LILLE DPM SYSTEM & VAL FAMILY

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2463

ABSTRACT

This document provides a brief description of the different steps from the beginning to the total completion of the Lille DPM program in France. The system performance and a technical description is provided. Following are the actual availability and schedule adherence results.

DESCRIPTION: The VAL system in service in Lille, France came about originally from the planning of a new town, four miles from Lille, called Villeneuve d'Ascq. During planning of the new town, it was decided that rapid transit service was needed between Villeneuve d'Ascq and Lille. High frequency but inexpensive service was considered fundamental to the system's success.

Table 1

Date	Step
1972	MATRA VAL system is selected : are one mile test tract is built to qualify the system
1977	Turnkey contract for Line 1 : 8 miles, 18 stations
1980	Qualification of the VAL system by UMTA after 15 days of continuous operation on the test track
1982	Revenue service on the first section : 2,5 miles 4 stations
1983 (May)	Revenue service on the second section : 6 miles 13 stations
1984 (May)	Revenue service on the entire line : 8 miles, 18 stations

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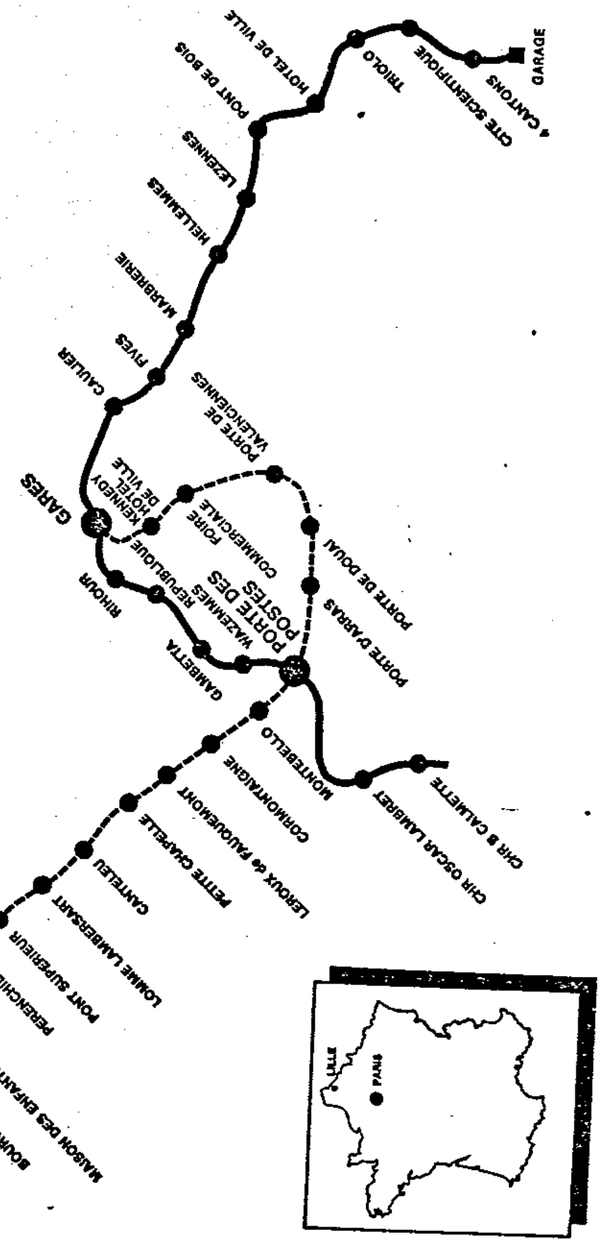

FIG.1 METRO DE LILLE — LIGNE N°1 -13,5km/8,5 miles --- LIGNE N°2 -12 km /8 miles

As a result, in 1971, the town of Lille requested a technical proposal for the design and construction of a fully automatic public transit line to link Villenueve d'Ascq with the Lille railway station, a distance of five miles (see Table 1). MATRA proposed a new automatic light transit system called VAL, and in 1972 was selected to qualify the proposed system on a one-mile test track using two prototype vehicles (see Table 1).

At the same time, a regional transit planning program was undertaken by the Communaute Urbaine de Lille (CUDL). CUDL is a regional agency representing four major cities (including Lille) and 83 other municipalities, and is chartered to provide and operate all transit facilities. CUDL evaluated the demonstration and determined that the VAL system was best suited to satisfy the transit needs of the region, which has a population of one million.

In April 1977, CUDL awarded MATRA a turnkey contract to implement the VAL system in Lille on Line 1, an 8-mile, 18-station system, shown in Figure 1.

Limited passenger service began in 1982 on a demonstration basis on a 2.5-mile, 4-station segment. In May 19-3, less than two months behind schedule, revenue service began on a 6-mile, 13-station section, and in May 1984 the entire line opened for revenue service. For about 60-, passengers are entitled to unlimited use of the system for one hour.

The 1976 budget for MATRA's contract was F.F. (French francs) 454 million. The final contract amount in 1976 francs was F.F. 515 million, which included 29 million francs in owner-requested changes and 32 million francs in cost increases caused by construction delays.

In 1980, the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation evaluated the VAL system at Lille during a four-week demonstration test, and concluded that VAL was suitable for use in UMTA's downtown peoplemover program.

A summary description of the Lille system follows, including those elements provided by MATRA and those provided by others. Figures 2 and 3 show VAL in operation.

General System Description

Line No. 1, which is now in full revenue service, directly connects Lille to the new town of Villeneuve d'Ascq. There are 18 stations on eight miles of double-track guideway. Station platforms accommodate two married pair units in a train. Initial operation is with a single married pair train.

The married pair units operate totally automatically with no operators on board. The minimum operating headway on the system is 60 seconds. With a single married pair the peak passenger line capacity is 7500

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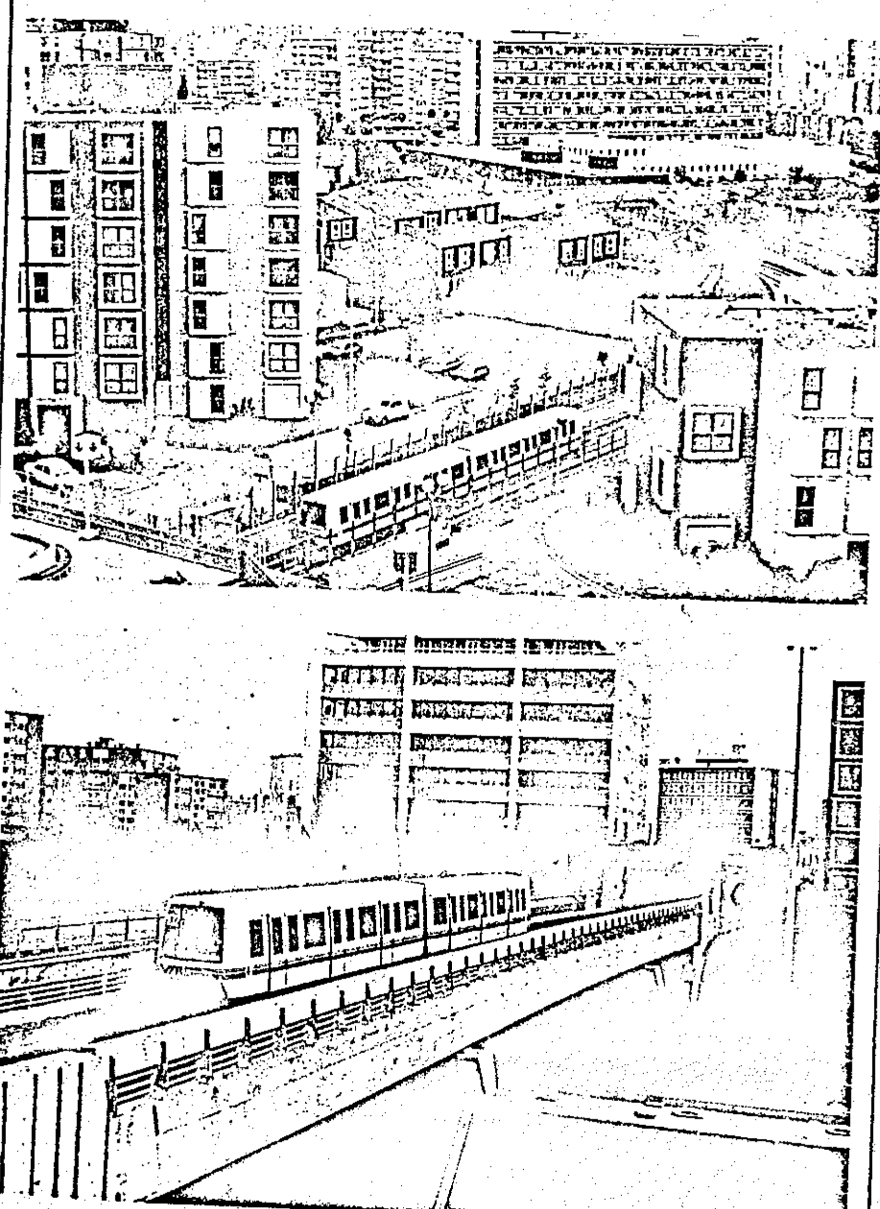
VAL IN VARIOUS ENVIRONMENTS Fig. 2



THE VAL VEHICLE IN SERVICE Fig. 3

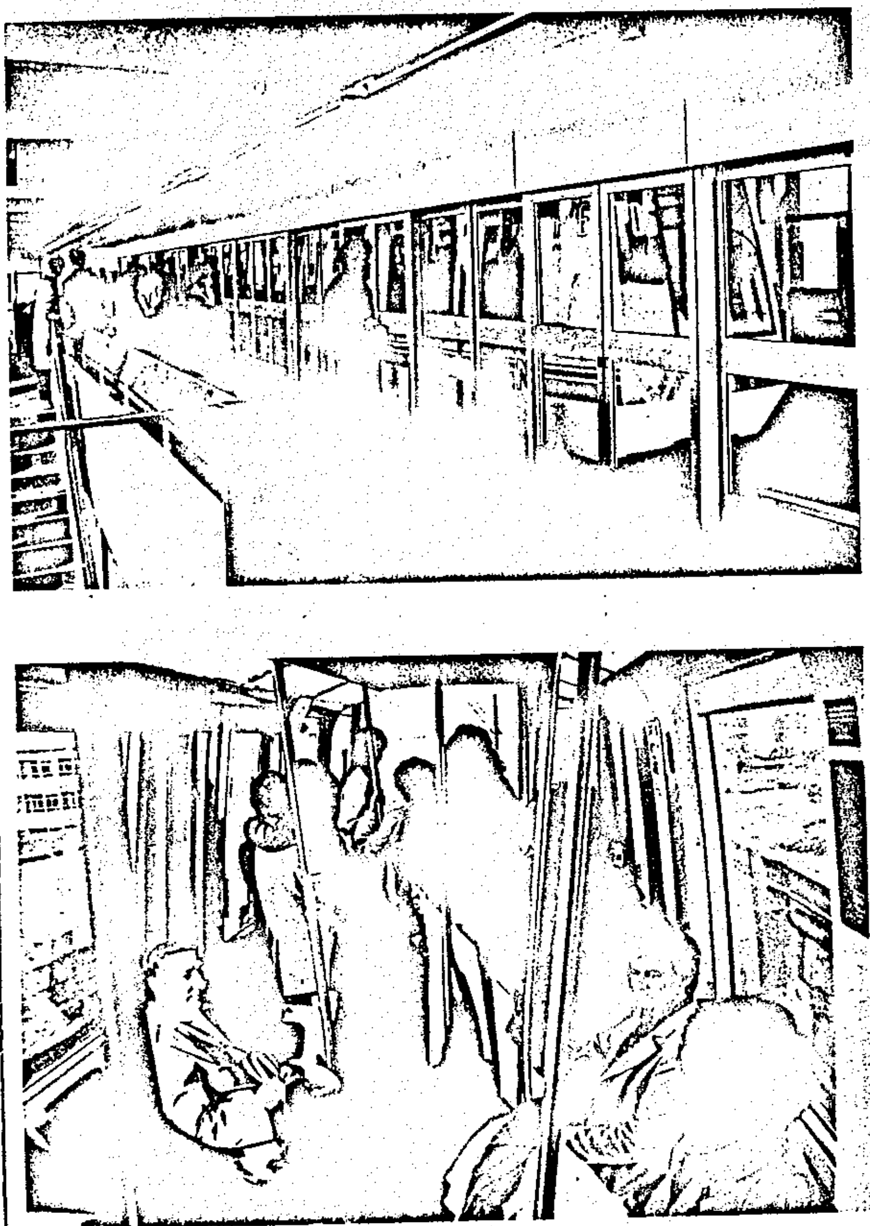


TABLE 2

VAL SYSTEM CHARACTERISTICS

Lille, France

System Performance:	
Max. theoretical one-way capacity (1)	12480 pax/h
Max. practical one-way capacity (2)	9600 pax/h
Normal one-way design capacity	7500 pax/h
Practical headway with on-line stations (3)	60 sec
Service availability	Schedule; 20 h/day
Type of service	Line-haul; on-line stations
Type of network	Line-haul
Traveling unit	Married pair
Interior noise	75 db A
Exterior noise (4)	72 db A
Unit Performance:	
Max. speed	80 km/h (50 mph)
Average speed	34 km/h (21.75 mph)
Normal operating speed	60 km/h (37.28 mph)
Max. grade on line with full performance (5)	7%
Average acceleration/deceleration	1.3 m/sec2 (0.132 g)
Max. jerk	0.65 m/sec3 (0.66 g/sec)
Min. emergency deceleration	1.8 m/sec2 (0.183 g)
Max. emergency deceleration	2.4 m/sec2 (0.244 g)
Stopping precision in station	0.3 m
Degredation if guideway is wet	None
Degredation for ice & snow	None - electrically heated
Unit design capacity	68 seated and 56 standing
Unit crush capacity	44 seated and 164 standing
Energy consumption of two car unit	6 kWh/mile
Stations:	
Type	On-line, 1-berth
Type boarding	Level
Tickets & fare collection	Automatic fare collection with honor system
Security	Closed circuit TV; police
Max. wait time (off-peak)	5 min
Vehicle in-station dwell time	10-30 sec
Station spacing (average)	0.85 km (.52 mile)

TABLE 2 (Cont)

Reliability & Safety:	
Fail-safe features	Components individually fail-safe
Strategy for passenger evacuation	Walkways
Strategy for removal of failed vehicle	Automatic push capability; manual backup; & small recover diesel vehicles
System life	Design goal 30 yrs
Unit life	Design goal 30 yrs
System mean time between failure (MTBF)	52 hours (est.)
System mean time to restore (MTTR)	0.3 hours
System availability	Design 99%; Operational 99.4%
Vehicle MTBF	624 hours
Guideway MTBF	926 hours
Control Center and communications MTBF	2880 hours
Fixed ATC equipment MTBF	303 hours

Personnel Requirements	Per Shift	Total Staff
Units & stations	Unmanned	–
Central control	2-6	20
Maintenance	45	77
Roving teams	6-12	34
Ticket control and passenger information	8	22
Administrative	11	17
		170

Notes:

(1) With 6 pax/m2 and jump seats up
(2) With 4 pax/m2 and jump seats up
(3) Includes 30-sec dwell time and time for switch command and verification
(4) At 60 km/h; at 7.5 m distance from track
(5) Using two motors of four

TABLE 2 (Cont)

VAL VEHICLE CHARACTERISTICS

Lille, France

Dimensions	
Unit length, overall	25,840 mm (84.8 feet)
Width, outside	2,060 mm (6.8 feet)
Height, clear inside	2,045 mm (6.7 feet)
Width, clear inside	2,010 mm (6.6 feet)
Height, overall	3,250 mm (10.7 feet)
Weight, empty	29,600 kg (65,120 pounds)
Weight, gross	45,200 kg (99,440 pounds)
Suspension	
Supported, verticle	Air cushion (4 per vehicle) elastomeric series suspension with 4 pneumatic tires per vehicle mounted on 2 axles
Axle	Steerable
Lateral Guidance	8 pneumatic horizontally mounted rubber tires per vehicle
In switching area	4 vertically mounted steel wheels
Roll	4 hydraulic shock absorbers
Propulsion & Braking:	
Type & no. of motors	2 DC rotary 380 V motors in series
Motor rating	120 kW
Type drive	Mechanical coupling through a differential
Type power	750 V DC
Power collection	Sliding contact shoes on steel power rails; 5 shoes per car (+, –, & ground)

TABLE 2 (Cont)

Auxiliaries	72 V DC stepped down from 750 V DC
Battery	72 V with battery charger
Type motor controller	Chopper
Type service brakes	Conjugated regenerative braking and pneumatic friction disks
Type emergency brakes	Pneumatic friction disks
Body	
Type frame	One-piece integrated body and frame made of aluminum
Body end material	Reinforced fiberglass
Doors	6 bi-parting, externally hung, pneumatically powered per side

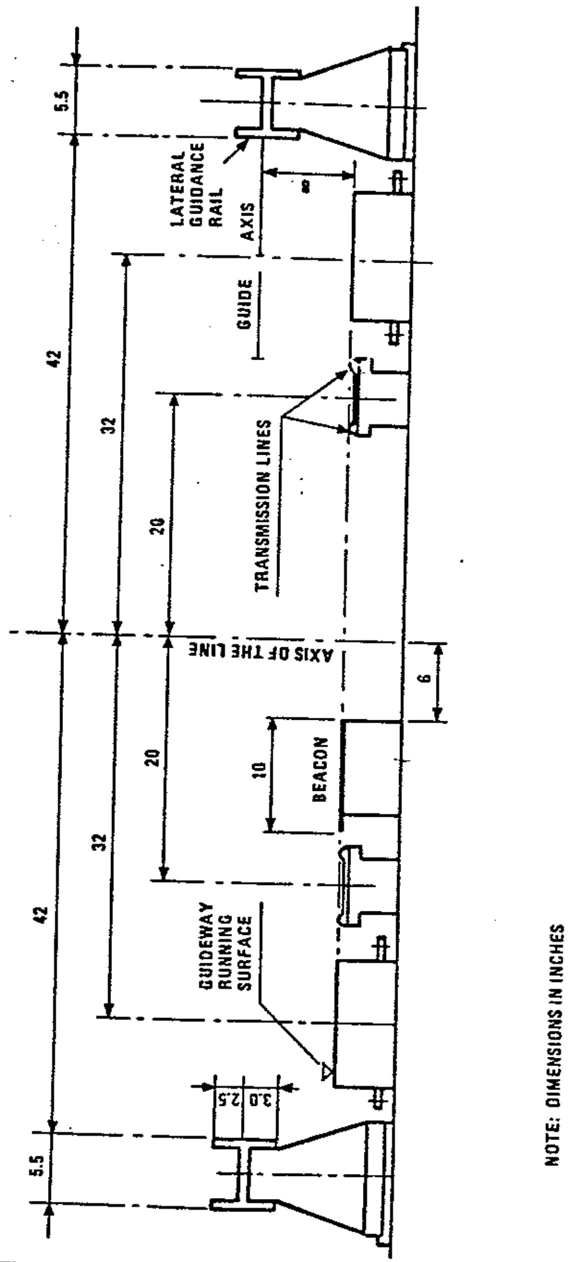
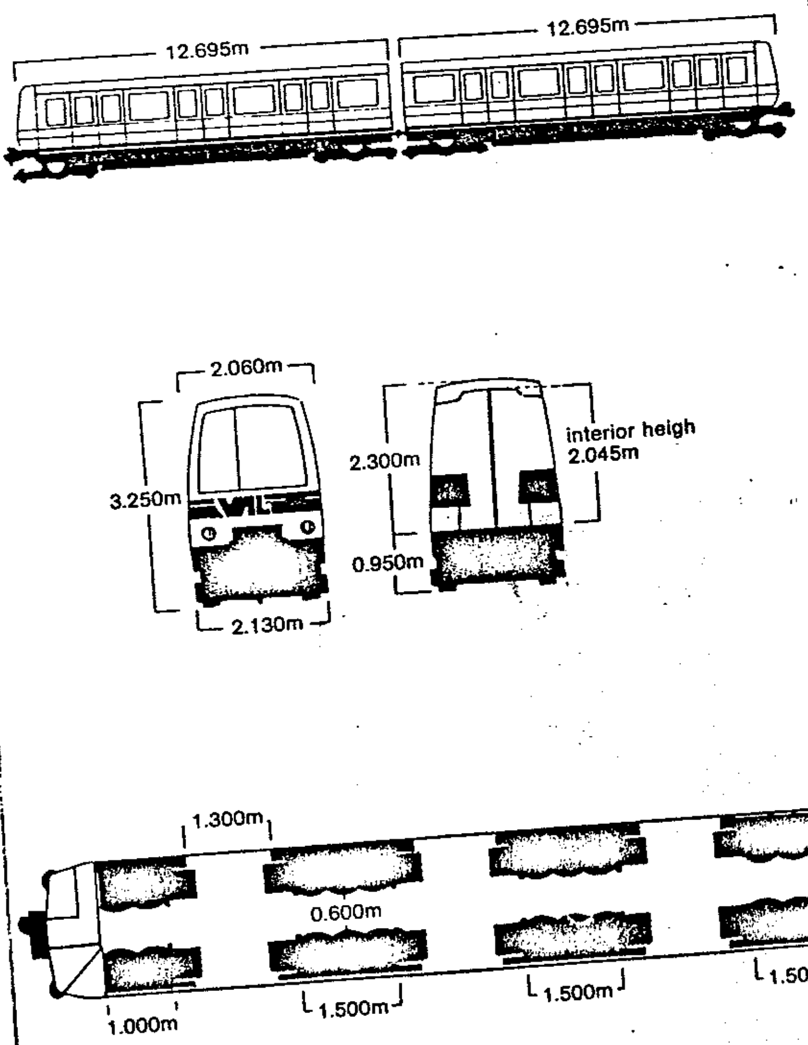


Fig. 5

CROSS SECTION OF SINGLE-TRACK GUIDEWAY

Fig. 4
UNIT DIMENSIONS OF THE VAL VEHICLE



passengers per hour; ultimately, with two married pairs, the system will be able to accommodate 15,000 passengers per hour. These capacity numbers are based on 124 passengers per married unit, of which 55% are seated. When the loading standards are decreased to four standees per square meter and the jump seats on the car are in the up position to accommodate more standees, the capacity of a married pair unit is 156 passengers, giving an overall line capacity of 9,600 passengers per hour.

Patronage to data significantly exceeds forecasts. Actual traffic in November 1984 was over 100,000 passengers per day, compared with expected ridership of 50,000 to 60,000. Ridership on the peak link in the peak hour was 6,000 in November 1984. The initial fleet consisted of 38 married pairs, but because of the rapid growth and heavy patronage, an additional 16 married pairs have been ordered.

Line 2, defined in 1974 as part of the initial network, has been designed, and construction begins in 1984. MATRA is responsible for everything except guideway and station construction and tunnel boring. A few improvements have been incorporated in the design of Line 2. These include electrical rather than pneumatic doors to increase reliability, and a static chopper cooled by radiators with GTO, rather than a mechanical ventilated thyristor chopper to improve reliability, save and protect against snowfall.

Line 2 is 8 miles long and has 18 stations. One third of the line will be on viaduct, and two thirds in bored tunnels. With completion of Line 2 the total Lille fleet will be 83 married pairs.

Table 2 summarizes the characteristics of the system and the VAL vehicle and Figure 4 shows the vehicle dimensions.

Guideway

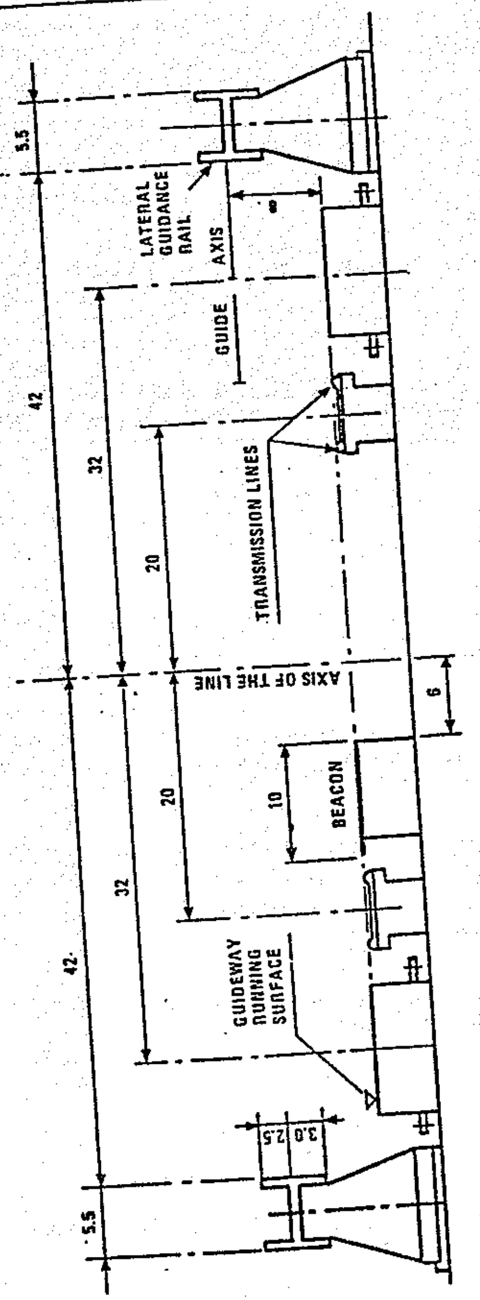
The VAL System in Lille uses four types of guideway elements: elevated, at grade, cut and cover, and tunnels. In each case, the concrete running surfaces are supported by a concrete structure.

The running surfaces are made of two prefabricated reinforced concrete beams, 5.20 meters (17 feet) long, 270 mm (10.6 inches) wide, and 140 mm (5.5 inches) thick (see Figure 5). The separation for expansion between these longitudinal beams is 5 mm (.20 inch). A special coating is used on elevated structures to provide adequate adhesion in the rain without abrasion to the tires.

Lateral guidance is provided by two steel "H" sections located on either side of the guideway. The lateral guidance wheels run on the side of this "H" section, 200 mm (7.9 inches) above the running surface. They are located by molded polyester electrical insulating supports spaced at 3.5 meter (11.5 feet) intervals on straight sections and 3.0 meters (9.8 feet) on curves. Electrical insulating supports are necessary because the lateral guidance beams simultaneously provide propulsion power. One rail serves as a positive while the other serves as a

Fig. 5

CROSS SECTION OF SINGLE-TRACK GUIDEWAY



NOTE: DIMENSIONS IN INCHES

LILLE AGT SYSTEM, FRANCE (Cont)

negative. The upper and outer face of the positive power rail is covered with an insulator. Bayonet-type expansion joints are used in the power and lateral guidance rails. Section insulation permits entire sections of the line to be cut, thereby providing a means of isolation. The lateral guidance rails are mounted first and all other surfaces mounted and controlled with reference to the lateral guidance rails.

The winter climate in the Lille area has necessitated heating the running surface and power rials of elevated guideway sections to provide good adhesion and power collection in the presence of frost and ice. Heating is provided by electrical wires submerged in the running surface beams and attached to the track of the lateral guidance running surface. Heater wires are supplied with 750 V DC power.

Switches

Wayside switches consist of an electrical actuator connected to a cantilevered rail and a guide channel 50 mm (2 inches) wide formed by two T-head rails. Each end of the channel is provided with a converging opening 200 mm (7.9 inches) wide to admit the vehicle switching guidewheel in the event of a flat tire. The switch is located on the centerline of the guideway and flush with the guideway running surface. The tires roll over the guide channel (see Figure 6).

The operating time of the switch is three seconds, including all position checks. A delay of five seconds prevents a second activation until the first is completed. The operating speeds over switches are 80 km/hr (50 mph) in straight sections and 40 km/hr (25 mph) km/hr in curved sections.

From a safety standpoint, the switch is designed for unusual transverse forces exerted by the rolling stock. The cars can traverse a switch backward without damaging the switch.

Under normal conditions, all switches are remotely controlled by the Wayside Control and Communications Unit. In the event of a transmission malfunction, the switch can be operated either electrically from a control panel in the station or manually by maintenance personnel.

Switches that are exposed to weather are provided with a 300 Watt/m heating system to permit operation in ice and snow.

Power Distribution

Six power rectifier (PR) substances are located along the line. Each power rectifier is supplied with 3-phase, 20-kV, 50 Hz input from one of the two distribution points. The 750 V DC from the PR substation is distributed to the guiderails, which also serve as the power rails. One rail serves as the positive and the other the negative. This 750 V DC also powers the guideway heaters.

Fig. 6

SCHEMATIC DIAGRAM OF SWITCHING EQUIPMENT

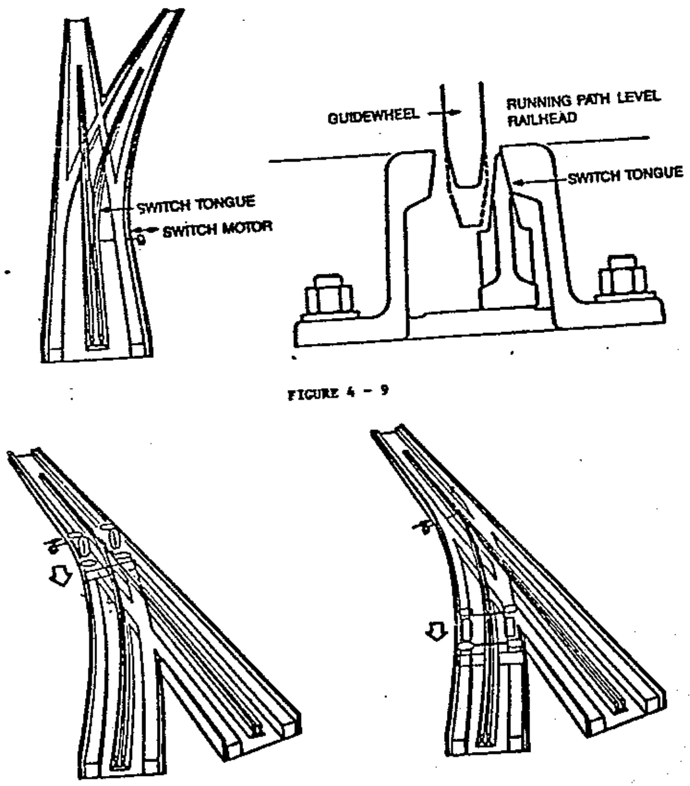


FIGURE 4 - 9

LILLE AGT SYSTEM, FRANCE (Cont)

In the normal mode, all of the PRs feed all sections of the line in parallel, and each of these sections can be isolated. Under overload conditions, when it is necessary to turn off the voltage on the line or to isolate a section, the Control Center initiates the opening of the 20-kV circuit breakers at the outputs of the distribution station, causing the PR output circuit breakers to open, which in turn open the isolating switches. Without a load the isolator switches are normally open. The power rails in the isolated section are short-circuited and grounded.

An emergency power cut-off loop makes it possible to turn off the 750 DC power from the vehicle or the Control Center. This is achieved by operating the output circuit breakers remotely at the distribution station. These in turn open the appropriate isolation circuits.

Line fault detectors actuate the opening of the 750 V power rectifier high-speed circuit breakers in the event of a failure or short circuit. This isolates and ground the section where the fault is located.

To feed back regenerated voltage from the vehicle electrical braking system into the line, a high-speed automatic switch directs 750 V DC to the power rectifier output.

Low voltage power substations are located at all the passenger stations on the line, and are connected in a loop with 3-phase, 20 kV, 50 Hz and distribute it to all stations and line auxiliaries. Each station consists of two separate medium- to low-voltage transformers. Each is designed to power all the priority equipment at the station, nearby ventilating equipment, and line illumination stations. In addition, the substations are equipped with Nicad batteries to power the emergency equipment with 110 V, 48 V and 24 V DC. The low voltage power to the maintenance area is supplied by a separate transformer.

Command and Control System

The VAL command and control system is designated to operate fully automatically. It is fundamentally a fixed block system. The command and control system consist of the hardware and software necessary to provide the following functions:

- Automatic Train Protection (ATP)
- Automatic Train Operation (ATO)
- Automatic Train Supervision (ATS)
- Manual Back-up Mode Operations.

ATP functions perform all actions necessary to provide safe operations regardless of malfunctions. ATO functions perform all non-safety-related automatic vehicle operations. ATS functions provide a capability to change modes of operations. Manual back-up mode operations are used in the event of a malfunction that cannot be safely resumed in an automatic mode.

The ATP, ATO, and ATS functions are performed by control system equipment distributed at three locations: the Control Center, the wayside, and on board the vehicle. A block diagram of the control system equipment is given in Figure 7. The command and control equipment is as follows:

- o Control Center equipment consists of control display panels, computers, and data communications equipment.
- o Wayside control equipment consists of wayside control and communications units (WCU), dwell operation control unit (DOCU), data transmission units (DTU), transmission lines, ultrasonic detectors (UD) and visual signals. This equipment is located both in the station and along the guideway.
- o On-board train control equipment includes: The safety and control equipment, including redundant ATP and ATO electronics and power supplies; uplink receivers to receive unit speed commands, remote commands, and voice communication via the guideway transmission line; two redundant downlink transmitters for passenger unit presence detection signals; a downlink transmitter for ATS and one transmitter for voice communications; two redundant tachometers per car generating a voltage proportional to speed; and two redundant phonic wheels producing pulses for each 3.81 mm (0.15 inch) advancement of the vehicle.

Circulation of units in the yard is entirely automatic, or remotely controlled from the Control Center, except into the workshop. Storage of the units is managed by the Control Center computer as part of the ATO of the line.

The operation, maintenance and storage facilities were entirely designed and built by MATRA as part of the Line 1 system control.

Operation, maintenance and storage facilities are located at one end of Line 1 in Villeneuve d'Ascq, on an 11-hectare site. They comprise:

- o The administrative and operation building, including the Line 1 Control Center.
- o The workshop, which has:
  - Six working stations with jacks permitting raising of complete units without separating the two cars, to any preselected height, for access to any part of the cars. The guidance of the cars in the workshop is ensured only by a central groove (no plates below) in the ground, giving a flat, clear and accessible area under the cars (See Figures 8 and 9).

Fig. 7

BLOCK DIAGRAM OF CONTROL SYSTEM EQUIPMENT

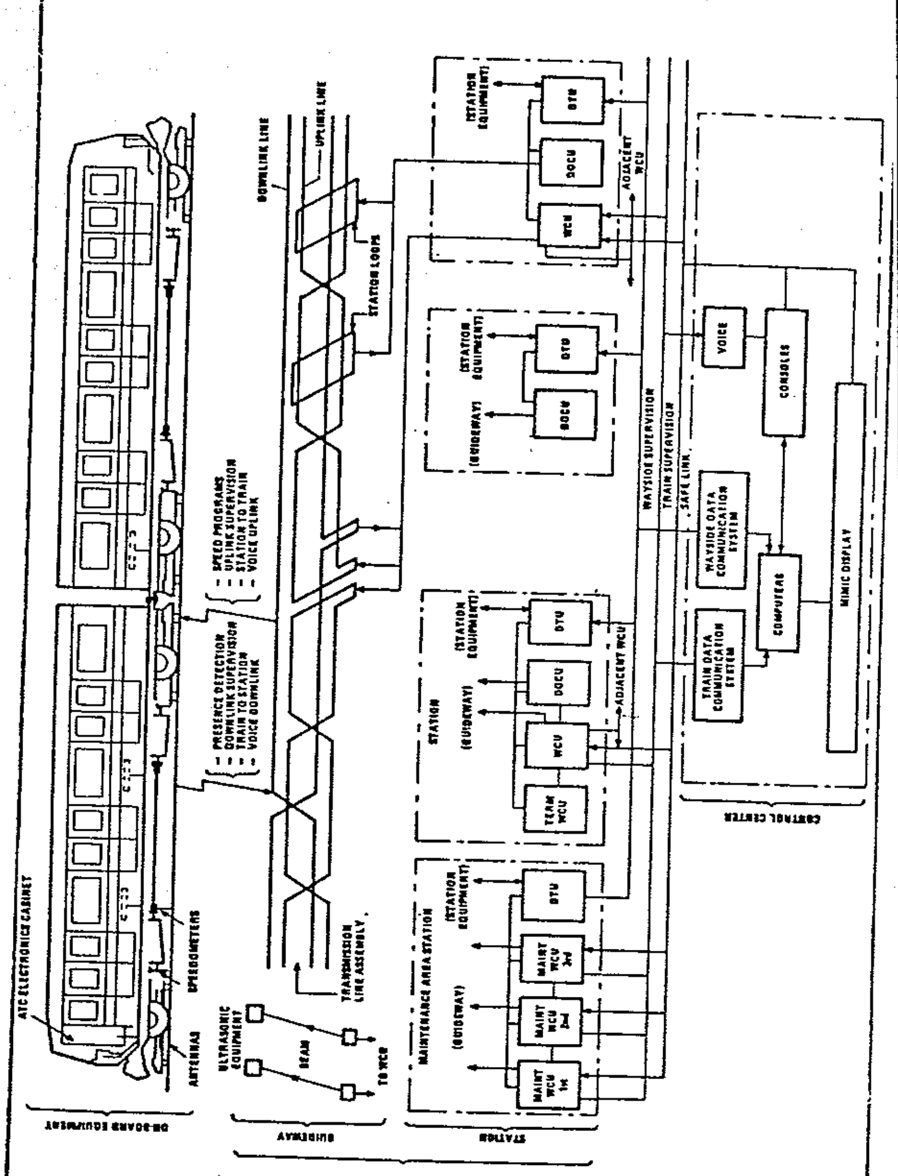
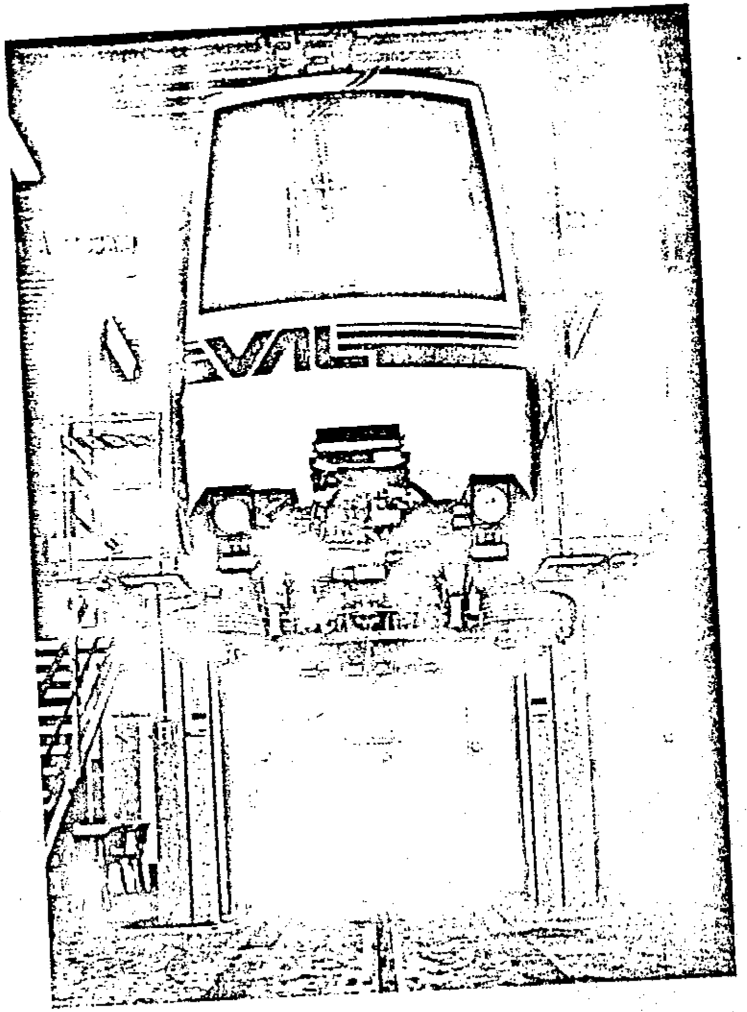
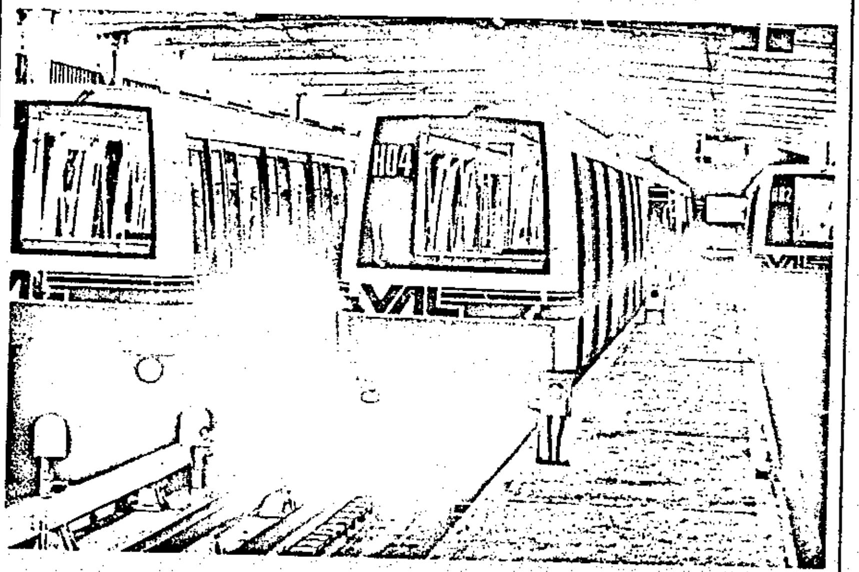


Fig. 8 VEHICLE ON JACKS AT LILLE WORKSHOP



LILLE STORAGE AREA Fig. 9



- Overhead crane for moving heavy equipment
- Spare parts areas
- Bogies cleaning area
- Electronic workshop and laboratories

o A covered vehicle storage area with capacity for 38 units, distributed on 4 tracks.

o A storage area for heavy equipment, such as trackway equipment.

o An automatic washing machine.

o A 2500-foot double test track, fully automated.

Availability Results

Table 3 provides an overview of the VAL system performance from Mai 1984 to Oct. 1984. The formulas from the RFTP were applied to the actual VAL data to present operating statistics in accordance with Jacksonville specification requirements. The mean availability from Mai 1984 to Oct. 1984 has been 0.9936 with the system averaging about 5200 vehicle-miles a day.

TABLE 3

AVAILABILITY PERFORMANCE

Date	Number of down hours	MTBF (hours)	TOTAL down Time (hours)	MTTR (hours)	Availability
May 1984	43	13.7	8.6	.200	.9853
June	50	11.8	2.6	.052	.9956
July	29	20.4	3.8	.131	.9937
August	24	24.8	3.3	.138	.9945
September	29	20.0	2.1	.072	.9965
October	51	11.6	2.2	.043	.9965
TOTAL	226	15.7	22.5	.100	.9936

Appendix

VAL Operations Data
1983-84

LILLE, 5 a.m., May 16, 1983, the first paying passenger boarded VAL, MATRA's fully automated metro.

From the initial stage of research and development to that day, thirteen years of team work had passed. This 328 million dollar project was finished on schedule and within the initial budget.

May 1983 is a landmark in the history of urban transportation: VAL became the first fully automated metro to operate in an open urban environment.

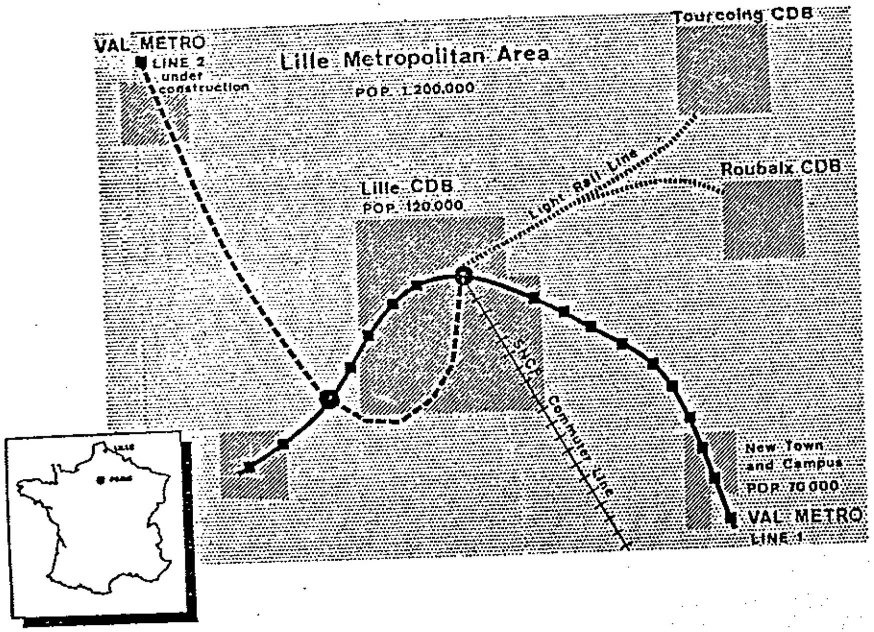
In this field it is not enough to achieve a "first". The constraints of public service are stringent: availability 20 hours daily, seven days a week, the year round, with safety standards higher than the Paris metro.... This sort of public service demands daily performance.

Now, the real world is the stage and for over 100,000 people in Lille, VAL has become part of the daily routine. Time has come to see how the recorded results match up to the initial expectations.

The Urban Setting

Lille Metropolitan area is not a typical French city: its population density is low and it is made up of three different main cities: Lille proper, Roubaix and Tourcoing. Total population is 1.2 million.

Line No. 1 is the first deployment of a future network. It has 18 stations distributed over 8.5 miles. Total population served is 350,000. This population is unevenly distributed along the line: in a new town and a university campus: 70,000, in Lille proper 120,000, in the suburb where a major hospital complex is located, 50,000, the remaining 60,000 are scattered along the line.



Availability and Schedule Adherence

Availability and dependability are the cardinal virtues of rapid transit. For the VAL at LILLE, non-availability may be defined as those occasions when a passenger has been delayed for more than 4 minutes. (1)

Automation sceptics have always been concerned that unmanned systems might not achieve an acceptable level of dependability. Some experts in France expressed doubt over whether the VAL system would meet the required availability standards.

In 1983, on the average the System Availability has been 0.986, indicating a very good record during the start-up period. In 1984, the average System Availability has reached 0.994. Recorded results prove very much above contract specifications which were set at 0.960.(2)

(1) System's availability is defined as the probability of finding the system operating normally; service is considered as normal in so far as delays do not exceed 4 minutes.

(2) From COMELI - the operating company - Monthly Reports The February .972 availability is due testing programs performed on the record leg of the line prior to its commissioning.

A recent survey conducted by U.I.T.P.(3) comparing various European metro networks shows that the VAL has the best schedule adherence record of all systems considered in spite of the fact VAL operates with the shortest headways.

According to this survey 94% of the trains completed a round trip on time. A round trip represents 17 miles and 36 stops. No human attendant could match this.

Safety

Human failure is the most likely cause of the very few accidents that still occur in rail transit today; full automation does away with this risk.

To date, VAL has safely carried over 35 Million passengers.

All station platforms are separated from the tracks by sliding doors. Another major risk is thus eliminated, and parents have no worries in allowing their children to travel on the VAL unattended.

Quality of Service

During the 20 hour service day, trains are operated at intervals from 1.4 minutes at peak hour to 4 minutes off-peak. For the user, waiting time is reduced to a minimum.

Optimized acceleration and braking, exploiting the performance of the rubber tire, give a high commercial speed: 22 miles per houk including stops (4). top speed is 50 miles an hour while cruising speed is 37 mph. This difference is ample for making up any delays if they occur and maintaining the steady flow of trains.

With this performance, the city center is now within ten minutes of the terminal located in the suburbs.

Train operation does not depend on availability of attendants. VAL has the capability of coping with unscheduled demand as additional trains may be inserted into the network through remote commands from the central control room when required.

Du ing the 1983 trade fair, an uninterrupted 44 hour service was maintained for the visitors with intervals between trains in the peaks reduced to one minute. Social functions, sports events, etc... are easily catered to . The service can be tailored to meet demand at very little extra cost. This flexibility is of course very much appreciated by users.

(3) "Methode mesure et de comparaison de la qualite d'Exploitation" comite Exploitation due Metro" U.I.T.P, 15.10.84, M. CHARPENTIER.

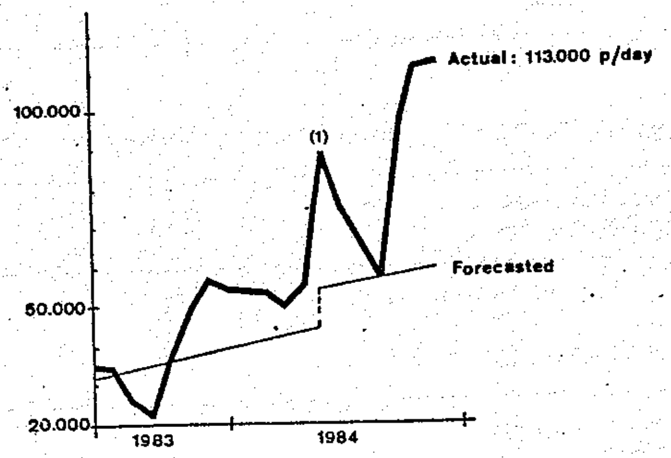
(4) Distance between stations is 830 yards on the average, dwell time in stations is 14 to 18 seconds.

Minimum waiting time, high commercial speed, operational flexibility, the smooth ride of the rubber tire, all these contribute to the high quality of service.

Patronage

In the last analysis, patronage is the best indication of passenger satisfaction. The following chart illustrates the growth of average weekday ridership over the past 18 months.

AVERAGE WEEKDAY RIDERSHIP



1- Opening second leg of Line 1

At the very beginning of revenue service operation, on the first leg in May of 1983, average weekday ridership was 35,000. It peaked in November of the same year with 57,000 passengers per average weekday. In May 1984, after the opening of the last leg of Line n°1, a further increase was recorded to 90,000 passengers. After the summer recess, another record ridership of 113,000 passengers per day occurred during the month of November, 1984. Total passengers transported in 1984 amounted to 22.3 million. At present, actual ridership is 50% above initial forecasts.

For 1985, anticipated ridership on an average weekday is 103,000 and total ridership for the year is estimated at 28 million passengers.

To cope with this unexpected patronage additional train sets will be delivered toward the end of this year making it possible to shorten headways to one minute at rush hour. Thereafter, four car consists operation will be initiated to accommodate the growing patronage.

The Economics of VAL

Labor Productivity

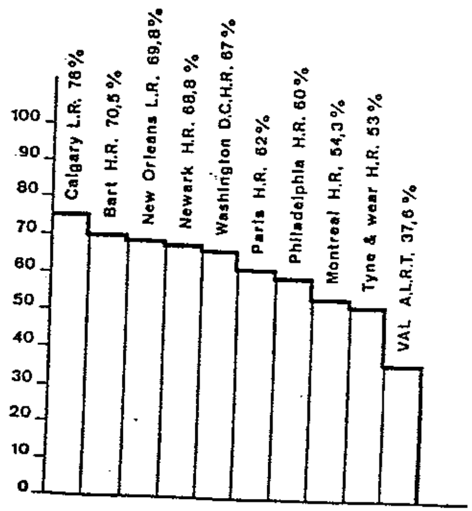
Most urban transportation systems throughout the world run into high deficits. It is exceptional when farebox revenue amounts to more than 50% of operating expenses. In fact, a 60% operating deficit is the most frequent situation.

Thanks to full automation, we are entering a new era. By combining driverless train operation with state of the art maintenance facilities, the VAL system achieves a quantum leap in labor productivity. This high labor productivity is illustrated in the fact that wages and salaries account for 40% of total operating expenses.

This proportion compares with 65 to 75% for most transportation systems in operation today.

The following chart illustrates this characteristics of VAL as compared to major rapid transit networks worldwide.

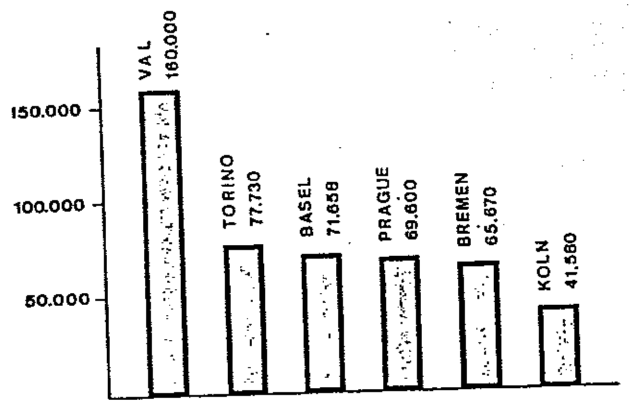
Staff cost as a portion of total cost



Another measure of labor productivity in urban transport may be obtained by computing the number of passengers transported per employee per year. This ratio is illustrated in the following chart.

Number of passengers transported per employee per year

VAL compared to light rail system



The basic facts are that VAL with a total staff of 170 in 1984 recorded 22.3 million passengers i.e. 131,000 passengers per employee. For 1985, total staff is 175 and expected ridership is 28 million i.e. 160,000 passengers per employee. Although the VAL has not yet captured all its potential ridership, it is already twice more productive that the best.

-- In 1984 and 1985, the personnel involved in the VAL system are as follows:

	1984		1985	
1 - Central Control		33		33
2 - Maintenance				
. Rolling Stock	32		32	
. fixed equipment	21		21	
. Tracks and buildings	19		23	
. Shop	9		9	
Total		81		85
3 - Roving teams		16		16
4 - Ticket control and passenger information		22		22
5 - Administration and management		17		19
Grand Total		170		175

Revenue and Current Expenditure and Operating Data

The recorded data available for 1983 and 1984 operation along with the budget for 1985 gives an illustration of the cost effectiveness of the VAL system.

Expense Category	1983(5) *	%	1984(6) *	%	1985 *	%
- Wages + Salaries	13.6	37.5	30.0	42.6	34.1	42.8
- Energy	4.6	12.7	8.1	11.5	9.0	11.4
- Spares, maintenance and sub-contracting	14.7	40.7	27.0	38.4	30.6	38.4
- Administrative insurance and misc.	3.3	9.1	5.3	7.5	5.9	7.4
TOTAL	36.2	100	70.4	100	79.6	100

* = Millions of French Francs

Revenue	1983(5)	1984(6)	1985
Farebox revenue	23.4*	59.0*	75.0*
Farebox recovery	64,6%	83,8%	94,2%

* = Millions of French Francs

Operating Data	1983(5)	1984(6)	1985
- No. of passengers (000)	8,126	22,062	28,000
- Train set x miles (000)	-	2,700	3,000
- Passenger x miles (000)	-	132,000	180,000
- Cost per passenger	F 4.25	F.3.08	F.2.84
- Cost per passenger mile		F.51	F.44

F = French Francs

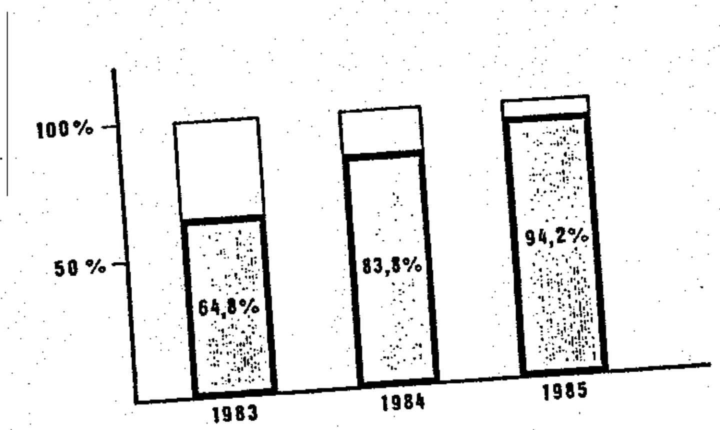
(5) For 1983, 7.5 months of revenue service for 13 stations out of 18.

(6) In 1984 the full line, 8.5 miles and 18 stations were opened in May.

From the partial opening of the line in May 1983 to date, the cost per passenger transported has been reduced by nearly half.

Most important for the city authorities: 18 months after the commissioning of the line, farebox revenue represented over 80% of current operation expenses. For 1985, anticipated income and expenses point to a 94% farebox recovery ratio.

FAREBOX RECOVERY RATIO



It must be noted that these remarkable results have been obtained in spite of a low fare policy. In Lille in 1984 average revenue per passenger transported was a mere FF 2.75 or less than U.S. $0.30.

Today in Lille, VAL offers riders the highest quality of service at most competitive rates while putting an end to what was for years a permanent operating deficit. Lille authorities do anticipate that the low fares imposed will actually balance current expenses. This is a key improvement brought about by new technology in urban transportation.

With the VAL technology, urban transportation moves away from its status as a labor intensive industry and for this very reason transit is no longer doomed to permanent deficits.

Riders Attitudes and Judgements

Before VAL went into service, a number of transportation specialists considered that it would be difficult to overcome riders reluctance to be left alone in trains without attendants.

Today, it is very reassuring to observe passenger reactions to riding in the VAL. No-one seems in the least concerned. A recent survey conducted by the University of Lille comes to the same conclusion(7).

"With respect to riders attitudes towards the absence of attendants, we have obtained an interesting result. The interviews reveal that passengers rank this characteristics last in the list.... This indicates that users forget about automated piloting...or that they are totally confident in the technology".

No less than 94.6% of passenger interviewed declare that they feel safe.

With respect to other VAL characteristics, the following opinions were registered:

- waiting time in the station:
  94.5% of users judged it short or very short.
- punctuality:
  according to 94.8% of users, VAL is punctual or very punctual.
- noise level:
  VAL is silent or very silent for 73.4% of users.

Overall Impact

The system being recent, one would have expected no major change in the overall transportation situation within the metropolitan area.

Such is not the case, surveys conducted by Communaute Urbaine de Lille indicate the following:

1 - In 1984, VAL ridership represented 35% of all public transit trips, metro, bus and tramway.

2 - Overall patronage in public transit from November 1982 to November 1984 has increased by 50%.

3 - Street-car ridership has increased by 35% during the same period.

(7) Gabillard, Impact des innovations technologiques du VAL aupres des usagers. Laboratoire d'Economie Publique Regionale, Universite de Lille, Fevrier 1984.

4 - Comparing November 1982 to November 1984 shows that the metro has multiplied by a factor of 6 bus ridership in the same zone before VAL operation started.

'5 - In 1983, one third of VAL riders are newcomers to rapid transit... 11.3% of them used their cars before. The number of car drivers who have shifted to VAL amounts to 1,350 daily.

6 - Finally a survey conducted within the VAL corridor points out a 15% reduction of automobile traffic as compared to the situation before VAL deployment.

Clearly, the VAL story is more than a technological achievement. These past months of operation have demonstrated that:

1 - Quality of service such as offered by VAL attracts ridership in excess of expectations.

2 - Full automation may achieve an availability ratio equal or superior to that of conventional transit systems;

3 - Gains in labor productivity are such that farebox revenue will offset operating expenses.

4 - Riders fully accept driverless vehicles

The Lille Metropolitan authority has been so convinced that a second line is now under construction with a completion date of 1988. Studies for two more lines have been ordered.

Two other French cities have expressed their interest: Toulouse and Strasbourg are actively proceeding with studies for the deployment of a VAL network.

STATISTICS

Month	Monthly (000)	Cumulative (000)	Average Weekday	Train Miles (000)
1983				
May 16	536.1	-	35,200	
June	970.3	1,506	34,700	
July	724.8	2,231	26,200	
August	651.2	2,881	22,700	
September	1,154.8	4,036	38,200	
October	1,319.2	5,354	49,800	
November	1,434.4	6,788	57,500	104.5
December	1,337.7	8,126	54,900	
1984				
January	1,327.0	9,453	54,000	111.2
February	1,224.0	10,677	53,600	103.8
March	1,245.0	11,922	50,395	111.8
April	1,223.0	13,145	55,600	127.4
May	2,182.0	15,327	89,700	152.8
June	1,902.0	17,229	75,900	156.6
July	1,651.0	18,880	67,900	151.6
August	1,388.0	20,268	57,200	150.5
September	2,375.0	22,643	97,700	160.7
October	2,537.0	25,180	112,500	165.5
November	2,745.9	27,925	113,000	155.0
December	2,263.0	30,188	93,120	159.6