

BOARD OF STATE HARBOR COMMISSIONERS.

S P E C I F I C A T I O N S

FOR A

S I X W H E E L

S W I T C H I N G L O C O M O T I V E

San Francisco, Cal., December 10th, 1910.

Specification of a six wheeled switching locomotive engine having three pairs of coupled wheels and an eight wheeled tender for the

BOARD OF STATE HARBOR COMMISSIONERS of SAN FRANCISCO, CALIFORNIA.

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GENERAL DIMENSIONS

Gauge 4 ft. 8 $\frac{1}{2}$ ins. Fuel - oil. Cylinders, Diameter 19", stroke 24". Drivers, Diameter 51". Working pressure 180 pounds. Boiler, Diameter 58", Type Straight Top. Firebox 71-11/16" long, 34-3/8" wide. Tubes, No. 213, Diameter 2", Length 14' 0". Heating Surface (approximate,) Firebox 117 Sq. Ft.

Tubes	1552	" "
Total	1669	Sq. Ft.

Grate area 17.1 Sq. Ft. Ratio to heating surface, 1 to 97. Wheel Base, Driving 10 ft. 6 ins. Wheel Base, Total Engine 10 ft. 6 ins. Weight (approximate) On Drivers 110000 lbs.) In Work-

Total Engine	110000 lbs.)	ing	55 TONS
Tender	80000 lbs.)	Order	

Tractive Power 25990 lbs. Ratio of Adhesion 4.2. Water Capacity 4000 gallons. Oil Capacity 1200 Gallons.

HEADLIGHT Two 18 inch round-case acetylene headlights, one front of engine and one rear of tender. Acetylene tank located on left side of engine.

POWER BRAKE Westinghouse-American outside equalized automatic air brakes, Schedules A-1, WM-2, and FL-1012, also straight air attachments, Schedules SWA and SWB, on all driving and tender wheels. Straight air valve on side of cab near window. 9 $\frac{1}{2}$ inch air pump located on left side of engine.

Slack adjuster must be applied to tender brake cylinder. Climax automatic couplers, on front of engine and rear of tender.

COUPLERS

STEAM HEAT None. SANDER, D&RG never clog sander.

Limiting **CONDITIONS** None. Curves 36 degrees.

DETAILS OF CONSTRUCTION

BOILER Made of plates of homogeneous steel for a pressure of 180 pounds per square inch, and tested with steam to at least 20 pounds per square inch above the boiler pressure, and with hot water to one-third above the boiler pressure.

Waist 58 inches in diameter at smoke-box end, made straight top, with one dome placed centrally. Waist plates 5/8 inch thick.

All longitudinal seams butt jointed, with double covering strips. All boiler and fire-box seams caulked inside and outside where possible. All holes reamed perfectly true after sheets are put together, holes slightly countersunk on inside and outside edges. No hand riveting permitted except where it is impossible to use power riveters. All caulking edges of plates planed where possible and caulked with round pointed caulking tool, insuring plates against injury by chipping in caulking with sharp-edged tools. All boiler brace jaws drop forged, with holes drilled. All jaw-pins to be turned to give full body bearing on both sides of jaw, and to be held in position by nut, washer and cotter-pin. All T-irons fastened to the interior of boiler-shell to be machined accurately to fit the radius of boiler. Tube-sheets to be thoroughly annealed and tube-holes accurately reamed to gauges; sharp corners carefully rounded to avoid cutting tubes in setting.

Throat-sheet of sufficient thickness to prevent undue thinning where flanged. All parts well and thoroughly stayed. Liners on inside of side sheets, providing double thickness of metal for studs of expansion braces, if side sheets are less than nine-sixteenths of an inch thick.

DOME Dome-ring to be of seamless open-hearth forged steel, turned and accurately fitted to the interior of dome-sheet before being drilled and riveted.

Dome-cap to be of forged steel. Dome-base to be of seamless open-hearth forged steel, flanged and radially planed to fit the outer shell of boiler. The interior bored to receive the body sheet of dome. All rivets connecting dome to boiler to be driven by hydraulic pressure.

TUBES Coatsville Rolling Mill Company's tubes, Coatsville, Pa., No. 12 wire gauge, with copper ferules and swaged at ends in fire-box tube sheet, 213 in number, 2 inches in diameter, and 14 feet 0 inches in length.

FIRE-BOX To burn oil, 71-11/16 inches long and 34-3/8 inches wide inside; of homogeneous steel, all flanged plates thoroughly annealed after flanging; side sheets 3/8 inch, ~~thick~~ back sheets 3/8 inch, crown sheet 3/8 inch thick, flue sheet 1/2 inch thick. Water space 3 inches sides and back, 4 inches front. Outside and inside surfaces of water space frame, against which the sheets of the fire-box and outer shell are riveted, to be machined smooth and fitted to gauges. Water space frame double riveted. Crown and sides in one piece.

STAY BOLTS Stay-bolts of iron, screwed and riveted to inside and outside sheets. All side stay-bolts to have three-sixteenth-inch hole, one and one-quarter inches deep from outside to indicate when broken in service. All stay-bolt threads turned off between sheets.

Fire door opening formed by flanging and riveting together the inner and outer sheets, except on small engines.

Fire brick arch None.

CROWN STAYING Crown sheet supported by radial stay-bolts screwed through crown sheet and roof of boiler, and riveted over. Central rows with heads below crown-sheet on boilers 42 inches diameter and larger. Provision to be made for vertical expansion $\frac{1}{2}$ of fire-box tube sheet, if diameter of waist is 46 inches or over.

- CLEANING HOLES** Cleaning plugs located where necessary for proper cleaning of boiler.
- STEAM-PIPES** In smoke-box of iron. Dry pipe inside of boiler of wrought iron or steel.
- THROTTLE-VALVE** Balance poppet throttle valve of cast iron, in vertical arm of dry pipe.
Southern Pacific System oil-burning arrangement, with 2 inch Van Boden burner, and including fire brick, to be furnished and applied by Railway Company.
- ASH PAN** With dampers suitably located.
- SMOKE STACK** Straight stack.
- SMOKE-BOX** Short, with low exhaust, and cleaning pipe.
- FRAMES** Of cast steel securely braced and provided with front and back lugs for cylinder connections.
- PEDESTALS** Pedestals in one piece with main frames, and protected from wear of boxes by cast iron gibs and wedges. Pedestal caps fitted and bolted to bottom of pedestals.
- CYLINDERS** Cylinder heads of cast steel.
High Pressure cylinders 19 inches diameter and 24 inches stroke.
Low pressure cylinders - inches diameter and - inches stroke.
Of close grained iron as hard as can be worked. Each cylinder cast in one piece with half saddle. When placed horizontally right and left hand cylinders to be reversible and interchangeable, accurately planed and fitted, and bolted together in the most approved manner. Valve face and steam chest raised above face of cylinder to allow for wear, except when piston valves are used.
Cylinders oiled by Nathan Bulls Eye automatic sight feed lubricator placed in cab, and connected to steam chest by suitable pipes.
- PISTONS** Heads of cast iron fitted with approved form of steam packing. **PISTON-RODS** of steel, ground and keyed or belted to cross heads, and securely fastened to pistons.
- PACKING** Metallic packing for piston rods and valve stems
UNITED STATES.
- GUIDES** Of steel, fitted to guide yoke of wrought iron or cast steel Laird.
- CROSSHEADS** Cast steel with suitable bearings.
- VALVE MOTION** Eccentrics and straps of cast steel.
Shifting link motion, graduated to cut off equally at all points of stroke. Links, sliding-blocks, pins, lifting-links and eccentric rod jaws made of hammered iron, well case hardened. Sliding blocks with long flanges to give ample wearing surface. Rock-shafts and reverse-shaft of wrought iron or cast steel. Slide valves
Piston valves.
- DRIVING WHEELS** Six in number, 51 inches in diameter. Centres of

cast steel turned to 44 inches diameter.

TIRES Of steel $3\frac{1}{4}$ inches thick when finished. All pairs flanged $5\frac{1}{2}$ inches wide.

AXLES Of hammered steel, journals 8 inches diameter and $8\frac{1}{2}$ inches long.

DRIVING BOXES Of cast steel, with bronze bearings.

SPRINGS Of cast steel, tempered in oil. **EQUALIZING-BEAMS** of wrought iron or cast steel.

RODS **CONNECTING** and **PARALLEL RODS** of hammered steel. Connecting rods forged solid and furnished with all necessary straps, keys and brasses. Parallel rods with solid ends. *Main* with front solid with adjusting wedge main stub with straps and keys and heavy bronze bushings. Bushings put in by hydraulic pressure, and well secured from turning in rod. Grease cups on connecting rods and crosshead ~~pin~~ pin.

OIL CUPS Lubrication of all bearings carefully provided for, and oil cups attached wherever required. Wick, plunger or adjustable needle oil-cups on ~~main~~ guides.

WRIST-PINS Wrist-pins of steel.

FRESH-WATER Supplied by two MONITOR injectors.

Main and side rods to be same as on Engine 1 ✓

CAB Substantially built of steel well finished, and substantially fitted together. To be provided with suitable windows and doors, conveniently arranged, and glazed with first quality double American crystal glass. Cab seats, cab seat cushions and an engineer's arm rest to be provided. Cast steel deck plate

Steel bumper at front of engine.

STEPS Step across front of engine, with hand-rail.

FIXTURES Engine furnished with two sand boxes, bell and cord, Gollmar Bell-ringer, extra fusible plug, engineer's torch.

BOILER FITTINGS: Whistle, one blow-off cock, two 3" Crosby muffled safety valves, blower valve, one steam-gauge and glass water gauge with lamps, gauge cocks.

TOOLS: Two Norton Ratchet 35-ton jack screws and levers, one pinch bar with steel point and heel, suitable wrenches to fit all nuts and bolts on engine, including two monkey-wrenches, one set of driving-box packing tools, one machinist's hammer, one soft hammer, and three cold chisels (two flat and one cape).

CANS: One long spout quart oil can, one two-gallon oil can, one tallow pot

FINISH Boiler and backhead lagged with approved magnesia boiler covering, neatly jacketed with polished steel and secured by iron bands. Dome lagged with same material as boiler.

Cylinders lagged with same material as boiler, neatly cased with iron, painted. Cylinder head covers of hydraulic forged steel, painted or polished.

Hand rails of iron. Cab-boards and running-boards of steel.

PAINTING Engine and tender to be well painted and varnished. Lettering and numbering to be painted as specified by purchaser. See Footnote.

CASE-HARDENING All finished moveable nuts made of steel, or iron case-hardened.

ALLOY All wearing brasses made of phosphor-bronze, or ingot copper, lead and tin alloyed in proportion to give best mixture for wearing bearings.

THREADS All threads on bolts to be United States standard.

GAUGES All principal parts of engine accurately fitted to gauges and templets, and thoroughly interchangeable.

PATENTS The builder must guarantee the Board of State Harbor Commissioners against loss through suits, royalties, or claims of any kind whatsoever on patented articles or material furnished by him.

~~Interstate~~ Ash pans, couplers and hand holds to be in accordance with Interstate Commerce requirements.

FLEXIBLE JOINTS one and one-half inch McLaughlin metallic connections for oil, between engine and tender, S. P. Standard; also three-quarter inch McLaughlin connection for oil heater.

TENDER

TANK Tank of steel strongly put together with angle-iron corners and well braced. Top and bottom plates $\frac{1}{2}$ " thick, inside plates $\frac{1}{4}$ " thick, outside plates $\frac{3}{16}$ " thick, riveted with $\frac{3}{8}$ " rivets, 1-1/4 inches pitch. Capacity 4000 gallons (of 231 cubic inches), Fuel capacity 1200 gallons. Shape of tank "U" shape, sloping back.

FRAME Tender frame substantially built of steel channels, strongly braced.

TRUCKS Two four-wheeled center bearing trucks, made with cross beams of steel channels Simplex steel bolsters. Additional bearings at sides of back truck. Springs, cast steel, tempered in oil.

WHEELS Chilled cast iron, plate center wheels 33 inches diameter. Brakes on all wheels.

AXLES of hammered steel; outside journals 4-1/4 inches diameter and 8 inches long. Oil-tight boxes with bronze bearings.

TOOL BOXES Tool boxes of hard wood, fitted with locks and keys.

Andrews cast steel side frames for tender trucks, S. P. Standard.

Steel bumpers front and rear of tender.

Minor side bearings.

Minor draft gear.

Oil tank located in fuel-space of tender.

PAINTING Painting to be as on engine 1. Engine number "4".

Lettering on tank "BELT LINE RAILROAD".

Lettering on cab panel:

"BOARD OF STATE

HARBOR COMMISSIONERS".

DELIVERY Delivery of locomotive must be made to the Board of State Harbor Commissioners, at San Francisco, California.

All materials used in the construction of the locomotive shall be of the best quality of their respective kinds, carefully inspected, and subjected to the following tests. Notwithstanding these tests, should any defects be developed in working, the corresponding part will be rejected.

**BOILER AND
FIRE-BOX STEEL**

All plates must be rolled from steel manufacture by the open-hearth process, and must conform to the following chemical analysis:

	Boiler Steel	Fire -Box Steel
Carbon, between ---	0.15 and 0.25%	0.15 and 0.25%
Phosphorus, not over	0.05%	0.03%
Manganese, not over	0.45%	0.45%
Silicon, not over	0.03%	0.03%
Sulphur, not over	0.05%	0.035%

No sheets will be used that show mechanical defects. A test strip taken lengthwise from each sheet rolled should without annealing have a tensile strength of 60,000 pounds per square inch, and an elongation of 25 per cent. in a section originally 8 inches long. Sheets will not be used if the test shows a tensile strength of less than 55,000 pounds, or more than 65,000 pounds, per square inch, nor if the elongation falls below 20 per cent.

FIRE-BOX COPPER

Copper plates for fire-boxes must be rolled from best quality Lake Superior ingots; they must contain at least 99.75 per cent. pure copper, and should have a tensile strength of 30,000 pounds per square inch, and an elongation of at least 35 per cent. in a section originally 2 inches long. Plates showing a tensile strength of less than 29,500 pounds per square inch will not be used.

STAY-BOLT IRON

Iron for stay-bolts must be double refined, and must show an ultimate tensile strength of at least 48,000 pounds per square inch, with a minimum elongation of 25 per cent. in a test section 8 inches long. Pieces 24 inches long must stand bending double both ways, without showing fracture or flaw. The iron must be rolled true to gauges furnished by the Baldwin Locomotive Works, and must permit of cutting a clean, sharp thread.

COPPER STAY-BOLTS

Copper stay-bolts must be manufactured from the best Lake Superior ingots; they must contain a minimum of 99.75 per cent. pure copper, and when annealed should have an ultimate tensile strength of 30,000 pounds per square inch, and an elongation of at least 35 per cent. in a section originally 2 inches long. Copper with a tensile strength of less than 29,500 pounds per square inch will not be used.

BOILER-TUBES

All boiler tubes will be carefully inspected and must be free from pit-holes or other imperfection. Each tubes must be subjected by the manufacturers, before delivery, to an internal hydraulic pressure of not less than 500 pounds per square inch. They must be rolled accurately to the gauge furnished by the Baldwin Locomotive Works, filling the gauge to a plump fit. They must be expanded in the boiler without crack or flaw, and must conform to the following requirements.

Blooms will not be used that show an ultimate tensile strength of less than 75,000 or more than 90,000 pounds per square inch, or an elongation of less than 15 per cent.

CHILLED WHEELS

All forgings which develop seams or pipes upon machining will be rejected.

If approved make and of following guaranteed mileage:

For 28-inch wheels--40,000 miles. For 33 inch wheels 50,000 miles.
For 30-inch wheels--45,000 miles. Other sizes in proportion.

(Adopted by Joint Committee Master Car Builders' Association, American Railway Master Mechanics Association of Manufacturers of Chilled Car Wheels, November 21, 1889).

Deficient mileage will be adjusted upon the return of defective wheel, or that part of same containing the defect causing withdrawal from service. Or, if preferred, wheels will be furnished subject to approved specification and drop test without mileage guarantee.

SPRING STEEL

All spring steel must be manufactured by the open-hearth or by the crucible process, and must be free from any physical defects. The metal desired has the following composition.

Carbon---	1.00%	Silicon, not over	0.15%
Manganese	0.25%	Sulphur, not over	0.02%
Phosphorus,			
not over	0.03%		

Steel will not be used which shows on analysis less than 0.90 or over 1.10 per cent. of carbon, or over 0.50 per cent. of manganese, 0.05 per cent. of phosphorus, 0.25 per cent. of silicon, or 0.05 per cent. of sulphur. A tempered bar resting upon supports 24 inches between centres must not take a permanent set of more than 0.05 inch after the first application of a load corresponding to a fibre stress of 135,000 pounds per square inch, nor more than 7.5 per cent of the total deflection under 160,000 pounds fibre stress, nor any further set after five additional applications of a load giving a fibre stress of 150,000 pounds per square inch.

PHOSPHOR-BRONZE

All bronze to be made from new metals and should show the following analysis:

Copper,	79.70%	Lead	9.50%
Tin,	10.00%	Phosphorus	0.80%

Bronze will not be used should analysis show results outside the following limits:

Tin,	below	9.00%	or over	11.00	per cent.
Lead,	"	8.00%	or over	11.00	"
Phosphorus	"	0.70%	or over	1.00	"

Bronze will also be rejected in case it contains 0.50 per cent. of any substances other than the four elements mentioned in this specification.

CHARCOAL IRON

A test section $1\frac{1}{2}$ inches long, cut from any tube, must permit of vertical hammering without showing transverse cracks when flattened down.

SEAMLESS STEEL

All tubes must be drawn from steel manufactured by the open-hearth process and must conform to the following analysis:

Carbon-----	0.18 to 0.24 %	Phosphorus not over	0.04 %
Manganese---	0.40 to 0.65 %	Sulphur	" " 0.05 %

A length of $1\frac{1}{2}$ inches, cut from any tube, must stand collapsing by vertical hammering without showing any cracks.

A length of 4 inches, cut from any tube, must stand horizontal collapsing until the sides meet without cracking.

BOILER-TUBES OF BRASS OR COPPER

Tubes of brass or copper to be of uniform circumferential thickness and solid drawn; to be perfectly round and to resist an internal hydraulic pressure of 500 pounds per square inch. After annealing they must stand the following bending and flanging tests:

BRASS AND COPPER PIPES

A length of 4 inches, cut from any tube must stand being sawn lengthwise and doubled inside out without showing signs of cracks. Any tube must stand having one end flanged without cracking. The tube will be held in a die with the end to be flanged projecting. For tubes of diameters between $1\frac{1}{2}$ and $2\frac{1}{2}$ inches this projecting end is to be five-eighths of an inch long. For other diameters a proportionate length is to be flanged.

BAR IRON

Bar iron should have a tensile strength of 50,000 pounds per square inch, and an elongation of 20 per cent. in a section originally 2 inches long. Iron will not be used if tensile strength falls below 48,000 pounds nor if elongation is less than 15 per cent. nor if it shows a granular fracture.

STEEL TANK PLATES

Tank-plates to be rolled from homogeneous steel billets, and must be of good finish and free from surface defects, such as spalling or bad buckling. The steel to be of such quality that pieces taken lengthwise of any plate shall show no signs of fracture when bent double while cold, over a mandrel whose diameter is one and a half times the thickness of plate so tested.

STEEL FOR FORGINGS

All blooms for use in axles, pins, rods, guides, and similar forgings, must be made by the open-hearth process and be free from seams, slivers, and other surface defects.

Drillings will be taken from a point midway between centres and the surface of the bloom, and must conform to the following specification when analyzed by Baldwin Locomotive Works standard method:

Carbon, about	0.40 %	Phosphorus not over	0.05 %
Manganese, not	over 0.60 %	Sulphur	" " 0.05 %

These blooms should be of such quality that a test piece, machined, cold from a full-sized bloom of each heat used, has, when tested, an ultimate tensile strength of 50,000 pounds per square inch and an elongation of 20

Each bidder must state in his proposal a specific sum for which he will furnish and deliver F.O.B. the locomotive described herein at the Belt Railroad in San Francisco.

Each proposal must be accompanied by a certified check for an amount equal to 5% of the amount of said proposal, such check to be made payable to the order of the Secretary of the Board of State Harbor Commissioners, conditioned, that if the proposal be accepted and the contract awarded, and if the bidder shall fail or neglect to execute the contract and give the bond required within six days after the award shall have been made, in that case the sum mentioned in said check shall be deemed liquidated damages for such failure and neglect and shall be paid into the San Francisco Harbor Improvement Fund.

All bids must be made on blanks furnished by the Board.

The contractor shall be required to give a bond in such sum as the Board may deem adequate with a surety company to be approved by the Board of State Harbor Commissioners for the faithful performance of the contract according to the true intent and meaning thereof and to the satisfaction of said Board of State Harbor Commissioners, and turn the same over to said Board free from all claims and demands, liens or charges for mechanics, material men, laborers, infringement and patent rights or from any other cause or causes whatsoever.

The Board reserves the right to reject any or all bids.

Acceptance of the Work

The locomotive will not be accepted until the same has been completed to the satisfaction of the Assistant State Engineer and a two(2) days trial trip with same has been made.

All damages whatsoever, prior to the acceptance of the locomotive by the Board of State Harbor Commissioners, and the Assistant State Engineer, will be at the risk of the contractor.

Payments

All payments will be made by drafts on the State Controller directing him to draw his warrants for the proper amounts against the San Francisco Harbor Improvement Fund.

After completion and acceptance of the locomotive, the contractor will be paid seventy-five (75) per cent of the contract price. The remaining twenty-five (25) per cent will be paid the contractor 35 days after the acceptance as required by law.

Ralph Barker,

Assistant State Engineer.

Board of State Harbor Commissioners,

State Department of Engineering,

December 29, 1910.