As we reported in R 4/08 (p. 6), and R 4/11 (p. 7), in 2008 SBB announced a project for the refurbishment of the four-car Class Re 450 trainsets, SBB’s first-generation double deck shuttle service stock, known as Doppelstock-Pendelzug (DPZ), of which 115 were built between 1989 and 1997.

Each trainset consists of a Class Re 450 single-ended locomotive (because of its function, generally referred to as a „power car”), one second class carriage (B), one first/second class composite (AB), and a second class driving trailer (Bt), so the trains are designed for push-pull operation. It was decided to replace the Class B carriages with new ones and to refurbish the Class AB and Bt vehicles.

In mid-2008 SBB thus placed an order with a consortium formed by Siemens and Bombardier for 121 new low floor double deck intermediate trailers for these trains. These 26.8 m long carriages are designated NDW (Niederflur-Doppelstockwagen - low-floor, double deck carriage), and are designed for 160 km/h running. Eight of the 121 were purchased by the Sihltal Zürich Uetliberg Bahn (SZU), and were scheduled for delivery in 2010 (see R 1/11, p. 10). The remaining 113 are to be owned by SBB. Deliveries started in 2011 and will continue until 2016. Offering step-free access from 550 mm high platforms, these carriages will comply with the Swiss Behindertengleichstellungs-gesetz legislation concerning provision for handicapped travellers.

Those carriages (Classes AB and Bt) which will be retained in the rakes are to be remanufactured and refurbished. This is being done under a project known variously as LION, or DPZ+. The LION acronym stands for:
- L = Lifting - external repainting, interior refurbishment (new seat cushions and upholstery, new floor coatings),
- I = Integration - integrating in the trainsets the NDWs to replace the original Class B carriages),
- O = Optimierung - optimisation, upgrading on-board facilities, including the installation of air conditioning to replace the existing ventilation system, the provision of an auxiliary converter, installation of vacuum retention WCs, and the fitting of electricity sockets (one shared between two seats in first class), and the provision of more stowage space for bikes and prams. The air conditioning in the cabs of the driving trailers is to be upgraded.

- N = Neugestaltung - a new arrangement. The original Class B carriages made redundant from the trainsets will be used to create rakes of stock hauled by Class Re420 locomotives, and will be used mainly during peak periods.

Various additional options were specified, but their cost first had to be assessed:
- improved larger text displays for destination announcements,
- installation of automatic passenger counters,
- exchanging the old door control system for a modern one was considered,
- an evaluation of whether there was a possibility of connecting the original diagnostics system, based on ABB’s MICAS S1 system, dating from when the Class Re 450s were built, to the SIBAS ProfiNet-based diagnostics system, supplied by Siemens, and the latter system’s communications bus, installed in the new NDW carriages. In addition the possibilities of connecting other diagnostic tools such as for door control systems, illumination system and the skid prevention system were explored, to see if a new interface would be necessary.

- the overall condition of the carriages was examined, with a view to replacing damaged and worn interior fittings.

All in all, the project was developed with a view to extending the service life of the carriages, operated by both SBB and SZU, by a further 20 years. The engineering of the LION project was realised externally by Cidecon (Basel), Enotrac (Thun), Prose (Winterthur) and Helbling (Aarau). The contract was to be managed by SBB, which would undertake the work on the carriages for SZU as well. The project involved 238 carriages, of which 115 were Class AB, eight were Class B and 115 Class Bt driving trailers.

The SZU trainsets, Re 450 067 and 070, which earlier belonged to SBB, will be each formed of one Bt, one AB, one NDW and one original
LION: S-Bahn Zürich Double-Deck Trains Reshuffled

Upper photo: SZU’s first new NDW double deck carriage was incorporated in SBB’s Re 450 051 trainset, seen here running on line S9 as train 18973 Zug - Zürich HB - Uster, at Mettmenstetten on 19 August 2011. This view enables a comparison of entrance heights of the NDW carriages and of the original stock.

Photos on this page: David Gubler

In early 2008 SZU bought two DPZ trainsets from SBB. The first to arrive was Re 450 067 on 4 April, entering regular service on the 19th of the month. It is seen here on 20 April 2008 on line S4 (Zürich HB - Adliswil - Sihwald), near Wildpark-Höfli halt, visible in the background. The second trainset was delivered to SZU on 9 October 2008. Since both trainsets now belong to a new operator, they have been renumbered, Re 450 067 becoming Re 456 551 and Re 450 070 becoming Re 456 552.

SZU has in total eight trains for line S4 (Langnau - Zürich HB), two of which are former SBB DPZ trainsets, the other six like this one seen near Wildpark-Höfli on 1 April 2008. The locomotive is a Class Re 456, one of the sextet Re 456 542 to 547, and is technically very similar to the Class Re 450, but has a different bodyshell, two cabs and no luggage storage compartment. The double deck carriage is identical to the DPZ Class B, and the two single deck carriages are of various types. These trains have also received an additional NDW, similar to SZU’s DPZ.

There is an interesting consequence to this. Because the four-car trains have become heavier, since December 2011 SZU has offered a somewhat restricted service to and from Wildpark-Höfli. At peak periods, when trains run at ten-minute headways, every other train stops there. The reason for this is that if all trains called there, some of them might run late and disrupt the intensive timetable, with detrimental knock-on effects later during the busy periods of the day. The measure was introduced purely to ensure that the timetable runs smoothly.
Class B car. Since SZU does not offer first class accommodation, the opera-
tor’s two AB carriages are now Class B
carriages, despite their first class ac-
accommodation having been retained.
SZU’s remaining six Class B carriages
and the new NDWs will be incorporated
in the six other trains hauled by a Class
Re 456 locomotive, which SZU opera-
tes on the S4 line (in total, seven SZU’s
rakes are needed, one is a reserve).

Principal Changes Involving
The LION Vehicles

The rough concept phase for pre-
paration of the DPZ+ project started in
April 2009, and continued until June
2010. Then followed the detail concept
phase, which also includes the creation of
a prototype LION trainset, and which is
scheduled for completion in mid-2012.
The challenges of the programme are
the large interventions necessary in
the bodyside structure, the installation
of the space-consuming air condi-
tioning units, and ensuring that the rebuilt
vehicles still comply with the permitted
axle-load, bearing in mind the consi-
derable weight that is added to them.

In the preparatory phases the
means of supplying electricity to
the air conditioning systems received
a good deal of attention. Three alter-
native configurations were evaluated:
one involving supplying the power from
the driving trailer, another from the loco-
motive, and the third involved a decent-
ralised power supply provided in each
car alone. Ultimately this latter option
was chosen, since ABB’s supply con-
verters had an acceptable weight and
volume, and this concept was regar-
ded as advantageous from the point of
view of maintenance, since the cars are
still independent ones.
The technical challenges for this
supply converter were the high power
density (compactness, low specific
weight) and the two separate variable
voltage and variable frequency 3-phase
AC outputs for the air-conditioning units
in addition to the standard 400 V/50 Hz
3-phase AC and the 36 V DC outputs.
Installing the supply converter in the Bt
driving trailer consumed four seating
places, whilst in the AB carriage one
of the WC cubicles was eliminated and
the space thus freed up was used for
this purpose.

In June 2010 SBB awarded
Liebherr-Transportation Systems
a contract to supply new air
conditioning systems for the
modernising of 238 cars forming
Class Re 450 trainsets. Each
system consists of two air condi-
tioning units, nozzle ventilation grilles
(exterior and outgoing air apertures),
outgoing air duct systems, outgoing
air fans and roof hood, two sets of
matting connectors for the air condi-
tioning, these integrating all
the electrical switch elements in
a separate switch panel, an air con-
trolling system with MMI,
consisting of a control and display terminal, CO₂ sensors and ambient air temp-

To save power, on this occasion, for the very first time for a Liebherr batch delivery,
heat pumps are being used, their efficacy having been tested on a laboratory
prototype and is being verified in a carriage during extented trials at SBB’s test
chamber in Olten. The heat pumps are based on a speed-regulated screw
compressor which works in conjunction with an occupant dependent fresh air
regulation significantly controlled by the mentioned CO₂ sensor. The first air
conditioning was supplied in spring 2011, and series delivery is to run from
September 2012 until 2017.

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Liebherr-Aerospace & Transportation SAS in Toulouse (France) is one of nine divisional control companies of the Liebherr Group and coordinates all activities in the fields of transportation systems and aviation equipment. The division employs almost 4,000 people worldwide.

Liebherr’s transportation systems branch develops and manufactures air conditioning systems, hydraulic actuation systems and power supply systems for rail vehicles of all kinds, and is backed by many years of experience. In addition to its own sales and service centres, the division has access to the Group’s development and service facilities around the world.
the entrance vestibules; this was also done in all rebuilt carriages. Even so, there was an increase in weight. Therefore, it was decided to exchange the original wheelsets, designed for a 18 t axle load, for new ones, designed for a 19 t axle load. Part of the work involved new wiring for the carriages, treatment of surfaces, the installation of new wooden flooring with new cove-rings, fitting new insulation materials, new ducts for the air conditioning, and suchlike.

Under the DPZ+ project the Class Re 450 power cars are to be modified slightly. The modifications include provision of LED headlights, optimisation of the slip prevention system, the installation of a new recording speedometer, and of a supplementary foot heater underneath the driving console. The traction motors together with their axle gearboxes are to be overhauled, with replacement of rotors, re-winding of stator coils and fitting of new sealing to the motor-gearbox interface.

**NDW Carriage Description**

The construction of the NDW cars is similar to that of the intermediate carriages incorporated in the Class RABe 514 EMUs. The bogies are produced by Siemens’s Graz works, and the bodyshells are built at the company’s Wien works, where eight carriages for SZU were also entirely built. This works was also responsible for the development and design of these vehicles. The remaining 113 bodyshells for SBB’s NDWs are being sent to Bombardier’s works in Villeneuve for fitting out and commissioning. This factory is also working to full capacity building the BLS Lüscherberger EMUs, building Inova cars being used for modernising SBB’s suburban Class RBDe 560 EMUs to create Domino trains (see R 2/09, p. 56), and is also principally getting ready to start up building SBB’s FV Dosto EMUs (see R 3/10, pp. 24 - 25).

The **bodyshell** profile of the NDWs complies with the Swiss EBV Spezial norm, ensuring maximum space and comfort levels. The bodyshell consists of a welded steel framework and steel sheet panels, mainly between 1.8 and 3.0 mm thick, these also contributing to the support of the structure. Wherever possible spot welding is employed. Two types of insulation are installed: Moniflex mineral wool for thermal insulation, and Terophon to reduce noise levels in the vehicle interiors. The bodyshell exteriors are coated in primer, followed by layers of water-based paint. In the saloons, entrance vestibules and staircases, rubber anti-slip flooring is fitted. The windows are non-opening and single-pane, measuring 1,250 m m in width. They are glazed with double-layer safety glass, tinted to reduce solar heating of the interiors.

The NDW car has two entrance vestibules, situated between the bogies to provide the same unbroken floor height at lower deck level, with sliding, two-leaf entrance doors on each side. Toughened safety glass is employed in

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the door windows as well. Entrance door width is 1,400 mm, with floor height at the door sill being 600 mm above rail level. This facilitates easy access from platforms of P55 design (550 mm high above rail top). But since not all platforms are of this type, an automatically-operating retractable step is also fitted (this is suitable for platforms of up to 400 mm in height).

The doors are opened and closed by means of an electric drive, buttons being fitted inside and outside to offer passengers the options of individual control and selective opening. Centralised door control is also provided, overriding the individual controls, and operated by the driver from the cab console. In addition, the doors are programmed to close automatically after a pre-determined period (5 seconds).

One vestibule of each car extends into a multi-function area with space for wheelchairs, bulky luggage and, in one of the intermediate trailers, bikes. The WC cubicle is situated on the lower deck, which means that access is no problem for wheelchair-bound travellers. The WC cubicles are affixed to the steel structure of the bodyshell, using elasticated fastening components. As in the case of other recent SBB trains, biological WCs are used. The 200-litre water tank for flushing and washbasin use is located on the lower deck.

At Siemens’s Wien works production of SZU’s NDWs started in February 2010. This photo, taken on 24 February 2011, shows the fourth (far right) to seventh SZU carriages together with the first of SBB’s NDWs.

Photo: Bohuslav Kotál

At Siemens’s Wien works production of SZU’s NDWs started in February 2010. This photo, taken on 24 February 2011, shows the fourth (far right) to seventh SZU carriages together with the first of SBB’s NDWs.

Photo: Bohuslav Kotál

With the entrance vestibules being situated between the bogies, the interior is thus divided into three parts. Between the two vestibules are the main saloons, on two decks. The two-flight staircases to the upper deck occupy part of the space over the bogies, with a mezzanine landing, 1,250 mm above rail level. Whereas the first, shorter flight to the mezzanine deck is straight, the second, longer flight is curved inwards, to take into account the limited headroom on the upper deck at the sides. This flight is also slightly narrower than the lower one.
The mezzanine decks have sufficient space for the provision of nine seats at each end of the carriage. The inter-car bellows-type gangways are accessed from here as well. There are wall-mounted litter bins in each vestibule. Most of the seating in the upper and lower deck saloons is arranged in bays in a 2 + 2 configuration, with a legroom of 1,700 mm. The seating upholstery is of a permeable textile material, while imitation leather is used for headrests. The seat units are mounted on brackets extending from the sidewalls, thus facilitating floor cleaning and providing stowage space for bulkier items of luggage. The luggage racks are fitted longitudinally above the windows.

The carriage is fully air conditioned, with one Faiveley air conditioning unit located at each end. These can easily be accessed from the roof for maintenance purposes. Ducts inside the sidewalls distribute the heated or cooled air to the interior. There is in addition a hot air, low pressure electrical heating system, operating off 400 V AC. Train lighting, both interior and exterior, is supplied from the 110 V static converter and from the battery. The saloons are illuminated by fluorescent cent tubes housed longitudinally in the luggage rack frames, these tubes also provide the emergency lighting. The text panels are located at the sidewall above the two windscreen in the lower deck, and in the saloons. Automatic next-station announcements over the public address can be supplemented by impromptu messages from the driver if required - there is a microphone on the driving console. CCTV is fitted.

The NDW is mounted on SF 100 bogies, designed in this project for a maximum operating speed of 160 km/h, although the top service speed of the DPZ trainsets is only 130 km/h. The bogies are connected to the bodyshells by means of pivots. The latter fit into traverses, which are screwed into the base of the bodyshell underframe. They transmit both longitudinal and transverse forces between bogie and bodyshell. Primary suspension consists of steel helicoidal springs, two per axle, with dampers. Secondary suspension is pneumatic, comprising two bellows, together with a rubber column, which provides temporary substitute suspension in the event of failure of the system. The bellows are connected to the bogie frame at their lower end, and to the pivot traverse at their upper end.

The air pressure in the bellows can be regulated, thus ensuring that the bodyshell remains at a constant height above rail level. Wheelset guiding is achieved via a swing-arm fastened to brackets on the underside of the bogie-frame. All equipment relating to the pneumatic systems is situated above the underframe, in the space under the stairs at either end of the vehicle. This is also where the anti-wheelslip/skid control system is located.

The pneumatic brake includes axle-mounted disc brakes, two per axle. Braking force is regulated according to the number of passengers being carried and their combined weight, with the input to the system being via press-
An SZU train on line S4 line, powered by an Re 456, arriving at Zürich-Brunau on 13 April 2012. Behind the locomotive is a NDW, followed by two DPZ double deck carriages, and at the far end, a single deck driving trailer.

The incorporation of a NDW car in a LION trainset means that additional control functions have to be transmitted via communication lines with the train, such as those for the control of entrance doors. Therefore the 13-pin lines were replaced by 18-pin ones, and a check of other communication lines demonstrated that they work sufficiently. The incorporation of a NDW car into the DPZ rakes brought with it a significant moment in the field of combining different diagnostic systems of different levels and ages. While in the original carriages new microprocessor controls have also been installed, such as those governing air conditioning, the new converter and door operation, the SIBAS Profinet diagnostic system in the NDW, the newest vehicle in the rake of stock, is able to read the diagnostic data of the whole train (excluding that of the Re 450 locomotive). It also paves the way for the future transmission of this information to the operator’s maintenance centres.

By April 2012 NDW carriages up to 023 had been delivered to SBB. They are currently stored at Zürich-Altstetten depot, waiting to be incorporated in the DPZ+ rakes.

New Trains Created From Old Stock

The 113 Class B intermediate trailers to be removed from the existing SBB’s DPZ trains will form six rakes of ten cars and seven rakes of six cars, topped and tailed by Class Re 420 electric locomotives. 30 of the latter, 420 201 - 230, are being adapted for this role, while simultaneously receiving a heavy overhaul, which will give them a further 20 years of working life. They will not, however, be fitted with ETCS, although the latter will be considerably extended on the SBB network over the coming years. In fact, for these 13 rakes 26 locomotives will be required, and remaining four will be held in reserve.

35 of these 113 Class B carriages are to be fitted out as AB first/second composites, similar to the arrangement on the original AB cars, with first class on the lower deck and on half of the upper deck. The WC cubicles will not be wheelchair-accessible but will be fitted out to cater for the needs of disabled passengers. 78 of the Class B carriages will have their WCs removed, to provide more room for standees. In all the cars CCTV and a passenger information system will be installed. 50 % of the fleet will be fitted with an automatic passenger counting system. These “new” trains will be designated HVZ-D (Hauptverkehrszeit-Doppelstockwagen, peak hour double deck carriages), the designation thus reflecting their principal intended use. In late

![individual seating systems for people on the move](www.kiel-sitze.de)
April 2012 two HVZ-D rakes were in service.

**Project Progress And Deliveries**

Tenders for project management, engineering works and supervision and technical leadership for the DPZ+ cars were invited by SBB in May 2009. The DPZ+ project, involving modernisation and modification of existing stock, was shouldered by SBB's own works. SBB Industriewerk (IW) Olten assumed responsibility for all the carriages, including the rebuild of Class B vehicles to create the HVZ-D rakes. The SBB IW Yverdon-les-Bains took on the Class Re 450 power cars. Work on the first SBB prototype LION, using Re 450 071 as a power car, started in summer 2010. To test the feasibility of the project the first two cars, one Bt and one AB from the fourth batch of original deliveries in the 1990s, were rebuilt at IW Olten. In this way verification of all the production processes was achieved, and the methods to be employed were improved, thus paving the way for batch production of the LION trainsets, and providing vital documentation for the certification process.

In February 2011 the first AB and Bt were sent to IW Olten, where the removal of about 20 t of material from each car took all of two months. For several weeks during the summer of 2011 these cars were subjected to tests in the SBB Klimakamer (climatic chamber) at Olten to check that all systems were functioning correctly within the specified operating temperature range of between -25 and +45 °C, this resulting in certain design and construction modifications.

Meanwhile the first NDW to be delivered was DPZplus 50 85 26-73 002-5 CH-SBB in February 2011. This underwent two months of testing in Switzerland, and it was first shown to the public on 2 May 2011 at Zürich HB. Re 450 071 was completed in mid-July 2011. The first Class AB and Bt cars were presented to the media on 8 December 2011 at IW Olten, and later that month they were sent to Zürich-Altstetten depot, to form a prototype DPZ+ rake, together with a NDW and Re 450 071.

Testing is now in progress, and will continue until summer 2012. The tests involve checking EMC, and running in multiple with an original Re 450-hauled rake of stock. Once all the required data have been obtained, the test documentation will be submitted to the Swiss rail authority, the BAV. Test commercial service is envisaged for the second half of 2012, with checking of the performance of the new air conditioning system. If any modifications are deemed necessary, they will be incorporated in the batch modernisations of stock.

Work on the batches of carriages is expected to start in September 2012, and it is planned to have two more DPZ+ trainsets outshopped by the end of the year, thus making three in total including the prototype. Seven trainsets are planned for 2013, and around 20 for 2014. Care has to be taken with the pacing of the project: the S-Bahn Zürich network carries around 500,000 passengers daily, and the risk of having too many trains out of service at any given time has to be avoided. Various dates have been announced by SBB for completion of the whole DPZ+ project, for instance June 2017. Now SBB aims to finish the work, costed at over 600 million CHF, by the end of the latter year.

Regarding the rejuvenation of the SZU fleet, the NDW carriages were delivered separately between May and July 2011. As part of the general NDW testing programme, the first two SZU carriages were tested on both the SZU and the SBB networks, incorporated in SBB's Re 450 trainsets, starting in June 2011. After that, all of the SZU carriages were incorporated in SZU rakes of stock, powered by Class Re 450 and Re 456 locomotives, to be ready to enter commercial service prior the start of the 2012 timetable. The refurbishing of SZU's Class Bt, AB and B carriages to DPZ+ standards will be realised at IW Olten in 2014, the Re 450 067 and 070 being dealt with at IW Yverdon simultaneously.

**Photos, unless cited, by SBB**

*Photo: Raimund Wyhnal*

A full-length HVZ-D trainset, the very first one, completed in September 2011, and seen here at Unterterzen, on the shore of Walensee, on 4 October 2011, powered by Re 420 202 and 230. This was one of the runs held on 4 and 5 October, prior to the launch of the regular service on 9 December. The older Class RBe 540 EMUs will also be replaced by these trainsets.

*Photo: Armin Schmutz*

Production of SBB's NDWs started at Siemens's Wien works in April 2010, and is now in full swing, as shown in this photo of carriage number 027, taken on 21 February 2012. The first finished and certified NDW was handed over to SBB in May 2011.