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RMSF FLATCAR BRAKE AND SPACERCAR COUPLER DESIGN REPORT

MASTER

OCTOBER 1968

NERVA TEST OPERATIONS
Jackass Flats, Nevada

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NTO DESIGN REPORT

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October 18, 1968

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1.0

INTRODUCTION

This Design Report was prepared in response to two design requests from E-MAD Operations (Reference a). The first request was for design of a set of failsafe brakes to replace the RMSF Flatcar brakes and, in the process, furnish remote braking capability. The second request was for redesign of the spacercar coupler to eliminate unintentional decoupling. Both of these designs have been completed and are presented in this report.

During the return of Phoebus II and subsequent to completing this coupler redesign, another instance of unintentional decoupling developed. This decoupling precipitated a search for commercially available couplers. Three couplers were found and evaluated for use on the RMSF Flatcars. No attempt was made to evaluate these couplers for use on the test car. However, WANL-GSE was informed of the search and briefed on the coupler possibilities.

2.0 DESIGN DISCUSSION

2.1 BRAKES

2.1.1 Description

The RMSF Flatcar Brake Study resulted in a design which incorporated the basic hardware in the existing parking brake, but replaces the mechanically actuated bumper rod with a pneumatic cylinder. Pressurization of the pneumatic cylinder releases the brake by compressing the actuator spring and thus unloading the brake linkage. Figure 1 illustrates this concept.

Because of the configuration of the brake shoe hanger shown in Figure 2, these brakes are self assisting when the wheels turn in the counterclockwise direction (that is, the moment caused by the friction on the brake shoe adds to the spring imposed moment on the brake shoe hanger). Thus, the amount of braking effort is increased for a given spring load. The converse is true for the wheels turning in a clockwise direction. Therefore, the new set of brakes that were added to the front trucks were installed opposing the rear truck brakes so that the total brake effort will be equal regardless of the direction of car travel.

NOTE

The forward set of brakes were added as a part of this design.

2.1.2 Design Information

Design criteria as per NTO-M-22758:

- a. Speed (Max) - 10 MPH

RMSF FLAT CAR
BRAKE SCHEMATIC
FIG.1

BRAKE ASSEMBLY
FIG. 2

- b. Grade (Max) - 3.5%
- c. Load (Gross) - 100,000#
- d. Failsafe

2.1.3 Design Calculation Results

- a. Braking Effort (Max¹ - 13,440#_f)
(Min - 6,720#_f)
- b. Stopping Distance for 100,000# Car Released Down a
3.5% Grade at 10 MPH
Max - 105 feet
Min - 33.8 feet
- c. System Operating Pressures
Brakes Set - 0 PSIG
Brakes Released - 50 PSIG
Brakes clear of wheels by 1/16" - 70 PSIG

2.1.4 Cost Estimates

- a. To modify nine cars plus spares - \$27,000
- b. To modify each RMSF Flatcar - \$2,494

2.1.5 Drawings

- a. J-1011127 E-MAD RMSF Flatcar Assembly
- b. D1010574 Brake Shoe Hanger

¹Maximum and Minimum brake effort is based upon the conditions, dry rails, and one rail greased, respectively.

- c. F1011151-1 Push Rod
- d. F1011151-2 Guide Bracket
- e. F1011131-1 Screw Spring Adjustment
- f. F1011131-2 Locknut
- g. F1011131-3 Adaptor Plate
- h. F1011151-3 Load Pin

2.2 PNEUMATIC COUPLER

2.2.1 Description

As illustrated in Figure 3, the pneumatic coupler consists of a vertical plate mounted on the Flatcar and a remotely actuated seal holder mounted on the spacer car coupler. The seal is designed to be large enough to always cover an area on the vertical plate which will include the air line hole. When the pneumatic cylinder is pressurized, the seal holder will move forward and seal against the vertical plate, completing the air line connection.

2.2.2 Design Criteria

- a. Pneumatic connector must furnish air tight connection for 70 psi air supply line between the locomotive and flatcar.
- b. Pneumatic connector must have the following flexibility:

Fore & Aft	+ .125"
Vertical	+ .250"

FIG. 3

Horizontal	$\pm .250''$
Rotation	$\pm 12^\circ$

2.2.3 Design Results

- a. Cylinder operating pressure - 125 psi
- b. Pneumatic coupler flexibility

Fore & Aft	$\pm .50''$
Vertical	$\pm .375''$
Horizontal	$\pm .375''$
Rotation	$\pm 15^\circ$

2.2.4 Cost Estimates

- a. To modify each flatcar - \$75
- b. To modify each coupler - \$792
- c. To modify 9 cars and 3 couplers - \$3200

2.2.5 Drawings

- a. F1011316 RMSF Spacercar Pneumatic Line Coupler
- b. F1011327 Mount Bracket
- c. F1011326 Seal Mount Bracket
- d. D1011328 Base Plate
- e. D1011329 Seal - Block Cover
- f. D1011331 Seal Block

- g. D1011333 Nut
- h. D1011333 Ball

2.3 COUPLER MODIFICATIONS

2.3.1 Description

Two coupler modifications were requested and designed into the existing spacercar coupler.

The first was to change the coupler latch mechanism from electrical to pneumatic operation and to redesign the supporting hardware. Installation of the pneumatic cylinder made it possible to redesign the coupler latching spring. The original spring was too short to adequately load the latch mechanism, and the spring constant was too small to be effective. The spring length was increased by one inch and the constant was increased to 65#/in. This new spring positively loads the coupler latch mechanism to 65# in the latched condition. The pneumatic cylinder adds another 310# force to the coupler latching mechanism to positively hold it in the latched position.

The second modification was the addition of a locking mechanism to prevent the coupling dogs from moving after the coupling operation is complete. This is shown in Figure 4. In operation, the pneumatic cylinder moves the slide rod forward forcing the lock pin down into the path of the dog. When the slide rod is retracted, the lock pin retracts by means of the return spring.

2.3.2 Design Information

- a. Operating Pressure - 70-100 psi
- b. Total latching force on coupler - 375#

COUPLER DOG LOCKING MECHANISM
FIG. 4

2.3.3 Cost Estimates

- a. To modify each coupler - \$1600
- b. Couplers to be modified - 3
- c. Total coupler modification cost - \$4800

2.3.4 Drawings

- a. J1011162 E-MAD Spacercar Coupler Assembly
- b. D1011313 Spring
- c. F1011308 Wedge Block Assembly
- d. D1011163 Cylinder Support Bracket
- e. C1011132 Clevis
- f. D1011134 Actuating Lever
- g. D1011309 Actuating Bracket
- h. F1011170 Dust Cover
- i. D1010576 Coupler Dog Locking Mechanism

2.4 COMMERCIAL AUTOMATIC COUPLERS

2.4.1 Description

Three commercially available automatic couplers were located and evaluated for use at NRDS. These couplers are of the rigid coupler design and vary both in operation and cost. They do have in common; however, their

three basic functions; namely, mechanical coupling, pneumatic air line coupling and electrical coupling. Although the electrical coupling is not of interest at this time, it may be later and can easily be added on when required.

The three coupler manufacturers are:

Ohio Brass Company	Telephone: 419-522-7111
380 North Main Street	Contact: Mr. H. R. Carlson
Mansfield, Ohio	
Symington-Wayne Corporation	Telephone: 312-939-1280
332 S. Michigan Avenue	Contact: Robert Messimer
Chicago, Illinois	
Westinghouse Air Brake (WABCO)	Telephone: 412-271-1490
Wilmerding, Pennsylvania	Contact: Mr. Stan Tayer

The Ohio Brass Coupler and the Westinghouse Air Brake Coupler were observed in operation and evaluated for use at NRDS. The Symington Wayne Coupler was not observed, but is very similar to the Ohio Brass Coupler. Table I compares the three couplers. It shows that the Ohio Brass Company Form 27 Coupler would cost the least of the three automatic couplers and is the easiest to install.

The Form 27 coupler, shown in Figure 5, is a hook type coupler with integral draft gear. All of the flexibility of this coupler is supplied by the ball anchorage unit. A spring carrier unit holds the coupler in a neutral position while uncoupled. The hook portion of the coupler is released by means of a pneumatic cylinder for remote operation and by means of a lever for hand operation. Guide pins in the face of the coupler align the pneumatic seal faces and also prevent the coupler from decoupling due to side loads. The only two means of unhooking the coupler are stated above. Thus, this coupler can not decouple accidentally as has the existing coupler.

AUTOMATIC COUPLER COMPARISON TABLE

Manufacturer	Wabco N-2	Wabco N-2A	Ohio Brass	Symington Wayne 4" Automatic
Model #	(Short Shank)	(Long Shank)	Form 27	Coupler
Price (Each)	\$800.00	\$1150.00	\$550 - \$700	
Delivery Time	6 Mo.	6 Mo.	5 - 8 Mo.	
Draft Gear Type	Tripple Joint	Stiff Shank	Self Containing Ball Joint	Tripple Joint
Will Supply Evaluation Models	Yes	Yes	Negative	Yes
Date Available	2 Mo.	About One Week	None	November
Mechanical Information				
Weight	200#	400#	600#	
Maximum Draw Bar Pull	300,000#	300,000#	115,000#	170,000#
Maximum Load In Buff	Shear Bolt Go 115,000#	Shear Bolt Go 115,000#	Shear Bolts Go 115,000#	400,000#
Gathering Range Vertical	$\pm 4"$	$\pm 4"$	$\pm 2\frac{1}{2}"$	$\pm 3"$
Gathering Range Horizontal	$\pm 4"$	$\pm 4"$	$\pm 2\frac{1}{2}"$	$\pm 2 \frac{3}{8}"$
In Service With	1. Cleveland Transit System 2. New York Trans- portation Authority	Will Be used On United A/C Rapid Transit Train	1. Philadelphia Market-Frank- ford Subway- Elevated Line	1. Toronto Transit Commission 2. Will Go Into Service On Boston MBTA System Soon

TABLE 1

OHIO BRASS CO FORM 27
AUTOMATIC CAR COUPLER

FIG. 5

WABCO's N-2 automatic coupler shown in Figure 6, uses a notched prong to couple to the mating coupler. A spring loaded latch located inside the coupler falls into the notch in the prong during the coupling operation. The spring latch is released remotely by means of a pneumatic cylinder. There are no manual means of releasing this coupler. This coupler like the Form 27 coupler requires a positive signal to decouple.

The N-2 automatic car coupler can be purchased in either of two shank configurations. The short shank shown in Figure 6 is designed to be used with the 572951 draft gear also supplied by WABCO at a cost of \$840. This increases the total unit price of the N-2 coupler to \$1640. The WABCO N-2A automatic coupler has a long shank and would require some type of ball or universal anchorage. Total overall unit cost on this coupler is approximately \$1650.

The Symington Wayne 4" automatic car coupler shown in Figure 7 is a hook type coupler very similar to the Ohio Brass Form 27 coupler. Remote decoupling is again done by means of a pneumatic cylinder. Provisions are also made for manual release. Draft gear for the 4" coupler is similar to the WABCO N-2 coupler draft gear. Total unit price for the 4" coupler and draft gear is approximately \$2000.

2.4.2 Design Criteria

- a. Minimum Draw Bar Load - 50,000#
- b. Minimum Buff Load - 100,000#
- c. Method of Coupling - Automatic
- d. Method of Decoupling - Remote

WABCO N-2 AUTOMATIC CAR COUPLER

Fig. 6

SYMINGTON WAYNE
4 INCH
AUTOMATIC CAR COUPLER

FIG. 7

e. Must Provide Automatic Air Line Connection

f. Draft Gear Gathering Range

Vertical	<u>±</u> 1.0"
Horizontal	<u>±</u> 2.0"

2.4.3 Cost Estimates

The following cost estimates are based upon the modification of 9 RMSF flatcars, the spacercar and two locomotives.

Coupler Manufacturer & Model Number	Couplers On Both Ends Of RMSF Flatcars	Couplers One End Only
Ohio Brass - Form 27	\$14,700	\$8,400
WABCO - N-2 + Draft Gear	\$34,650	\$18,150
Symington Wayne - 4"	\$42,000	\$24,000

2.4.4 Evaluation

- All three couplers meet the design criteria.
- The Ohio Brass Company Form 27 Coupler would cost the least to purchase and install.
- Installation of any of the three couplers can be accomplished with a minimal of car modification. The Form 27 coupler would however be the easiest to install because of its integral draft gear and ball anchor design.

2.5 CONTROLS

2.5.1 Description

Controls will be required to operate the brakes, coupler release and the Pneumatic Coupler, if the commercial Coupler is not used. Each of these control systems will be handled as an individual entity. Brake control will be supplied by means of an electric remote pressure regulator. Increasing the air pressure to the brake cylinder will decrease brake effort. The brake control unit will have one three-position toggle switch which will be marked increase-off-decrease. Increase and decrease will refer to braking effort not to air pressure.

Location of the control system components will be as shown in Figure 8. The control box will be in the cab of the locomotive. The pressure regulator will be located on the spacer car down stream of the air receiver tank. Air for the brakes will be supplied to the receiver tank from the main air supply line on the spacer car.

2.5.2 Modified Coupler Controls

Modified coupler controls will be located as shown in Figure 9. The solenoid valves will be located on the spacer car in close proximity to the air receiver tank. Wires will be run from the solenoids to the relay box on the MCC or L - 3. The three-way switch which will control the coupler action will be located in the cab. Switch positions will be marked ready, couple and uncouple. In the ready position the dog lock mechanism will retract to free the coupler dogs during the coupling operation. In the couple position the pneumatic coupler cylinder will pressurize to connect the brake air line.

2520-

RMSF FLAT CAR BRAKE
PNEUMATIC & ELECTRICAL
SCHEMATIC

FIG. 8

RMSF SPACER CAR MODIFIED
COUPLER
PNEUMATIC & ELECTRICAL SCHEMATIC

FIG. 9

The dog locks will be extended and the coupler release cylinder will stay in the latched position. In the uncouple position the coupler release cylinder will pressurize and release the coupler main jaw. The dog locks will remain locked and the pneumatic coupler cylinder will pressurize and release the coupler main jaw. The dog locks will remain locked and the pneumatic coupler cylinder will depressurize breaking the airline to the RMSF Flatcar brakes.

The light (indicated in Figure 9) on the dog limit switch is devised to indicate that both dogs are in the normal position prior to turning the three-way switch to the couple position. These limit switches should be manually checked prior to remote coupling operations.

NOTE

Location of the relay box on the locomotive or MCC is not a requirement. If located on the spacercar, one relay box is all that would be required.

2.5.3 Commercial Coupler Controls

Commercial coupler controls will be installed as shown in Figure 10. Since there are no dog lock or pneumatic coupler cylinders the control is simplified to an ON-OFF switch which would be marked couple-uncouple.

In all control applications 100 psi air will be used to actuate cylinders. 28 VDC power supplied from the locomotive or MCC batteries will be used to operate the solenoids. In both cases 28 volt batteries are not available therefore center taps will have to be made into the existing batteries.

RMSF SPACER CAR - COMMERCIAL COUPLER

PNEUMATIC & ELECTRICAL SCHEMATIC

FIG. 10

2.5.4 Cost Estimates

a.	Remote Pressure Regulator and Control Plus Spares	\$1,500
b.	Electrical Controls	\$1,000
c.	Valves and Tubing	<u>\$ 500</u>
	Total	\$3,000

3.0 DESIGN SUMMARY

3.1 DESCRIPTION

- a. Brakes were designed for the RMSF Flatcars which use most of the components of the existing brakes. These brakes will add a minimum of 6720# of braking force to the locomotives brakes and automatically set if the car is released from the locomotive.
- b. A pneumatic coupler was designed to supply air from the locomotive to the flatcars for brake operations.
- c. The spacercar coupler was redesigned to release with air instead of with a solenoid. This change allows for positive latching of the coupler with the assistance of air pressure in addition to the redesigned latching spring. In addition, a set of dog locking devices were designed which prevent the coupler latching dogs from rotating after the coupler is latched.
- d. A vendor search revealed that there are at least three commercially available automatic couplers that are acceptable for use at NRDS. These couplers are in the rigid coupler class which is used on rapid transit and subway systems throughout the United States and Canada. Each coupler provides positive mechanical coupling plus air and electrical connectors.

3.2 COST

Cost for the entire brake and coupler package (based upon the use of the Ohio Brass Company Form -27 Coupler) is as follows:

- a. To modify brakes and couplers - \$38,000.
- b. To modify brakes and replace couplers with commercial couplers on both ends of flatcars - \$60,000.
- c. To modify brakes and replace couplers with commercial couplers on one end of each flat car - \$41,000.

3.3 RECOMMENDATIONS

Replacing the existing couplers with commercial automatic car couplers is highly recommended for the following reasons:

- a. The cost differential between modifying the existing couplers and replacing them with the Ohio Brass Company Form 27 Automatic Car Coupler is \$3,000 if couplers are added to only one end of each flat car. Because cars are parked and picked up in the same direction, couplers are required on only one end of each car.
- b. Reliability of the commercial coupler is higher than the existing NRDS coupler. The reliability of the modified NRDS coupler has yet to be proved. The reliability of the commercial coupler is proved in use daily.

REFERENCES

NTO-M-22758	D. Gray to P. Neal June 10, 1968 Subject: Design Criteria for Flat Car Brakes and Los Alamos Couplers
ED-837 (Symington Wayne)	Maintenance Instructions and Parts List for Type RT-101 Tight Lock Coupling Waugh Equipment Company Chicago, Illinois (Devision of Symington Wayne)
84491-1 (WABCO)	N-2A Automatic Car Coupler Assembly
Publication No. K-424 (Ohio Brass Company)	Air Operated Coupler Equipment - Form 27 Instructions and Replacement Parts

1968 OCT 25 AM 11 29

TO: D. Gray / S. Hilberg
FROM: P. E. Neal
SUBJECT: Transmittal of RMSF Flat Car Brake and Spacer Car Coupler Design Report
DATE: 23 October 1968
NTO-22419
CEF:omg
DISTRIBUTION: SNPO/NRDS: RLBeeston, BJBillings, CRHoward
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NTO: LLClarke, CADeLorenzo, CEFuchs, WRKazor, BTKlem, WRMorris, WDWayne, File (3)

Reference: (a) Memo NTO-M-22758 from D Gray to PE Neal, dtd 6-10-68, Subj: Design Criteria for Flat Car Brakes and Los Alamos Couplers
(b) Memo NTO-M-25204 from H Silver to MG Theo, dtd 6-14-68, Subj: Transmittal of RMSF Flatcar and Spacer Car Coupler Assembly Drawings
Enclosure: (1) RMSF Flat Car Brake and Spacer Car Coupler Design Report, NTO-R-160

The attached design report, NTO-R-160, is forwarded to you to support discussions with the Customer relative to installing remote actuated brakes on the RMSF flat cars and replacing the existing automatic car coupler with a commercial coupler.

Some additional redesign will be required to fit the commercial couplers into the flat cars. This redesign is minor however and can be accomplished in about two weeks. A space study is presently in progress to define the method of mounting this coupler.

The commercial couplers will also fit the NRX type test cars after minor modifications have been made. This will also allow pneumatic brakes to be designed for the test cars. Although test car brakes were not a consideration

in NTO-M-22758, they are a natural add-on if a commercial automatic car coupler is accepted for use on the RTS system. The present test car brakes have been notably deficient in longevity, failing to operate after two or three applications.

Detail and assembly drawings of the RMSF flat car brakes have been forwarded to you under separate cover. The drawings for the modified coupler and pneumatic airline coupler are complete, but will not be released until a decision has been made on the recommendation of the attached report.

P. E. Neal, Manager
Technical Support

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