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Class ALP-45DP Locomotive
InnoTrans Megareport, Part 2
In The Birthplace Of The Gravitas

On 18 August 2008 Bombardier was awarded two contracts to build electro-diesels for passenger services in the United States and Canada. One of these, worth 178 million EUR, is for 26 locomotives, with an option clause for 63 more, and is for the New Jersey Transit Corporation (NJT). The other is for Agence Metropolitaine de Transport (AMT) of Montreal, is worth 152 million EUR, and is for 20 such locomotives, with an option clause for ten more.

The American railway **network** is characterised by few electrified routes for passenger services, while the non-electrified network, used nowadays mainly by freights, is huge. Long distance passenger trains are mostly diesel-hauled, even under the wires, while in suburban areas passengers are often faced with the disadvantage of changing trains, from electric- to diesel-hauled stock, at the end of the local electrified network. Moreover, tunnel safety regulations prohibit underground running with diesel haulage in certain urban areas, such as New York. Local passenger operators, of which NJT is a prime example, are increasingly concerned about the unpopularity and inconvenience of such changes, and efforts are now being made to offer through trains, without a time-consuming change of traction type. The answer is clearly the electro-diesel, either in locomotive or multiple unit guise, and hence the decision by both NJT and AMT to opt for electro-diesels, namely Bombardier's ALP-45DP (Dual Power) locomotive.

The **design** of the ALP-45DP is based on NJT's Classes ALP-46 and ALP-46A (see R 1/10, pp. 40 - 43), ALP standing for American Locomotive, Passenger. The „4" refers to the fact that it is a four-axle machine and the „5" denotes the power rating, which is about 5,000 kW. The ALP-45DP is a single-cab machine, and can be used in conjunction with a driving trailer car on rakes of double or single deck push-pull stock. The cab layout is similar to that of the ALP-46, while the FLEXX Power 250 bogies have been adapted for a higher axle-load and can be used at speeds up to 200 km/h.

The electric power system incorporates Bombardier's MITRAC traction and control technology, together with the same type of IGBT traction converters as those installed in members of the European TRAXX family. Diesel power is provided by two high speed diesel engines fulfilling both the current Tier 2 and the future Tier 3 US exhaust emissions requirements and offering lively acceleration, such as is necessary for passenger service operation. High fuel efficiency is achieved using a novel power management system, which can also be installed in European TRAXXes should clients require this.

NJT is the third largest public transport **operator** in the USA, while AMT is the second largest operator of suburban rail services in Canada, and the sixth largest in terms of patronage on the continent. It also plans and integrates all forms of public transport in Greater Montreal.

ALP-45DP Operation

Metro North, Long Island Rail Road (LIRR) and Amtrak have been using electro-diesels, such as Classes DM30AC and P32-ACDM, for many years on suburban services out of **New York**, though these locomotives operate off 650 V DC third rail. The reason for this is the prohibition on the use of diesel power in the tunnels which access the principal stations in the centre of New York. The ALP-45DP is, however, the first American main line electro-diesel to combine diesel power with an overhead wire-powered propulsion system, a more complex arrangement. NJT's 26 ALP-45DPs will be deployed on the Raritan Valley and North Jersey Coast lines, with the change from diesel to electric power taking place at the junction with the Northeast Corridor line, which links Washington with New York.

AMT has plans to increase capacity on the Deux-Montagnes, Blainville-Saint-Jerome (non-electrified) Vaudreuil-Hudson Lines, with doubling of some single track sections and re-signalling. Scheduled to start up in 2012 are suburban services on the 51 km route from **Montreal** to Repentigny and Mascouche, making use of part of a Canadian Pacific line that was closed many years ago, and involving construction of an entirely new section of line between Repentigny and Terrebonne. Some of the ALP-45DPs will be employed here, using electric power to traverse almost 5 km long Mount Royal tunnel (on the 25 kV, 60 Hz Deux-Montagnes line) to access Central Station in Montreal. It is also planned to divert the Montreal end of the Blainville-Saint-Jerome line so that it joins the Deux-Montagnes line to pass through Mount Royal tunnel. This will cut journey time to and from the city centre by around 15 minutes, and will enable ALP-45DPs to be used on this route.

ALP-45DP Design Challenges

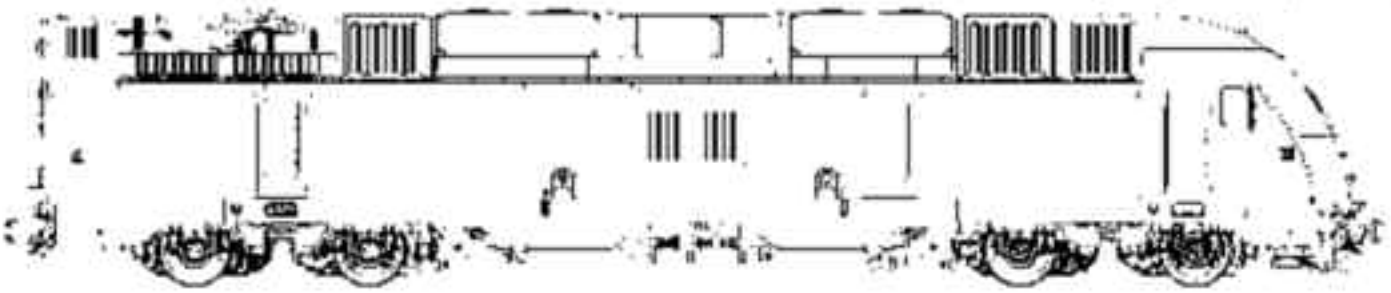
The ALP-45DP had to be designed to comply with certain operating requirements laid down by NJT and AMT. These included the limited headroom in the Hudson River and other Northeast Corridor tunnels, which means that locomotive height (excluding the pantograph) must not exceed 4,440 mm. Maximum length was specified as 21,800 mm - with a longer locomotive there would be complications related to front end overhang clearance. Low noise levels and low levels of noxious exhaust emissions (the EPA Tier 3 requirement becomes effective on 1 January 2012) from the diesels were also requested. Maximum axle-load was fixed at 32.6 t, and that with a Bo'Bo' axle arrangement, the latter being the standard, rather than Co'Co', for passenger locomotives in the USA. Another important task was to evenly distribute the weight and to keep the centre of gravity as low as possible to minimise centrifugal forces on curves. To keep the unsprung mass as low as possible, the traction motors with gearboxes are suspended from the bogies.

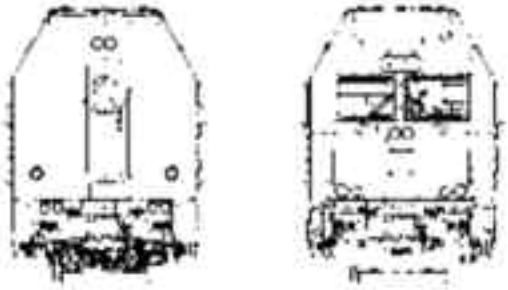
NJT's second ALP-45DP, 4501, at Kassel works on 7 October 2010.

In the USA the standard low speed (between 900 and 1,000 rpm) diesel **engine** would be too heavy for installation in an electro-diesel such as the ALP-45DP. It was thus decided to opt for high speed (1,800 rpm) diesel engines, of the same power rating, but considerably lighter, of more compact dimensions, and thus easier to install. There are two diesel gensets. The chosen diesel power system thus enabled the design of the ALP-45DP to be based on that of the ALP-46A, with bodyshell, bogie and electric driveline technology being similar. The diesel prime movers are 12-cylinder Caterpillar 3512C HD models, each with a rating of 1,567 kW and together delivering 3,108 kW at engine shafts. Depending on trainset

Principal Technical Data

Ambient Temperatures	- NJT Locomotives	-40 to +60 °C
	- AMT Locomotives	-40 to +50 °C
Track Gauge		1,435 mm
Axle Arrangement		Bo'Bo'
Operating Voltages	- NJT Locomotives	25 kV, 60 Hz
		12.5 kV, 60 Hz
		12 kV, 25 Hz
	- AMT Locomotives	25 kV 60 Hz only
Max. Operating Speed	- Electric NJT	201 km/h
	- Electric AMT	129 km/h
	- Diesel NJT	161 km/h
	- Diesel AMT	105 km/h
Continuous Tractive Power	- Electric	4,000 kW
	- Diesel	2 x 1,567 kW
Starting Tractive Effort		316 kN
EDB Power At Wheel Rim	- During Recuperation	4,000 kW
	- During Resistor Braking	1,300 kW
Max. Effort Of EDB		150 kN
Minimum Service Brake Deceleration		0.76 m/s²
Minimum Emergency Brake Deceleration		0.94 m/s²
Length Over Couplers		21,800 mm
Distance Between Bogie Centres		13,250 mm
Bogie Wheelbase		2,800 mm
Wheel Diameter (New/Worn)		1,118/1,046 mm
Maximum Width		2,950 mm
Maximum Height Over Rail Top		4,400 mm
Minimum Curve Radius Negotiable		91 m
Weight In Working Order		130.6 t
Maximum Axle Load		32.65 t
Fuel Tank (Usable Capacity)	- NJT Locomotives	6,056 l
	- AMT Locomotives	6,813 l





Diagrams: Bombardier

length and auxiliary power consumption this results in a power rating of up to 2,650 kW at wheel rim. Maximum speed using diesel power is 161 km/h (100 mph). When operating on electrified sections of route the rated power at wheel rim is 4,000 kW (equal if the train heating is on or off). For a limited time a maximum power of 4,400 kW can be delivered. Maximum speed using electric power is 201 km/h (125 mph).

ALP-45DP Design Concept

The design of the ALP-45DPs is essentially based on the TRAXX and ALP-46 locomotives. The front end being similar to that of NJT's ALP-46s, to ensure that all three ALP types have identical cabs, as far as is possible. The front ends of all three types are of considerably more massive construction, and more robust than those of their European TRAXX cousins, to meet the American FRA crashworthiness standards. But unlike the ALP-46, the ALP-45DP is a single-cab locomotive, the reason for this being that it will usually be coupled to a rake of doubledeck stock.

The ALP-45DP **weighs** slightly less than the limit of 130.6 t. The locomotive is thus heavier than the 92-tonne Class ALP-46 and ALP-46As. The extra weight results from the two diesel gensets, heavier electrical equipment, and the even more robust bodyshell design. To counter this burden as much as possible, attention was paid to bodyshell and underframe design, to ensure that these basic elements were as light as possible. The bodyshell framework consists of steel box girders, clad in sheet steel panels of various thicknesses of up to 12 mm, and partly up to 25 mm. Whereas the bodyshell of the ALP-46 weighs about 24 t, that of the ALP-45DP weighs around 29 t.

As far as **crashworthiness** is concerned, the AAR (S-580 norm) and APTA (American Public Transportation Association) stipulate that the bodyshell must be capable of resisting end-on compressive forces of up to 3,560 kN. The seven roof sections are made of lightweight welded aluminium structures, and can be removed and refitted very rapidly, thus affording easy access to the machinery spaces.

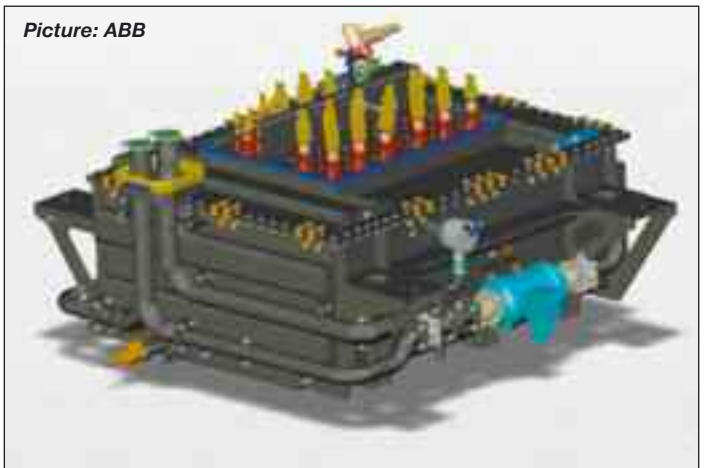
The ALP-45DP is mounted on FLEXX Power 250 **bogies**. Wheelset suspension is by means of pairs of helicoidal steel springs, fitted one inside the other (a parallel arrangement) on account of the locomotive's considerable weight. Wheelset guidance is provided by horizontal links. The wheels and axles are produced by Bonatrans of Bohumin, and assembled at Bombardier's Siegen works. The secondary suspension is of Flexicoil type, and once again, on account of the weight involved, one coil is fitted inside the other. Transmission of longitudinal forces between the bodyshell and the bogies is realised via two angled rods, connected to the bodyshell under the fuel tanks.

The **electrical equipment** is situated in the centre part of the machinery space and is basically identical for both the NJT and the AMT versions of the locomotive. Here can be found the high voltage and auxiliary equipment (including the high voltage vacuum circuit breaker, the disconnecting switch, the high-voltage arresters, the filters, the auxiliary switches, and the voltage and current measuring devices) and the two MITRAC TC 3360 DP traction converters. The latter are of identical construction, one working independently for each bogie. The converter cubicle houses the four-quadrant converters, DC link capacitors, four inverters for each traction motor, the change-over switches for the different overhead line voltages (three in the case of the NJT version) and for transition to and from diesel operation, together with the control electronics.

A FLEXX Power 250 bogie for the ALP-45DP at the Kassel works following delivery from Siegen. Compared with the ALP-46s and ALP-46As, there is twice the number of hydraulic dampers, and the bogie crossbeam is also of more massive construction, on account of the greater weight of the electro-diesel version of the ALP.

For the ALP-45DP ABB of Geneve designed a traction transformer that is 35 % lighter than the earlier version which is installed in the ALP-46, although both types have similar technical requirements. The transformer weighs less than 10 t and is exceptionally compact, to fit between the two fuel tanks. This was achieved by redesigning the auxiliary transformers and by increasing the operational temperature of the oil from 105 to 135 °C. Unlike some other electro-diesels that usually travel only short distances using each type of power and have only one diesel engine, the ALP-45DP is a long distance locomotive with two high power diesels and full power electric propulsion equipment. This means space for other components, such as the traction transformer, is severely reduced.

Picture: ABB



1350, the third ALP-45DP electro-diesel to be built, and the first of the batch ordered by AMT, at Kassel on 7 October 2010. At 7 kW the Liebherr air conditioning units are very powerful indeed, and like on the TRAXX and ALP-46(A) locomotives they are situated in the cab ends under the driving consoles.

The **traction converter** changes the 1,360 V (approximate value) single-phase voltage from the main transformer into a three-phase, pulse-modulated voltage of around 2,100 V 50 Hz for the traction motors. The DC intercircuit functions on 2,800 V. From the DC link the four traction inverters supply each traction motor individually. The rectifiers are water-cooled, incorporating IGBT elements with a closing voltage of 4,500 V. The inverters, of compact design, also have a 3 x 480 V, 60 Hz output for the train power supply (known in the USA as HEP, or Head End Power).

The traction **transformer** is suspended beneath the underframe of the locomotive, at the centre-point, immediately underneath the high-voltage devices, thus ensuring short high voltage line connections. Despite the space and weight constraints, the transformer can operate off three voltage systems (12 kV 25 Hz, 12.5 kV 60 Hz and 25 kV 60 Hz), giving an output up to 6,000 kVA. The main transformer has four secondary windings, that can be switched to provide a constant voltage of 1,360 V independently of the catenary supply to supply both traction converters. The main transformer also incorporates:

- a large 1,100 kVA three-phase transformer which provide the 3 x 480 V 60 Hz power for the train's electrical requirements (HEP),
- one 140 kVA variable frequency auxiliary transformer (supplied by a converter making a U/F ramp), which feeds the motors powering the fans, the transformer oil pump and the compressor at 480 V,
- two second harmonic reactors that can be switched to operate using either 50 Hz or 120 Hz.

The driving consoles of the ALP-45DP are, as far as is possible, identical to those installed on the ALP-46(A) electrics, though of course with certain adaptations on account of the fact that diesel power is also involved. On the right-hand panel is the brake control, the red lever activating the train brake and the black one the locomotive brake. The left-hand panel includes the direction of travel switch and the tractive/EDB force controller. The red switch on the far left is the alerter acknowledge button, and the tall lever (only fitted on the NJT version) in front of it operates the horn. The adjacent panel on the far left includes the lighting switches. The central horizontal panel incorporates controls for the pantograph, sanders and front/rear lights, and a switch for Voltage Changeovers/Phase Breaks (neutral sections). The sloping central panel houses the ACSES display and switches. The operation data and diagnostics screen is on the left, while on the far left is the train radio panel. On the right are the two main manometers together with the three gauges showing the tractive and braking effort and the overhead wire voltage. Rear view mirrors are fitted on the cab sides.

Because the mode change is fully automatic, there are no dedicated switches for activating the diesel engines on the driver's desk. Switching from electric to diesel traction is initiated via the Fault Reset button on the left-hand panel (the orange one). The change-over sequence from electric to diesel mode runs automatically as follows: converter one switched off, diesel engine one started via alternator 1, converter two switched off, diesel engine two started via alternator 2, pantograph lowered. For the diesel to electric traction change-over the Pantograph-Up button on the central horizontal panel is used.

The transformer withstands the intense thermal shock caused by instantaneous acceleration, since locomotives in North America are commonly required to go from zero to full throttle at once even under Canadian winter

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conditions (when temperatures can fall as low as -40 °C).

There are two diesel **gensets**, which are situated on either side of the high voltage equipment, delivering a continuous power rating of about 2,600 kW at wheel rim, this value without any HEP load and dependent also on any internal auxiliary loads. Each 1,600 kW traction alternator feeds one part of the central traction converter, enabling the same electric systems to be used when the locomotive is running in diesel or in electric mode. Underneath each engine are situated the fuel tanks, fore and aft of the traction transformer, and close to the inner ends of the bogies. To save weight, the two tanks form an integral part of the bodyshell structure.

The **diesels** are four-stroke, water-cooled, supercharged Caterpillar 3512C HD models rated at 1,567 kW at a nominal speed of 1,800 rpm, and equipped with direct fuel injection and intercooling. Engine performance is governed by an electronic control module. This also transmits engine status data to the main control and diagnostics system. The fuel cooled engine control module for the control circuit is housed in a metal box on the front part of the engine, and can easily be accessed from the passageway through the machinery space. The engine is mounted on the underframe using flexible rubber-bonded blocks. Charge air is sucked in through a filter on the roof. The exhaust passes through silencers with integrated Diesel Oxidation Catalysts and is emitted via a roof-mounted exhaust outlets.

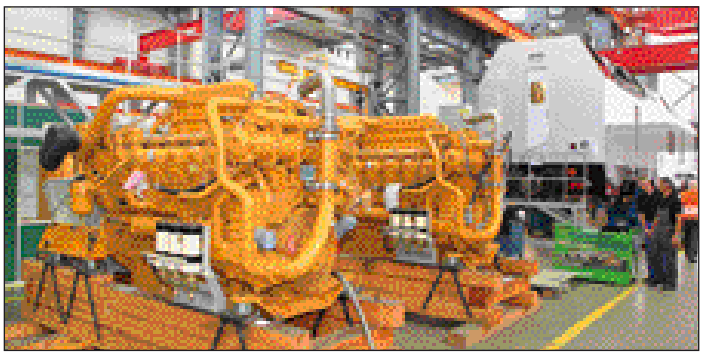
The MITRAC TG 3800A traction alternators are produced by Bombardier's Hennigsdorf works. They have an output of approx. 1,700 kVA at 1,800 rpm. **Switching** from electric to diesel traction and vice-versa (the so called mode change) can take place either when stopped or on the move, and is fully automatic. The train speed limitations for on the move switching are to be defined by the operator. The only constraint when switching from electric to diesel mode is that the driver must allow sufficient time before the train reaches the end of the electrified section of track. Trackside indicators on routes operated using ALP-45DPs will inform drivers where to start the mode change.

Most of the remaining equipment (the compressed air rack, the 1,300 kW brake resistor, the low voltage cabinet and the battery housing) is situated in the rear section of the machinery space. There is only one pantograph, of an identical type to that fitted on the ALP46s, produced by Trans Tech (part of Stemmann Technik), which is located at the rear end of the roof, and the remainder of the roof space houses silencers and the hydrostatically powered cooling units for the diesels, converter and transformer.

Each wheelset is powered individually by a MITRAC DR 3700 F **traction motor**, rated at 1,300 kW. The three-phase asynchronous traction motors, manufactured at Bombardier's Hennigsdorf works, are fully-suspended within the bogie and linked by a hollow shaft traction drive to the axles. Gears and traction motors are combined within a single unit. FAG supplied the axleboxes and the bearings.

The mechanical part of the **braking** systems was manufactured by Faiveley, the two disc brakes being fully integrated in each axle driveline system (mounted on the hollow shafts). This system has a braking value of 90 t. On account of the considerable weight of the locomotive, there is also a friction shoe brake on each wheel, giving a braking value of 40 t. The brake control system is Wabtec's Fastbrake. Electrodynamic recuperative braking is possible under all three voltage systems, although at present the Montreal network operator does not permit recuperated energy to be fed back into the overhead line. Under the latter situation and when the locomotive is running in diesel mode, the regenerated energy is dissipated in the brake resistor. The spring-loaded parking brake acts on the disc brake units on the on each wheelset.

The high voltage and **auxiliary** power rack contains the switching and protective devices for the 480 V level. The auxiliary power converters for generating the 480 V 60 Hz supply is integrated in the main converter. The battery charger for the 74 V battery is located in the low voltage cubicle in the rear compartment. The main transformer is cooled by a biodegradable firesafe ester oil, the converter by water with glycol anti-freeze. Mahle Behr Industry supplied one electric cooling unit (for transformer oil and converter coolant) and two diesel cooling units for the roof. Each traction motor is cooled by its own individual blower. The motors of the fans for the cooling of the traction transformers, the motors driving the water circuits of the traction converters, and the motors driving the cooling fans of the traction motors each have independent power supplies whose voltage varies between 0 and 480 V, with a frequency ranging from 0 to 60 Hz. The machinery spaces are ventilated by filtered air which is sucked in from a by-pass on each traction motor blower.



Two CAT 3512C HD engines at Kassel works for NJT's second ALP-45DP, on 7 October 2010. The engines, weighing about 7,100 kg each, are built at Caterpillar's works in Lafayette, Indiana.

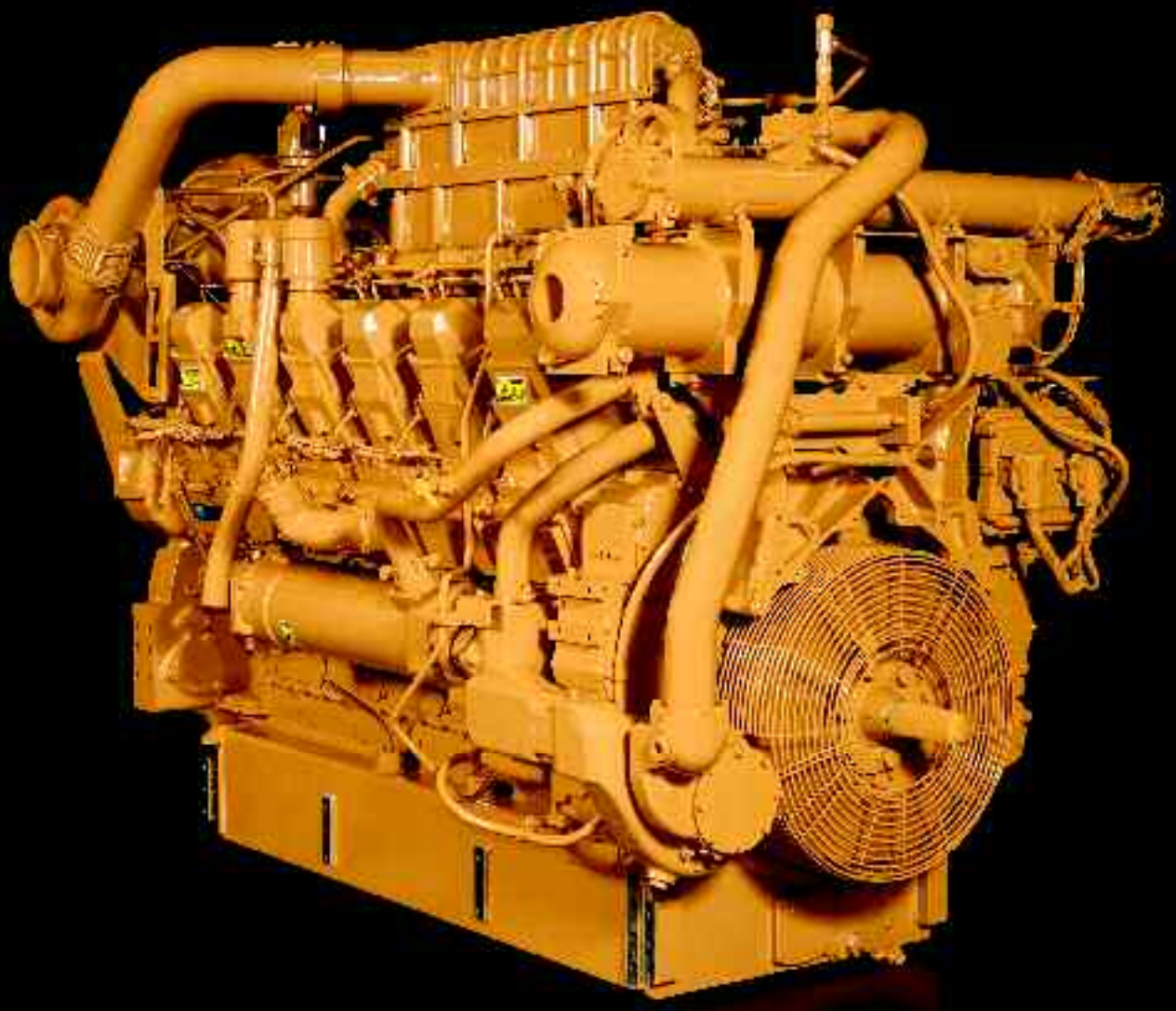
The **compressed air** is generated in by a Knorr SL-40 screw compressor, which is capable of producing around 3,400 litres per minute of air pressurised at 10 bar. Outside air is sucked in via a highly effective dry air cleaner, and the compressed air is stored in two 480-litre chambers. These are situated underneath the mainframe adjacent to and between the bogies, and they are fitted with safety valves to prevent damage to the pneumatic system should the pressure rise above 10.5 bar. A pressure sensor is also incorporated in the system, and this switches the compressor on should the air pressure fall below 6.5 bar. Should the pressure fall below 5.0 bar the brakes are applied automatically, and only when it has risen again to above 6.0 bar can the locomotive can be made operational again.

Bombardier's MITRAC **control system** governs and monitors the running of the locomotive's systems. Commands from the driver or signals from the automatic train control and safety systems are converted into data telegrams by control processors before being distributed to the addressed functions via data buses. The diagnostic system analyses the data and suggests corrective action the driver might take. The control system computers and processors also supervise and self-test their own operation and report any defects. Operation in multiple is possible - two locomotives being the maximum, and this is also feasible when the locomotives are operating in push-pull mode. It is also possible for ALP-45DPs to run in multiple with ALP-46(A) and other existing NJT (and AMT) vehicles. The NJT locomotives are equipped with ACSES ATP and alerter (the driver vigilance device), while on the AMT

The door at the rear of the locomotive enables train crews to move between the latter and the rest of the train.

The InnoTrans 2010 dusk falls on 23 September: ALP-45DP in the company of a couple of other Bombardier exhibits - an ITINO DMU and a London Underground MOVIA EMU.

Fit for locomotives...



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locomotives only an alerter is installed, since the AMT network does not have an ATC (Automatic Train Control) system.

The **anti-slip/slide** protection system is an integrated function of the propulsion drive system. A sensor on the axle-box measures wheel rpm, and both acceleration and braking are actively controlled to minimise the risk of wheel-slip and wheel-slide. Four sanders are fitted, two on each leading axle, and each set is activated according to direction of travel, either manually from the console or automatically, should slipping or sliding occur. No flange lubricator system is installed.

The fire protection system is produced by FOGTEC Rail Systems. It is a high pressure water mist system, with linear heat detectors in the machinery room to monitor the two diesel engines. Additional smoke detectors in the machine room do initiate a warning message to the driver. As on the ALP-46s, there is a WC cubicle for the driver, situated near the inner end of the locomotive. This is accessed from the machinery gangway. The locomotive has two entrance doors to the cab and two side doors in each sidewall for maintenance access. There is a door at the rear end of the locomotive enabling train crews to access the rest of the train.

Performance Characteristics

Since the ALP-45DP is heavier and larger than the ALP-46 and ALP-46As, both of which have a tractive power of 5,300 kW at wheel rim, its performance is somewhat less lively. When operating in electric mode the power available for haulage purposes is not diminished when train heating, lighting, air conditioning and other auxiliary functions are simultaneously being supplied. However, when in diesel mode, there is a certain amount of the available power that has to be abstracted for these facilities - around 600 kW with a rake of eight double deck carriage - still leaving some 2,040 kW available at wheel rim for haulage. In both diesel and electric modes the starting effort is identical, 316 kN.

The ALP-45DP is designed both for suburban-type **services**, with station stops every 5 km or so, and for limited-stop middle distance operations, on which smart acceleration and high maximum speeds are essential. The high speed diesels, running between 600 and 1,800 rpm, ensure that acceleration with a rake of between five and eight double deck carriages is a function only of the trailing load, and not a function of the reaction time of the diesels. Medium speed diesels require over 30 seconds to reach their maximum performance. So, compared with locomotives fitted with the latter type of prime mover, the ALP-45DP will be capable of cutting inter-station journey times.

The ALP-45DP weighs around 130 t and has an **adhesion** weight around 25 %, while the European TRAXXes, by way of comparison, have an adhesion weight of around 36 % on account of their lower weight. The lower value for the ALP-45DP is accounted for by the greater locomotive weight coupled with an identical (to the TRAXX) traction force. When a lower adhesion factor is required, better acceleration is achieved under conditions of low adhesion (such as during the autumnal leaf-fall), thus ensuring that train schedules are not disrupted.

On 22 September at InnoTrans 2010 the first ALP-45DP locomotive was formally handed over by Peter Amman, Sales Director Bombardier (right) to Steven H. Santoro, the Assistant Executive Director of NJT (in the middle) and Nancy Frechette, Vice President Operations AMT (left).

Older types of American and Canadian diesels gained an unwanted notoriety in urban areas for their high noise and noxious exhaust **emission levels**, especially when they were left with their engines idling at night, in order to heat coaching stock. The ALP-45DP can be stabled in electric layover mode on electrified sidings, using either the catenary power supply or a plugged-in „shore supply" with its diesels switched off. A „shore supply" of electricity for train heating and air conditioning can also be used on non-electrified sidings, this being more environmentally friendly than using idling diesel engines. Moreover, on non-electrified stabling tracks where there is no „shore supply" the on-board power requirements when stock is stabled between duties can comfortably be met using just one of the two engines. And in addition to this, when power requirements are low during a journey over a non-electrified line, one of the diesels can simply be switched off, to reduce noise levels, exhaust emissions, and fuel consumption.

Fuel consumption is an important consideration, and that of the ALP-45DP is, naturally, lower than that of an older American or Canadian diesel of a similar power rating delivered by a single large slow speed prime mover. As a result, though depending on the required operating range of the locomotive, smaller fuel tanks may be fitted. Having two engines is better than having one, as well. Should one of the diesels fail, the other can still be used to enable the train to continue to the next station (or until it reaches an electrified line) under reduced traction power. Reduction of power supply for the passenger stock is not allowed, thus the reduction will follow on the traction power only.

The diesel exhausts conform to the new Tier 3 requirements of the U.S. Environmental Protection Agency (EPA). Through use of a self-ventilated asynchronous alternator for the diesel gensets the weight and size of the latter have been reduced. A stabled locomotive's diesel gensets can also be **started up** using the energy from the intermediate DC circuit of the traction converter for the traction alternator, which in this mode is used as a starting gear. This eliminates unnecessary drain on the batteries. It also implies that the latter need not be quite so large in terms of capacity as would otherwise be the case.

The principal technical **differences** between the NJT and AMT ALP-45DPs are:

- the AMT locomotives have a snow-plough of a slightly different design (on account of track clearances),
- the AMT locomotives are not equipped to be fuelled automatically, whereas the fuel tanks on the NJT machines are designed so that they can be filled using automatic pistols,
- the AMT locomotives have fuel tanks with a greater usable capacity. Under NJT rulings regarding safety in tunnels, each fuel tank compartment has a capacity of just 400 gallons (1,514 litres), ie. of 4 x 400 gallons in total,
- the AMT locomotives have two horns with high notes and two with low notes, while those of NJT have only one set of horns,
- the AMT locomotives have an additional compressor and side mirror heating,
- the AMT locomotives have different sets of on-board tools, such as signal flags and indicators, spanners and cables,
- the AMT locomotives have no ATC system, but are equipped with a separate speed indicator,
- the AMT locomotives have different Train Line Cabling (HEP supply and control circuits) and functions,
- the AMT locomotives have different software functions and screens for use when running in multiple on account of other types of rolling stock,
- the AMT locomotives have labelling either in French or in both French and English.

Construction And Deliveries

The bodyshells of the ALP-45DPs are built at Bombardier's Wrocław works, while the bogies come from Siegen, and assembly and fitting out are undertaken at Kassel. Development and design were realised rapidly - both NJT and AMT are keen to get the locomotives into service as soon as possible, so everything was done to ensure that construction could begin in the shortest time feasible. Experience with the earlier ALPs and with the TRAXX family was of course invaluable. Both NJT and AMT have their own **consultancy** companies, each with five sub-groups, and up to November 2010 there had been around 120 official meetings to discuss design and progress work on the locomotives. It is planned to outshop the remainder of the whole batch of 46 locomotives during 2011.

The **NJT** locomotives will be numbered 4500 to 4525. NJT's 4501 was outshopped at the end of October 2010. It was subjected to static testing within the Kassel complex, since dynamic testing on the German network or on the European test circuits are not possible, because of both the locomotive's greater loading gauge and its different operating voltages. 4501 is to be dispatched to the USA in January 2011. Dynamic testing will take place at the TTCI centre in Pueblo, Colorado, and the locomotive will be handed over to NJT in August 2011. However 4500, the first member of the batch, which was an InnoTrans 2010 exhibit, is to remain in Germany until February 2011. In July 2010 NJT's board decided to order another ten ALP 45DPs as part of the option clause, however, the contract for these has not yet been signed.

The **AMT** locomotives will be numbered 1350 to 1369. The first was completed in November 2010 and will be dispatched to Canada in early 2011. Thorough testing will take place there, with a view to entry into commercial service in autumn that year. AMT's second locomotive, 1351, is scheduled to pay a visit in August 2011 to the RTA Rail Tec Arsenal climatic tunnel in Wien. This is a vital stage in the testing procedure, on account of the severe winter conditions in and around Montreal. One of the diesel gensets, together with a complete traction chain, has also been subjected to tests at Bombardier's PowerLab centre in Zürich-Oerlikon.

Bombardier was among the European pioneers in developing the latest generation of electro-diesel trains - namely the AGC BiBi multiple units for SNCF. But the ALP-45DP represents a further **step forward** in electro-diesel technology. Using the DC intercircuit of the traction converter as an interface, it would be a simple matter in the future to incorporate various other energy sources, such as batteries, supercapacitors and fuel cells. It would also be feasible to do this while keeping the locomotive's axle-load within the 22.5 t limit of most European networks.

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using Bombardier Transportation sources

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