



Technical diagnosis and management assessment of the Lyon-Madrid rail section

EXECUTIVE SUMMARY

This report analyses the rail section infrastructure and identifies technical bottlenecks and cross-border problems, and the limitations caused by the infrastructure organisation and management of the corridor.

STUDY CONDUCTED BY:
TEIRLOG Ingeniería
with the collaboration of Robert Claraco (2015)

The full document is accessible to the project's Stakeholders Interest Group on the CLYMA website: www.clyma.eu



DEVELOPMENT OF THE
**CONNECTION
LYON-MADRID**
ON THE MEDITERRANEAN
CORRIDOR



Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Foreword

European standards indicate that the operational and infrastructure requirements for the Madrid – Lyon rail corridor should be as follows:

Technical concept	Standards
Gauge	UIC 1.435 m
Electrification	25.000 V
Safety and communication system	ERTMS
Type of trains	ME 100 and ME 120
Maximum length	750 metres
Axle load	22.5 tonnes
Loading gauge	C
Weight of the trains	2,400 tonnes

These issues have been analysed separately for the Spanish and French sides.

Reliability of flows and capacity/slots availability will be analysed basically on the busiest sections of the axis.

1. Analysis of the infrastructure
1.1. Railway infrastructure in Spain

Track gauge

Stretch	Length (km)
Madrid - Salamanca	256
Salamanca - Zamora	195
Zamora - Valladolid	206
Valladolid - Burgos	243
Burgos - Leon	208
Leon - Gijón	172
Gijón - Asturias	196
Asturias - Cantabria	198
Cantabria - Basque Country	198
Basque Country - Navarre	208
Navarre - Aragon	198
Aragon - Catalonia	208
Catalonia - Valencia	208
Valencia - Balearic Islands	208
Balearic Islands - Murcia	208
Murcia - Alicante	208
Alicante - Andalusia	208
Andalusia - Extremadura	208
Extremadura - Castile	208
Castile - Castile-La Mancha	208
Castile-La Mancha - Madrid	208
Madrid - Almería	208
Madrid - Murcia	208
Madrid - Alicante	208
Madrid - Valencia	208
Madrid - Barcelona	208
Madrid - Paris	208

The Spanish side of the freight corridor has approximately 1,400 km of length. There are 2 railway lines between Madrid and Barcelona. UIC gauge (1435 mm) line, exclusive for passenger trains (High Speed line). Iberian gauge (1667 mm) line, which can be used by passenger and freight trains. The part between Barcelona and the French border has also 2 options: Barcelona-France border, the UIC line (TP Ferro) and Iberian line (Portbou) allow mixed traffic (passengers and freight).

- Between Madrid and Barcelona, UIC gauge line is exclusive for passenger traffic, never freight.
- Between Barcelona-France border, the UIC line (TP Ferro) and Iberian line (Portbou) allow mixed traffic (passengers and freight).

1. Analysis of the infrastructure
1.1. Railway infrastructure in Spain

Freight Traffic intensity (weekly average)

Madrid node (freight traffic)

A main freight flow exists in the rail arc between San Cristóbal Industrial and Vicálvaro Clasificación, to which other terminals are connected. Interior freight traffic is more intense (over double) than at the beginning of the corridor (direction to Barcelona and Lyon). Freight traffic uses exclusive rail stretches, at stretches of San Cristóbal-Vicálvaro Bajo, Villaverde-Vicálvaro and San Fernando-Alcalá de Henares. In these two double tracks, where passenger and freight trains are separated. Madrid node provides an exclusive rail infrastructure for freight trains. Potential bottlenecks are solved by two double track stretches.

1. Analysis of the infrastructure
1.2. Railway infrastructure in France

Type of railway

Between Lyon and Nîmes, from the point of view of communications between the two railways on the right and left banks of the Rhône, there exist 4 possibilities to change from one route to the other, whatever the direction of the traffic:

- Givors - Chasse-sur-Rhône
- Peypaud - St Rambert d'Abion
- La Mouille sur Rhône - Livron
- Avignon

The drivers are trained to use all routes and the line regulation can be changed without previous notification. On the By-pass Voie sur Rhône - Livron, RFF is the owner the lands next to the railway. A project for an intermodal station accessible from the north or the south was considered so that the trains carry out loops without making manoeuvres. Besides Lyon, there are 4 possibilities to connect the two double tracks situated along the two sides of the Rhône

1. Analysis of the infrastructure
1.3. Spanish Road infrastructure

Traffic (total)

Stretch	Type	Intensity
Madrid - Salamanca (A-2)	Highway	68,093
Madrid - Salamanca (AP-2)	Highway	8,275
Salamanca - Zamora (A-2)	Highway	16,142
Zamora - Valladolid (A-2)	Highway	19,515
Valladolid - Burgos (A-2)	Highway	18,103
Burgos - Leon (A-2)	Highway	21,476
Leon - Gijón (A-2)	Highway	22,243
Gijón - Asturias (A-2)	Highway	40,487
Asturias - Cantabria (A-2)	Highway	28,407
Cantabria - Basque Country (A-2)	Highway	28,407
Basque Country - Navarre (A-2)	Highway	28,407
Navarre - Aragon (A-2)	Highway	28,407
Aragon - Catalonia (A-2)	Highway	28,407
Catalonia - Valencia (A-2)	Highway	28,407
Valencia - Balearic Islands (A-2)	Highway	28,407
Balearic Islands - Murcia (A-2)	Highway	28,407
Murcia - Alicante (A-2)	Highway	28,407
Alicante - Andalusia (A-2)	Highway	28,407
Andalusia - Extremadura (A-2)	Highway	28,407
Extremadura - Castile (A-2)	Highway	28,407
Castile - Castile-La Mancha (A-2)	Highway	28,407
Castile-La Mancha - Madrid (A-2)	Highway	28,407
Madrid - Almería (A-2)	Highway	28,407
Madrid - Murcia (A-2)	Highway	28,407
Madrid - Alicante (A-2)	Highway	28,407
Madrid - Valencia (A-2)	Highway	28,407
Madrid - Barcelona (A-2)	Highway	28,407
Madrid - Paris (A-2)	Highway	28,407

An intense traffic is produced in the stretches between west Barcelona and the French border, which is the common itinerary of Madrid-Barcelona traffic and Mediterranean coast. Both road alternatives are strongly used. The two options connecting the south of Barcelona with the French border are strongly used. Toll highway (AP-7) offers a faster and more comfortable itinerary than conventional road (N-4) in this part of the corridor (high saturation). Metropolitan Urban Areas have the highest traffic intensity (over 70,000 vehicles/day), where long distance traffic is mixed with commuters (bottlenecks at peak hours). The node of Zaragoza offers the highest intensity point among the intermediate stretch, where there are not capacity problems at Zaragoza's ring.



Technical diagnosis

In short, most of the bottlenecks are linked to the infrastructure on the Spanish side, whilst on the French side most problems are related to capacity limitations.

On the **Spanish side the infrastructure limits the train length** and the freight **train weight**:

- Train length limitations (500 m maximum) on the entire line: Madrid – Zaragoza – Barcelona – Border.
- Lack of adequate side-tracks along the line Madrid – Zaragoza – Barcelona – Border.
- Various sections with >15‰ characteristic gradient.

UIC is not available from Madrid to Zaragoza and Barcelona on the conventional lines used by freight trains.

From Barcelona to the French border, UIC is available only on the mixed line used by high-speed passenger trains. Freight trains face substantial limitations on this UIC line for operational, infrastructure, safety and cost reasons.

On the French side, there are no significant limitations related to infrastructures (850m-long trains are allowed, there are no problems of characteristic gradient, etc.). From Perpignan to Nîmes the development of high-speed for passengers was recently postponed by the French Authorities. However, the **Narbonne-Nîmes section** faces **serious capacity constraints**.

Cross-border between Spain and France remains the main problem of the corridor for freight trains.

From Barcelona to Le Perthus border on the UIC line:

- **Difficulties in making a mixed rail track compatible** for high-speed passenger trains & freight trains.
- **3 Electrification systems** (25 KV, 3 KV & 1.5 KV)
- **2 safety systems** (ASFA, ERTMS) and KVB in France
- **Gradient > 15‰**
- Substantial toll
- No competition on UIC traction
- **High traction costs**

On the conventional Iberian gauge line, between Barcelona and Portbou, there are no capacity problems, although cargo must be transhipped or axles changed, which substantially increases costs.

Bottleneck summary

1. Common bottlenecks of the Madrid-Lyon axis

COMMON BOTTLENECKS		
●	1	Different track gauge: UIC gauge between Lyon and Barcelona, Iberian gauge between Barcelona and Madrid
●	2	Different voltages: 3 kV in Iberian and mixed gauge in Spain, 25 kV in the Mollet-TP Ferro stretch and 1.5 kV in France.
●	3	Different safety systems: ERTMS in Spanish UIC gauge tracks, ASFA in conventional Spanish network and KVB in France.
●	4	Cross-border bottlenecks (see 2, Cross-border section)

2. Cross-Border Section

CROSS-BORDER SECTION		
Le Perthus tunnel connection		
●	1	18% gradient for 3 km at the Le Perthus and Girona Tunnel.
●	2	Although the Mollet-TP Ferro UIC gauge line was designed for 750m-long trains, the current maximum length allowed is 500m, for safety reasons.
●	3	The toll of the Le Perthus Tunnel substantially increases the cost of trains and limits their competitiveness.
●	4	Limited commercially attractive available slots for freight trains (due to maintenance operations and passenger traffic and lack of sidings in the Mollet-TP Ferro stretch).
●	5	Mollet-TP Ferro: Crossing of high-speed trains with freight trains causes safety and operational restrictions that limit freight trains' competitiveness.
●	6	A telephone blocking system has to be used from Le Perthus to Le Soler.
●	7	Three-phase locomotives are needed to run on the line from Barcelona to the border
Portbou connection		
●	8	Portbou-Cerbère link consists of two single tracks (one Iberian and the other UIC), limiting capacity in comparison to a double-track solution (manoeuvres).
●	9	Portbou does not meet the requirements for direct and fluid international freight traffic: (UIC gauge, different voltage, length of trains and safety systems).
●	10	Complicated manoeuvring and operations are required to access Perpignan, thus decreasing the efficiency of the traditional rail crossing through Portbou.
Common		
●	11	Locomotive and driver change at the border section. Need for cross-border training for drivers (languages, rulebooks, etc.).

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●



Bottleneck summary

3. Spain

OPERATIONAL		
●	1	Extremely limited capacity for commercially viable freight trains in lines with mixed traffic (freight and high-speed passenger trains).
●	2	Two single-track stretches between Zaragoza and Reus working as a one-directional loop. Northern is not included at the TEN-T Core Network, and is required for the correct operation of this rail stretch.
●	3	Extended transit times for international freight trains (lack of competitiveness).
●	4	Mollet-Perpignan: Limitations arise from the mix of freight and passenger trains on high-speed lines: different speeds, reduction in the number of slots (capacity), high maintenance costs.
●	5	Potential limitations for dangerous goods transport on the current urban tunnel of Girona.
●	6	In stretches with the 3 rd rail there are speed limitations at railway changes (10 km/h due to risk of derailment). This restriction could reappear in future stretches built with this double gauge solution.
●	7	Girona-Portbou: speed limit 30 km/h at tunnel number 11 in pair direction
●	8	Castellbisbal-Mollet stretch: Commuter traffic mixed with freight flows starting/ending at Port of Barcelona.
CAPACITY		
●	9	Metropolitan Area of Madrid: High commuter train traffic between Alcalá and Guadalajara hinders daytime traffic of freight trains.
●	10	From Madrid to Zaragoza, Calatayud – Ricla is the only single-track section of the line (potential bottleneck).
●	11	Congestion in single track sections from Zaragoza to Reus: <ul style="list-style-type: none"> Zaragoza-Tardienta: Saturation level over 50% at Tardienta. Huesca-Lleida (Monzón): Lack of suitable slots for freight due to maintenance operations. Lleida-Reus: Freight traffic limitations due to regional passenger trains between Lleida and rest of Catalonia. Saturation level over 60% in the stretch Zaragoza-Mora-Reus (South). Potential bottleneck at the southern bypass at the Zaragoza node (Information study projected to increase capacity, eliminate the current 19‰ gradient and improve PLAZA access).
●	12	Barcelona access for freight: <ul style="list-style-type: none"> Serious congestion from Martorell to Castellbisbal: very high commuter traffic combined with a heavy flow of freight trains (connection with the Port of Barcelona). The construction of the 3rd rail between Castellbisbal and Sant-Vicenç will add UIC gauge traffic without increasing its capacity (more traffic with same capacity). No additional or alternative itineraries proposed. Current congestion in Mollet-Sant Celoni section due to substantial commuter traffic.

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●

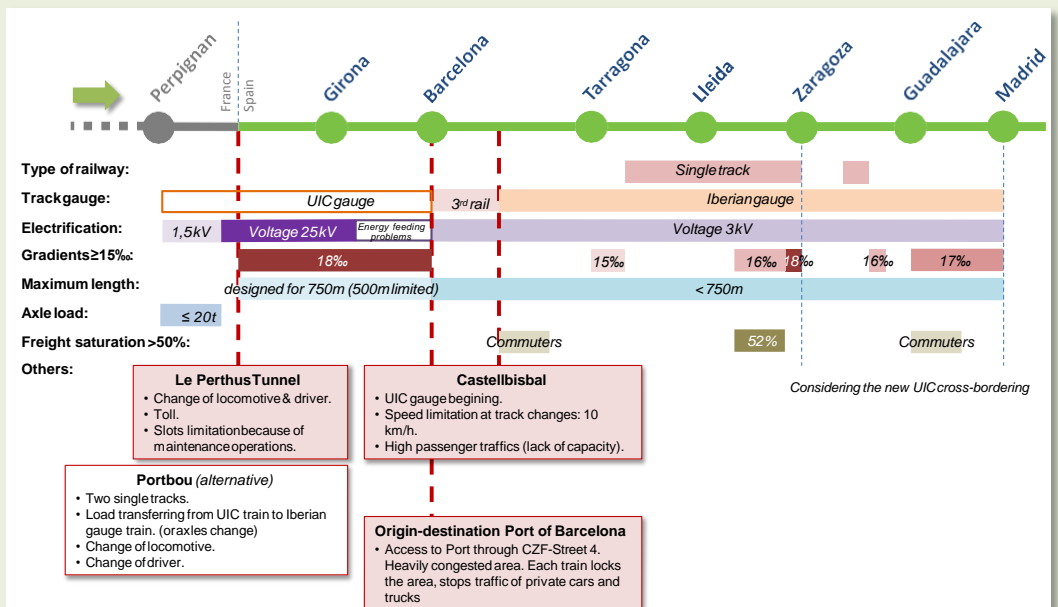
Bottleneck summary

INFRASTRUCTURE	
●	13 Rail Access to the Port of Barcelona. Trains from the Port's South area (more than 75% of traffic) currently run across a heavily congested area (No "4" Street)
●	14 UIC gauge (sometimes with 3 rd rail tracks) for freight trains only from the Port of Barcelona to the French border.
●	15 Lack of UIC rail access to most of the cargo terminals and private factories (Port of Tarragona intermodal terminal, La Llagosta, SEAT, CELSA, BASF,...)
●	16 Spanish railways limits train length to 500m, even on the UIC line. On the French side, the rail corridor allows 850m-long freight trains.
●	17 > 15‰ ramps in several sections of the line, thus limiting train weight, equipment required, speed, etc.
SUPERSTRUCTURE	
●	18 Insufficient energy power from Mollet-Vilobí d'Onyar (80 km).
●	19 Mollet-TP Ferro: Train traffic would have to be interrupted in case of power cuts due to induced current.
OTHER CONSIDERATIONS	
●	20 Zaragoza-Reus intermediate single track sections: If UIC gauge is included in the future, both lines will need to be adapted (Northern and Southern line).

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●

Lyon-Madrid connection: itinerary constraints

SPAIN



Bottleneck summary

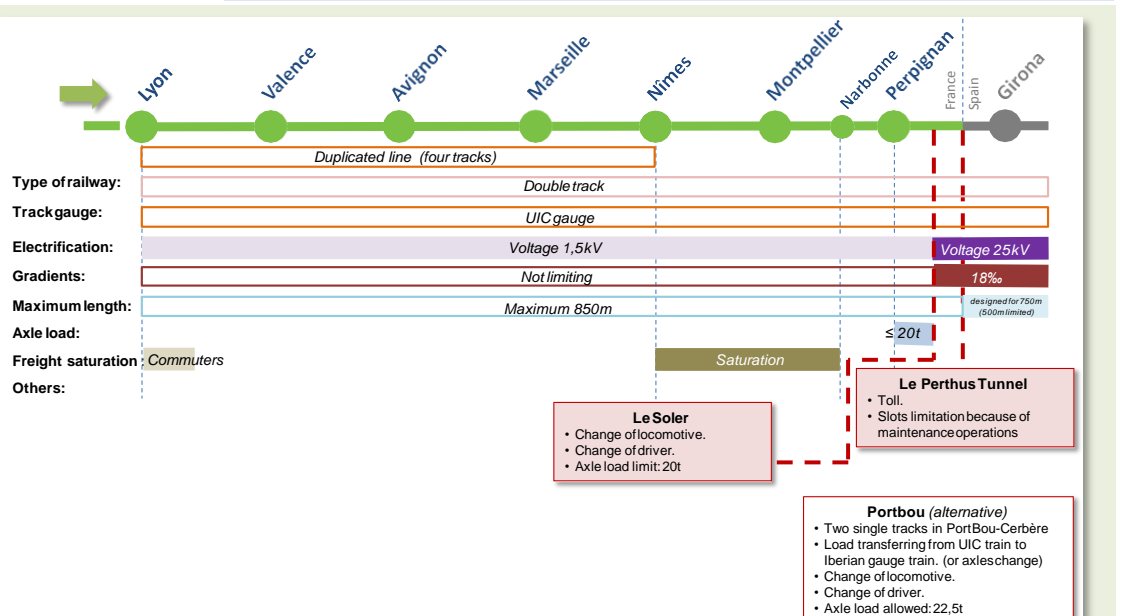
4. France

OPERATIONAL	
●	1 Lack of commercially viable slots for freight trains. Congestion of the lines and lack of transparency of slot distribution procedures.
CAPACITY	
●	2 Substantial capacity problems in different sections, namely: <ul style="list-style-type: none"> ▪ Narbonne-Nîmes: 60% saturation level, 6 freight trains available per day. ▪ Fos-sur-Mer: 85% saturation level, only 2 freight trains available per day. ▪ Avignon-Marseille: 70% saturation level, 5 freight trains available per day. Current capacity is clearly inadequate if freight trains are to develop further.
INFRASTRUCTURE	
●	4 Perpignan-Narbonne line: close to sea level, making the route vulnerable depending on weather conditions (winds particularly).
SUPERSTRUCTURE	
●	5 Voltage of the railway network: 1,5 kV. Need for three-phase locomotives to operate along the international corridor.
●	6 KVB is the safety and communication system. No previsions of development of ERTMS in the network.
OTHERS	
●	7 Perpignan (St. Charles terminal): Rail connection with St. Charles crosses high speed line (problems with manoeuvring).

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●

Lyon-Madrid connection: itinerary constraints

FRANCE



Management assessment

The following assessment aims to identify and assess the **limitations caused by the rail infrastructure's organisation and management**.

Two issues should be highlighted in this respect:

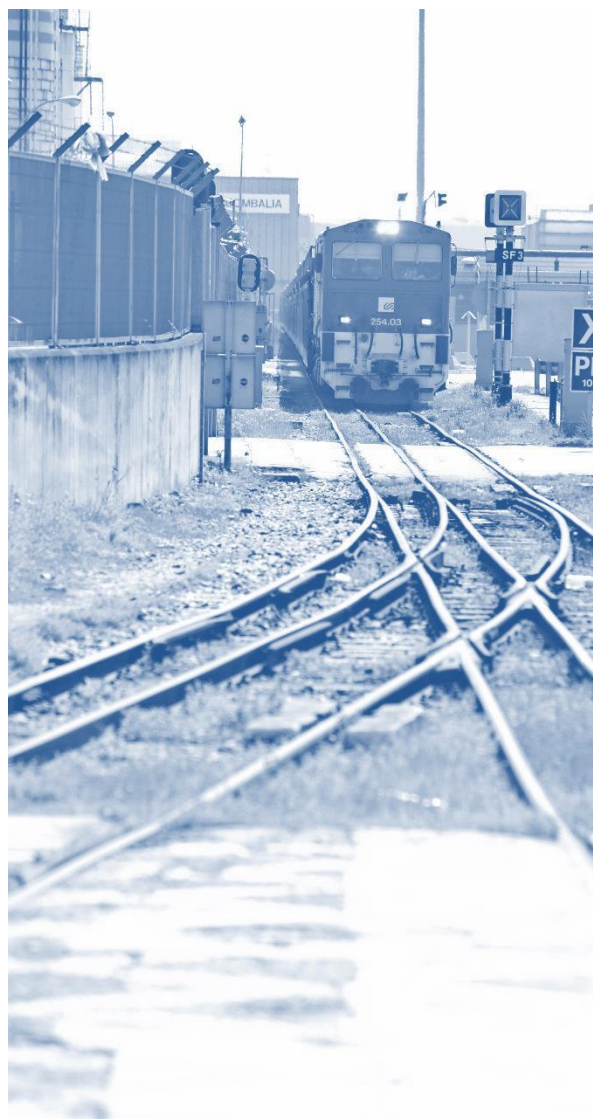
- **International interoperability** management issues on both border crossings (UIC gauge connection at TP Ferro and conventional gauge connection at Portbou-Cerbère);
- **Management of the lineal and node infrastructure**, service provision and competition within the rail industry in both countries involved.

Different sources were consulted when performing this assessment:

- **Personal interviews:** Rail agents contributed by naming the problems of the corridor from the management point of view. This information has been compared and verified to conduct this assessment of the infrastructure management.
- **Publications and existing documents:** Publications about Competition and Market from CNMC (National Markets and Competition Commission) in Spain and ARAF (Rail Activity Regulation Authority) in France, Network Statements from the various railway administrators and other documents related to management issues on the corridor

The assessment developed on **rail management** was structured as follows:

- **Capacity and slot availability** for cargo lines.
- **Slot management** by rail infrastructure managers.
- **Terminal management**, situation of intermodal terminals.
- **Rolling stock**.
- **Provision of rail services**.
- **Competition and Market**, all elements affecting free competition among rail operators are analysed.
- **Temporary factors**, temporary circumstances affecting rail traffic management in specific stretches are mentioned.





Summary of management issues

CAPACITY AND SLOT AVAILABILITY		
SP	●	Long maintenance periods of the Mollet-TP Ferro line decreases its capacity by 23%
SP	●	The conventional Iberian gauge line in Spain has sporadic slot capacity or availability issues as follows: <ul style="list-style-type: none"> Metropolitan areas due to high commuter traffic. Axle change or container transshipment at the Portbou-Cerbère stretch. Potential risk of cargo capacity decrease due to a possible future increase on the number of passenger trains (at third rail stretches or single track stretches between Zaragoza and Reus)
FR	●	Heavy regional traffic hinders slot coordination for long-distance freight itineraries (particularly international traffic)
SLOT MANAGEMENT		
SP	●	Infrastructure administrator - strong ties with the incumbent in Spain and France prevents a transparent system of slot management.
SP	●	The “European corridor” concept is not applied as regards management.
SP	●	Occasional coordination issues among the assigned slots and the maintenance schedules in the infrastructure .
FR	●	The procedure followed to obtain rail slots (booked almost one year in advance) is sometimes inefficient and overly rigid.
FR	●	It is easy and inexpensive to obtain last-minute slots without previous planning. However, they are not appropriate for long-distance itineraries (international, for example).
S/F	●	Different priority criteria in both countries of the corridor. In Spain, passenger services have priority over cargo services. However in France, services planned in advance (passenger or freight) have priority.
TERMINAL MANAGEMENT		
S/F	●	Congestion in some of the biggest terminals in the network located in Spain and France (Madrid, Barcelona, Lyon).
SP	●	Lack of adequate equipment (Cranes, Reach Stackers, etc).
SP	●	Rail operators consider that ADIF concession model has not solved the terminals’ operational problems (short periods of time, not allowing investments, subrogation of personnel, different contracts in one terminal for different traffic, obligation to maintain obsolete equipment, etc.).
FR	●	Some terminals are close to saturation.
S/F	●	Lack of flexibility in terms of management and opening hours.
SP	●	High prices

CB: Cross border
FR: France
SP: Spain
S/F: Spain & France

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●

Summary of management issues

ROLLING STOCK

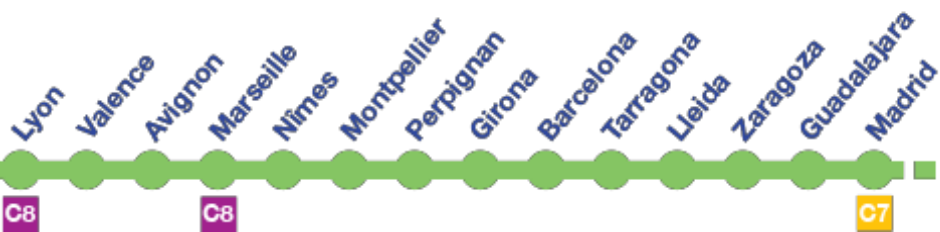
CB	●	Only the Spanish public operator Renfe has adapted its locomotives to run along the international section of TP Ferro, although they cannot continue the itinerary to France (as ERTMS is not installed in the French part).
FR	●	It is difficult and expensive for foreign companies to adapt locomotives to KVB and BAL systems.
SP	●	In Spain, the existence of a gauge different to UIC makes it more difficult to acquire rolling stock and the second hand market is very limited. There is no competition in Iberian gauge rolling stock supplies.
SP	●	The rental unit ROSCO does not satisfy private operators and the alternative option is to invest in new material.
SP	●	The only 4 locomotive type approved for TP Ferro stretch (Renfe's property) are not included in ROSCO's offer .
SP	●	Renfe Operadora has a privileged position because most of the type approved train repair workshops belong to Integria, one of its subsidiary companies .

PROVISION OF SERVICES

S/F	●	It would desirable to simplify the licensing processes in both countries in accordance with European Regulations.
SP	●	Safety certificate requirements can be restrictive for small rail operators : the candidate company must previously have locomotives to be able to operate on the particular stretch.
SP	●	Driver training and authorisation procedures have certain requirements that favour the public rail operator (i.e. practices in assigned stretch or safety certificate entailment, or the fact that a safety certificate becomes invalid when the authorised driver leaves the company).
SP	●	Lack of transparency of the current system: it is difficult for rail operators to know operating costs in advance for running a line (viability analysis).
SP	●	The charges system for the utilisation of railway infrastructure and facilities is complex and does not follow a process that encourages small operators to use these infrastructures: <ul style="list-style-type: none"> ▪ The charge for the requested traffic has a higher unit cost per km for short distances. ▪ It is necessary to pay the entire annual charge, regardless of the month in which the rail operators began their activity. ▪ The charge for capacity booking is paid by every operator for the requested capacity and not for actual use.

COMPETITION AND MARKET

FR	●	The division between users and network manager is not clear enough . The existence of two national entities (RFF and SNCF) does not effectively guarantee that division.
SP	●	Advantages granted to Renfe Operadora : <ul style="list-style-type: none"> ▪ It was receiving public funding to offset generic losses. ▪ It has an overcapacity of type-approved rolling stock, and does not sell locomotives to other operators. ▪ As Renfe Operadora performs other activities in monopoly conditions, internal cross-subsidies can be produced to compensate for possible losses in other activities. ▪ Grandfather clauses provide Renfe preferential use of infrastructures. ▪ Renfe Operadora holds stakes in the capital of other competitors.
FR	●	Advantages granted to SNCF <ul style="list-style-type: none"> ▪ SNCF has exclusivity in some rail traffic. ▪ The French government plans to group SNCF and RFF together again in the same holding company, so SNCF will be both user and manager, calling into question the guarantee of a fair access to the network in France.
SP	●	Intermodality within the cargo transport system is not very developed . There are no strong intermodal operators.
FR	●	Intermodal services are receiving subsidies, as Rail motorways or ITUs movement .



Summary of management issues

INTERNATIONAL INTEROPERABILITY (THROUGH TP FERRO)

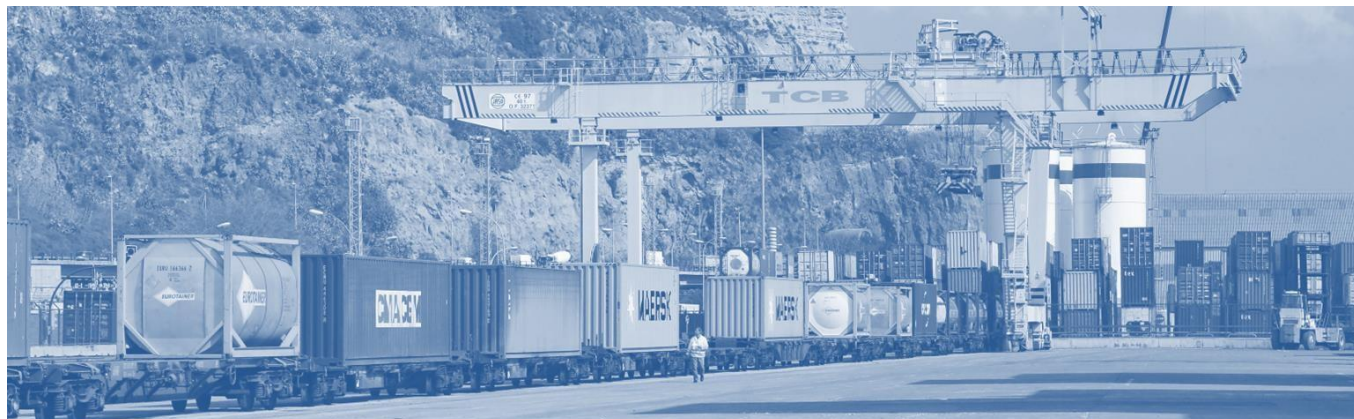
CB	●	Lack of coordination among the three different network statements (Adif, RFF and TP Ferro).
CB	●	Lack of authorised locomotives: Renfe is the only rail operator with locomotives authorised to perform the international crossing at TP Ferro. Private operators cannot face the heavy investment required by UIC-gauge to meet type-approval requirements
CB	●	Restricted capacity for operational reasons: type-approved locomotives able to offer traction are occupied at all times (at maximum rotation).
CB	●	Continuity of traction between Spain and France cannot be achieved without changing locomotives: the ERTMS system is not yet developed on the French side and is unlikely to be implemented in the short term.
CB	●	High cost in charges and fees for crossing the international section through Le Perthus.
CB	●	The infrastructure constraints mentioned in the document “Technical diagnosis of Madrid-Lyon Axis infrastructure”.

INTERNATIONAL INTEROPERABILITY (THROUGH PORTBOU)

CB	●	The amount of these operations is similar to the cost of Le Perthus crossing: around € 1,000 per train.
CB	●	These operations take around 5 hours (transshipment or change of axles), whilst in TP Ferro the locomotive change operation takes around 1 hour (if international slots are available).
CB	●	The change of axles has been operated as a monopoly since 1953. Handling can cause damages to axles (old installation).
CB	●	In any case, locomotive and driver must be changed due to the different gauges at both sides of the border.

CB: Cross border
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S/F: Spain & France

Type of shortcoming: Critical ● Significantly restrictive ● Restrictive ●



CLYMA project consists of the implementation of the corridor approach to a section of the **Mediterranean corridor**, concretely to the Western part of the corridor and specifically to the Lyon-Madrid Axis.

The project comprises of studies and actions on the organization and optimal implementation of the **TEN-T network**, taking into account long term perspectives, environmental aspects and associated needs, as well as studies that promote environmental sustainability, resource efficiency and low-carbon transport within an integrated transport concept. This should stimulate the deployment of the **Green Corridor concept**. The project also intends to develop a **managerial structure** for the intermodal corridor.



PROJECT OFFICE



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