



**Technical Note, 28<sup>th</sup> Mar 2019**

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## **Single- and double-deck trains**

“Providing the right type of train is a key decision for any passenger railway, and choice needs to reflect the requirements of passengers in the relevant market segment. Norske Tog (NT) has rolling stock suitable for the key markets of inner-suburban, outer-suburban and longer-distance.

Where line capacity is at a premium (such as through Central Oslo), railway operators must think carefully about how best to provide the maximum capacity for passengers. Some elements of railway capacity (e.g. number of tracks; signal spacing) relate to infrastructure, whilst others relate to rolling stock. Increasing train capacity can be achieved in various ways, including wider trains, longer trains and higher (double-deck) trains, within each of which seating capacity can also be varied. Norway is fortunate in having a relatively wide loading gauge in international standards (3.2m), but many trains in the Oslo area are now of their maximum length of 220m (typically 10 cars). Recently, questions have therefore been asked about the relative appropriateness of single- and double-deck trains for Norway. However, because the railway is a classic ‘system’, this choice has considerable implications. This means that trade-offs must be made, the relative balance between the options being affected by local circumstances.

Maximising train capacity is not the same as maximising the number of seats – indeed, as passengers typically use up c. 0.5m<sup>2</sup> when seated but only c. 0.25m<sup>2</sup> when standing, the maximum number of passengers can be carried when there are as few seats as possible. This may be an appropriate solution for inner-suburban services such as those to/from Spikkestad and Lillestrøm. However, passengers travelling from more distant suburbs usually want a seat, and that can lead to pressure to have double-deck stock, in which the number of seats per carriage is maximised.

At first sight, double-deck stock can look attractive to passengers seeking a seat on a busy railway. It has advantages where platforms are short, journey distances long (so the availability of a seat is important) and there is no particular pressure from the sheer quantity of passengers. Unfortunately, urban railway capacity is not only determined by signalling systems and the number of seats per train, but also by what happens at stations. Here, the performance of double-deck stock is very poor, as there tend to be more passengers per doorway, seating densities are relatively dense, and stairs have to be used to access the seating areas – all factors which make boarding and alighting more difficult and time-consuming. To make up for this, vestibules and doorways may have to be larger, thereby reducing the ability to provide as many seats as possible.

As passenger movement times increase, total station stop times also necessarily increase which, in turn, reduces the number of trains which can be operated – a type of negative feedback loop. For train services of 12tph (trains per hour) or less, this should not be an undue problem. However, as service frequencies increase (in the core area, if not on branch lines), this can be catastrophic for service control. For instance, the Oslo system is often unable to achieve the 24tph timetabled in the peaks because (despite the provision of duplicate platforms) dwell times at the key station of Nationaltheatret are unmanageable; similar experience is reported from similar situations such as on the Paris RER.

As overall demand levels rise, single-deck trains are normally to be preferred. It is physically easier in these trains to increase the number of doors, whilst the average distance between seat and door also falls (which helps alighting rates). Where journeys are shorter, a reduction in the number of seats is also possible; this increases overall train capacity, and also speeds up passenger movement rates.

These generic arguments can be supported by observations, because a wide range of vehicle types is in service around the world, enabling us to examine their relative performance, as follows:

<i>Market</i>	<i>Metro</i>	<i>Inner-suburban</i>		<i>Outer-suburban</i>
<i>Train type</i>	<i>Single-deck few seats</i>	<i>Single-deck conventional</i>		<i>Double-deck many seats</i>
Seating arrangement	1+1	2+2	3+2	3+2
Seats per carriage	40	70	80	120
Planned standing per carriage	100	45	25	20
Door width	1.4	1.2	1.2	1.7
Boarding rate (pass/second)	1.25	1	0.9	0.9
Boarding rate (pass/second/metre of door width)	0.85	0.8	0.7	0.5
Alighting rate (pass/second)	1.1	0.8	0.7	1.0
Alighting rate (pass/second/metre of door width)	0.75	0.75	0.65	0.6
Time for 10% of carriage off & on passenger movements (seconds)	24	27	28	30

#### Typical Rolling Stock and Passenger Movement Values by Type of Train

Whilst double-deck stock can be appropriate for outer-suburban traffic, denser and shorter-distance traffic is likely to require single-deck stock. Countries such as Norway, where demand has risen

significantly in recent years, may find themselves having to change rolling stock type towards single-deck designs with fewer seats, a change which will obviously require management of public expectations. Such changes have already been undertaken elsewhere (e.g. in Sydney, where inner-suburban routes are now receiving 'metro'-type stock, replacing the historically-provided double-deck trains).

Given this international experience, we can infer some conclusions. Prospective users of NT's rolling stock need to bear in mind passenger movement rates at their key stations, and the number of likely boarders and alighters at the critical doors, before selecting a rolling stock type. If this is not calculated adequately in advance, alterations may be needed to timetables and (rather more significantly) it may limit the number of trains which can be run, thereby reducing the total capacity available to passengers. Maximum line capacity is likely to be provided by the high-frequency operation of single-deck trains with lots of space for passengers to stand, board and alight."



Norske Tog's Type 72, a conventional single-deck electric multiple unit, with 3+2 seating"