *



FIELD WORK

Aerial photo featuring the treated area, the reservoir area and the surveys undertaken.

PICTURE TO THE LEFT

In order to drill the terrain, a vibrator is introduced into the soil on the force of its own weight and with the assistance of pressurised air.

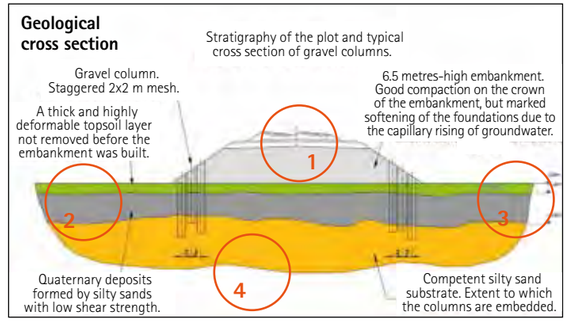
Geological-geotechnical cross section

1. Typical embankment fill to a maximum height of 6.5 metres. It was confirmed that the compaction level of the fill dropped as the depth increased, from standard penetration rate values that are normal for quality fill (NSPT>10) in the first metre, to very low impact levels (NSPT=5) in the deepest sections, in contact with floodplain deposits, indicating a softening of these materials due to the effect of seepage water.

2. Old deformable topsoil (NSPT=2) with a strength of 1 metre, which was not rehabilitated when constructing the existing embankment.

3. Quaternary alluvial deposits, comprising silty sandy soil with low compactness (NSPT=4) and a thickness between 3 to 4 metres.

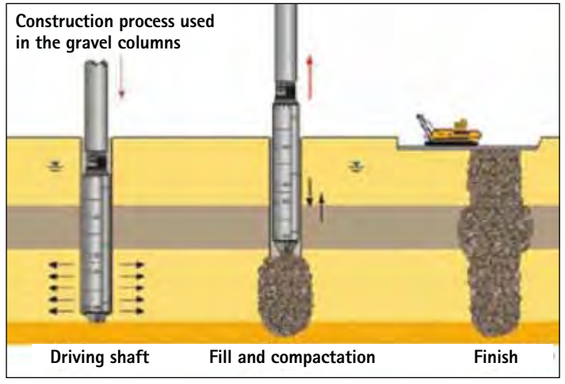
4. Tertiary substrate, with better geotechnical characteristics than on higher levels.

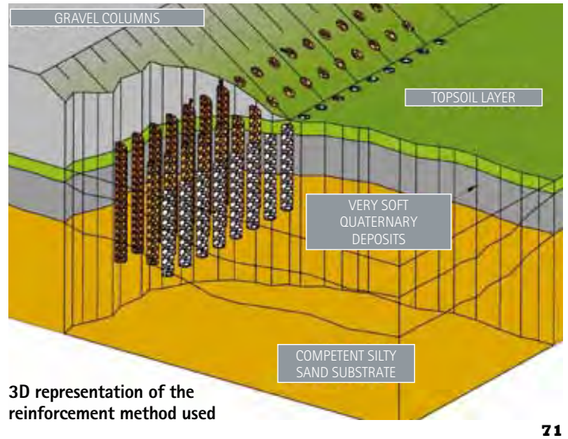


Description of the plan of the adopted solution

In order to choose the reinforcement method to be used, various possibilities were analysed with regard to their technical, timeframe and financial aspects. Reinforcement with gravel columns was the best solution, as it allows the foundation material to be strengthened, prevents landslides and subsidence, and does not require excavation or the undermining of the existing embankment fill.

The use of gravel columns (vibro-displacement) consists of making perforations by introducing a vibrator into the soil. Once the competent substrate has been reached, the perforation is concluded and, while the vibrator is moving upwards, it is providing gravel into the borehole through an interior hollow tube. The drilled hole is therefore filled from the base, ensuring correct gravel densification. Two aims were pursued with the gravel column mesh design: to establish the density of the columns required in order to guarantee a minimum subsidence safety factor of 1.5, and to reduce the deformation of the support ground. The result of the stability calculations was a 2x2 metre column mesh in a staggered pattern. This produces a 'screen effect' on the embankment, creating an area of improved soil that hinders the appearance of fracture circles. A 3x3 metre column mesh was suggested to cover the crown in order to produce a 'reinforced' effect within the embankment body. A pre-load of 2 metres of soil situated at the crown of the embankment fill was introduced to reduce the level of subsidence. The aim was to drain off the groundwater and submit the terrain to a higher stress level than those expected with the track on service, thus avoiding unwanted subsidence.





3D representation of the reinforcement method used

Modular railway architecture

Eight new modern stations for the 'Western Corridor' in Bogotá

Published in itransporte 42

A standard building model adaptable to each site, light and airy, and located in the city centre: that is Ineco's vision for the 8 stations in the 'Western Corridor', the first in the Colombian capital's future commuter rail network, which will restore part of Bogotá's historic Savannah Railway.

Three formal and functional station models have been established: standard station (Fontibón, Catam, Funza, Mosquera, Madrid and El Corzo), terminus station (Facatativá), and the Ciudad de Cali station in Bogotá, designed to serve as an interchange with the 'Transmilenio' buses.

Bogotá is the capital of Colombia and the Cundinamarca region, the country's most populous area, with 7.8 million inhabitants. The city's bus network is the backbone of its public transport system, and private vehicles are currently the only alternative. This is why the regional authorities want to revive the railway option by restoring part of the route of Bogotá's old Savannah Railway, which stopped operating in 1991, and integrating it into a new, modern light train-tram commuter network.

Ineco is participating by performing different tasks in the first phase, the *Western Corridor*, which will be joined by another two branch lines from the capital to Zipaquirá and Tocancipa. The 32-kilometre corridor will include 8 stations, 3 in the city centre (Ciudad de Cali, Fontibón and Catam) and the rest in the municipalities of Funza, Mosquera, Madrid, and Facatativá (which will have 2: El Corzo and Facatativá). ✱

Location of the stations

Ineco prepared the site study, as well as the functional definition and design proposal for the new stations. To choose the location within each municipality, a number of factors were considered: proximity to the existing track (as there is no plan to modify the current route), ease of access for users from the city centre, expected growth areas and the characteristics of the rail line. Other factors considered were integration into the urban fabric and minimising the effects on traffic and public services (water, sanitation, electricity, etc.).

Urban railway model

Another basic conditioning factor was the railway model chosen, the train-tram, a light rail system that combines the characteristics of trams and trains: it runs fast on interurban sections (up to 110 kph), but travels slowly in the city (40 kph). It is flexible because it intersects with pedestrian and automobile traffic at the same level, avoiding the need for fencing and the resulting 'barrier effect' of a conventional railway line. This allows for the creation of boulevards around the tracks, making it easier to integrate the railway into the city and place stations downtown.

The design features convenient access to the tracks, natural light and ventilation, and durable, vandalism-resistant materials.

THE KEY ROLE OF BUSES IN THE BOGOTA AREA

The future commuter rail corridor will be connected to the 'Transmilenio' system, the city's mass transit service (which has no subway). This is a network of articulated buses running on dedicated lanes along routes known as trunk lines, with stations located all over the city. It began operating in 2000 and is the backbone of Bogotá's urban transport network. So far, the buses are also the only option for interurban travel between the capital and the municipalities in the metropolitan area.

Design process and guidelines

The Ineco team designed a standard station model that can be varied to adapt it to each location. This optimises construction times and costs, while the aesthetic unity contributes to the creation of a brand image for the new line. The buildings are located at street level. A double platform was chosen rather than a central platform, as this option is more convenient for passengers and has a higher capacity. Access is centralised at a single point in each station, and access to the platforms will be controlled past the point where the ticket windows will be located. As far as construction materials are concerned, Ineco proposes that they be durable and vandalism-resistant, for a modern design in which natural light and ventilation will play a central role.

CIUDAD DE CALI STATION. This is the last station on the line and was designed to become a modal interchange linked to the 'Transmilenio' system. The station will have two levels and will be connected by a transverse walkway to the 'Transmilenio' stop located on the south side of the avenue.

19th century spirit, 21st century design

Renovation works for Renfe

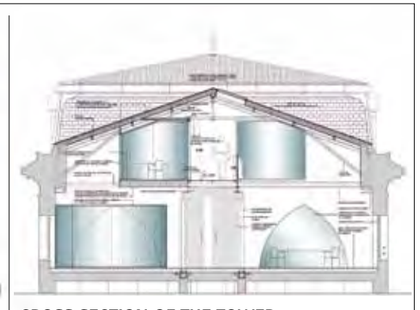
Published in itransporte 38

With over 150 years of history, Renfe's offices on the Avenida Ciudad de Barcelona, in Madrid, are in the process of being renovated. Since 2007, Ineco has been carrying out refurbishment projects and providing site management services for these emblematic buildings.

Renfe's historic office buildings make up the complex that once was the headquarters of the old Madrid–Zaragoza–Alicante (MZA) railway company. The four different constructions of the complex, arranged lengthwise, are separated by patios and connected by glass walkways with a metal structure. These were added after work was completed on each building between 1901 and 1921. The oldest building was designed by the famous French architect Victor Lenoir in 1862 and inaugurated in 1864.

Madrid's General Urban Development Plan of 1997 granted comprehensive cataloguing conditions to the complex. This involves protecting the elements that must be preserved, such as the facades, structures and walking routes (lobbies, stairs and hallways). The only works permitted are restoration, conservation, refurbishment and specific restructuring.

Such projects require proof of compliance with regulations, the Technical Building Code (CTE), accessibility requirements and recovery of the building's original conditions of use. ✱



CROSS SECTION OF THE TOWER

Responding to Renfe's needs

The purpose of the project was to respond to Renfe's needs. In order to do so, Ineco drew up the projects required to completely define the exterior and interior restoration of the building complex, their docks and common elements, and applied for permits from the City Planning Department. The company also provided consultancy services for comprehensive project management for the buildings, as well as comprehensive site management.

While drawing up the project for the renovation of the facades and roofs, Ineco

was assisted by architect Javier Contreras, an expert renovator. Before drawing up the projects, the company performed data collection, conducted topographical surveys to draw up plans of the buildings in their current condition (with particular emphasis and detail on historic and ornamental architectural elements) and took samples from bearing walls and ceiling structures for structural analysis. Samples were also taken from the facade to perform a petrological analysis and determine the degree of alterations present.

The project and the necessary procedures

The projects were submitted in 2008 to the COAM (Madrid Official Association of Architects) for approval, and to Madrid City Council to request work permits.

Taking into account the extent to which the buildings are protected, the actions considered in the projects are intended to maintain the exterior appearance with regard to volumetry, materials and decorative elements. To break the rigidity of the arrangement marked by the bearing walls, the spaces in the reception areas and lobbies are arranged in a circular pattern, ignoring the presence of these walls by giving continuity to the finishes and installing a lift.

On the two upper levels, the project involves recovering the space under the mansard roof. To do this, the skeleton shaping the space in the intermediate sections is bared, emptying out the ceiling structures and leaving the metal structure visible to achieve a feeling of spaciousness.

The first project undertaken was in building number 6, which received a work permit in 2009. Due to the complexity of the entire renovation, the works were divided into eight projects. The work to be performed was also divided. In addition to drawing up each project as an independent strategy, studies were conducted to coordinate all of the projects. A project phase plan was also prepared to provide for the additional temporary measures required so that the other buildings could be used while each one was being renovated. Ineco applied for the building permits in 2009, satisfying all of the City Planning Department's Technical Licensing Unit's requirements. The permits were granted that same year.

The Iron Bridge is refurbished

Work on the Mérida railway bridge is completed

Published in itransporte 45

DIAGONAL STRUTS REPLACED

WORK ON THE TRACK

LOWER DIAGONAL STRUTS REPLACED

Repairs made in abutments, antiroll devices or reinforcement of diagonal struts and rail bearers are some of the actions carried out by Adif in the modernisation of the emblematic railway bridge over the Guadiana river in Mérida. Ineco was responsible for the preliminary studies, the drafting of the construction project and technical assistance for the work.

Since the 1st century B.C., bridges have crossed the Guadiana river to connect the ancient town of Emerita Augusta. This is the case of the ancient Roman Bridge, the first construction work carried out in what is now the capital of Extremadura.

The Iron Bridge of Mérida, one of the emblematic infrastructure works of the 19th century, has allowed trains to cross the river for almost one and a half centuries. Ineco participated in the modernisation project, which was necessary to allow the bridge to continue serving the city in the 21st century. The Bridges Division of Adif conducts systematic control and maintenance programmes for bridges of the conventional railway network. In compliance with the guidelines set by the Instruction on Technical Inspections in Railway Bridges (ITPF-05), periodic technical inspections and load tests are performed on all bridges.

The preliminary studies carried out by Ineco alerted of the need for work on the bridge in order to ensure its correct conservation and adaptation to the traffic it carries. Ineco is experienced in this field, since it has been collaborating with Adif since 1985 providing technical support in the execution of inspections, load tests and bridge projects. *

IMPROVEMENT OF THE STRUCTURE

Among the different actions carried out in the Iron Bridge are those meant to improve its structural capacity, reinforcing diagonal struts and rail bearers, installing antiroll devices and replacing deteriorated elements.

The Iron Bridge in 1883

In the year 1856, Robert Kith, a mining engineer based in Seville, drew attention to the need of a railway joining the Spanish cities of Mérida and Seville to establish the port of Seville as a natural exit for the products of Extremadura. Construction work started on the Iron Bridge in 1881 and it was completed in 1883, almost 30 years after it had been planned. It was built by the Compañía de Ferrocarriles Extremeños and designed by one of the partners of the company, the English engineer William Finch Festherstone.

It is a riveted metal bridge with 11 isostatic spans, each 54.450 metres long, and a total length of 604.465 metres. Each segment has two isostatic beams consisting of Linville type trusses with a 6.38 metres edge. The position of the deck, formed by rail bearers and joists, is intermediate-upper with respect to the main beams.

MODERNISATION ACTIONS. The modernisation work on the bridge was completed in October 2011. The works carried out include several conservation actions and improvements on its structural capacity. Among the former are actions on stirrups and piles, such as clearing vegetation, consolidating joints, filling gaps in walls, adaptation of worn footings or cleaning support crowns. Reinforcement work was also carried out as a result of local damage and to replace loose or lost rivets. Among the actions for improving the structural capacity are the installation of antiroll devices, reinforcement of diagonal struts, main beams and rail bearers, and replacing bracing struts and rail bearer extension brackets.

Makkah–Madinah high-speed railway line contract signing

An overview

A GRAPHIC JOURNEY

One of the largest foreign contracts ever won by Spanish companies was signed last January 14 in the Intercontinental Hotel of Riyadh, capital of Saudi Arabia. The 12 Spanish representatives of the winning consortium Al Shoula and the two Saudi representatives (the Al Shoula industrial and financial group, led by Prince Abdul Aziz Bin Misha'l, and the local construction firm Al Rosan), participated in the official signing ceremony.

The event was attended, among other authorities, by Jubarah bin Eid Al-Suraiseri, Saudi Minister of Transport; Abdul Aziz Al-Hokail, President of the Saudi Railways Organisation (SRO), and the Spanish Ministers of Transport, Ana Pastor, and Foreign Affairs, José Manuel García-Margallo. *

ROYAL CONGRATULATIONS

His Majesty, King Juan Carlos I, personally congratulated the consortium members (among them, Pablo Vázquez, President & CEO of Ineco) who he received in audience on February 7 at the Zarzuela Palace in Madrid.

Once again, the Ministers of Transport, Ana Pastor, and Foreign Affairs, José Manuel García-Margallo, showed the institutional support for this Spanish business initiative.

01

02

03

04

PHOTOS BY JOSÉ SOLORZA / INECO

01. 'Family pictures' of the partners, with a representative of the SRO, posing in the Conference Hall of the Intercontinental Hotel of Riyadh where the official ceremony would be held on the following day: Renfe, Adif, Talgo, Ineco, Consultrans, OHL, COPASA, IMATHIA, Dimetronic, Indra and Cobra.

02. During a break in the preparatory work, Prince Abdul Aziz Bin Misha'l inspects the model of the future Haramain high-speed train to be built by Talgo.

03. Manuel Benegas, Director of the Makkah–Madinah project, and Javier Cos, General Manager for International Business and Development, both of Ineco, signing the technical proposal. The full documentation, in duplicate, amounted to more than 40,000 pages, which were signed one by one.

04. In the centre, the Ineco delegation in full during the signing of the Master Agreement: Javier Cos (bottom centre); Juan Luis Monjarás, Project Manager; Manuel Benegas, and the Department Head for Asia and Africa, José Solorza. Next to them are executives of COPASA, Renfe and Cobra.

PHOTO BY JOSÉ SOLORZA / INECO

05. The official ceremony was opened with the reading of a sura from the Quran by an imam.

06. In the forefront, the Saudi authorities and Spanish Ministers. Behind them, the members of the consortium.

07. Javier Cos under the spotlights and microphones of the Saudi press covering the event, which was also covered by the Spanish media.

08. Pablo Vázquez, President of the Spanish consortium, welcomes Jubarah bin Eid Al-Suraiseri, Saudi Arabian Minister of Transport.

09. Meeting between Saudi Arabian Minister of Transport and the High-Speed Makkah–Madinah consortium, held in Madrid on June 5.

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12

TIME TO WORK. A few days after the signing, the top parties responsible for the Haramain project in the SRO, the Project Manager, Mohamed Mahmoud Ould Cheikh, and Russell Adams, from the British firm Scott Wilson, visited Ineco's offices in Madrid.

10. A delegation of the consortium, with representatives of Ineco, Renfe, Adif, Talgo and Consultrans, received the visitors in Madrid. They later took a trip on the Spanish high-speed train.

11. Juan Batanero, Area Director for Railway Installations and Systems of Ineco, conversing with Mohamed Mahmoud.

12. The representatives of the SRO were also received by José María Urgoiti, Area Director for Railway Projects, Works and Maintenance of Ineco (second from the left).

13. Javier Guerrero, Head of OCL Department of Ineco, shows some catenary components to Mohamed Mahmoud.

13

'The HHR is a challenging and exciting project for all of us in Saudi Arabia'

Abdul Aziz M. Al-Hokail

President of the Saudi Railways Organization (SRO)

Saudi Arabia will have by 2015 one of the most extensive rail networks in the world. Abdul Aziz M. Al-Hokail plays a key role in this new scenario.

Al-Hokail was born in Al Majma', near Riyadh (Saudi Arabia). He studied at the University of Texas (USA), and joined Saudi Aramco (Saudi Arabian Oil Company) after graduating as Petroleum Engineer in 1964. He then held a number of high positions in upstream operations, downstream and other industrial operations, as well as member of Board of Directors of Saudi Aramco since 1989. He later became an Executive Vice President of Aramco prior to joining the SRO as President as per Royal decree.

Currently, as President of the SRO –which employs more than 1,400 people–, he is the main responsible of the mega railway projects that will change the map of Saudi Arabian transportation and allow new connections with Middle East countries.

'This is the first high-speed railway to be implemented in a harsh desert environment, with high temperature and sand storms'

What does Haramain High-Speed Rail mean for Saudi Arabia and the millions of pilgrims that visit the holy cities?

The Haramain High-Speed Rail Project (HHR) is the most important milestone of the Saudi railway expansion. It will transform the transportation quality and choice between the holy cities of Makkah and Madinah, as part of set of high class services. The Custodian of the Two Holy Mosques, King Abdullah Ibn Abd Al-Aziz, is ensuring that the mosques will be available to pilgrims, visitors and citizens.

Could we say that, in many aspects, this is a unique project in the world? Which of those aspects would you highlight?

Most definitely, it is a unique project, as it will connect the most important holy cities of the Muslim world, providing high quality transport service to more than 2.5 million passengers a month. Technically, it is the first high-speed railway to be implemented in a harsh desert environment, with high temperature and sand storms. It is a challenging and exciting project for all of us in Saudi Arabia.

At what point is the first phase of the construction of HHR right now? What technical difficulties have you found at the moment?

The first phase of the construction is progressing well. We now have the first 100 kilometres of the route completed and another section of more than 100 kilometres will be ready before the end of this year. The four passenger stations are also progressing well and they will be completed as planned.

How are the two phases of the project being coordinated?

Coordination and interface management are the keystones to the project's success, and we are giving this issue the importance it merits. Interface management teams comprised of all contractors and relevant stakeholders frequently review interfaces to speed up progress and ensure the delivery of a well-integrated project.

'The success of the HHR will depend on how the contractor will overcome the different problems created by the challenging conditions'

What are the main technical challenges of this project?

As we said earlier, this is the first high-speed railway project to be delivered in a harsh desert environment. The success of this project will depend on how the contractor will overcome the different problems created by the challenging conditions, like the effects of temperature, sand and dust on the trains, the railway systems and their integration.

Spanish Talgo will supply the rolling stock.

The SRO is financing the entire project, with an expected investment of €12 billion.

HHR is part of the comprehensive plan to expand Saudi Arabia's railway network through the SRO. Specifically, the Land Bridge will connect with the HHR. How will the construction of both projects be coordinated? What synergies will result from this connection?

The HHR project and Land Bridge project are both part of the Kingdom's expansion program: each one has its own specificity and focus, and they will meet in a short section close to Jeddah and they will also share a station. The two projects will have different construction timetables, so it is important to coordinate their designs and ensure that they will fit their respective needs and purpose in an optimal manner. A technical committee is already working to meet this target.

Among the millions of HHR potential users there will be some with modest economic resources... What type of pricing policy does the SRO prefer? Will the high demand expected allow access to HHR for users with lower purchasing power?

It is the policy of the Kingdom of Saudi Arabia to provide best quality services with low prices for all citizens irrespective of their wealth, and this is always emphasized by King Abdullah Ibn Abd Al-Aziz. Pilgrims are considered to be the Kingdom's special guests and they too will benefit from this policy.

The main objective of this project is to provide fast, safe and reliable transport for the citizens and pilgrims, at prices that are set to meet their budget. The pricing mechanism is monitored by the government to ensure fair access for all.

In your opinion, what does the Spanish companies' expertise contribute to the HHR project?

During the last decade, Spain has developed a first class high-speed rail network, and it is now a leader of this industry. We trust this experience will be beneficial for the project's success and for know-how transfer to the Saudi engineers, technicians, and local market.

'Spain has developed in the last decade a first class high-speed rail network, and it is now a leader of this industry'

In your last trip to Spain you travelled from Madrid to Málaga (a 532-kilometre trip) using the state-of-the-art Spanish High-Speed Rail network (Alta Velocidad Española). What were your impressions of this journey?

Both the train and the service were impressive and expect for Al Shoula Consortium to build on this high benchmark, by applying Spanish technology and experience to the HHR project and the services. ✱

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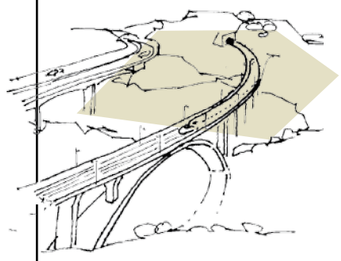

Our team comprises over 3,000 professionals: expert engineers and consultants on projects involving airports, air navigation, conventional and high-speed rail networks logistics, urban transport and roads. Ineco boasts cutting-edge technological capacities.

Ineco in the world

Our experience has enabled us to develop projects in over 40 countries across four continents. Over the last few years, Ineco has won more than 150 contracts around the world, testament to our capacity to work overseas.

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