Bordeaux: Fronting the French tramway revolution

Article from the December 2002 edition of *Tramways & Urban Transit*

From 2004, trams will become the backbone of city transport, and one in two public transport users will be aboard a tram, C. J. Wansbeek reports.

A revolutionary fervour has taken possession of Bordeaux, the capital of the French Département (province) of Gironde, a city, 200 km north of the Spanish border, near the Atlantic coast, but 95 km from the mouth of the River Garonne. Here, tram tracks are being laid throughout the city. Wherever you go, it is new rails that you see. In this blessed city, where it seldom snows and almost never freezes, the first stage of a large tramway network is nearing completion, with construction taking place at almost breakneck speed. Many of the city roads are closed temporarily, and of course blaming the tram for everything that goes wrong is fashionable.

Soon, the reward will come. A brand new, complete tramway system, designed to improve life in this city (the fifth largest in France) dramatically. From 2004 on, trams will be the backbone of city transport. Every second public transport user will be a tram rider. It has been calculated that on average the tram will result on a time gain of eight minutes on every public transport trip now made by bus.

The kernel city of Bordeaux has a population of 220 000. The metropolitan area has 700 000. It is a centre of wine trade, and much agricultural produce is exported via the harbour. Dassault and other aerospace and ICT industries have factories at Bordeaux. Chemicals, pharmaceuticals, wood and furniture are also prominent. It is a prosperous city, with a low incidence of crime. This orderly, safe city is not afraid to offer its citizens very beautiful trams, with a refined interior: upholstered seats, with soft dark blue cloth. Hopefully, vandals can be kept under control.

The Bordeaux tram follows the French success formula. A low-floor tram without frills, but very cleverly designed, with a touch of local flavour, and, above all, superb quality. Classic, yet modern. Good-looking, yet utterly "performant", as they say in France. So the Bordeaux tramway, like other new French systems, will be double-track standard gauge, 750 V dc, segregated over its full length, with tram lanes or green manicured lawns. No other vehicles, including buses or taxis, will be allowed on the tram lanes, as is the norm in France.

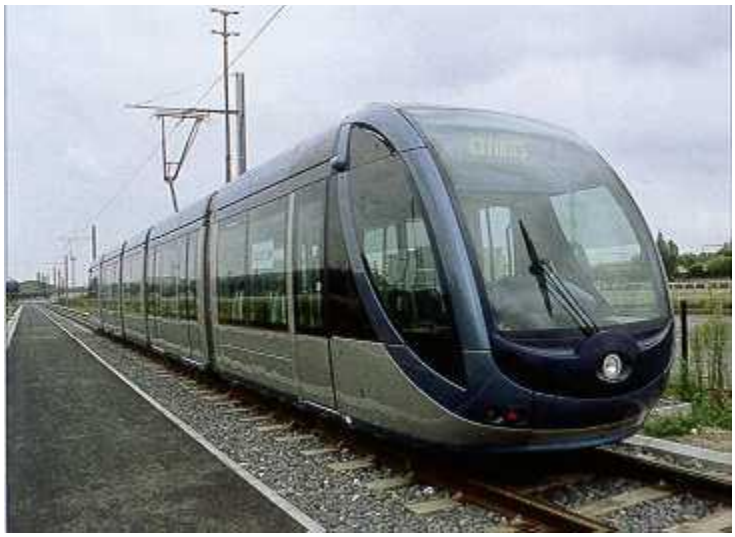
At the same time, France is an innovative nation, so the lush Bordeaux green lawns are fixed on a hard concrete layer. In exceptional cases, say if a breakdown of a vehicle occurs, heavy trucks may use the grassed areas, since they are designed to carry the weight of road traffic. There will be automatic priority at traffic signals at all road crossings, in line with the French formula. Equally important, there will be no tunnels or elevated sections. However, there is one brilliant exception, in the form of a long, gently bending and rather steep tram-only viaduct near Lormont, in the north-eastern sector of Bordeaux, a stunning piece of light rail architecture.

This is a very long section, completed in the summer of 2002, parallel to motorway RN 10, in an area known as Côte des Quatre Pavillons, where the tram will pass over a succession of three viaducts, with lengths of 300 m, 135 m and 180 m respectively. The architectural line of these sleek viaducts is traditional. They are part of a segment where the tram climbs 60 m over a distance of one kilometre. For safety reasons, there is a narrow pedestrian evacuation walkway besides it; hopefully children will not use it as a playground.

Unlike many new systems in the UK, the Bordeaux tramway does not run over any former railway alignment. It is essentially a city street system. The track layout is simple, just three long lines. Nowhere are there complicated branches or additional parallel tracks of the sort one sees in German towns. With one exception there will be no branch lines, simply because that would mean longer headways. Nor will there be any short-working routes, and the Bordeaux system is not equipped with reversing sidings or half-way turning circles.

According to Monsieur François Saglier, director of the tram project, the new tramway must be highly visible, and tram lines must be easy to recognize by the public. This too is part of the French success formula. Keep it simple. The exception: tram line A, at its north-eastern extremity splits into two, with one branch going the south-east, the other continuing to the north. But these are not "antennas", which is the French term for branches, because the Bordeaux system is based on heavy long lines.

The Bordeaux tramway system will offer a basic four-minute headway service over the full length of the system during rush hours, and eight minutes at other times. This is essential. A clean, punctual tram, every four minutes. Indeed a "light metro". The strict 4-minute rhythm is now the common denominator of most new French tramway systems. For Bordeaux, it means a capacity of 4 500 passengers per direction per hour (for lines A and B), and 3 000 passengers (for line C). As the tram lines do not overlap, they cannot block each other, and the system is designed to enable all three lines to reach their full capacity at all times of the day. Tram service will start at 05.00 daily, and continue until 01.00 in the morning.



Five-section Citadis 302, still unnumbered at the depot/workshops *(CJ Wansbeek*

Until 1958, there was a tramway system at Bordeaux, also standard gauge. This included interurban tramlines on both sides of the Garonne River, which cuts the city on two, with the historic inner city on the left bank. In the 1930s, there had been over 25 city tram routes and twelve interurban lines, with nearly 200 km of track length. The flat land in and around Bordeaux made it relatively easy to expand the tramway system to such an enormous size. Like many other French tramways of those times, the Bordeaux system was partially equipped with "caniveau", which meant power supply via conduit current collection in a slot between the rails. However, this technology was primitive, pedestrians sometimes had to mind their steps in order to avoid short-circuits.

A unique feature of the new tramway network will be the sections without overhead wires. These will be equipped with third-rail, for power supply. To this end, a new technology has been developed by a French company. It is expected that third-rail operation will soon receive formal legal approval from the authorities. The Bordeaux tramway may inspire decision-takers in those cities, where there is preference for a solution without overhead wires, for aesthetic or safety reasons. The case of Firenze (Florence) in Italy comes to the mind. The Bordeaux experience will become the proof of the pudding.

"Caniveau" is "out", it has become a non-word. On the other hand, "third rail" is "in" today as the proper description of the new technique. However, memories of the pre-1958 tramways linger on, so, when by the 1995 there was talk of building a new tramway, the public and the politicians assumed that conduit operation could easily be re-introduced. Many Bordelais (inhabitants of Bordeaux) had memories of the three-rail tram of yesteryear. Without much thought for technicalities, they simply demanded a third-rail

based tramway. In particular, the French Ministry of Culture fought for a catenary-free new tram, saying the overhead wires could ruin the sight of the city's historic facades.

Few realised that a return to the conduit was impracticable, and that a new technology had to be developed. The initiative did not come from the French industry. The industry did not try to impose a new technology on Bordeaux. But it delivered when requested. The Paris-based firm INNORAIL (a subsidiary of SPIE-Enertrans), in collaboration with Electricité de France, created a new third-rail technology after five years of experiments. As described in this magazine, issue of December 1999, SPIE-Enertrans conducted field experiments with third rail power supply over a section of the metre-gauge line 68, the only surviving tramline of Marseille.

The result is APS, or ground-level current collection (Alimentation par Sol). The third rail, in the middle of the tracks, serves as the power supply. This rail consists of a succession of 8-m long powered sections, interspersed by 3-m neutral sections. The tram as it rolls by activates the powered section underneath, by touching it with a "frotteur"(skate). Each time no more than two -- separated — 8-m long sections are powered. This means that pedestrians in front of the tram or behind it do not run any risk, since the rail not under the vehicle is always neutral.

So, APS entirely replaces overhead. Each 8-m long section of powered third rail is controlled by a "coffret" (small metal box) installed in the nearby pavement, and this box contains the electronics that provide the security check analysis and control the system; from each of these boxes power is permitted only to those rail segments above which a tram is actually passing. The standard distance between these "coffrets", which are hardly visible, is 22 m.

The tram collects the electric power each time through skates, installed in the middle underneath the vehicle. This means that at the moment when one skate touches a neutral section, the other skate is drawing power from a powered section. In case of irregularities, the "coffret" is automatically switched off, and the tram continues its journey by switching to battery-generated power. Each "coffret" can also be switched in or out by the central control facility.

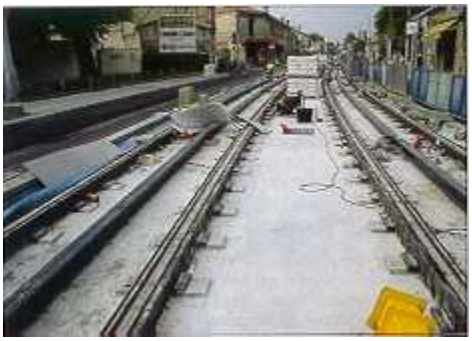
The transfer points between overhead and third rail are all located at stopping points with the driver advised by signal when to command the lowering or raising of the pantograph and skates. The procedure, including safety verification, takes only 20 seconds.

The third-rail is installed in such a manner that no road traffic can cause any harm to it, and the third rail can easily be combined with any type of pavement or road surface. According to INNORAIL, a third-rail powered tram offers the same performance as a traditional tram powered by overhead wires. The key will, of course, be to satisfy the safety authorities as to the reliability of the command and control system and its fail-safe characteristics over an extended period of trial operation. Can electronics and data transmission be even more reliable than the old mechanical conduit system?

At first, this third-rail solution was destined for inner-city sections, but for a variety of reasons, other participating communities also demanded their share, and in 2002, it was decided that a total length of 10.5 km of Stage One of the system will be equipped with third rail.

The following segments will be third-rail:

- tracks of lines A. B and C in central Bordeaux;
- tracks of line B in the town centre of Talence, near the university campus;



A third rail section nearing completion near the University of Talence *(CJ Wansbeek*

- tracks of line A at Cenon and Lormont

The innovative third-rail powered network of Bordeaux will contribute to the success of the French tramway revolution, which started with Nantes in 1985. After that, new tramways, all standard gauge, opened in Grenoble, Paris, Rouen, Strasbourg, Montpellier, Orléans and Lyon. Tramways currently under construction or planned are Nice, Le Mans, Brest, Mulhouse, Toulon and Valenciennes. The variety is increasing: Bordeaux will have third-rail power, Mulhouse and Paris will have trams over railway tracks. Alstom provides the largest Citadis fleet in France, and the stakes are high, given the implementation of the surface current collection system.

The Bordeaux tram scene has behind it a period of bad luck. From 1940 onward, trolleybuses replaced a few tramlines, but already in 1957 the last trolleybus was phased out. In 1958, the last remaining tramlines were withdrawn almost single-handedly by a powerful mayor (1949-1995), Jacques Chaban-Delmas, who also was French prime minister (1970-1972). Like so many of his generation, M. Chaban-Delmas preferred the motor car, and he simply wrote off trams as outmoded. In later years, he tried to build a heavy metro, which came to nothing, given the weakness of the subsoil. Not to be overlooked is the fact that a heavy metro costs four times as much to construct per km than a modern tramway, according to Bordeaux figures. After that, Chaban-Delmas tried to promote a VAL-type automatic mini-metro.

Once upon a time, Bordeaux was in Arab hands

Two thousand years ago, Bordeaux, under the name of Burdigala, was the main city of a Gallic tribe, the Biturges Vivisci. After that, it became a main city in the Roman Empire. Between 732 and 735 the city was occupied by the Arabs, and then re-conquered by Charles Martel. During many centuries, Bordeaux belonged to a succession of counties and regional rulers (including some time under the English. It became a part of France as late as 1452, and it took many centuries to fully integrate the people of Bordeaux. In 1793, a very violent revolt started against the centralised power imposed by Napoleon. Occupied by the Nazis in 1940, Bordeaux was liberated in 1944, with the aid of American troops who had landed in Normandy a few months earlier.

The VAL solution was adopted by Lille, Toulouse, Rennes and, recently, Torino (Italy). But Lille now admits that its choice in favour of the VAL was a mistake, and that a tram would have been a wiser solution, but it is now too late for comebacks. At Bordeaux, valuable years were lost. The VAL project studies cost the equivalent of EUR 50 million. For this sum, three or four km of tramline could have been built. In the end, the VAL scheme was rejected.

Monsieur Chaban-Delmas, who once killed the tram, refused to bring the tram back. That was left to a next generation of city leaders, who, in 1997, unanimously decided to build the tram, on the basis of a project proposal prepared by SYSTRA-SOFETRU, the engineering and consultancy firm owned jointly by RATP (Metro of Paris) and SNCF. The trams were ordered from Alstom, leaders of a consortium that includes SPIE-Enertrans (ground power supply), Cogifer (rail infrastructure), and local civil engineering companies. According to François Saglier, the tram was the winning option, as it could bring "un réseau très maillé", i.e. a fine-tuned system able to serve all corners of the city. Monsieur Saglier is a well-known name in French transport circles; he earned is laurels as the project director of METEOR, the automatic metro line (line 14) at Paris, inaugurated in 1998.

A pivotal role is played by Connex, a division of Vivendi, which, under contract with the Communauté Urbaine de Bordeaux, has the franchise to operate most city lines, including the tramway. Connex is a rising star in the light rail field, it will also be the operator of the "Trambaix" tramlines under construction at Barcelona, in nearby Spain. The Barcelona system also has ordered Citadis trams, and prospects for a close light rail co-operation between Bordeaux and Barcelona seem bright.

At Bordeaux, the mayor, Monsieur Alain Juppé (re-elected in 2001), is a powerful source of support for the tramway. There is no political opposition against the project. Mr. Juppé also happens to be the chairman of the regional transport board, in which Bordeaux and 26 surrounding self-governing communities co-operate. These 27 communities, comprising 552 sq km, are united under the name of

CUB, Communauté Urbaine de Bordeaux. Not all neighbourhoods of the Communauté will see tram service soon, but it is planned to extend the system now under construction.

The Bordeaux tram will strengthen the cohesion of the city, the tram will positively influence future urban development. Monsieur Saglier says a surface tram line provides structure to a city, whereas an underground line does not. He refers to the case of Rouen, which inaugurated a north-south tram line in 1994. The Rouen tramway brought much improvement to the city, but not in the quarter of town where the tram is in tunnel, he underlines. He says that Rouen now regrets that it included a tunnel section for its tram line.

In January 2000, the Bordeaux project received the Déclaration d'Utilité Publique, the legal instrument required for all major infrastructure works in France. Since then, the project has been in the pressure cooker. One decision was taken after another. Three new, long lines, no overlaps between them. The two busiest lines will be served by longer trams, the third line (slightly less busy) with shorter trams.

In April 2000, the rolling stock was selected. Alstom received an order for 38 seven-section 42-m long Citadis-402 low-floor trams plus 6 five-section 33-m long Citadis-302 trams. A total of 44 units. The decision was taken before the court by ADtranz (since absorbed by Bombardier), who felt their offer was better value. But although its final verdict is still awaited, the court found nothing wrong in the way Bordeaux had proceeded. The only other supplier in the race had been AnsaldoBreda.

When Stage Two was approved, a repeat order for another 14 seven-section Citadis-402 and 12 five-section Citadis-302 trams was placed, a total of 26 cars. This brings the grand total to 70 low-floor trams. Technically, all trams can be used on all routes. They will not be operated in coupled sets. The longer trams can carry some 300 passengers, the shorter ones some 200. It is observed with great interest that Montpellier, which inaugurated its tramway in 2000, has ordered two intermediate sections, to stretch its five-section 33 m long Citadis trams, and Bordeaux is aware that the Citadis is of a modular design, and can be stretched.

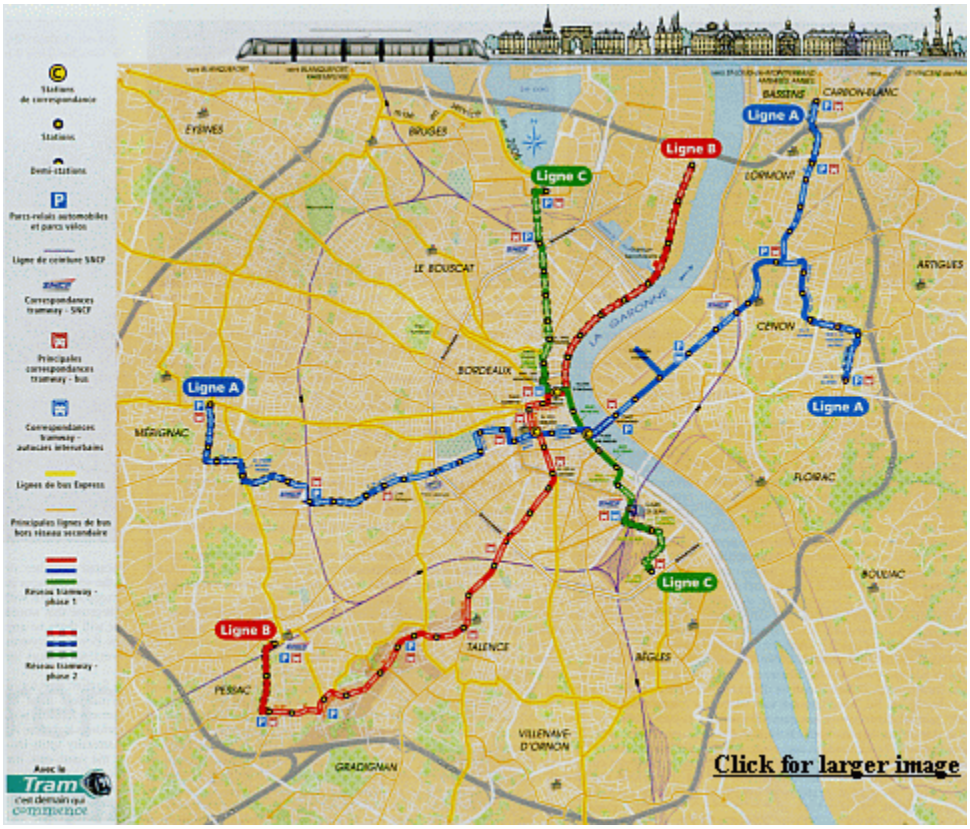
Citadis for Bordeaux

The standard-gauge, double-ended Citadis 100% low-floor trams are built by Alstom, at their factory at Aytré, near La Rochelle. The 5-section vehicle, type Citadis 302, has a length of 32 m and a capacity of 200 passengers. The 7-section vehicles for Bordeaux are of type Citadis 402, with a length of 44 m and a capacity of 300 passengers. Alstom has just decided to drop the numerical model designations for Citadis, but they are retained here for clarity.

	Citadis-302	Citadis-402
Length (m)	32.90	44.00
Width (m)	2.40	2.40
Height (m)	3.27	3.27
Entrance level (mm)	320	320
Passengers seated	48	70
Standees	170	230
Total capacity	213	300
Motors 9kW)	4x120	6 x 120
Axles	6	8
Max. Speed (km/h)	60	60

The first tram, a five-section car (yet unnumbered) was delivered in May 2002, and immediately after that, testing began. Three Citadis will be delivered each month. By September 2002, a seven-section tram had already covered a distance of 15 000 km over Alstom's own demonstration and test track near the tram factory at Aytré, near La Rochelle, which lies 200 km north of Bordeaux. Tracklaying at Bordeaux had already started in October 2000. The three tramlines are now simultaneously under construction. All three will be inaugurated on the same day. That will complete Stage One. It has already been decided that all three lines will be extended at both ends, which means seven extensions (as line A in the north splits in two, and both these prongs will be extended). These seven extensions together make up Stage Two. The tram lines are:

- line A, the "Blue" line. Stage One comprises 12.5 km, 26 stops, from Mérignac in the west, to the NE, where splits in the form of a two-pronged fork, with a three-stop "prong" going to the east (Cenon), and a four-stop "prong" to the north (Lormont). This is the only river-crossing tram line. After the three planned extensions under Stage Two, total line length will be 19.9 km with 38 stops;



The future Bordeaux tram network, showing the relationship with the river, railways and major roads. Stage 1(2003) comprises Line A from CHR Pellegrin to Lormont and Cenon, Line B from Pessac to the city centre, and Line C from Gare St Jean to the city centre. Also shown are the seven extensions which together make up Stage 2 (by 2007) *(CUB*

- line B, the "Red" line. Stage One comprises 9.3 km, 20 stops, from the city centre (and later the north, parallel to the Garonne river), to Pessac in the SW, where it serves the vast campus area of Bordeaux University. After extensions at both extremities under Stage Two, total length will be 15.4 km with 30 stops;
- line C, the "Green" line. Stage One comprises a short line of 2.85 km with 7 stops. It will run north-south, and it will serve the Saint-Jean main railway station. Exclusively on this line, the shorter five-section Citadis trams will run. After extensions at both extremities, total length of line C will be 8.0 km with 19 stops.

Stage One costs EUR 638 million. It comprises the construction of lines A, B and C with a total length of 24.5 km and 53 stops. By the end of 2003 or at the latest in early 2004, Stage One will be fully operational for all three lines.

Funding for Stage Two has already been secured, an amount of EUR 436 million, on top of the EUR 638 million for Stage One. This means that all seven planned extensions are now being prepared for construction in the period 2004-2006. The seven extensions of Stage Two add up to a total length of 18 km, and will increase the system length to 43.7 km and 84 stops. The completion of Stage Two will mean that within a walking distance of 500 m, the tram reaches 37% of the population, 50% of all jobs in metropolis, and 65% of all schools and university campuses. The commercial speed of the Bordeaux tram will be 21 km/h system-wide, which is the best in France.

By 2006, the tram will be the backbone of urban transport, and hopes are that the municipal elections of 2007 will bring support from the voters for an ambitious follow-up programme under Stage Three. This

Stage Three is in the study phase, and nothing has been approved. The implementation of Stage Three may start by 2010. Interesting proposals are included in Stage Three, such as:

- extension of tramline A to the international airport at Mérignac (app. 7 km);
- creation of a new tramline D from the city centre to the north-western part of the city (app. 10 km). This line D might also serve the neighbourhood of Le Bouscat, which in the past opposed the tram, but has reversed its policy and it is now assiduously courting CUB to be served by the tram;
- a further extension of line C to the north, to reach an expo centre near a lake, as well as the suburbs of Bruges and Blanquefort (app. 8 km);
- extension of line B from Pessac to the north, including a crossing with line A, by using the SNCF railway tracks which form part of the semi-circular SNCF line through western Bordeaux. Indeed, a Karlsruhe-style bi-modal solution, in the form of trams adapted to run over high-voltage railway lines.

Monsieur Saglier, who attended a UITP conference in June 2002, drew the conclusion from that meeting that there is no urgent need to plan a hybrid, bi-modal "tram-train" option in Karlsruhe-style. His watchword at present is to wait and see.

The interior of a bordeaux Citadis; green cloth seats are attractive. *(CJ Wansbeek*

All city bus lines will be rerouted, to become feeder lines for the urban rail system. At 15 points near tram stops, there will be Park + Ride facilities, each with a capacity varying between 100 and 600 places. Unlike the P+Rs near Montpellier tram stops (where the security guards leave their duty daily at 20.00), those at Bordeaux will be under manned surveillance 24 h per day, completely fenced off, with all movements through one entrance gate. Only a rigorous surveillance of the P+R will bring the car driver in the tram, it is assumed. This is particularly true in the hilly area in the north-east, where there will be five big tram-related P+Rs, which hopefully will attract thousands of commuters to travel by tram.

The only tramline to serve the main railway station, Gare Saint-Jean, will be line C. Near this station, a simple tram stop will be built, with an unpretentious shelter. No frills, no subways, not even a roof between the tram stop and the railway station. This Gare Saint-Jean is important, it is the terminus of the super-fast TGV trains, which cover the 570 km to Paris within three hours. Should traffic develop in a positive manner, then further embellishments and improvements are possible, such as a walkway to protect train commuters changing to the tram. But the overriding priority at this moment is to build all tramlines on time, with simple, uniform stations. It should be noted that it is important that tramline C will serve Saint-Jean, whereas this railway station had been left out from the earlier VAL mini metro plan. A VAL lacked the flexibility required in the narrow streets surrounding Gare Saint-Jean.

Interior of the driving cab of the double-ended

As is usual in France, the streets used by the tramlines will undergo a thorough face-lift. All facades will be cleaned. In the rue Thiers, it was decided to widen an already wide tram reservation on green lawns even further, by adding long rows of trees on both flanks. All over the length of the "voies engazonnés" (tram lines in green lawns), there are sprinkler devices for automatic regular water spraying.

Citadis for Bordeaux. *(CJ Wansbeek*

A strategic point is the long Pont de Pierre (Stone Bridge), commissioned by Napoleon, who needed a bridge over the Garonne River (there was no such bridge at that time). Tram line A, the "Blue" line, will run on a reservation in the median strip of this bridge, and for the private motor car there remains only one lane in each direction. This centrally-located bridge is vital, as the softness of the subsoil rules out tunnels, including tram tunnels. This in part explains why line A is the record-holder with seven P+R facilities, the tracks over the bridge will add to the tram's superior performance.

At five stations the tram will offer interchange with the railways, including regional lines as well as high-speed TGVs. These stations are: Saint-Jean, Pessac-Centre, Cenon-Thiers, Mérignac-Arlac, Bordeaux-Ravezies.

The depot/service centre/workshops for the new network are situated beside the east bank of the river in the Bastide area, accessed from tram line A in Avenue Thiers by the Pont Bouthier across the railway tracks. The 11 000 m2 facilty is designed to accommodate 70 trams, with up to nine at a time in the workshop, with its underfloor wheel lathe. The depot incorporates a 250-m test track which includes a section of third rail for powered APS trials. 20 trams will be delivered here by the end of 2002. They will be seen on trials along Avenue Thiers towards Lormont and Cenon from March 2003.

The author would like to express his gratitude for Monsieur François Saglier, Director of the Bordeaux Tram Project, for his kind assistance with the preparation of this article.

M. François Saglier, Director of the Bordeaux Tram Project

Webmasters Note: *Line A opened on the 23rd December 2003 and lines B + C are expected to open early 2004. There have been reliability problems on the 3rd rail section with failures of the switch boxes but it is too early to tell if this is just teething problems or something more serious. It has been reported that Pessac and Mérignac are considering to have overhead installed for their extensions rather than the 3rd rail system.* Jan 2004

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