

The N&W Class J No. 611 electric-to-steam

Conversion

Text and photos by Charles & Ryan Bednarik



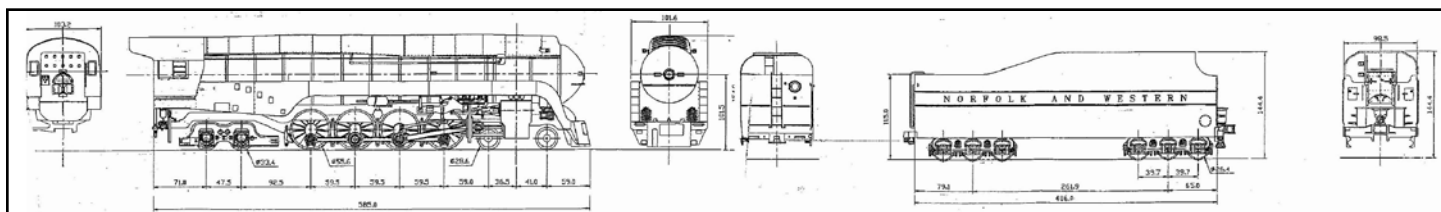
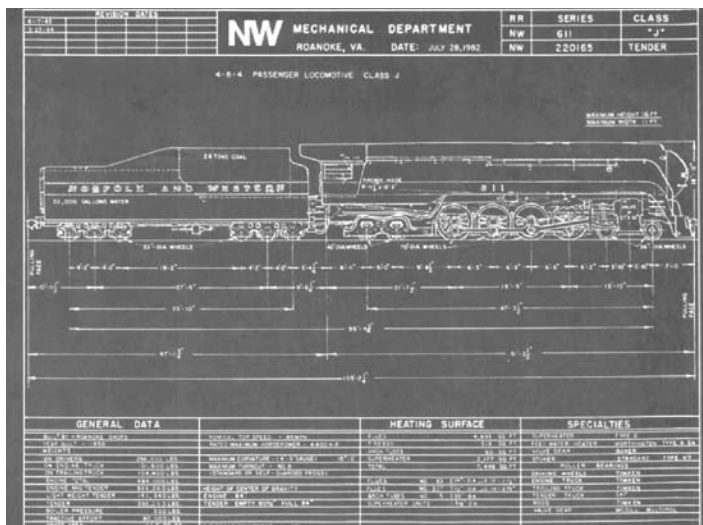
An article published by fellow hobbyists in the *Gauge One Model Railway Association Newsletter and Journal* in 2006, on how they converted an electric locomotive to live steam, inspired us that if we could find an existing electric Norfolk & Western Class J Gauge 1 model locomotive, we were confident that we could convert it. The search was on — with many opportunities slipping beyond our grasp. Finally, on eBay there was the earlier version of the South Korean-made Samhongsu Class J No. 600 for sale. When we reached the owner he indicated that model was sold, but he had another available, the last one in his collection. Thus the quest has begun to have a small-scale live steam representation of (arguably) one of the finest steam locomotives ever to grace the iron ribbons: N&W Class J No. 611 had arrived.

The Class Js were famed for their dual-service

capability, pulling long freights and running passenger trains at 90 mph. Automatic lubrication at over 200 points and roller bearings everywhere (axles, main and side rods, valve gear, wrist pins) permitted 15,000-mile per month usage and 1½-year intervals between shop visits. The Class Js could be fully serviced in just about an hour. With this efficiency, this small group of locomotives could handle 80 percent of the N&W's passenger trains. They operated daily between Cincinnati and Norfolk, Va., pulling such trains as "The Powhatan Arrow," "The Pocahontas" and "The Cavalier."

The N&W Class Js were assigned the passenger service for the Pocahontas and Cavalier through Roanoke on their daily 680-mile runs between Norfolk and Cincinnati.

A second order of the Class J in 1943, built within



Different scales: Top left, the blueprint for N&W Class J No. 611; top right, workers in the N&W Roanoke erecting shop work on No. 600. Bottom, the Samhongsra drawings for its model of No. 611. Top photos: Published with permission, Norfolk & Western Historical Photo Collection, Norfolk Southern Archives.

World War II restrictions on locomotive construction, was designated for freight service until the end of the war.

After passenger service was changed to diesel-powered locomotives in 1958, the once-proud Class J was demoted to freight service. On Jan. 6, 1958, tests were conducted with a Class J pulling 198 empty hopper cars estimated at 4,950 tons. A second run with 53 loaded, 24 empties with a total weight of 4,818 tons was successful, averaging about 38 mph.

On Feb. 28, 1958, Class J No. 607 pulled 150 coal loads having 122,970 tons. The run was near four hours in service with a top speed of 40 mph. A Class J in freight service running the 100-mile Columbus, Ohio, to Portsmouth, Va., route for a two-hour trip that averaged 50 mph.

The relatively short,

mountainous N&W routes, required the Class J to start and stop frequently with a five-10 car passenger train, while keeping to a strict schedule. Fast acceleration from 25- to 60-mph was not uncommon in order to handle sustained grades at track speed, and sprint to 90 mph or so when necessary. Several of the Class Js ran almost 3 million miles each before retirement.

In spite of having only a 70-inch driving wheel, the design safety limit of the rotational and reciprocating mechanism was more than 140 mph. Tractive effort of 80,000 pounds (without a booster truck) for the Class J was not matched by any other 4-8-4 in the United States.

This enabled Class J to start heavy trains unassisted on steep gradients, curves or both, and still safely run at 100 mph the few places that speed was permit-

The N&W Class J No. 611 series: electric-to-steam conversion

How do you get a live-steam model of a locomotive you've always loved? Charles and Ryan Bednarik — owners of Triple R Services of Mount Holly, N.J. (www.realsteamservices.com) — decided to convert a 1:32-scale, electric N&W Class J No. 611 to live steam. In this five-part series, they walk readers through their process of removing the electromechanical pieces and adding in the boiler and fittings.

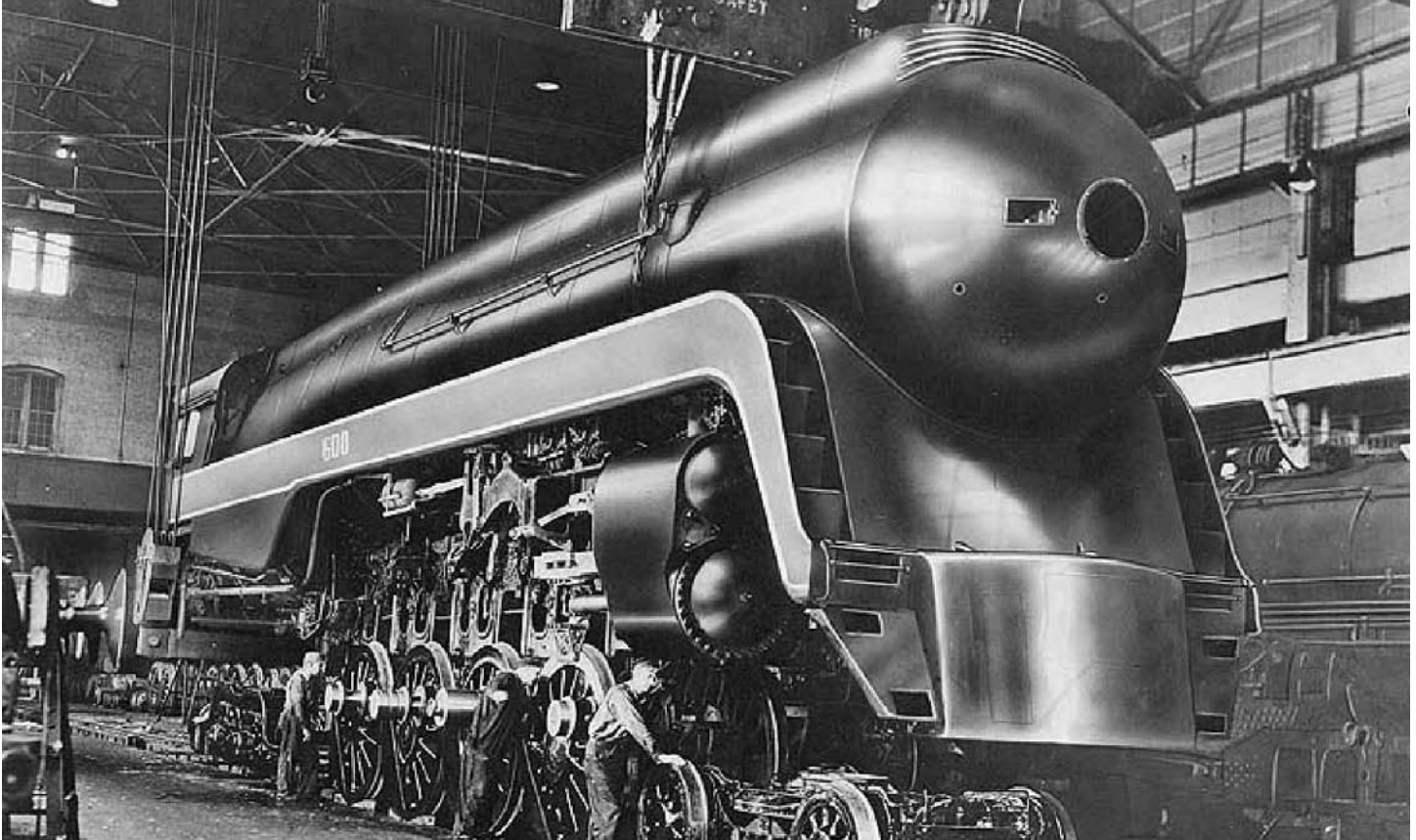
Part One: Background; general overview of conversion up to the finish of electrical removal.

Part Two: Overview of swap; focus on chassis, cylinder, suspension, running gear, tender mods and build expectations.

Part Three: Basic components — cylinders, steam lines, axle pump and running gear.

Part Four: Basic components — boiler, back head, exhaust and plumbing.

Part Five: It's alive — completed and running.



Body work: *In the Roanoke shops in 1946, a body is lowered onto a Class J chassis. Published with permission, Norfolk & Western Historical Photo Collection, Norfolk Southern Archives.*

ted. Performance in regular service was equally impressive, with speeds on straight sections of track reported to approach 100 mph.

Judging by their performance in hauling a 15-car 1,050-ton train at speeds in excess of 110 mph while on loan over Pennsylvania Railroad’s “racetrack,” the Fort Wayne Division, is a claim that is hard to match from any other Class One railroad of the 1950s.

**Samhonga
N&W 4-8-4 Class J performance**

The locomotive will be able to track well on most of the layouts a hobbyist would encounter, with a minimum radius of 6.7 feet. Based on the original setup of the electrical output the locomotive, it should be able to achieve 85 scale mph with a full consist. With tractive effort estimated to be 12

pounds, performance expectations under steam are that the engine should compare with the Aster GS-4 (7.9 pounds) and Berkshire (10 pounds). The Class J will be able to pull 250 pounds of train at a constant 85 scale mph throughout a steaming session for standard-gauge live steam.

The performance would be ongoing with the large firebox and steam production over an hour-long run. The size of the firebox will be larger than the GS-4 and boiler will be only one-third smaller than the Aster Bigboy.

Using Martin Evans’ factor of 30-times tractive effort, the N&W Class J should be capable of pulling 355 pounds under optimal conditions. Based on actual performance of GS-4 locomotives (Aster, Accucraft) pulling 250 pounds of train (18-car Accucraft Daylight set), the estimate for the converted N&W J is deemed to be fairly accurate.

Gauge One live-steam performance*				
Locomotive	Tractive effort (est.)	Wheel diameter	Stroke	Bore diameter
N&W Class J	11.9 lbs.	2.18" (55.3mm)	0.94" (24mm)	0.59" (15.00mm)
NKP Berkshire	10.2 lbs.	2.08" (53.0mm)	0.94" (24mm)	0.59" (15.00mm)
SP GS-4 (Aster)	7.9 lbs.	2.44" (62.0mm)	0.86" (22mm)	0.59" (15.00mm)
SP GS-4 (Accucraft)	8.8 lbs.	2.44" (62.0mm)	0.86" (22mm)	0.62" (15.88mm)
PRR K4	5.4 lbs.	2.44" (62.0mm)	0.78" (20mm)	0.51" (13.00mm)
USRA Mikado	6.7 lbs.	1.96" (50.0mm)	0.78" (20mm)	0.51" (13.00mm)

*Estimates based on calculations from Martin Evans (“The Model Steam Locomotive,” 1983).

N&W Class J locomotives

Profile, in-service Class J

Locomotive Base ID271:

- **Railroad:** Norfolk & Western.
- **Whyte classification:** 4-8-4.
- **Road numbers:** 600-613.
- **Gauge:** Standard (4-foot, 8½-inches).
- **Builder:** N&W (1943-1950).
- **Wheel arrangement:** 4-8-4.
- **Engine weight:** 494,000 pounds.
- **Tender weight:** 378,600 pounds.
- **Total weight:** 872,600 pounds.
- **Valve gear:** Baker.
- **Driver diameter:** 70-inches.
- **Overall wheelbase** (engine & tender): 95.40 feet.
- **Tender water capacity:** 22,000 gals.
- **Tender fuel capacity (coal):** 26 tons.
- **Weight on drivers:** 288,000 pounds.
- **Cylinder, bore x stroke:** 27-inches by 32-inches.
- **Boiler pressure:** 300 psi.
- **Tractive effort:** 77,899 pounds.
- **Adhesion factor** (weight on drivers/tractive effort): three.

N&W Class J frame and body construction in service

The Class J was built on a rigid steel frame cast by General Steel Castings Corp. This large one-piece casting included not only the complete locomotive frame, but the two cylinders, the mounting brackets for certain auxiliaries and an extended frame support for the cab. Air compressors were mounted on the pilot beam area in front of the boiler. Hollow sections cast integral with the frame were designed to serve as reservoirs for compressed air used to operate the air brakes and signaling devices.

The performance of the Class Js was because of the use of Timken lightweight compound rods and dynamic augment to cross counterbalance the locomotive. A unique side-rod and driver counterbalancing design, in conjunction with stiffened centering of the leading and trailing trucks, permitted speeds in excess of 100 mph with drivers only 70 inches in diameter, performance unequalled by other Class One U.S. railroads.

According to vibration calculations, the balancing theoretically would have allowed speeds of up to 140 mph without the rail damage that would have occurred with conventional designs. The piston, piston rod, crosshead, side-and-main-rod assembly are of Timken Roller Bearing Co. light-weight design.

Samhongs model

The N&W Class J No. 611 build dimensions:

- **Length:** 23 inches.
- **Width:** Four inches.
- **Height:** Six inches.
- **Weight:** 19.8 pounds.

The N&W engineers incorporated needle, roller and tapered roller bearings throughout the locomotive to reduce friction and wear.

Mechanical pressurized lubrication systems could operate 1,300 miles between refills, feeding oil to 220 points. Grease fittings were located to allow fast lubrication of 72 points. Eleven of the Class Js operated a total of more than 5 million miles with only two roller-bearing failures.

Developing components for the Samhongs model conversion

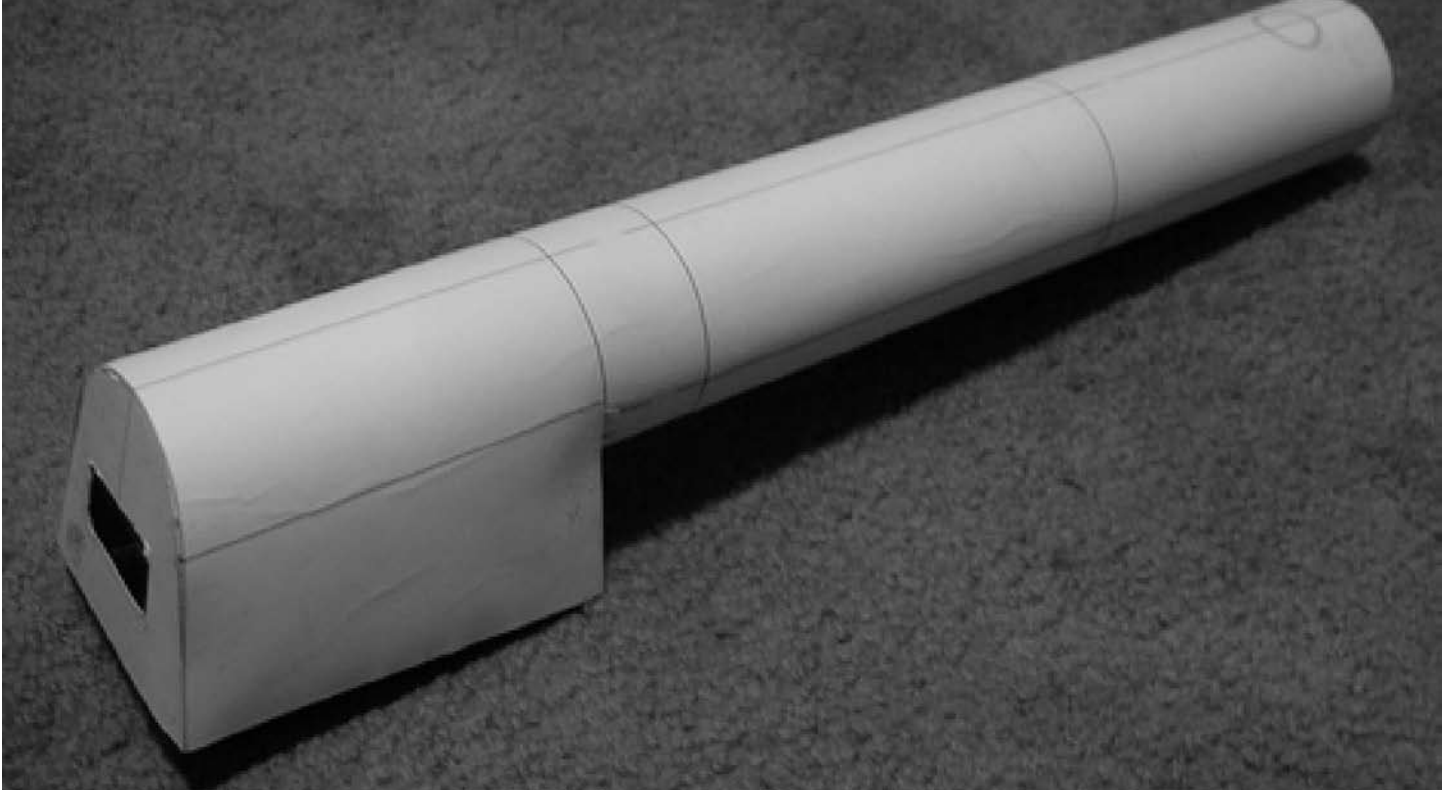
In order to retrofit the major component to a platform that originally designed for electric — and at the same time keeping many of the production components — was going to require inside access to the model structure. Some of the areas to examine closely would be the boiler shell, cab, cylinder casting, drivers, frame, running gears and trailing truck. Each major area would have to be developed to retrofit components such as the boiler, axle pump, cylinders, running gear, fire grate/ash pan, water tank and steam appliances. This resulted in a list of things to do along with how to get it done. It would also require resources and references for materials, supplies, third-party services and build time. Our original schedule was developed for initial completion in fourth quarter of 2011.

At this point, having a prototype boiler and cylinder design, the project seems to be on target. The two key components are the boiler and cylinders. Presently we have the outer portion of the boiler that has been successfully test fitted. The cylinder drawings for this first retrofit will be a “D” valve, but plans are to later convert to piston valves, remaining true to prototype of the real Class J. The cost and time factor of developing the casting and technique of building the cylinder set as in the “old days” was not going to be timely for the project.

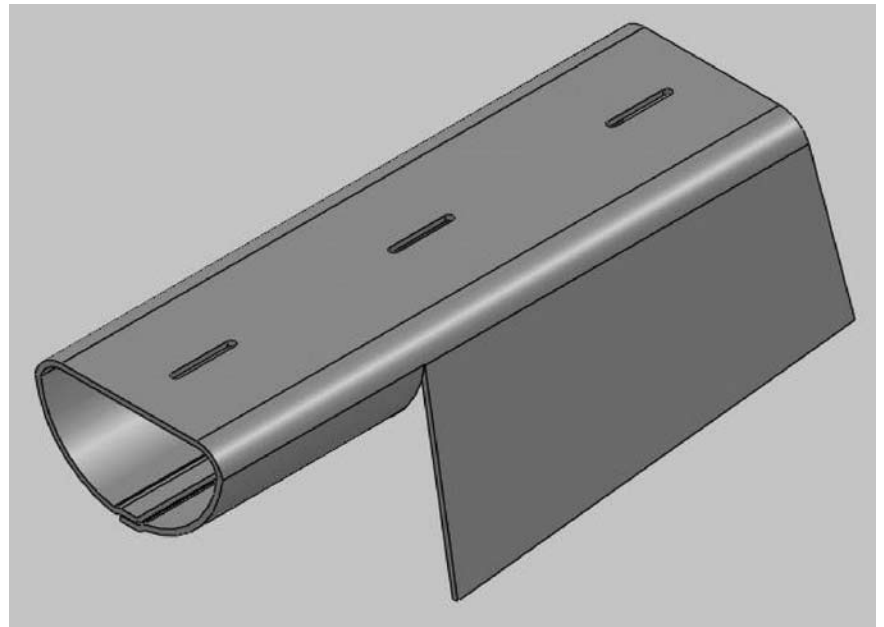
N&W Class J boiler in service

The N&W J boiler — along with the cylinders, combined with the size of the drivers — were key to its success during service.

The riveted boiler was built to be unusually large in diameter without exceeding the clearance and height limits of Eastern railways. The Class J had



Computer-assisted design: *Our friend and colleague, Justin Koch, designed the boiler and firebox for the 1:32-scale N&W Class J. He first did concept drawings in a CAD program and then, later, used the software to create three-dimensional drawings of the boiler, above, and the firebox, right.*



the longest combustion chamber of any 4-8-4 and the largest firebox on any of bituminous coal-burning Eastern 4-8-4s:

- Direct heating surface: 578 sq. ft.
- Indirect heating surface: 4,693 sq. ft.
- Total evap. htg. surface: 5,271 sq. ft.
- Firebox htg. surface: 5 arch tubes; 60 sq. ft.
- Combined htg. surface: 7448 sq. ft.
- Evap. htg. surface/cyl. vol: 248.56 sq. ft.
- Superheating surface: 2,177 sq. ft.
- Grate area: 107.7 sq. ft.

Samhonsa specifications for boiler

The boiler shell will be a one-piece unit from the smokebox (the cab floor and backhead were sol-

dered to boiler shell) to the footplate. To explore the interior of the boiler shell required removing the nose cone, a simple press fit, followed by dropping the pilot truck and a large allen screw removed. The cab had to be removed along with the scale backhead to open the other end of the boiler shell.

Boiler shell overall:

- Length: 18 $\frac{3}{8}$ inches.
- Width (cab): 4 $\frac{1}{8}$ inches.
- Diameter (smokebox): Three inches.
- Stack diameter: One inch.

Firebox:

- Length: 4 $\frac{3}{4}$ inches.
- Width: Four inches.
- Depth: Four inches.



Bench work: *The Samhongs Class J sits partially deconstructed on the workbench.*

The boiler's total dimensions (in general one can compare to the Accucraft Cab Forward for a size perspective) and efficiency makes it a candidate not only for burning Welsh coal, but any good anthracite coal available. Finally, the boiler fuel set up will allow for either coal-burning or alcohol. The over-all length of the firebox and boiler combined is 500mm (~19³/₄ inches).

Firebox:

- 130mm long by 89mm wide by 84mm high, sloping to 93mm high (5.1 inches by 3¹/₂ inches by 3.3 inches, sloping to 3.6 inches).

- 1mm (.04 inches) thick side walls/front.

- Combustion chamber: 35mm (1.4 inches) long.

Boiler:

- 70mm (2³/₄ inches) outside diameter.

- 338mm (13.3 inches) length

The smokebox will be 54mm (2.1 inches) in length. The boiler will have a water tube area 249mm long (seven tubes; one of them three-quarters of an inch, while the other six will be three-eighths of an inch) and the mudring will be 12mm wide by 3mm thick (about a half-inch wide by .1-inch thick). The smokestack will have a 21.5mm (almost three-quarters inch) outside diameter tube.

The N&W Class J tender in service carried 35 tons of coal and 20,000 gallons of water. Stops were frequent enough to avoid the need of service-only stops. Plugs and chutes were provided at regular stops. If there were unexpected delays, a Class J could fuel or water at any of many on-line service points provided for freight use.

The Samhongs N&W Class J No. 611 tender specifications:

- Length: 16 inches.
- Width: 3.9 inches.
- Height: 5.68 inches.
- Weight: 8.8 pounds, dry.
- Wheel diameter: 1.03 inches (26.4mm).
- Water capacity: 800 ml, 1800 ml combined with auxiliary water tank (27 ounces and 60.9 ounces, respectively).
- Coal capacity: Two pounds.

While the engineering of this conversion is exciting, we found that the research into the actual workings of the prototype N&W Class J locomotives to be almost as compelling. Next time we will concentrate on getting the cylinders and valve chests to fit on the frame as well as remaining close to scale in size or appearance.