

Ogden, Utah. April 14, 1947

Road test of locomotive 4007 equipped with single stack Sweeney Nozzle and Master Mechanic's front end arrangement.

Locomotive 4007 was equipped with a single stack, 24 inches in diameter at choke, $26\frac{1}{2}$ inches in diameter at top. For the first help, Cheyenne to Sherman the Sweeney Nozzle had a 6 inch diameter center plate giving a Nozzle area of 50.4 square inches.

On the first help March 20, 1947, Cheyenne to Sherman, locomotive 4007 was tight for steam it being necessary to trade water for steam to maintain 220 p.s.i. boiler pressure. The draft had very little action on the fire and on arrival Sherman fire was banked across the front of firebox.

On March 21, the center plate was changed to $6\frac{1}{2}$ inch diameter giving the nozzle an area of 48.2 square inches. Steaming of locomotive was improved but not sufficiently to consider locomotive a free steamer.

On March 26, a $6\frac{3}{4}$ inch diameter center plate was applied to nozzle reducing the area to 47.1 square inches. On the help, Cheyenne to Sherman locomotive steamed satisfactorily but not as free as desired. The fire burned better but banked badly in the right front corner of firebox. March 28, locomotive was dispatched West. Locomotive steamed and burned a good fire except for bank in right front corner. In order to maintain full boiler pressure it was necessary to force fire which caused some excess smoke. There was not sufficient steaming margin, and the average fireman would have trouble getting over the road. Locomotive performance could not be considered good as 15 to 20 minutes longer was required over each District as compared with other 4000 class locomotives with comparable train. Locomotives best performance was at approximately 16 p.s.i. back pressure. At higher back pressures locomotive did not steam and at lower back pressures performance fell off noticeably as indicated by loss of speed. One round trip Ogden to Green River and return was made with $6\frac{3}{4}$ " center plate on nozzle. Steaming qualities were only fair and performance poor as indicated by time required to get over the road.

It was thought that a draft plate placed under table plate in front end would improve draft distribution in firebox and give better control of fire so that banks could be eliminated at front of firebox. No improvement could be noticed and in fact the added resistance in front end appeared to increase the amount of smoke.

At Cheyenne April 4, the draft plate was removed and a 7 inch center plate applied to nozzle reducing the area to 46.0 square inches. One round trip Cheyenne to Laramie and return was made with no noticeable improvement in steaming quality or draft through fire. Maximum back pressure was increased slightly but locomotive performance was

not improved.

It was then decided to modify the front end diagram by inserting a netting panel 12 inches wide and extending across the diagram. This opening was approximately on boiler center line. One round trip Cheyenne to Laramie was made with this arrangement but there was no noticeable improvement in condition of fire or steaming quality.

As locomotive 4007 was not evaporating or using water at the high rates that the average 4000 class locomotive does, left injector performance was not satisfactory. This was because the water-exhaust steam ratio was out of balance due to high back pressure and low water rates. Size 18 tubes were therefore applied to bring the injector range closer to locomotive requirements. While locomotive was held for injector work a $7\frac{1}{2}$ inch center plate was applied to exhaust nozzle reducing area to 43.4 square inches.

On April 9, locomotive 4007 was dispatched West. There was a noticeable improvement in steaming quality and fire was considerable better with no banks at any time. Grates were not touched on entire trip Cheyenne to Green River and fire was still in very good condition. Locomotive performance was about as on previous trips. Maximum back pressure was approximately 20 p.s.i. with $7\frac{1}{2}$ inch center plate on exhaust nozzle locomotive can be considered a free steamer and the average fireman would seldom have any trouble with firing.

The performance of locomotive 4007 with the present nozzle and stack arrangement indicates that the size nozzle required (43.4 square inches) for free steaming, reduces the performance characteristics of the locomotive considerably. This is shown by time required on the various territories. There will undoubtedly be some small savings in coal and water but sufficient data has not been obtained to establish a definite figure. It is probable that because of lowered performance Enginemen will work higher back pressure than usual in an attempt to decrease running time. The net result will be even smaller fuel saving and possible frequent non-steaming reports.

Due to less draft and therefore lower firing rates and lower flue gas velocities, steam temperatures are from 50 to 100 degrees lower than on 4000 class locomotives previously tested. Lower superheat means a direct loss in cylinder horsepower.

In order to improve the performance of locomotive 4007 to the point where it compares with the standard 4000 class locomotive, it will be necessary to increase the nozzle size comparable to the present 56.5 square inches. To do this with the annular ported Sweeney Nozzle will require a larger stack and a correspondingly larger outside diameter of the nozzle. A stack diameter of 27 inches at the choke would be a minimum requirement with the nozzle designed to fill the stack as in the present arrangement.

It is doubtful if the high capacity performance of the 4000 class locomotive with the double stack arrangement will be equaled with any single stack arrangement

Charles Shipman

Omaha - April 17, 1947

411-443-01

Mr. P. J. Lynch:

Referring to previous correspondence in connection with application of single smoke stack and Master Mechanics front end to locomotive 4007.

Attached is memorandum report submitted by Engineer Road Tests P. E. Flebbe and Charles Shipman, Asst. General Fuel Supervisor, covering observations and data obtained on various test runs made by this locomotive, for your information.

J. Gogerty

Union Pacific Railroad Company,
Research & Mechanical Standards

Memorandum Report Covering Performance Locomotive 4007
Equipped with Single Smoke Stack and
Master Mechanic Front End

Road test of locomotive 4007 equipped with single stack, Sweeney nozzle and master mechanic's front end arrangement.

Locomotive 4007 was equipped with a single stack, 24" in diameter at choke, 26-1/2" in diameter at top. For the first help, Cheyenne to Sherman, the Sweeney nozzle had a 6" diameter center plate giving a nozzle area of 50.4 sq. in.

On the first help March 20, 1947, Cheyenne to Sherman, locomotive 4007 was tight for steam, it being necessary to trade water for steam to maintain 220 psi boiler pressure. The draft had very little action on the fire and on arrival Sherman, fire was banked across the front of fire-box.

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On March 26, a 6-3/4" diameter center plate was applied to nozzle, reducing the area to 47.1 sq. in. On the help, Cheyenne to Sherman, locomotive steamed satisfactorily but not as free as desired. The fire burned better but banked badly in the right front corner of firebox. March 28, locomotive was dispatched West. Locomotive steamed and burned a good fire except for bank in right front corner. In order to maintain full boiler pressure, it was necessary to force fire, which caused some excess smoke. There was not sufficient steaming margin, and the average fireman would have had trouble getting over the road. Locomotive performance could not be considered good as 15 to 20 minutes longer was required over each district as compared with other 4000 class locomotives with comparable train. Locomotive's best performance was at approximately 16 psi back pressure. At higher back pressures, locomotive did not steam and at lower back pressures, performance fell off noticeably as indicated by loss of speed. One round trip, Ogden to Green River and return, was made with 6-3/4" center plate on nozzle. Steaming qualities were only fair and performance poor as indicated by time required to get over the road.

It was thought that a draft plate placed under table plate in front end would improve draft distribution in fire-box and give better control of fire so that banks could be eliminated at front of firebox. No improvement could be noticed and in fact the added resistance in front end appeared to increase the amount of smoke.

At Cheyenne, April 4, the draft plate was removed and a 7" center plate applied to nozzle, reducing the area to 46.0 sq. in. One round trip, Cheyenne to Laramie, and return, was made with no noticeable improvement in steaming quality or draft through fire. Maximum back pressure was increased slightly but locomotive performance was not improved.

It was then decided to modify the front end diaphragm by inserting a netting panel 12" wide and extending across the diaphragm. This opening was approximately on boiler centerline. One round trip, Cheyenne to Laramie, was made with this arrangement but there was no noticeable improvement in condition of fire or steaming quality.

As locomotive 4007 was not evaporating or using water at the high rates that the average 4000 class locomotive does, left injector performance was not satisfactory. This was because the water-exhaust steam ratio was out of balance due to high back pressures and low water rates. Size 18 tubes were therefore applied to bring the injector range closer to locomotive requirements. While locomotive was held for injector work, a 7-1/2" center plate was applied to exhaust nozzle reducing area to 43.4 square inches.

On April 9 locomotive 4007 was dispatched west. There was a noticeable improvement in steaming quality and fire was considerably better with no banks at any time. Grates were not touched on entire trip Cheyenne to Green River and fire was still in very good condition. Locomotive performance was about as on previous trips. Maximum back pressure was approximately 20 psi. With 7-1/2" center plate on exhaust nozzle, locomotive can be considered a free steamer and the average fireman would seldom have any trouble with firing.

The performance of locomotive 4007 with the present nozzle and stack arrangement indicates that the size nozzle required (43.4 sq. in.) for free steaming, reduces the performance characteristics of the locomotive considerably. This is shown by time required on the various territories. There will undoubtedly be some small saving in coal and water

but sufficient data has not been obtained to establish a definite figure. It is probable that because of lowered performance, enginemen will work higher back pressures than usual in an attempt to decrease running time. The net result will be even smaller fuel saving and possible frequent "non-steaming" reports.

Due to less draft and, therefore, lower firing rates and lower flue gas velocities, steam temperatures are from 50 to 100 degrees lower than on 4000 class locomotives previously tested. Lower superheat results in a direct loss in cylinder horsepower.

In order to improve the performance of locomotive 4007 to the point where it compares with the standard 4000 class locomotive, it will be necessary to increase the nozzle to a size comparable to the present 56.5 sq. in. To do this with the annular ported Sweeney nozzle will require a larger stack and a correspondingly larger outside diameter of the nozzle. A stack diameter of 27" at the choke would be a minimum requirement with the nozzle designed to fill the stack as in the present arrangement.

It is doubtful if the high capacity performance of the 4000 class locomotive with the double stack arrangement will be equaled with any single stack arrangement.

Attached is copy of tabulation showing water and coal consumption, running time and other data for runs outlined above.

P. E. Flebbe, Engr. Road Tests

Charles Shipman, Asst. Gen'l
Fuel Supervisor

April 15, 1947

UNION PACIFIC RAILROAD COMPANY

GENERAL PERFORMANCE LOCOMOTIVE 4007

NOTE:-

THESE FIGURES
HAVE NOT BEEN
CHECKED AND
ARE SUBJECT
TO CORREC-
TION.

	DATE 1947	LOADS	EMPTIES	TONS	LBS. TANK WATER	LBS. COAL	RUNNING TIME	LBS. COAL PER HR.	LBS. TANK WATER PER HR.	RATIO TANK WATER TO COAL	NO. STOPS	TERRITORY
	MARCH 28	0	98	2189	180875	38544	3 HR. 12 M.	12045	56523	4.69	2	CHEYENNE - LARAMIE
	MARCH 28	95	1	4259	416643	84279	7 HR. 48 M.	10805	53416	4.94	3	LARAMIE - GR. RIVER
	MARCH 29	82	5	4233	228392	49764	3 HR. 41 M.	13511	62007	4.59	1	GR. RIVER - EVANSTON
	MARCH 29	82	5	4233	78512	14728	2 HR. 9 M.	6850	36517	5.33	1	EVANSTON - OGDEN
	MARCH 31	89	5	4188	61325	-	1 HR. 57 M.	-	-	-	0	EVANSTON - OGDEN
	MARCH 31	89	5	4188	139638	33479	2 HR. 19 M.	14431	60189	4.17	1	GR. RIVER - CARTER
	MARCH 31	89	5	4188	186900	40601	3 HR. 49 M.	10629	48927	4.60	1	CARTER - OGDEN
HELPER 7005 TO WAHSATCH	MARCH 30	57	45	4587	242100	53070	3 HR. 34 M.	14866	67815	4.56	2	OGDEN - EVANSTON
	MARCH 30	56	42	4580	90425	18230	1 HR. 42 M.	10724	53191	4.96	0	EVANSTON - CARTER
6-3/4" CTR. PL.	APRIL 4	69	3	4176	126718	28596	2 HR. 33 M.	11214	49693	4.43	2	LARAMIE - CHEYENNE
6-3/4" CTR. PL.	APRIL 2	65	12	4376	144300	32131	2 HR. 55 M.	11017	49475	4.49	2	LARAMIE - CHEYENNE
7" CTR. PL.	APRIL 5	57	1	3668	126650	28111	2 HR. 41 M.	10476	47199	4.51	2	LARAMIE - CHEYENNE
7" CTR. PL.	APRIL 8	64	9	4637	148225	40538	3 HR. 21 M.	12101	44246	3.66	2	LARAMIE - CHEYENNE
HELPER 3978 TO SHERMAN	APRIL 5	79	1	3513	143932	34657	2 HR. 31 M.	13771	57193	4.15	1	CHEYENNE - LARAMIE
	APRIL 8	72	0	3420	106875	25269	2 HR. 2 M.	12428	52562	4.23	0	CHEYENNE - LARAMIE