

Swedish State Railways steam engine class S/Sa

For Trainz Railroad Simulator



Swedish State Railways light tank engine for passenger trains, class S/Sa of 1908.

Class	S (Sa between 1916-1942)
Type	Mid-size passenger- and local train engine
Configuration	1'C1'
Built years	1908-1916
Total produced	46
Valve gear	Walschaert (Heusinger)
Length	11 800 mm
Boiler pressure	11.5 kg/cm ² (12 kg/cm ² for some boilers)
Weight in service	60.0 / 62.0 / 62.7 tonnes*
Adhesive weight	40.0 / 41.3 / 42.1 tonnes*
Coal capacity	2.0 / 2.2 / 2.2 tonnes*
Water cap	7.0 / 8.0 / 8.0 m ² *
Tractive effort ¹	7 390 kgf
Maximum permitted speed	80 km/h

* The numbers represent the different series. The first figure is for the 900-series. The mid figure for the engine from number 1049, and the last figure for engines from number 1174.

Delivery of the Swedish State Railways' (*Statens järnvägar, SJ*) light passenger engine class S/Sa begun in 1908 and proved to be a very successful construction. The engines were built in three series. The first series, with engine numbered 938-949 at SJ, was delivered by three different Swedish workshops in 1908. These engines originally had a smaller coal box and a shorter boiler with 3600 mm long tubes, compared to the later series when they were delivered.

The second series, with engines numbered 1049-1058 at SJ, was delivered during 1910 and was built with a larger coal box compared to the first series to allow longer radius of action, but with the same, shorter boiler as the first series. The locomotives in the third and last series, SJ number 1174-1178, 1247-1260 and 1274-1280, were delivered between 1914 to 1916, and were built with a similar larger coal box as the second series, but with a longer boiler with 4000 mm tube length to increase the efficiency. Both boiler types originally had a maximum pressure of 11.5 kg/cm², which was unusual at SJ, where most classes had boilers built for 12 kg/cm². However, later built spare boilers for the class S/Sa were made with thicker sheets to allow these boilers to be used at 12 kg/cm².

During the time of service of the class S/Sa, the boilers were exchanged between locomotives during major overhauls, which resulted in that engines from the first series could get the longer type of boiler and vice versa. Due to this some of the engines never got a boiler with 12 kg/cm² pressure, but had boilers with 11.5 kg/cm² maximum pressure throughout their time of service until scrapped.

1 Simplified value for quick comparisons. Calculated as $\frac{0.65 \cdot p d^2 l}{D}$

The individual engines (even from the same series) differed from each other slightly, most noticeable on the shape and size of the coal box and the water tanks. Several engine also had the tank lids behind the cab raised by a decimetre.

The locomotives were used for light passenger services, especially in the south of Sweden where the distances between the stations were shorter than in the north, and in the suburban traffic around the largest cities Stockholm, Gothenburg and Malmö. The class could also be used for goods services, although this was more unusual. The first locomotives delivered in 1908 were given SJ class S. But the class of the engines was changed in 1916 to Sa to create a major class letter (S) for passenger tank engines and a minor class (a) to identify this particular type. One year later the first cousins was delivered to SJ, the larger passenger tank engine class Sb. The last locomotives class S/Sa delivered during 1916 was delivered as Sa from the workshops. The engines were reclassified back to S in 1942, when SJ had a major reclassification of steam engines. During the 1940's many stream engine hauled passenger services were replaced by railbuses to cope with the decreasing number of passengers and higher cost of operating steam engines. Also the main lines of SJ were electrified during the 1920's, 1930's and 1940's, which made several class Sa engines redundant. Some of them were sold to private railways, although most of them were returned to SJ when the lines were bought by the Swedish State in the 1940's and 1950's. Several class Sa ended up in Scania (*Skåne*), the southernmost province of Sweden, during the 1950's and 60's, an area with many shorter, newly nationalized and non-electrified railway lines.

Preserved SJ class S/Sa:

- (1054 – In Gävle since 2012, Spare part engine/scrapped?)
- 1178 – Nene Valley Railway, England. Under overhaul?
- (1252 – Scrapped in Kristianstad around 2012, tanks and boiler(?) preserved as spare parts)
- 1260 – National Railway museum in Gävle, planned overhaul
- 1277 – Veteranjärnvägen in Klippan, in service
- 1280 – Skånska Järnvägar in Brösarp, under overhaul, currently paused

- MYJ 33 – From private railway MYJ (Malmö – Ystad's Railway) similar to class SJ S/Sa. In storage at Skånska järnvägar, Brösarp.

SJ Sa 1277

The class Sa number 1277 was delivered from workshop *Vagn- & Maskinfabriksaktiebolaget* in Falun, Sweden in 1916 with manufacturing number 222, as one of the class Sa engines in the third and last series ordered by SJ. The engine was classified Sa directly from delivery. The engine was fitted with steam brakes for the driving wheels and vacuum brake for the train brakes. The engine was equipped with boiler S 1375, built for 11.5 kg/cm² boiler pressure and with *Falu superheater*, a replica of Schmidt's superheater invented by the workshop in Falun as the works did not have patent rights to build Schmidt's superheater. The engine was also equipped with a speedometer model *Penta*. The engine was sent to SJ's 2nd District, Gothenburg. The engine served in this district to the mid 1950's.

During 1921 the engine had the steam brake replaced by a airbrake system Knorr, used for both

the wheels of the locomotive and the train. At the same time the engine had its kerosene lights replaced by acetylene gas lights of a type called "simplified AGA" (AGA was a Swedish industrial gas company), which meant that the kerosene lamp housing was rebuilt instead of completely replaced by the AGA standard light housings.

The vacuum brake was kept, which meant that the loco had two brake systems in use for the train brake until 1929 when the vacuum brake was deemed redundant and was removed. At the same time as the vacuum brake was removed, the loco was fitted with AGA standard lights, by replacing the old and larger kerosene light houses by the smaller AGA lanterns. This is the type of lanterns the engine has even today.

At an overhaul in may 1929 the original boiler was exchanged for boiler S 1378. That boiler had been delivered by the Motala work for SJ Sa 1280 and was equipped with Schmidt's superheater. Sa 1277's old boiler was overhauled and the *Falu* superheater was exchanged for a Schmidt's superheater. That boiler was put into SJ Sa 1049 one year later.

During the late 1920's and throughout the 1930's (and probably before and after this time period) the engine 1277 was used for passenger services in the Gothenburg area, and especially on the *Bohus* line (*Bohusbanan*) along the Swedish west coast up to the seaside town of Strömstad not far from the Norwegian border. The class Sa was the most common engine type on the line at this time, but issues with the water quality on the northern parts of the line caused problems with erosion of the boilers. Due to this, the Sa engines serving the *Bohus* line (and among them number 1277) were fitted with connections on the balance pipes between the side and back water tanks and an extra valve on the gas pipe to the rear lights to allow connecting an extra water tender. This arrangement was (perhaps a bit jokingly) called *Bahr tender* after Chief Mechanical Engineer Per von Bahr in Gothenburg, who likely came up with the idea. Old, unused two-wheel tenders from goods engines class Kd (which in turn had changed to larger, three-wheel tenders of class C) were rebuilt for this purpose. The changes was mainly the front of the tenders which were fitted with regular buffers to be able to connect them to the Sa engines, just as any wagon. The length of a Sa engine and a class Kd tender was short enough to fit on the 15 meter turntable in Strömstad without the need for decoupling the tender. It seems like the *Bahr tenders* did not belong to a single Sa engine, but they were connected whenever a specific engine should run the longer service to Strömstad from Gothenburg. For shorter services in the Gothenburg suburban area they ran without the tender as there were no turntables (and no time for using a turntable) on the stations where the trains changed direction. And running tender-first was not an option, as that would reduce the maximum permitted speed to 45 km/h. The *Bahr tenders* were used during the 1930's and were then taken out of service. The southern half of the *Bohus* line was electrified 1939, which probably meant that the Sa engines could run services on the north half without the need for an extra *Bahr tender*. Some of tenders were rebuilt to be used for other tasks, while some were scrapped. The minor modifications on the engines were kept, and can still today be seen on Sa 1277.



SJ class Sa 1277 with a "Bahr tender" class Kd at the turntable in Strömstad. Photo 9th August 1935.

During the second world war importing coal was hard, and Sweden did not have any large scale coal mines, so SJ had to find other types of fuel for the steam engines and numerous engines were rebuilt for being fired with wood. Sa 1277 was rebuilt for burning wood in 1941. The changes included changes to the grate, changes to the chimney and an extension to the coal box to allow for loading more wood, as wood is both lighter than coal and has a lower energy density. The engine burned wood until some time 1951-1952 when it was rebuilt back to burn coal again.



SJ Sa 1277 rebuilt for wood burning. Notice the extensions of the rear buffers to give space for extra wood storage. Photo from the 1940's.

Sa 1277 was re-classed back to S in 1942 in SJ's major steam engine reclassification. The engine belonged to SJ's 2nd district until at least 1954. The northern part of the *Bohus* line was electrified 1950 so the Sa engines that were used there were transferred to other lines or scrapped. Number 1277 was transferred to Kristinehamn and used there during its last years of service. The engine was conserved at SJ's main workshop in Östersund 1965 for the "preparedness reserve" and put in storage at Strömsnäsbruk in case of a war. 1973 the engine was withdrawn from the reserve but it was not sent to scrapping until 1978. The engine was saved however, by Helsingborg's Heritage railway (*Helsingborgs Veteranjärnväg*). The engine is owned since 1980 by the association The heritage railway (*Föreningen Veteranjärnvägen*) based in Klippan in the southernmost part of Sweden. The engine was stored in non-operational condition during the early 2000's, but was overhauled and has been in operation since 2013.



SJ class Sa 1277 rebuilt for burning wood. Photo from the 1940's. Note the extended back buffer plate.



S 1277

SJ class Sa 1277. Photo 1950's-60's, possibly in Kristinehamn

The engine in the simulator

The model for Trainz is made with high detail meshes featuring PBR (Physically Based Rendering) textures, LOD (Level of detail), correct animations of everything from the Walschaert's vavle gear to windows and vents as well as realistic engine specs. The model is based on how SJ Sa 1277 looked like during the 1930's when the vacuum brake had been removed and it was fitted with AGA standard lights as well as the connections for *Bahr tenders*. The model also features a detailed and realistic interior with lot of functionality. The engine and the interior uses the STL (Swedish Trainz Laboratories) stream engine scripts and does therefore have all the regular features of the script library, such as animated couples and hoses, plus a lot of additional functionality.

Doors and windows

The doors and windows in the interior, as well as the roof vent and the glass shields around the side windows can be opened and closed and all animations in the interior is mirrored on the exterior model. If you open the left door in the interior, the left door on the exterior model will open just as much. The side windows are locked with cabin hooks that must be lifted before the window can be slid open.

Brakes

The model is fitted with air brakes system Knorr, both for the engines own brakes, as well as the train brake, just as how the real 1277 has been configured since 1929. The train brake, using the *K16* brake valve, applies to both the engine's brakes and the train's brakes. The hand brake spider in the interior is non-functional, since Trainz does not currently support this kind of brake.

Injectors

The injectors (system Gresham) have all the functionality as in the STL stream engine scripts, like sound and smoke effects when the injector spills when opened or closed.

Emergency valve for the crown

The engine features an emergency valve where the main valve for the "crown" (the valve housing on the top of the boiler) can be closed by pulling one of the wires in the roof over the doors. By pulling the wire down in the game the valve is closed. In reality the mechanism is reset by pushing the fireman's shovel at the spring in the roof behind the roof vent. In the game both the wires and the spring can be used for triggering the emergency mechanism by dragging downwards as well as resetting it by dragging upwards. The emergency valve will close the steam supply for the whistle, the steam heating and heating of the lubricator.



Water gauges

The water gauges have all the functionality from the STL stream engine script. They are deceptive, that is, the water level will rise when running the engine uphill and sink when running downhill due

to the water surface in the boiler trying to keep in level. The handles at the water gauges works as in the STL stream engine script.

Lubricator Friedmann model N

The engine is equipped with a functional lubricator, Friedmann model N. The lubricator has six separate pumps, each with its own reservoir, which feeds separate locations at the cylinders and valves. Three locations at the left cylinder and valve and three locations at the right side. Each pump has a connection selection switch and a rate knob. The connection switch controls the connection between the reservoir, the sight glass and the pump and has three positions:

1. *Normale* (straight down) The pump is fed oil from the reservoir and the reservoir is connected to the sight glass such that the sight glass tells the oil level of the reservoir.
2. *Glasbruch* (to the right) The pump is only connected to reservoir and not the sight glass. This position is used when when sight glass is broken to prevent oil in the reservoir from leaking out.
3. *Kontrolle* (straight up) The pump is only connected to the sight glass and not to the reservoir. This position is used to check if a pump works and the amount of oil that particular lubrication point uses.

The rate knob controls the amount of oil that is pumped to that particular lubrication point each pump stroke.

The lubricator is operated by a lever connected to the rear driving wheel on the right side of the locomotive, which means the lubricator feeds more oil the faster the wheel turns. The movement from the lever turns a ratchet-wheel at the back side of the lubricator which performs a stroke with all six pumps simultaneously for each turn of the ratchet wheel, which happens approximately once every 24 turn of the driving wheels. The ratchet-wheel can also be manually turned by a crank at the front of the lubricator to perform a single pump stroke, which can be used to manually press out oil to the cylinders when the engine is standing still. To refill the oil reservoirs, open the lid of the lubricator. You probably have to run the loco for a long time to see that the oil level has dropped in the sight glasses.



Water level taps

To check the water level in the engine's tanks, there are two taps at the front wall, to the right of the boiler, below the lubricator. These tell if the water level in the tanks are above six and four cubic meters respectively. In addition to these there is a tap on the water pipe to the driver's injector that can be used to check the water level (as long as the injector is not in operation and sucks water from the bottom of the tank) as well as a tap to fill a bucket with water. This tap tells if the water level is above two cubic meters in the tanks. The engine's both side tanks and the back tank below and on the sides of the coal box are all connected with each other, acting as one large tank, so the taps tell the total water level in all tanks.

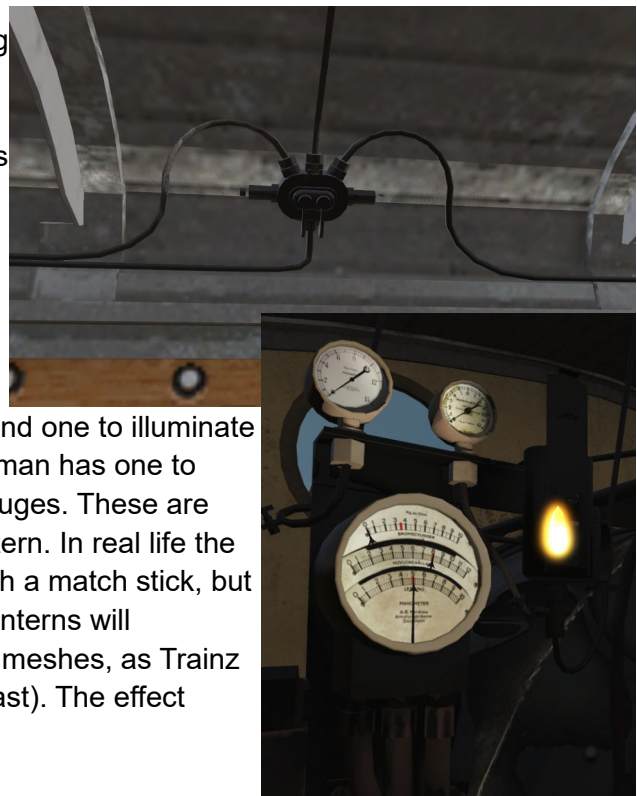


Firebox

The model's firebox has a few extra effects, such as the colour of the fire changes based on the temperature of the fire. A cold fire has more of a red tone, while a warm fire gets more yellow and then white depending on the temperature. The animation of the flames will also change depending on the draught through the tubes. A higher pressure of the exhaust steam from the cylinders or an open blower results in higher flames.

Lights

The engine is fitted with the AGA standard lighting system driven by acetylene gas, where the buffer lanterns can be controlled with two gas taps located in the ceiling, above the fireman. The taps should control the front and back lanterns respectively, but unfortunately due to limited support in Trainz, only the front one works. In the cab there is also three smaller lanterns for illuminating the controls at nighttime. Two are located at the driver's side, one for the manometer beam to illuminate the manometers and one to illuminate the reverser scale and the speedometer. The fireman has one to illuminate the boiler manometer and the water gauges. These are turned on by flipping the little valve below the lantern. In real life the back lid must be slid open and the gas ignited with a match stick, but in the game they are automatically ignited. The lanterns will illuminate parts of the interior using self-emissive meshes, as Trainz does not support real lights (as of TRS2019 at least). The effect might have some artifacts when used in daylight.



Lids for water tanks and the coal box

The lids on the engine's water tanks and coal box are automatically opened when the engine is loading coal or water. They can also be opened manually by the menu opened by right-clicking the engine and pressing "View details...". This works both in Driver and Surveyor mode.

Bahr-tender class Kd

The Kd tender also features water lids that are automatically opened when the tender is loading water. In Trainz like in the real life, the water tank of the tender and the tanks on the engine are connected by water hoses in a way that make them work as one single tank, spread over two vehicles. When a Bahr-tender is coupled to the Sa engine, the water levels in the tender and in the loco will be equalized and the water levels will be updated every 10th second as long as the tender is coupled. This means that the water levels reported by the water level taps in the cab will mean that there are more than six or four cubic meters of water left if the tender is coupled to the engine. When coupling a tender to a Sa engine, the water hoses as well as the small gas pipe will be connected between them automatically. In some cases this is not always triggered when the vehicles are placed in Surveyor mode, but they will automatically be connected once switching to Driver mode. It is also possible to trigger them to connect by decoupling and re-coupling the tender from the engine in Surveyor.

Happy driving!

// Korvtiger – February 6th 2022