

= NSB Class 73 =

NSB Class 73 ( Norwegian : NSB @-@ type 73 ) is a class of 22 electric multiple units built by Adtranz for the Norwegian State Railways . The four @-@ car trains were modifications of Class 71 , which was again based on the Swedish X2 . The A @-@ series consists of 16 intercity trains ; they were delivered in 1999 and 2000 and are used on the Bergen , Dovre and Sørland Lines . The intercity service was branded as Signatur until 2003 . The B @-@ series consists of six regional trains delivered in 2002 and used on the Østfold Line . The regional trains were originally part of the Agenda concept . The trains have a power output of 2 @, @ 646 kilowatts ( 3 @, @ 548 hp ) and a maximum speed of 210 km / h ( 130 mph ) . They have an overall length of 108 meters ( 354 ft ) and have a capacity for 208 seated passengers in the A @-@ series and 250 in the B @-@ series . The trains have tilting mechanism allowing for faster travel through curves .

The trains were delivered late , and were put into service after the Norwegian Railway Inspectorate had given dispensation from parts of the safety regulation . On 17 June 2000 , a train derailed at Nelaug Station after an axle broke . The class was grounded for a month , and the investigation showed both design errors , and lack of proper inspection and testing . After they were put back into service , they were not allowed to use the tilting mechanism ? thus not being allowed to run faster than their predecessors . The construction was reinforced , and in 2004 , the tilting mechanism was re @-@ enabled along with higher speeds . In 2007 , a train derailed on the Bergen Line , and questions were raised about the trains ' ability to operate in snow , however the accident report showed that the trains ' front axle load was just as able to cope with heavy snow conditions as the locomotives running on the line , and that the derailment would have been more severe if the same conditions would hit a normal train with less secure connections between carriages . On 16 June 2011 , two units were destroyed when the train ran into a fire in a snow tunnel at Hallingskeid Station .

= = Specifications = =

Class 73 is a four @-@ car electric multiple unit built by Adtranz . Each four @-@ car train has eight bogies ? of which three are powered ? with a total power output of 2 @, @ 646 kW ( 3 @, @ 548 hp ) . The trains have active tilting , which allows speeds 20 to 30 percent higher than conventional trains through curves on conventional lines . Maximum permitted speed is 210 km / h ( 130 mph ) . A four @-@ car train is 108 @. @ 48 meters ( 355 @. @ 9 ft ) long ; an A @-@ series weighs 215 @. @ 1 tonnes ( 211 @. @ 7 long tons ; 237 @. @ 1 short tons ) while a B @-@ series unit weighs 216 @. @ 1 tonnes ( 212 @. @ 7 long tons ; 238 @. @ 2 short tons ) . The trains have a steel body and the entire cabin is pressurized . Rail brakes are installed on all carrying bogies .

The A @-@ series has a capacity of 207 seated passengers , while the B @-@ series has room for 250 . The difference is due to the B @-@ series having a smaller bistro and more compact seating . In the A @-@ series , each of the four cars has seating in a different color ( blue in BFM73 car , green in BMU73 , red in BFR73 , and yellow leather in BM73 and in the bistro area in BFR73 ) . Originally , three of the cars had floors with carpet , while the fourth car ( BFM73 ) had vinyl , of consideration to people with allergies . The carpets were removed in about 2005 as it was difficult to keep them clean . Seating is in two classes , standard and Komfort ( originally " Plus " ) ; the latter ( BM73 car ) with leather seating and power supply for laptops . All the cars have cherry tree wood interior . The trains are equipped with a dining section ( BFR73 car ) and warm meals can be served at the seat or in the diner . The menu is according to the time of day , with breakfasts in the morning and larger meals in the afternoon and evening . The trains also feature a family section with a play area and HC area ( BFM73 car ) . The BFM73 car has also a bicycle room behind the driver 's cab . From 2011 , the trains are equipped with free wireless Internet .

= = History = =

== Background ==

In 1990 and 1994 , NSB published two reports regarding the future of intercity rail transport in Norway . The reports concluded that there would have to be invested 56 billion Norwegian krone ( NOK ) in new infrastructure if the main corridors were to be built as high @-@ speed railways . Instead , the use of tilting technology was proposed to allow higher speeds on existing lines . In 1992 , the Parliament of Norway voted to build Oslo Airport , Gardermoen and connect it to the capital with the high @-@ speed Gardermoen Line . It was decided that the service should take 19 minutes ? and not one minute more . When issuing invitations to tenders , NSB specified this time limit as a criterion , which was also the reason the line was dimensioned for 210 kilometers per hour ( 130 mph ) .

Proposals had been made for NSB to purchase the same units as the Swedish State Railways ( SJ ) , the X2 , in a Nordic cooperation to use the same trains in Norway , Sweden and Denmark , but the idea was abandoned . In 1994 , NSB launched plans to build 200 kilometers ( 120 mi ) of high @-@ speed railways by 2011 , but also these plans were shelved . In May 1995 , Osmund Ueland was hired as director @-@ general of NSB , and he scrapped all plans to build new railways , and instead decided to focus on tilting technology .

Class 71 and 73 are based on the Swedish X2 , built by Kalmar Verkstad ( KVAB ) for the Swedish State Railways , and introduced in 1990 . Carbody is built of stainless steel . Forty @-@ three units were delivered by 1997 ; they each considered of a locomotive and two to five unpowered carriages , including a driving trailer . The locomotives had a power output of 3 @, @ 260 kW ( 4 @, @ 370 hp ) and a top speed of 200 km / h ( 120 mph ) . Compared to X2 , Class 73 has an upgraded bogie construction and motors in multiple cars instead of having a locomotive unit . The latter forces a four @-@ car configuration , but allows for better traction and better use of space and weight by placing the technical equipment throughout all four cars .

In 1993 , NSB test @-@ ran an X2 train on the Randsfjord Line , and between 29 September and 21 December 1996 , ran a unit in regular service on the Sørland Line . On 23 February 1995 , NSB signed a contract to purchase 16 Class 71 trains for use on the Airport Express Train on the Gardermoen Line . The contract included two options , one for 16 trains for intercity traffic and one for 6 trains for regional traffic . The reason for using the same type of train as the Airport Express Train , was to reduce maintenance and operation costs through having a unified fleet . The options would only modify the trains slightly ; they were primarily designed for the airport service and any optimization for intercity and tilting technology was secondary in the design process . The first option was taken out on 5 March 1997 .

The differences between Class 71 and 73 is that the latter has a different interior , four instead of three cars , different door design , the removal of one set of doors per car and the addition of tilting . At the time of ordering , it was announced that the trains would enter service on the Sørland Line during the summer of 1999 , the Dovre Line during the fall of 1999 , and the Bergen Line during the fall of 2000 . Class 71 was delivered in 1997 and 1998 ; one of the units was delivered with tilting technology to test it out ? and subsequently removed . The first batch of trains cost NOK 1 @. @ 6 billion .

In April 1999 , NSB launched a new branding scheme for their trains . In addition to Puls for local trains and Agenda for regional trains , the Signatur ( " Signature " ) concept was introduced for intercity trains . Signatur would only be used on the Class 73 services , and consist of two classes , Comfort and Comfort Plus . NSB abolished its branding of only having red trains , and introduced a blue and silver livery on the Class 73 trains . The new service had fewer stops and faster travel times . To take advantage of the faster speeds , the Norwegian National Rail Administration needed to do upgrades to the track , overhead wires and signaling for NOK 1 @. @ 2 billion .

Tickets on the Signatur service cost NOK 25 more than with conventional trains , which would continue to run . Tickets were also made available via Amadeus , a ticket reservation system in Norway previously only used for airlines . Prices became differentiated , with prices between Oslo and Kristiansand varying between NOK 250 and 780 , depending on time of travel and class . NSB stated that they hoped to compete with airlines between the two cities , as travel time from city

center to center was about the same as by plane .

= = = Entry into service = = =

Three days before scheduled services were to start , permission to use the trains had still not been granted by the Norwegian Railway Inspectorate . The inspectorate had a series of safety concerns , including follow @-@ up on the safety terms for the wheels and axles ; lack of documentation of the crew 's training ; denying NSB 's request to have fewer inspections and less maintenance on the trains ; lack of consideration of critical events deemed to have a high probability to occur but have a low consequence ; lack of a safety inspector for operations and maintenance ; and that the trains were so heavy that they would exceed the permitted axle load of the lines . Det Norske Veritas ( DNV ) warned against a possible weakness in the axles . NSB wanted to use an expert from Deutsche Bahn to perform the necessary tests , but limited availability of the expert resulted in the Norwegian National Rail Administration granting a half @-@ year delay of the inspections .

On 28 October 1999 , Minister of Transport Dag Jostein Fjærvoll asked the directors of the three involved parties , Osmund Ueland of NSB , Sverre Quale of the inspectorate and Steinar Killi of the National Rail Administration , to meet at his office the following day if the issue was not resolved . The following day , the inspectorate gave permission for the trains to be taken into use , despite noting a series of non @-@ conformities with safety regulations : the inspectorate lacked a list of the train 's deviations from the safety regulations ; lack of a system to automatically monitor the speed of the trains , particularly when automatic train stop was disconnected ; lack of safety training for the crew ; lack of an evacuation analysis ; and lack of control of the marking of safety equipment . Most of the deviations were to be followed up within two weeks . Quale stated that the deviated issues were of a nature which had not previously been applied to trains and that it was therefore not critical .

The first train was delivered on 22 October and was put into use on the Sørland Line from 1 November . Scheduled travel time was reduced by 40 minutes to 3 hours and 40 minutes . In December , the trains had problems with the pantographs not working correctly in cold weather , causing the trains to lose power and be several hours delayed . NSB stated that a contributing cause was the previous year 's mild winter , which made it impossible to test the trains in extreme weather . After two and a half months of operation on the Sørland Line , every other train was at least 5 minutes late and every tenth train at least 20 minutes late . The trains also caused travel sickness , also among employees , particularly on the section from Kristiansand to Bø . NSB stated that this had also occurred on the old trains and that it was reports of the number of people affected were exaggerated .

On 16 December 1999 , NSB confirmed the option for another six Class 73 trains , costing NOK 680 million , for use on the Østfold Line . On 7 January 2000 , the trains were put into service on the Dovre Line between Oslo and Trondheim , and on the Sørland Line between Kristiansand and Stavanger . The travel time from Trondheim to Oslo was 5 hours and 46 minutes . In an independent marketing survey , Signatur customers were more satisfied than the customers for the two main airlines , Braathens and Scandinavian Airlines , but the train service had a lower reputation than the airlines . By May , the number of passengers on the Sørland Line had fallen by 10 percent . The reason was the limited capacity during the weekends ; while NSB had previously run trains with 400 to 500 seats , Class 73 had considerably less capacity . Additional services were introduced on the Dovre Line from 11 June 2000 , while the introduction on the Bergen Line was delayed because the infrastructure upgrades on the Bergen Line were not yet completed .

= = = Axle faults = = =

On 17 June 2000 , a Class 73 train derailed at Nelaug Station on the Sørland Line . The train was traveling at slow speed and no @-@ one was injured , but had the derailment happened at full speed , it could have been fatal . The derailment was caused by a fatigue failure in the front axle of the train . All Class 71 and 73 trains were immediately grounded , and were investigated by

maintenance crews . The derailed train had recently had its axle checked for fatigue , but no cracks had been found . On 19 June , NSB stated that they had made insufficient tests during the 100 @,@ 000 @-@ kilometer ( 62 @,@ 000 mi ) controls . Class 71 had been through ultrasonic testing and were therefore allowed to resume operation the day after the accident . A DNV report from late August concluded with that the cracks had been caused by rust , which was again caused by water being sealed in by the corrosion @-@ protective layer .

On 23 June , Quale stated that the inspectorate should never have approved the trains . He stated that the Sørland Line was extreme in Europe in the number of curves , and that this gave increased stress on the axles . The tests which were used to approve the trains had been done on the Dovre Line and with a Class 71 set equipped with tilting technology , a class which weighs less than Class 73 . He further stated that NSB had controlled only part of the axle and that if proper tests had been made , the fatigue would have been discovered . NSB stated that they had tested the trains on a section of the Dovre Line they considered to be more curvy than the most curvy parts of the Sørland Line . There was also a misunderstanding in the approval , as NSB had said to DNV that the tests on the Dovre Line were not to be considered representative for the Sørland Line , while the inspectorate had the impression that DNV had approved the tests also for the Sørland Line . NSB stated that all tests would be done again before the trains were put back into service .

NSB stated that they would demand a discount from Adtranz . Following the incident , the trains would have to be in for maintenance examinations every 100 @,@ 000 kilometers ( 62 @,@ 000 mi ) , rather than every 1 @,@ 200 @,@ 000 kilometers ( 750 @,@ 000 mi ) . With each exam costing NOK 50 @,@ 000 , NSB stated that this represented an extra cost of NOK 20 million per year . The contract between Adtranz and NSB states how often trains are to be maintained , and Adtranz holds a financial responsibility if the trains systematically need more maintenance than that . By 24 June , cracks had been found in two additional units . Similar cracks had occurred in the X2 trains , but after many years of operations . The same manufacturer had been used for the axles on both trains . In Sweden impurities in the steel , combined with undersized axles , were thought to be a cause , but replacements had caused the same issues . On 26 June , NSB stated that in April they had discovered that not checking the whole axle was a weakness in the maintenance procedures , but that despite this , no new examinations had been done . The reason this was ignored , was that there was nothing that indicated that this part of the axle represented a weak point .

Ueland was unanimously fired as CEO by NSB 's board on 29 June . Immediately afterwards his deputy Randi Flesland resigned , after she had rejected the board 's proposal for her to become acting CEO . The same day , Adtranz assumed full responsibility for the defects , and guaranteed that they would cover NSB 's costs . In a report , Adtranz stated that the axles should be examined every 6 @,@ 000 kilometers ( 3 @,@ 700 mi ) , which would mean weekly inspections . They stated that they hoped further inquiries would find a way to have less frequent inspections . This was rejected by NSB , who would not have sufficient trains to run the schedules with such a tight inspection scheme . Instead , Adtranz and NSB agreed to a new programme which would involve inspection every three weeks .

The trains were put back into service on 13 July . The trains were only allowed to operate at conventional speeds and had to go through a weekly inspection . At the same time , NSB removed the surcharge on the Signatur services . NSB stated that they were considering revocation the purchase of the four trains which were still to be delivered . In addition to problems with axles , there were also issues with the braking and air conditioning systems . In mid @-@ August , the tilting mechanism was disabled on all the trains because of a fault in a bearing in the connection between the bogie and the body which allowed for a movement of several millimetres ( at least 0 @.@ 1 in ) . In late August , problems occurred with the braking system causing the trains to automatically brake even when not receiving such signals from the automatic train stop system .

The cause of the cracks was a rubber washer which had been installed on the first eight trains ? rather than the conventional plastic cover ? which was intended to protect the axles from ice and stones . Adtranz had delivered thousands of trains with the conventional method without cracks , but the washers trapped water and this caused them to corrode and crack . Adtranz had applied a coat of paint as the sole means to avoid corrosion to the axle . The DNV inspector had " hardly believed

his ears " when he heard about it . In addition , the axles were undersized , and DNV stated that it was only under duress that they considered it safe to operate the trains at conventional speeds , and that all the axles would have to be replaced . On 30 August , NSB gave Adtranz two weeks to solve the axle issues unless the contract was to be revoked .

In mid @-@ September , the press announced that on 8 May 1996 NSB had agreed that Class 71 's axles could receive a steel quality substandard to European standard and recommendation from the International Union of Railways . The reason was that the class would have a much higher weight than planned , and that this would cause the trains to operate more slowly and thus not be able to reach the airport in the desired 19 minutes . Class 73 inherited the same axle quality from the Class 71 order . On 11 September , Adtranz accepted responsibility for the axle problems , and stated that they would replace all axles free of charge , an operation which would cost them NOK 70 million . In October , Adtranz announced that they would also replace all the wheels on both classes . NSB was spending NOK 1 @.@ 5 million on brake discs and brake shoes per month . The parties continued to disagree on the size of compensation Adtranz should give NSB , with NOK 100 million separating the two . In July , NSB replaced DNV with CorrOcean as their inspection supplier for the class . NSB stated that this halved the cost of the inspections . The same month , Bombardier Transportation , who by then had taken over Adtranz , stated that they were going to replace the bogie frames for all the Class 71 and 73 , as well as Class 93 trains , as part of the compensation deal with NSB .

= = = Bergen and Østfold = = =

The first of the B @-@ series trains were delivered for trial runs on 7 March 2001 . In May , NSB stated that they would never be able to operate the trains with the speeds they had previously stated they could , and that at least for the next year , the tilting trains would operate at the same speeds as conventional trains . On 17 September 2001 , the trains were put into service on the Bergen Line between Oslo and Bergen . During the following winter , the trains had problems running through snowdrift unless they were running at a sufficiently high speed . Because part of the Bergen Line had frost heave , trains were forced to drive extra slowly , causing trains to get stuck . NSB stated that tests had shown that Class 73 was better able to do this than EI 16 , which had previously been the main locomotive on the line , although Class 73 did not do as well as the modern EI 18 . In January 2002 , NSB started rebuilding the A @-@ series trains with a larger baggage compartment . This was largely because of insufficient space for passengers to take skis with them .

The B @-@ series was originally put into service on the Sørland Line between Kristiansand and Stavanger , as part of the brand Agenda . The B @-@ series had been planned for use on the Østfold Line , but because the latter is largely a commuter service with many standing passengers , the company was not comfortable using the trains there until the issues regarding the axles and wheels had been resolved . NSB also stated that they were dissatisfied with that the A @-@ series and B @-@ series were not capable of working together . The B @-@ series ' lack of a manned dining car meant that they could not be used on intercity trains , while the A @-@ series ' smaller seating capacity meant it could not be used on regional trains . The B @-@ series was put into service on the Østfold Line on 6 January 2003 . NSB stated that the new class would offer better comfort and reduce the railway 's problems from delays caused by icing . On the Østfold Line , the maximum speed is 160 km / h ( 99 mph ) . From June 2003 , NSB discontinued the brands Agenda and Signatur . The same year , NSB adjusted the timetables so that the trains took the same time as the conventional trains , and that they would use one minute more than in 1982 . Starting on 15 December , three of the services on the Østfold Line were extended to Gothenburg in Sweden .

On 21 February 2007 , a Class 73 derailed after hitting an avalanche between Hallingskeid and Myrdal on the Bergen Line . The accident raised questions about the class 's abilities to handle hard snow , such as in avalanches . In particular , a DNV report from 1999 had shown that the train could act as a sled , lose contact with the tracks and slide on top of the snow . A former NSB employee who worked with route planning , stated that a locomotive @-@ hauled train would be better suitable for such situations , because more of the weight is located at the front of the train , and it will

therefore plow instead of slide . The National Rail Administration said that they took extra precautions for the Class 73 trains and that during snowfall they would run a snow @-@ clearing unit ahead of all Class 73 runs . NSB stated that they would consider the possibility of reverting to conventional trains , but that unless new information could shed light on the situation , they would retain use of the Class 73 trains .

NSB assured passengers that the trains were more capable than their reputation , and that they would continue to be used on the Bergen Line . If an alternative was needed , NSB stated that they would have to use El 18 locomotives in combination with B5 carriages . However , the carriages were at the time being used on regional rush @-@ hour trains around Oslo , were in need of renovation and did not offer the facilities required by intercity travelers . In October , NSB stated that they planned to withdraw Class 73 from service on the Bergen Line , because the use of multiple units was not flexible enough . With locomotive @-@ hauled trains , it was possible for the company to add or remove just a single carriage , but with multiple units , it was necessary to double the capacity if a single unit was insufficient . While originally planned to be introduced in 2008 , delays in the upgrades delayed the delivery of the carriages beyond 2010 .

On 16 June 2011 , a fire started in the snow tunnel at Hallingskeid Station on the Bergen Line . As the station is unmanned , there was no prior warning of the fire until the driver saw it from the cab just as the train entered the tunnel . More or less simultaneously , the train reached the point of the line where the fire had damaged the overhead supply . The driver immediately applied the emergency brake , which caused the train to stop 5 to 10 meters ( 16 to 33 ft ) from the fire . Because the train had no power , it was not possible to reverse out . The 257 passengers were then immediately evacuated . All personnel acted according to regulations and no @-@ one was injured in the accident . According to the driver , had he not lost the power , he would have continued through the tunnel , as the fire was just at the beginning stage . The train , which consisted of two Class 73 units , no . 10 and 13 , eventually caught fire and was damaged beyond repair . Class 73 trains are to be taken out of service on the Bergen Line from the fall of 2012 .

= = Mid @-@ life overhaul = =

Early May 2014 Dutch railway refurbishment and overhaul company NedTrain announced they had won the contract to refurbish the entire fleet . The first set was to arrive in May 2014 for inspection , scheduling of the works involved and evaluation of the process while the remainder of the fleet would come in from spring 2015 . All sets were to be transported by rail via Sweden , Denmark and Germany to the main facility in Haarlem .