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Truck Design Optimization Project Phase II

Wear Data Collection Program Report-Volume I

Wyle Laboratories
Scientific Services
& Systems Group

Colorado Operations
4620 Edison Avenue
Colorado Springs,
Colorado 80915

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G. B. Bakken
C. W. Jones
W. R. Schmidt

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G. B. Bakken, C. W. Jones, and W. R. Schmidt

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16. Abstract
This program is part of the field studies conducted during the TDOP Phase II Project. TDOP is designed to examine the performance of various freight car truck designs with the objective of improving the efficiency and productivity of rail freight transportation. Maintenance and repair costs of truck components constitute an important factor in the cost-effectiveness of a particular truck design. In the program, Type I trucks (standard, three-piece trucks) and Type II trucks (trucks with design features which functionally change truck/carbody behavior) were placed in revenue service in unit coal trains. The objectives were to collect wear data, establish wear trends, evaluate various measurement techniques, develop a measurement schedule, and provide input to economic models. The plan, procedures, and data base description of the program are contained in Appendices A, B, and C, of Volume I. The trucks were periodically removed from service, disassembled, and measured for wear. Approximately 1,000 wear measurements were taken on each truck at each measurement interval. These measurements are contained in Volume II. for data up to ... miles.

~~these~~ trucks are ASF Ride etc....

vintage

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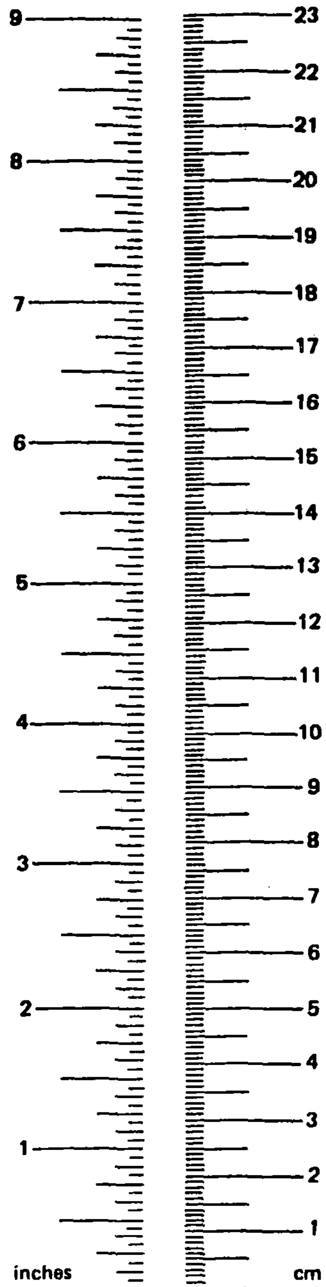
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

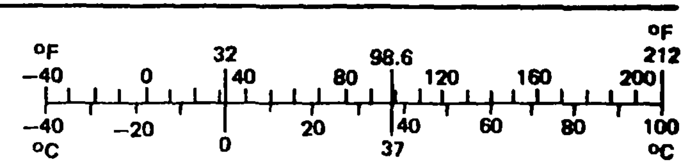
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286. Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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Executive Summary ?

SECTION 1 - INTRODUCTION

1.1 BACKGROUND

The Truck Design Optimization Project (TDOP) is a series of studies sponsored by the Federal Railroad Administration (FRA) to define and quantify the performance of freight car trucks. For the purpose of TDOP, a Type I truck is defined as a standard, three-piece freight car truck or its modified versions with basically similar configurations. The Type II (or premium) truck is defined as a truck whose design features bring about a functional difference in truck and carbody behavior. In Phase I of TDOP, standard, three-piece trucks were tested under a variety of track, carbody, load, and speed conditions. The goal of TDOP Phase II was to characterize the performance and cost-effectiveness of the Type II trucks with reference to the standard Type I trucks. This goal has been pursued through field testing, computer modeling, economic analysis, and engineering analysis.

This report describes the results of a study in the field testing area, the TDOP Wear Data Collection Program. In this program, the amount of wear on several trucks, both Type I and Type II, was measured at various mileage intervals. The objectives of the program were to:

- Collect wear data
- Establish wear trends
- Evaluate various measurement techniques
- Develop a measurement schedule
- Provide input to economic models

1.2 SCOPE

The trucks selected for the program have been in revenue service since April, 1979. The Type I trucks tested were the American Steel Foundries' (ASF) Ride Control truck, the Barber S-2 truck, and the Barber S-2 Heavy Duty truck with C-PEP (center plate extension pad). The three initial Type II trucks tested were the Dresser DR-1 Steering Assembly truck, the Barber-Scheffel truck, and the National Castings Swing Motion truck. Another Type II truck, the Devine-Scales truck, was added to the program in February of 1980 but was removed after 6 months because of the excessive repairs it required; these repairs are described in Section 3. The MTS Maxiride 100 truck (another Type II truck) was added to the program and placed in service in April, 1981.

The trucks were run under hopper cars in unit coal trains between coal mines in Utah and Colorado and a steel plant in California. The trains passed through Las Vegas, Nevada, where periodic wear measurements were taken at the Union Pacific's repair-in-place (RIP) track. Most of the service was on the Union Pacific's main line class 4 track, with curves of up to 10 degrees. The speed of these trains was up to 65 mph with an approximate average speed of 45 mph. Figure 1-1 shows the basic components of a typical freight car truck. Figures 1-2 through 1-9 show the trucks tested in the program.

1.3 REPORT ORGANIZATION

This report is organized into two volumes. Volume I includes the body of the report and three appendices that contain the wear data collection plan, procedure, and data base description. Volume II contains the computer printouts of the wear measurements; it is grouped into eight sections, corresponding to the eight trucks in the wear program.

1.4 ACKNOWLEDGEMENTS

The authors would like to acknowledge the generous assistance and support of the many people who contributed to this program. A particular debt is owed to Frank Bruner, Assistant Chief Mechanical Officer, Union Pacific Railroad; Charlie Johnson, UP's Director of Road Tests; Paul Rhine, of the Environmental Planning Department; Don Joy, General Car Foreman; and Mike Palipkonich, Derrick Foreman. The truck manufacturer's representatives that provided Wyle with the benefit of their expert knowledge included Garth Tennikait of American Steel Foundries; Nick Darien and Jerry Musolf of Standard Car Truck; Geoffrey Cope of Dresser Industries; Norm Morella of National Castings; Phil Connaught and Luigi Induni of MTS/Socimi; and Brian Scales representing The Devine Manufacturing Company.

The authors would also like to thank those members of Wyle's Colorado Springs staff who have contributed to and supported the project over the last three years, principally Edward Gadden, Everett Bates, David Gibson, Richard Peacock, and Robert Esquibel. Finally, this acknowledgement would be incomplete without mention of the continual support that Wyle Laboratories has received from the FRA's Office of Freight Systems, notably from Arne J. Bang, ~~former~~ Chief, Freight Services Division; and Dr. N. Thomas Tsai, the project's Contracting Officer's Technical Representative.

1. Brake Shoe
2. Wheel
3. Axle
4. Truck live lever
5. Brake Beam
6. Roller bearing adapter
7. Roller bearing end cap
8. End cap retaining bolt
9. End cap locking plate
10. Truck side frame
11. Truck spring
12. Truck bolster
13. Roller bearing assembly
14. Truck side bearing roller
15. Truck side bearing housing
16. Truck dead lever
17. Clevis at dead lever
18. Clevis at dead lever fulcrum
19. Dead lever ancor/underframe mounted
20. Center pin
21. Truck center plate cast integral with truck bolster

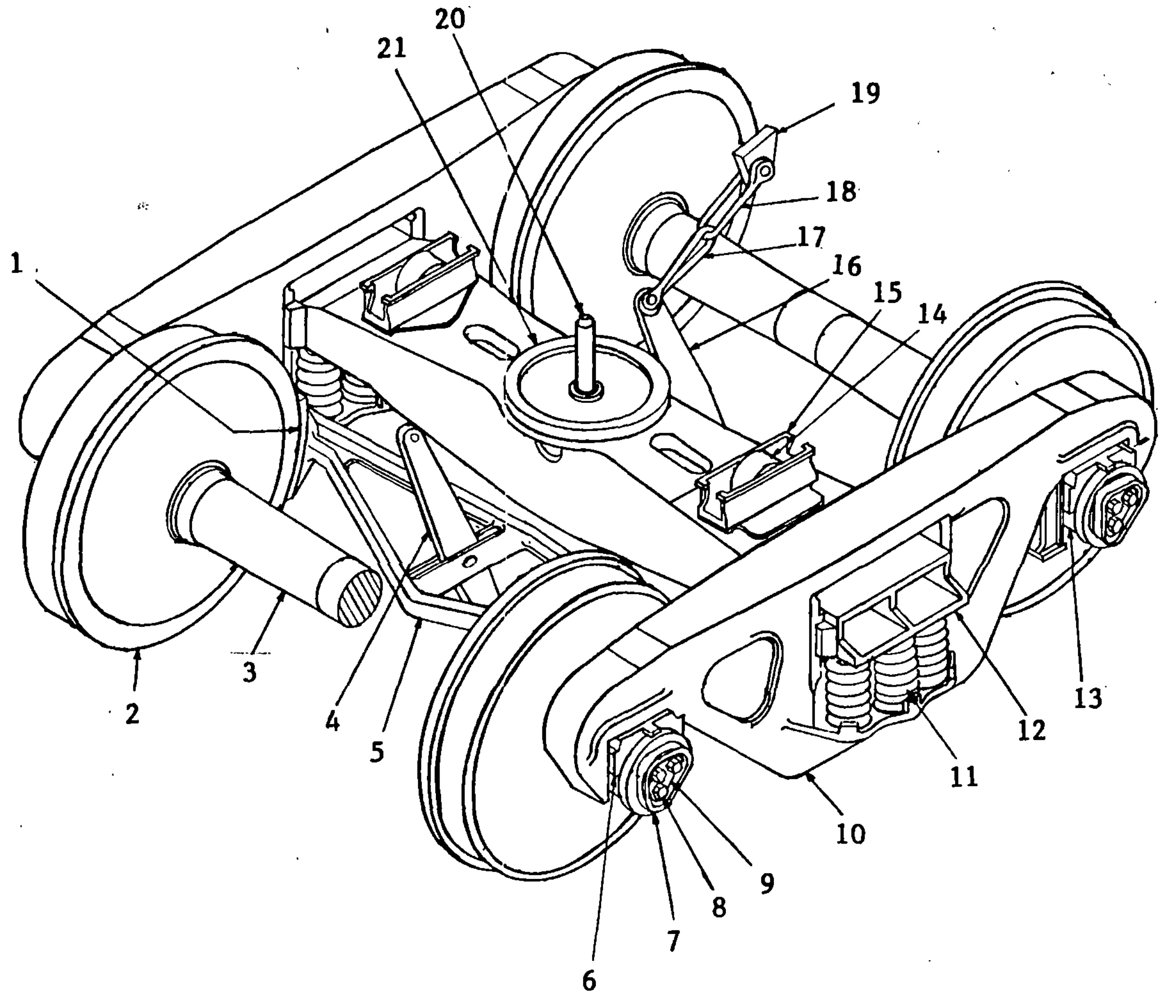


FIGURE 1-1. BASIC COMPONENTS OF TYPICAL FREIGHT CAR TRUCK

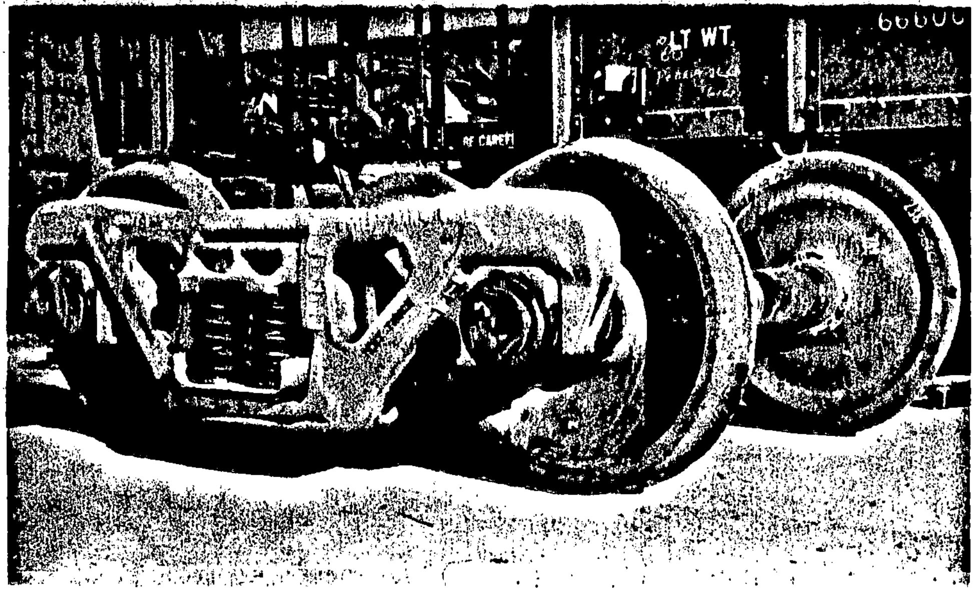


FIGURE 1-2. NATIONAL CASTINGS SWING MOTION TRUCK

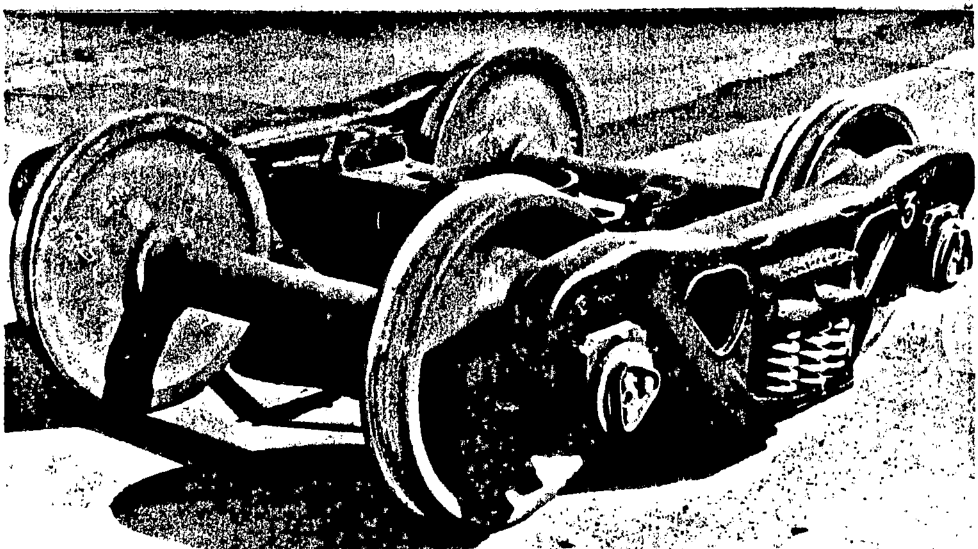


FIGURE 1-3. BARBER S-2 TRUCK

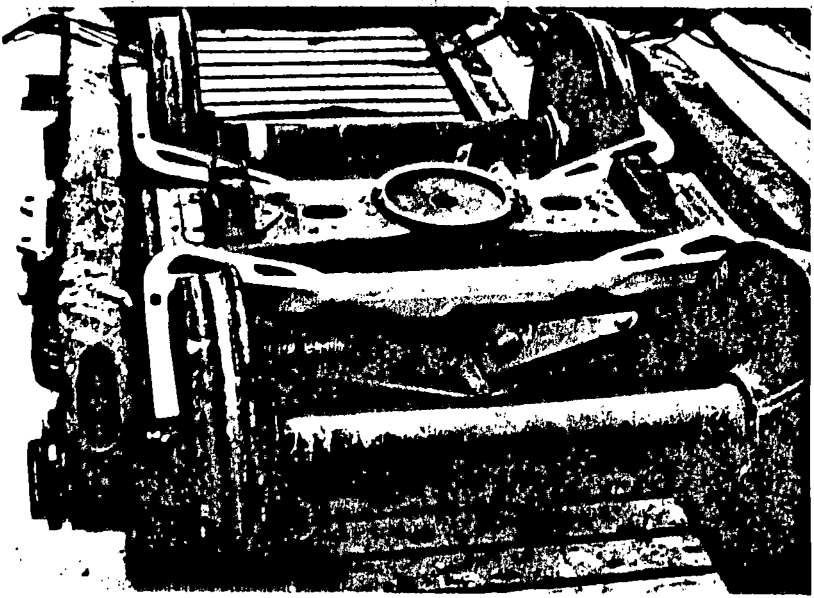


FIGURE 1-4. DRESSER DR-1 TRUCK

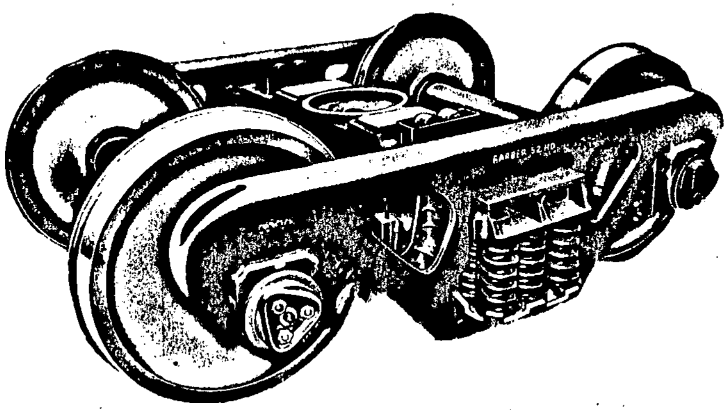


FIGURE 1-5. BARBER S-2 HEAVY DUTY TRUCK

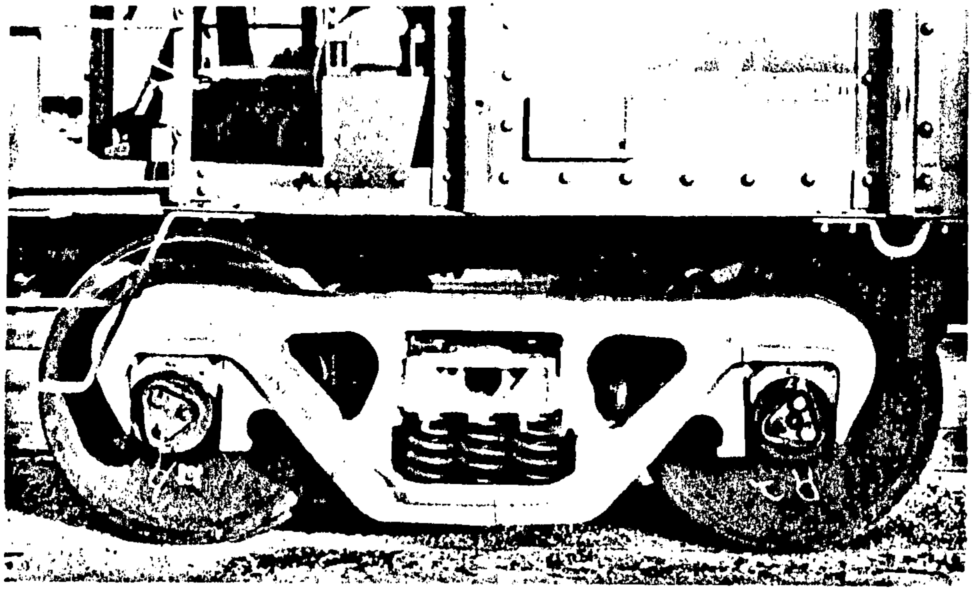


FIGURE 1-6. ASF RIDE CONTROL TRUCK

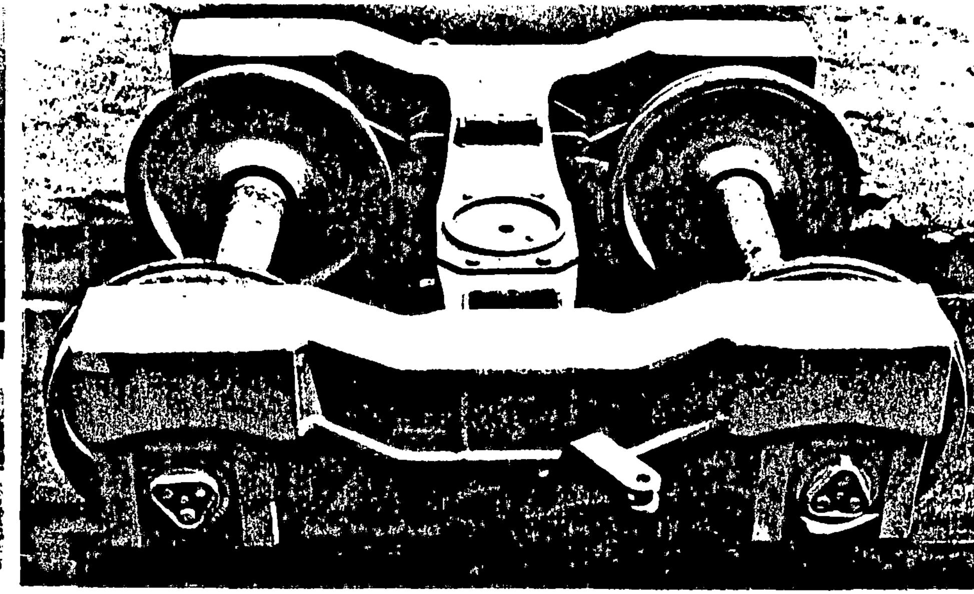


FIGURE 1-8. DEVINE-SCALES TRUCK

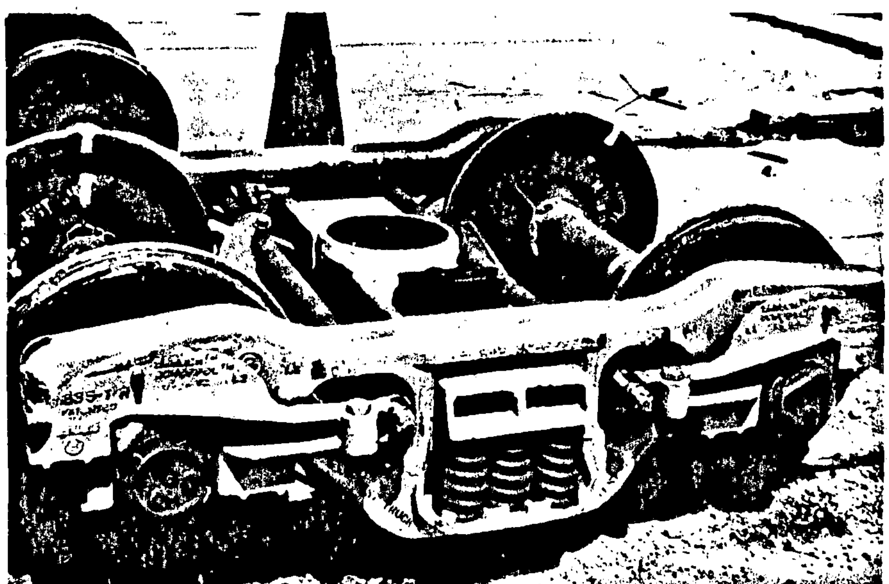


FIGURE 1-7. BARBER-SCHEFFEL TRUCK

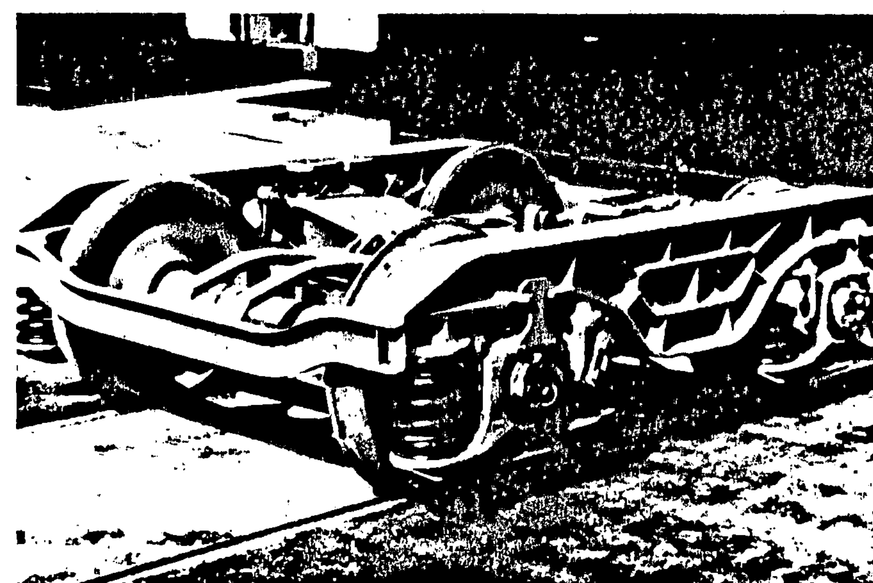


FIGURE 1-9. MAXIRIDE 100 TRUCK

SECTION 2 - PLAN AND PROCEDURE

2.1 PLAN

The planning document for the TDOP Wear Data Collection Program is contained in Appendix A. It called for obtaining and preparing the trucks for the program, taking initial, zero-mileage, measurements, and then following up with cyclic wear measurements every 12,500 miles of revenue service.

The program began in January, 1979, and was scheduled to conclude in September, 1980, with each truck having accumulated approximately 250,000 miles. However, because the trucks were being used in actual revenue service, several were rotated out of service for routine maintenance checks and were not promptly returned to the unit train, or they were routed to other locations by railroad personnel who were unaware that the trucks were in a test program. Other delays were caused by using the same ~~Type II~~ truck for both the wear program and the TDOP Phase II truck performance testing effort. Therefore, the goal of 250,000 miles has not yet been reached.

Table 2-1 shows the accumulated mileage for the trucks at the time of the last measurement cycle in January, 1981. These mileages range from about 31,000 to 131,000 miles except for the MTS Maxiride 100 truck, which entered the program only recently. The trucks will remain in service as the program continues, under FRA sponsorship, to the 250,000-mile point. The dates and approximate mileages at which wear was measured on each truck are shown in Table 2-2.

2.2 PROCEDURE

The detailed procedures for the wear program, including instruments and equipment, truck preparation and identification, and initial and cyclic measurement techniques are contained in Appendix B.

2.2.1 Pre-Service Preparation

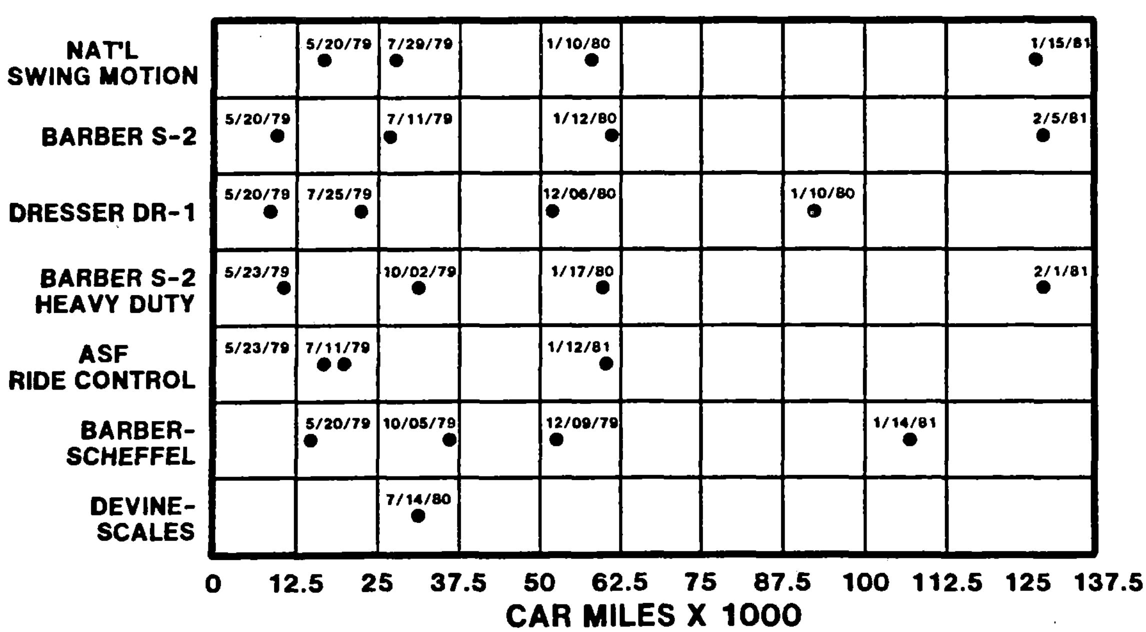
Prior to placing the trucks into revenue service, a number of pre-service tasks had to be performed to prepare the trucks. This preparation took approximately three months to complete. Before acceptance by a railroad of any truck type not previously approved for interchange service, permission had to be obtained from the three

TABLE 2-1. MILEAGE STATUS

TRUCK	DATE ENTERED SERVICE	MILEAGE LAST CYCLE
National Swing Motion (Car #001)	4-4-79	125,701
Barber S-2 (Car #002)	4-8-79	127,576
Dresser DR-1 (Car #003)	4-8-79	90,116
Barber S-2 Heavy Duty with C-PEP (Car #004)	4-4-79	131,493
ASF Ride Control (Car #005)	4-4-79	59,813
Barber-Scheffel (Car #006)	4-4-79	107,813
Devine-Scales (Car #007)	1-16-80	31,619*
MTS Maxiride 100 (Car #008)	4-17-81	N/A

* Removed from program in July, 1980.

TABLE 2-2. WEAR MEASUREMENT CYCLES



railroads (the Union Pacific, Atchison, Topeka & Santa Fe, and Denver & Rio Grande Western railroads) responsible for the unit coal train as it made round trips between Colorado (or Utah) and California.

Cars were selected from the Union Pacific's fleet; they were all 100-ton, self-clearing hopper cars, and each car was equipped with a remote control retainer valve and separate retainer air line in order to be acceptable for service in the unit coal trains. The carbody center plate on each was inspected and measured. Any center plate that showed an "out-of-circular" condition or other evidence of damage such as may have arisen from a broken vertical wear ring on the existing truck bolster (see Figure 2-1) was cause for rejection of the car for test purposes.

Each car in the program was identified with a placard in each corner. The side frames, bolsters, and all other substantive truck components were spray painted with aluminum paint before initial measurement and assembly. The words "test truck" were stenciled on each side frame and bolster, and the words "test wheels" were stenciled in at least four locations on each axle. The trucks and wheelsets also were marked with AAR location designations. The truck component identification markings, except for springs, were impression-stamped on non-wearing surfaces. Additionally, some truck components, such as friction castings, pedestal roofs, and center plate wear liners had to have indexing features designed for them for accurate wear measurements (see Figure 2-2).

Initial, or inventory, measurements were taken on the trucks; some 7,000 individual measurements in all, or about 1000 per truck. Truck components that were measured included wheels, brake shoes, bearing adapters, bolsters, and side frames. Measurement techniques included the use of ultrasonic thickness gages, micrometers, calipers, and depth gages with indexing features.

2.2.2 Data Collection

An example of the measurements taken is the truck bolster center plate liner and wear ring, accomplished with a template and an ultrasonic gage (see Figure 2-3). Eight wear ring thicknesses and twelve wear liner thicknesses were measured along the bolster longitudinal and lateral axles using the location template. The minimum

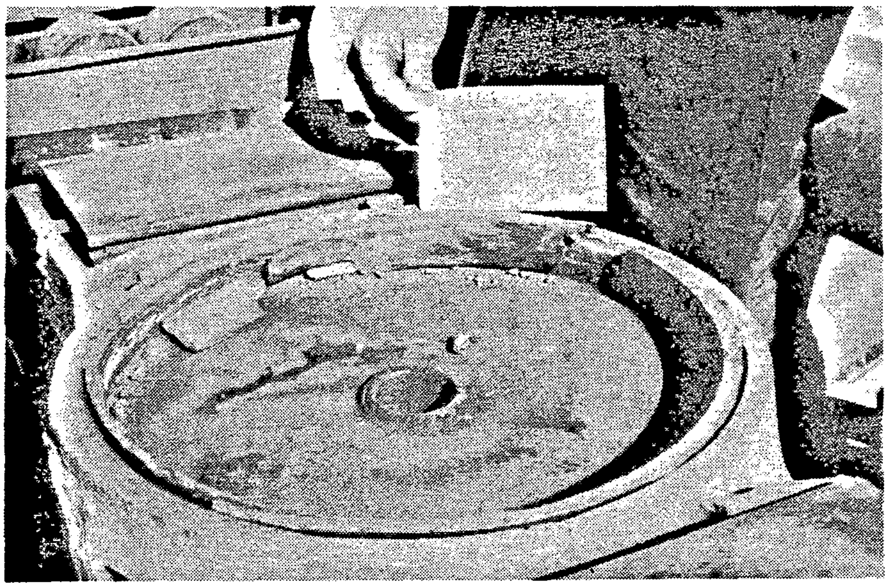


FIGURE 2-1. DAMAGED TRUCK WEAR RING

FIGURE 2-2. DIAL DEPTH GAGE USED WITH INDEXING FIXTURE

FIGURE 2-3. MEASUREMENT OF TRUCK BOLSTER CENTER PLATE LINER AND WEAR RING WITH INDEXING TEMPLATE AND ULTRASONIC GAGE

thickness of the wear ring was located to define the major wear axis. The angle was measured using the pointer and protractor disc on the template. The template was then rotated to align with the major wear axis and the eight ring and twelve liner thickness measurements were made with the ultrasonic gage.

Another measurement example is the relative height of the roller bearing adapter crown, measured with a dial depth gage in conjunction with a three-legged, "milk stool" indexing template (see Figure 2-4). Twelve measurements were taken on each of the adapters, six on the crown, and three on each lug lateral face.

Wheel profiles were taken along with precise tape line circumference readings and the front-to-front distance. The wheel tread width of both wheels was recorded and a magnetic clamping device and set screw fastening method was used on Pullman Standard's profilometer to ensure repeatable alignment of the profile tracing stylus on the wheel tread (see Figure 2-5). With the exception of the Barber-Scheffel, all the trucks in the program were equipped with AAR 1/20" profile wheels. The Barber-Scheffel truck used wheels with the Barber-Scheffel profile.

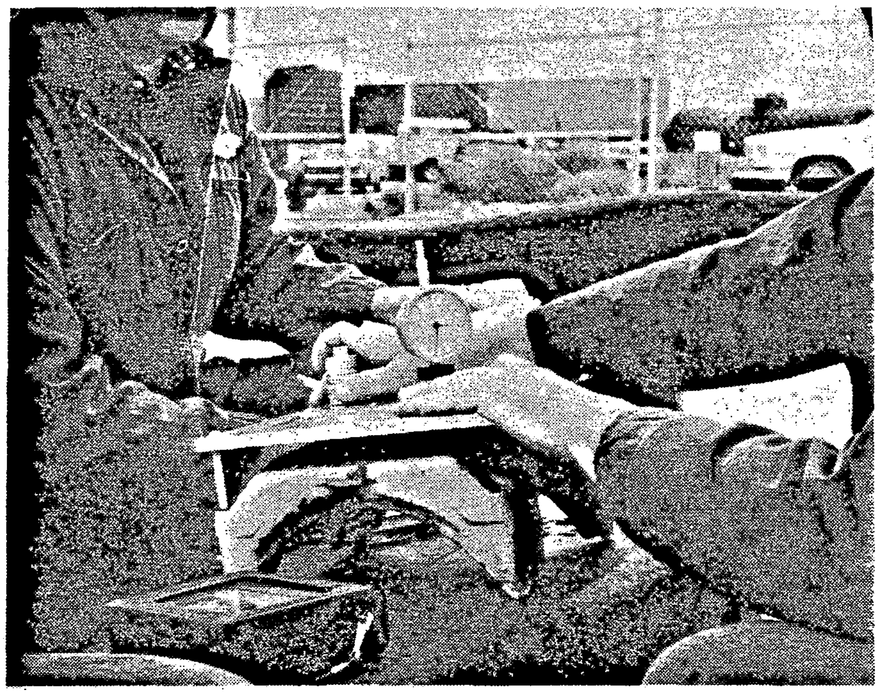


FIGURE 2-4. MEASUREMENT OF ROLLER BEARING ADAPTER CROWN USING DIAL DEPTH GAGE AND INDEXING TEMPLATE

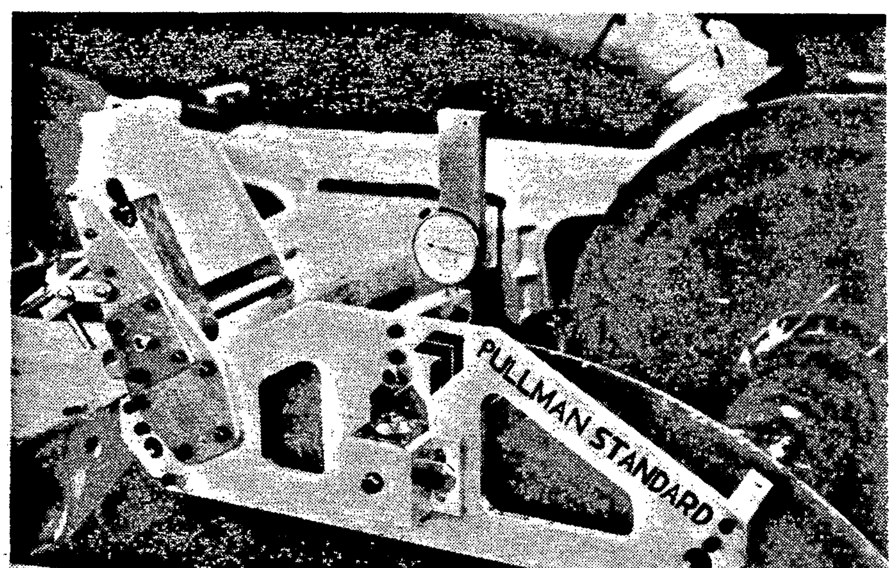


FIGURE 2-5. MEASUREMENT OF WHEEL PROFILE USING PULLMAN STANDARD PROFILOMETER

Special features of some trucks required additional measurements; for example, the outside diameter of the male portion of the pin and socket connection of the DR-1 steering arms. On the National Swing Motion truck, additional measurements included the transom and bolster stop, and the rocker seat and bearing thicknesses.

Measurements made with ultrasonic thickness gages, calipers, micrometers, depth gages, and feeler gages were recorded to a resolution of $\pm$ .001 inches. Measurements made using tape measures, scales, and AAR gages were recorded to the nearest graduation (e.g., 1/64 of an inch for wheel circumference). Weights, such as those for the bearing adapters and friction castings, were recorded to the nearest ounce.

The accuracy, resolution, and repeatability of each measurement was used to determine the number of times it was sampled during a measurement cycle. Initially, it was intended that a minimum of two samples of each measurement be taken. If the variation between the two measurements exceeded the stated measurement tolerance requirement (e.g., $\pm$ .005 inch), two additional measurements were to be taken at that measurement location. After gaining experience in taking the measurements, it was determined that only one sample was necessary in most cases, thereby reducing by half the amount of time required to measure a truck.

In addition to measurements, photographs of wear on truck components were taken periodically; any unusual damage or wear encountered was photographed. All data collected were stored in the TDOP wear data base and made available as input to the TDOP economic cost/benefit analysis of Type II truck designs. It should be noted, however, that the results of a study using one-car samples must be used with caution. The relatively loose tolerances used in manufacturing freight car trucks, combined with the peculiarities of captured unit train service, cause significant deviations from the wear trends one would expect under normal conditions.

2.2.3 Data Base

The data base for this program was developed with Wyle Laboratories' Interdata 8/32 computer using TOTAL as a data base management system (see Appendix C for a complete description of the data base). This system is ideal for the wear data in that it allows for both fixed data files (master files) and variable files. Through TOTAL, each variable wear data record is linked to each of five master files. This creates multiple access paths within the data base and allows wear data to be analyzed in a variety of ways. For example, first line analysis can readily be made of wear data along these major access paths:

- Car number/truck type
- Individual part number
- Component grouping,
- Part location on car, i.e., BL1,AR4
- Measurement cycle date/mileage
- Wheel wear on a specific car.

Inventory component change-out analysis can also be performed, such as: brake shoe replacement between dates 0179 to 0979, or wheel change-out on car number 003.

The TDOP wear data base can be used to provide quality assurance during the measurement program, and to provide data for detailed engineering analysis of rates of deterioration. Variance reports that listed previous measurements and the changes in these measurements aided the field team in comparing results. These reports were also used to flag possible measurement errors. In addition, inventory change-out reports indicating recent part replacements were generated to keep track of the current state of the program.

To fulfill the objective of providing data for engineering and economic analysis, several forms of graphical displays can be plotted. Changes in wear rates can be quantified through the use of standard statistical analysis methods and plotting the results in various ways. Examples of plots are comparative trend wear analysis plots and curve-fitting plots.

Under comparative trend wear analysis, single-curve plots can be used to compare wear measurements of selected components (i.e., bolster wear plates) between various truck types, and multi-curve plots can chart the wear on individual components (i.e., brake shoes) as a function of time or mileage.

The TDOP wear data base is designed to collect data from multiple sources by truck type, manufacturer, load capacity, operational classifications, curve-to-tangent ratios, mechanical wear, and repair and maintenance costs. Data from participating railroads, the Wear Data Collection Program, and the FAST (Facility for Accelerated Service Testing) Program are used. Fixed information such as truck type and manufacturer need be recorded only once in the master files of the data base. Variable data such as wear measurements, track characteristics, and maintenance hours can be entered in the variable files as appropriate.

SECTION 3 - RESULTS

Wear has been observed on most components of the six trucks that have accumulated an average of 100,000 miles. However, for the most part, dramatic wear has not been seen, which is understandable since trucks with this mileage accumulation are still considered relatively new. Measurement techniques and the relative worth of making specific measurements at various mileage intervals were evaluated. The data collected during the measurement program provided an input to the economic analysis to assist in determining if any difference in wear could be associated with the cost advantages or disadvantages of any particular truck design features.

3.1 WEAR TRENDS

Since each Type II truck is designed differently, it would not be meaningful to compare them as a group to Type I trucks as a group. However, comparisons of wear on similar components could be made among the trucks.

The truck wheels are among the first components to show wear. The amount of wear on the wheels of six of the test trucks as measured by flange width is shown for each truck in Table 3-1. A summary of truck wheel wear is shown in Table 3-2. Figures 3-1 through 3-7 show initial and final profiles for the wheels on each of the trucks.

TABLE 3-1. FLANGE WIDTH (INCHES) ON NEW AND WORN WHEELS*

Truck	New Wheels	Worn Wheels (After Approx. 100,000 Miles)	Difference (As Measured w/AAR Finger Gage)
National Swing Motion	1.45	1.28	-.17
ASF Ride Control	1.45	1.30***	-.15
Barber-Scheffel	1.47	1.42	-.05
Dresser DR-1	1.44	1.39	-.05
Barber S-2	1.44	1.29	-.15
Barber S-2 Heavy Duty	1.38**	1.28	-.10

* Average of R1, R2, L1, and L2 measurements

** Flange width at first cyclic measurement (12,306 miles) - data missing from inventory (zero-mileage) measurement

*** After approximately 60,000 miles

TABLE 3-2. SUMMARY OF TEST TRUCK WHEEL WEAR

TRUCK	TYPE	SERVICE MILES	AVERAGE CROSS-SECTIONAL AREA REMOVED FROM TREAD & FLANGE (SQ. INCHES)	AVERAGE CROSS-SECTIONAL AREA REMOVED FROM TREAD & FLANGE PER 10,000 MILES (SQ. INCHES)	AVERAGE DECREASE IN WHEEL RADIUS AT TAPING LINE (INCHES)	AVERAGE BEGINNING TAPE LINE CIRCUMFERENCE (INCHES)	NOTES
National Swing Motion	II	125,701	.339	.0269	.062	113.75	1
Barber S-2	I	100,094 (avg)	.373	.0374	.067	113.75	2
Dresser DR-1	II	90,116	.188	.0208	.057	113.80	1
Barber S-2 Heavy Duty	I	131,493	.275	.0209	.050	113.67	3
ASF Ride Control	I	59,813	.186	.0315	.027	113.68	1
Barber-Scheffel	II	92,709	.224	.024	.061	113.34	5
Devine-Scales	II	31,613	.192	.061	Unavailable	114.50	4

NOTES:

1. All original wheels continue in service.
2. Two wheelsets removed at 83,000 miles for shelled-out tread; one wheelset removed at 116,000 miles for grooved tread (with brake shoes not normal to car); one original wheelset continues in service.
3. All original wheels in service until Feb. 5, 1981; two wheels removed for causes not related to wheel wear (loose bearing seal backing rings) and replaced with new wheels for service continuation.
4. Truck removed from program after 31,613 miles.
5. Hardened wheels used for first 15,104 miles, then changed over to Class "U" wheels.
6. All wheels are Class "U" untreated cast steel, CJ36 (two wear type) for freight service, except Barber-Scheffel wheels which are Class "U" untreated cast steel (two wear type), with special profile.

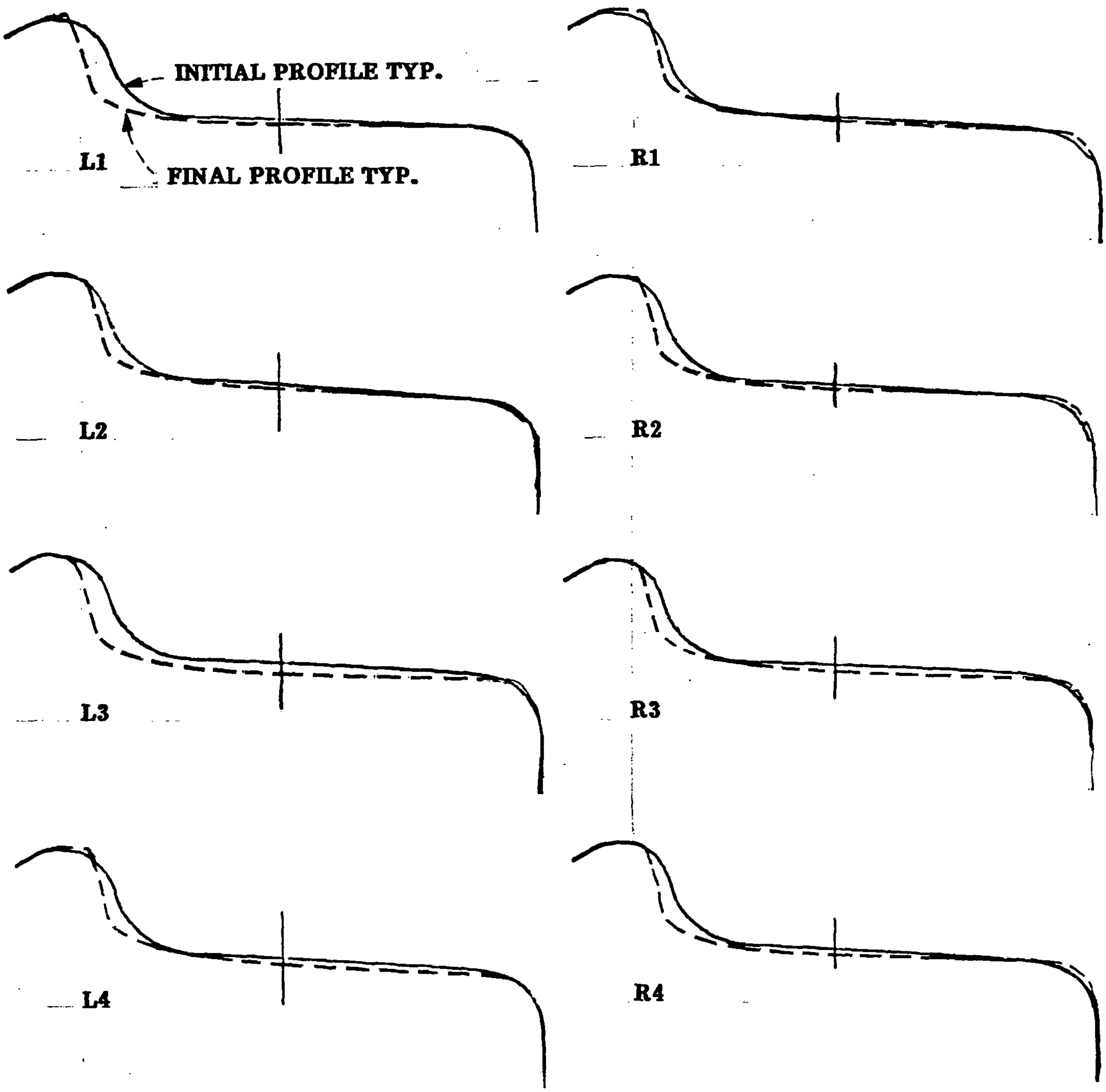


FIGURE 3-1. WHEEL PROFILE HISTORY - NATIONAL SWING MOTION TRUCK UP TO 125,701 MILES

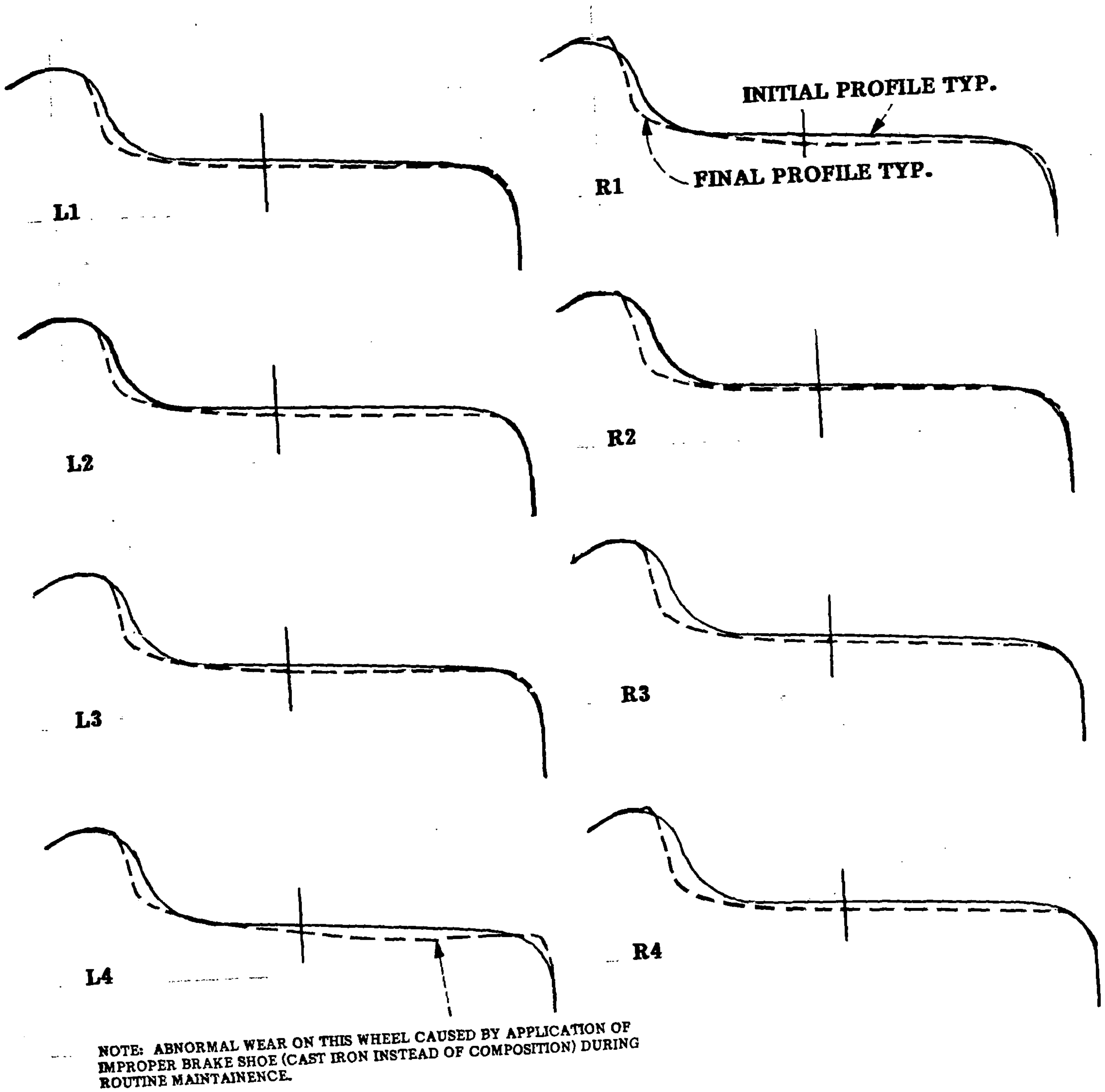


FIGURE 3-2. WHEEL PROFILE HISTORY - BARBER S-2-C TRUCK UP TO 100,094 MILES

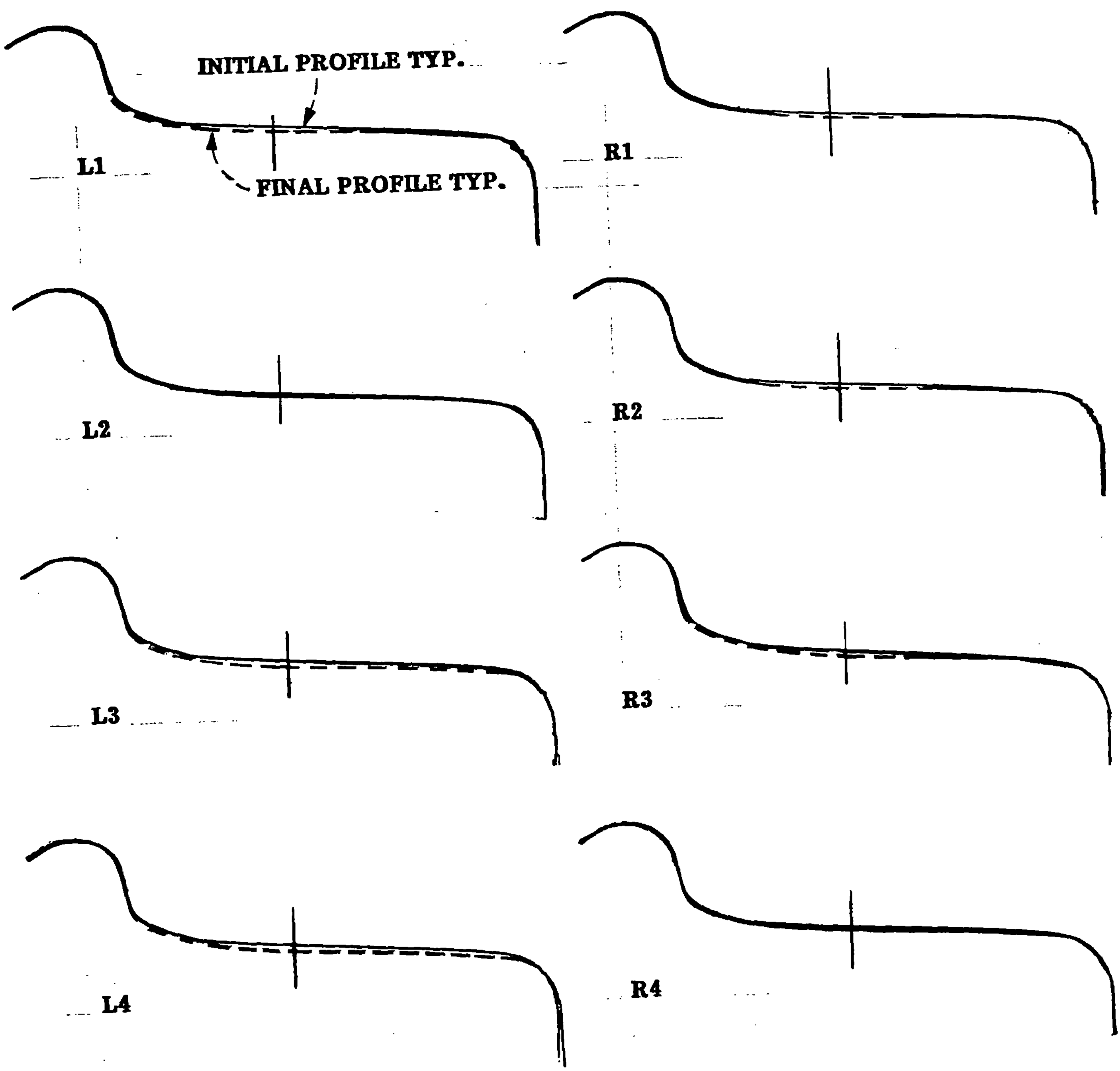


FIGURE 3-3. WHEEL PROFILE HISTORY - DRESSER DR-1 TRUCK UP TO 90,116 MILES

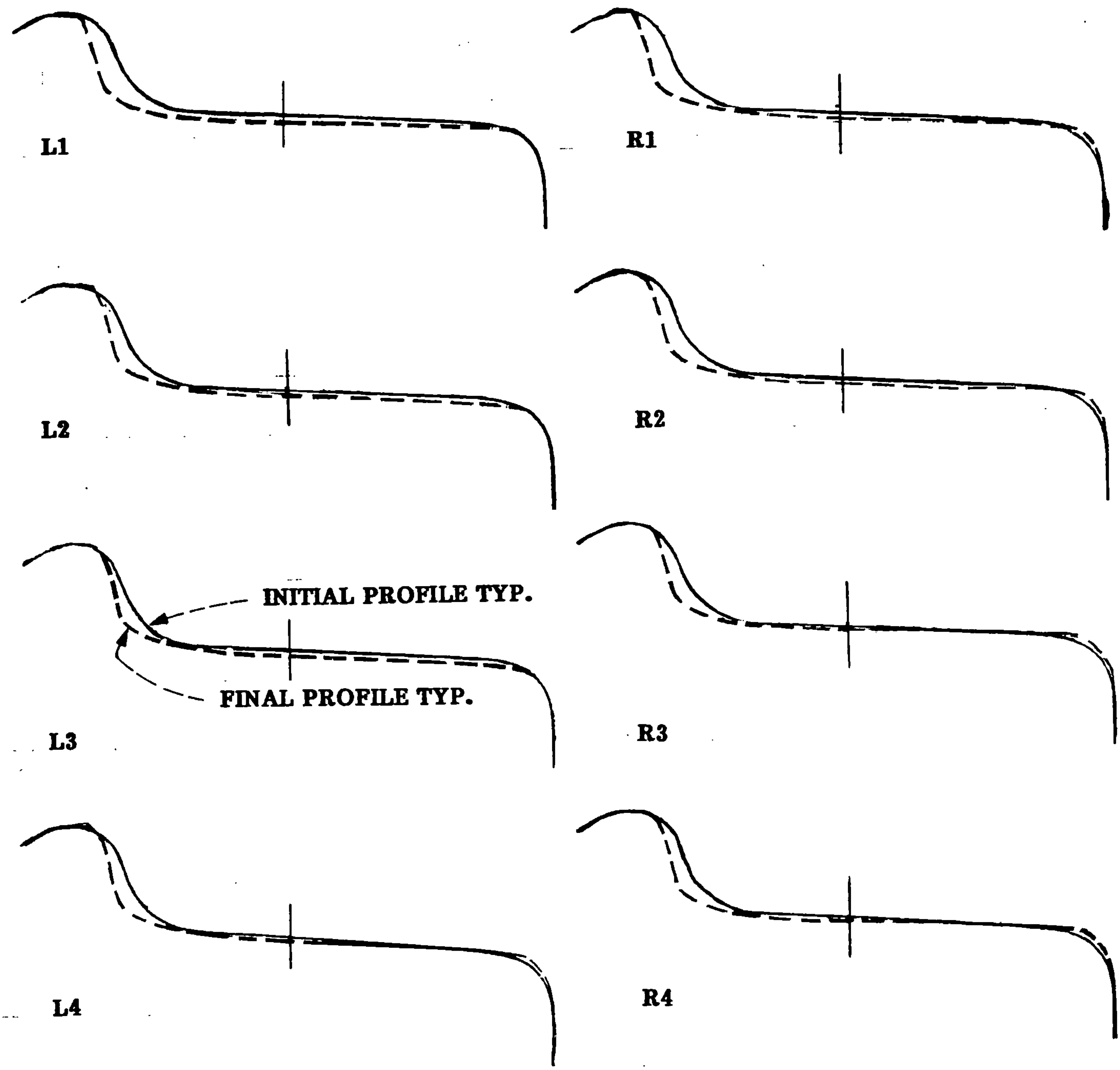


FIGURE 3-4. WHEEL PROFILE HISTORY - BARBER S-2 HEAVY DUTY TRUCK WITH C-PEP UP TO 131,493 MILES

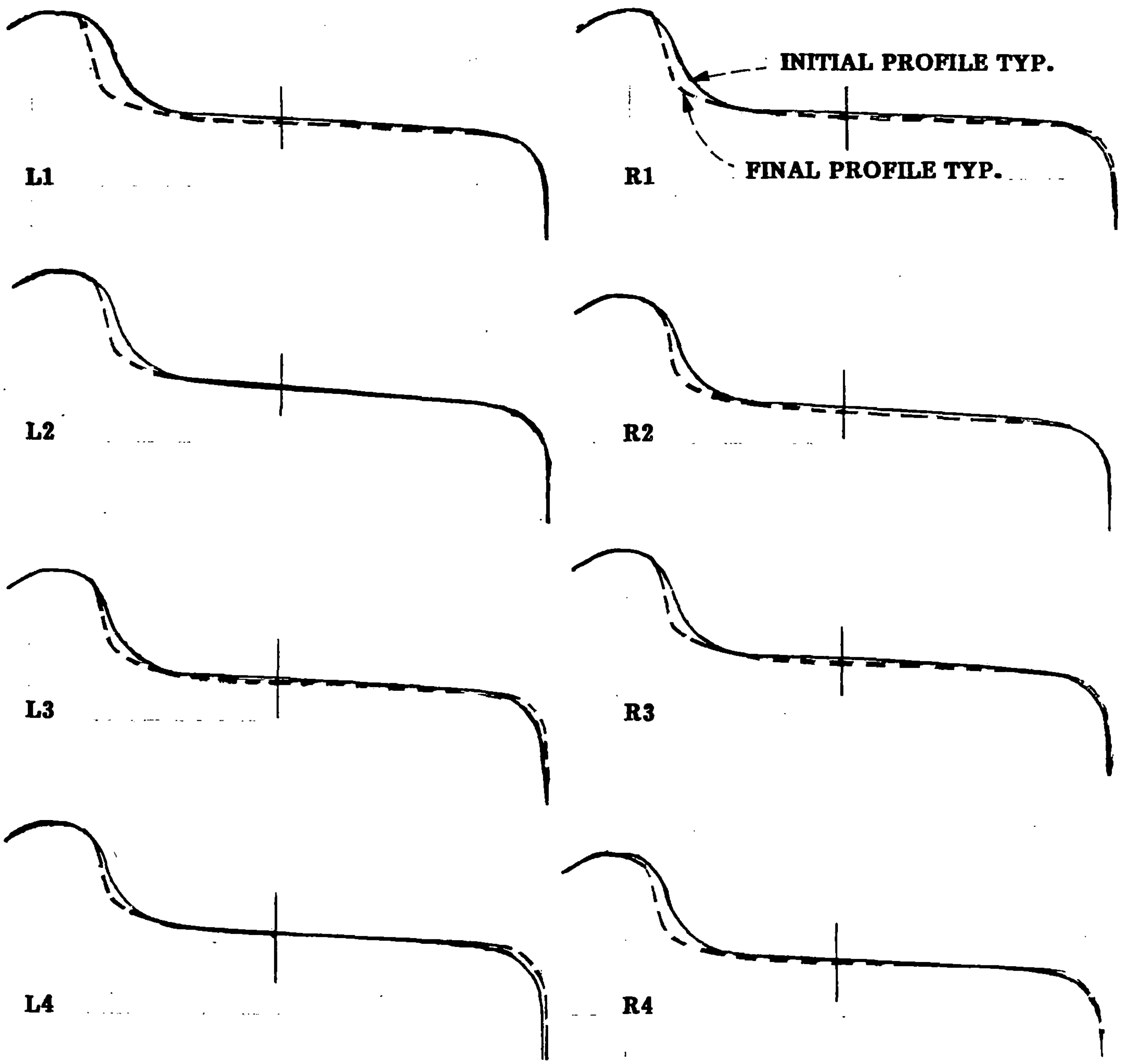


FIGURE 3-5. WHEEL PROFILE HISTORY - ASF RIDE CONTROL TRUCK UP TO 59,813 MILES

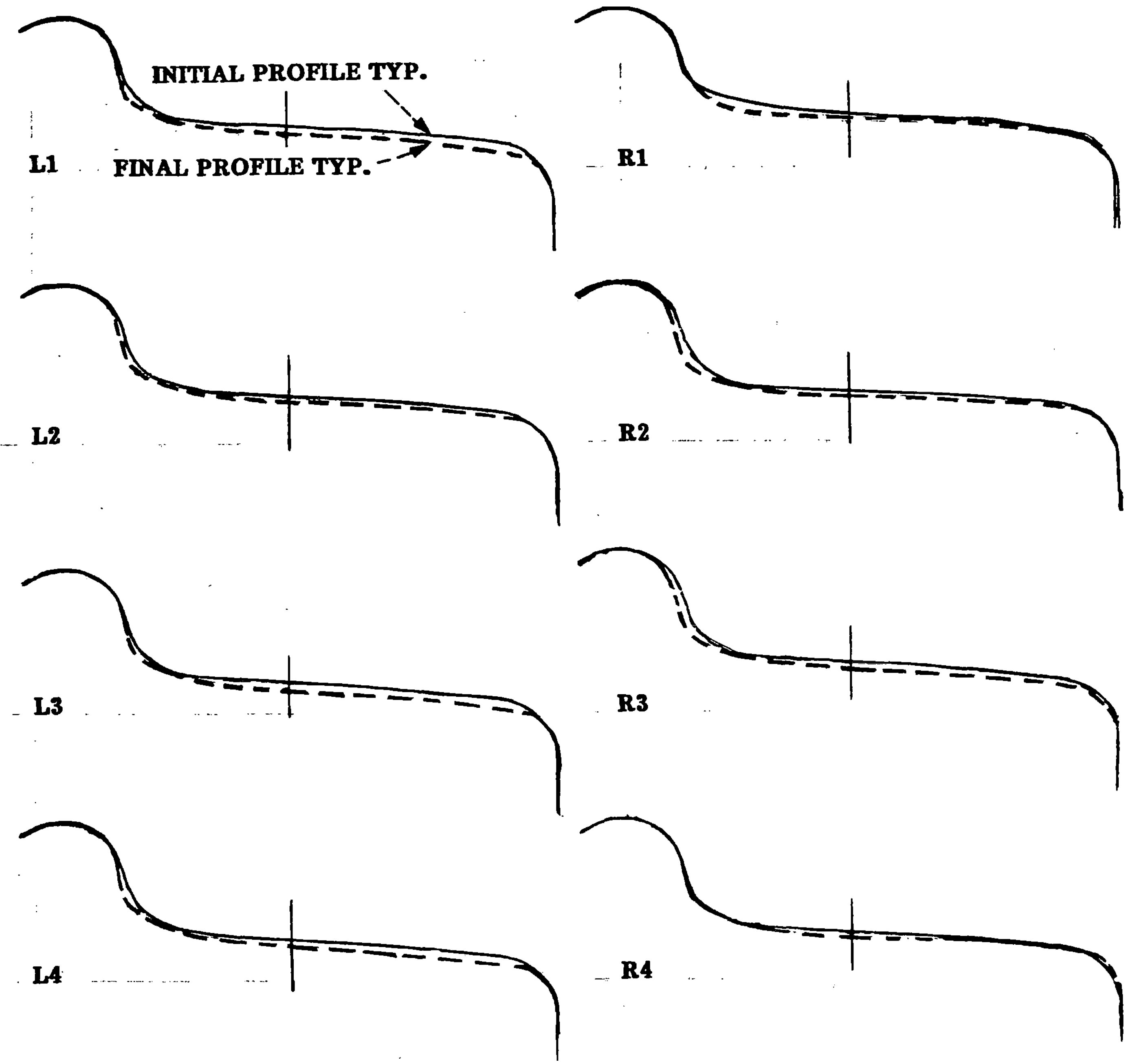


FIGURE 3-6. WHEEL PROFILE HISTORY - BARBER-SCHEFFEL TRUCK UP TO 92,709 MILES

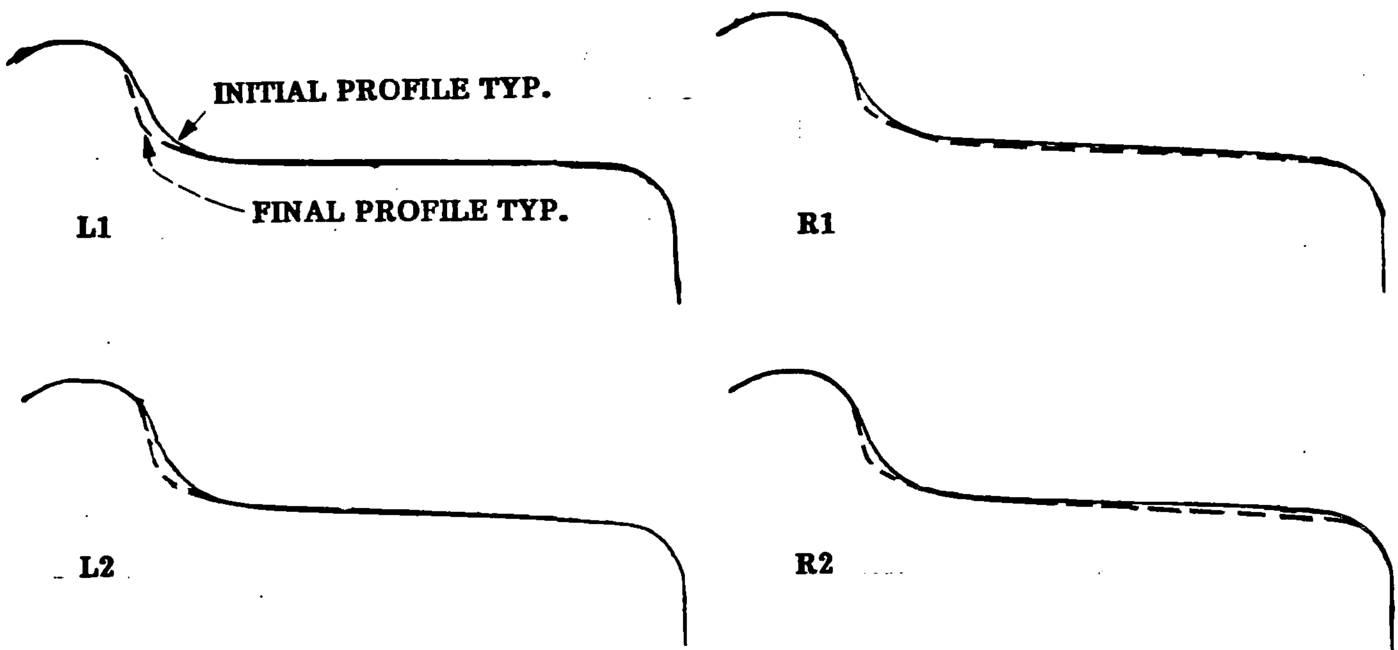


FIGURE 3-7. WHEEL PROFILE HISTORY - DEVINE-SCALES TRUCK UP TO 31,613 MILES

Other components showing noticeable wear are the bolster gibs, side frame column wear plate, friction castings, and bearing adapters. The 1,100 measurements taken at each cycle are given in detail in Volume II of this report. For assistance in using Volume II, see Table 3-3 which lists each type of measurement taken and indicates whether the measurements increase or decrease with wear (e.g., when two points on the same part wear away from each other, the intervening distance increases). The table also shows the code used on the computer printout to identify the various measurements in Volume II. In a few cases, data are missing from the printouts, especially in the early measurement cycles when malfunctions were discovered in some of the measurement fixtures.

The following paragraphs give a summary of the wear observed on each truck during the program. Generally these comments address wear on components which are common to all the trucks. However, some of the unique design features of each Type II truck were measured (see the listing under "Special Measurements" in Table 3-3). The measurements to date in the program are not considered sufficient to determine life cycle wear of the components.

The wear patterns described below are the result of approximately 100,000 miles of service. These trucks, when compared to the trucks under most revenue service cars, have incurred insignificant degradation. The trends which have appeared to date are most likely representative of the break-in period rather than long-term wear. Several more years of service will be required before accurate evaluation of component life can be made.

3.1.1 National Castings Swing Motion Truck (Figure 1-2)

a. The bolster-to-side frame interface (analogous to the anti-rotation lug face surface of a Type I truck) wore only about one-third as fast as other trucks with conventional lugs.

b. Wheel wear fell between a conventional Type I and a steering truck (see Table 3-2).

c. Upon initial installation of the trucks, a pedestal jaw to jaw spacing mismatch occurred (ref. pg. D-20-1969 of the AAR Manual of Standards and Recommended Practices). Both trucks have side frames mismatched in

TABLE 3-3. TDOP WEAR MEASUREMENTS (SHEET 1 OF 3)

Code*	Truck Bolsters	Per Car Cyclic	Per Car Invt'y Only	To Show Wear, Measurements Correctly Read:
EJ0000	Wear ring thickness 8 pts truck axes + 45° axes	16		Decreasing
EJ0000	Horizontal wear liner thickness 24 pts (removable wear liner)	48		Decreasing
FG1000	Center plate horiz. surface relative height 24 pts	24		Increasing
FG0000	Center plate diameter		2	————
FF0000	Gib thickness 3 pts/gib	48		Decreasing
FF0000	Column width (between gib lat. faces) 3 pts/gib pair	24		Decreasing
FF3000	Inboard gib spacing (between long. faces) 2 pts/gib pair	8		Decreasing
FF3000	Column spacing (between long. faces) 2 pts adj. to inbd. gibs	8		Decreasing
FF3000	Column spacing (between long. faces) 2 pts adj. to outbd. gibs	8		Decreasing
	Truck Side Frames			
FJ0000	Pedestal lug thickness (perpendicular to long. faces) 3 pts/lug	48		Increasing
FJ1000	Pedestal lug width (across lat. faces) 1 pt/lug	16		Decreaisng
FJ1000	Pedestal lug spacing (between long. faces) 1 pt/lug pair	8		Increasing
FJ1000	Pedestal jaw spacing (at brg. contact pt) 1 pt	8		Increasing
FJ0000	Pedestal roof thickness 6 pts/roof	48		Increasing
FK0000	Wear plate thickness 9 pts/wear plate	72		Decreasing
FJ0000	Anti-rotation lug thickness 3 pts/lug	24		Decreasing
FJ2000	Anti-rotation lug spacing (between long. faces) 3 pts/lug pair	12		Increasing
FJ3000	Column spacing (between wear plates) 6 pts/side frame		24	————
FJ0000	Column width 6 pts/side frame	24		Decreasing

* Component code to identify readings within data listing. Refer to Volume II for complete car records.

TABLE 3-3. TDOP WEAR MEASUREMENTS (SHEET 2 OF 3)

Code*	Truck Components	Per Car Cylic	Per Car Invt'y Only	To Show Wear, Measurements Correctly Read:
BE0000	Brake shoe thickness 12 pts/shoe	96		Decreasing
BE0000	Brake shoe weight	8		Decreasing
FB0000	Side bearing roller diameter 4 pts/roller	32		Decreasing
FB0000	Side bearing cage base thickness 1 pt/roller	8		Decreasing
FM4000 Outer FM5000 Inner	Spring squareness 4 pts/spring		256	———
FM3000 Load FM6000 Side	Spring free length 1 pt/spring			
EY0000	Bearing adapter long. stop relative thickness 2 pts/adapter	16		Increasing
EY0000	Bearing adapter lug thickness (across lateral faces) 1 pt/lug	32		Increasing
EY0000	Bearing adapter crown height (thickness) 6 pts/adapter	48		Increasing
EY0000	Bearing adapter weight	8		Decreasing
EN0000	Friction casting vertical face thickness 9 pts/casting	72		Increasing (except ASF)
EN0000	Friction casting sloping face thickness 6-9 pts/casting	72		Increasing
EN0000	Friction casting weight	8		Decreasing
	Wheels and Wheelsets			
N/A	Wheel profile (profilometer) 2 pts/wheel	16		———
FN0000	Rim thickness (AAR gage) 2 pts/wheel	16		Decreasing
FN0000	Flange height (AAR gage) 2 pts/wheel	16		Increasing
FN0000	Flange width (AAR gage) 2 pts/wheel	16		Decreasing
FN0000	Tread thickness (micrometer)	16		Decreasing
FN0000	Wheel circumference at tape line (AAR gage)	8		Decreasing
FN1000	Wheel outside-to-outside distance 2 pts/wheelset	8		Decreasing

* Component code to identify readings within data listing. Refer to Volume II for complete car records.

** Not in Volume II, see body of report for description.

TABLE 3-3. TDOP WEAR MEASUREMENTS (SHEET 3 OF 3)

Code**	Carbody (Removed from Trucks)	Per Car Cyclic	Per Car Invt'y Only	To Show Wear, Measurements Correctly Read:
FV0000	Center plate diameters 8 pts, car axes and diagonal axes	16		Decreasing
FV0000	Center plate diameters 2 pts, wear axes	4		Decreasing
FV0000	Angle of minor axis		2	————
FW0000	Side bearing wear plate thickness 2 pts/plate	8		Decreasing
	Special Measurements			
	National Swing Motion Truck:			
ZC0000	Rocker seat trunnion thickness 2 pts/trunnion	8		Decreasing
ZC0000	Rocker seat bearing thickness 2 pts/bearing	8		Decreasing
ZC0000	Bolster lateral stop thickness (replaces gib thickness) 3 pts/stop	4		Decreasing
ZC0000	Transom stop thickness (replaces side frame column width) 3 pts/stop	4		Decreasing
	Barber S-2 C-PEP Truck:			
FZ2000	C-PEP free height 2 pts/C-PEP	8		Decreasing
FZ2000	C-PEP compressed height 2 pts/C-PEP	8		Decreasing
	Dresser DR-1 Truck:			
ZC1000	Steering arm shaft diameter 4 pts/shaft	8		Decreasing
ZC1000	Steering arm bushing diameter 4 pts/bushing	8		Increasing
ZC2000	Bearing adapter elastomeric pad height 2 pts/adapter	16		Decreasing
	Barber-Scheffel Truck:			
ZC3000	Elastomeric shear pad height 2 pts/pad	32		Decreasing

** Component code to identify readings within data listing. Refer to Volume II for complete car records.

length by approximately .075 inches, which is within allowable tolerances for mated side frame pairs. Both longer side frames were on the right hand side, being "4-button" frames as opposed to the shorter "3-button" frames used on the left. It is difficult to tell what effect this mismatch had upon the performance of the trucks. The manufacturer was advised of this situation, but since this condition is within AAR specifications, the decision was made not to switch side frames.

d. The pedestal jaw rocker castings had a tendency to fall out of their pockets when dismantling the truck. It was necessary to re-weld two of these items to secure them for reassembly.

3.1.2 Barber S-2 Truck (Figure 1-3)

a. This Type I truck behaved as might have been expected. It showed relatively high wear in the places where Type II trucks design features could be expected to extend component life. Wheels, bolster gibs, and side frame stop surfaces showed the most wear; friction castings and bearing adapters also wore relatively fast compared to the other trucks in the program.

   It must be noted, however, that three friction castings from a lot known by the manufacturer to be metallurgically inferior were installed in this truck at the R1, R2, and L3 positions. Two of the castings were replaced before 61,000 miles and the third will probably have to be changed out at the next measurement cycle. All three castings were marked with the foundry symbol and identical casting lot number of a production run that contained approximately one inferior casting for every 25 produced. As castings are replaced, care should be taken to ensure that more castings from this same lot number are not put into service. What the wear characteristics of the trucks would have been if the friction casting had not failed is unknown. It is probable that they were adversely affected to some extent. (This situation is an example of the difficulties of using a one-car sample as a statistical basis for wear pattern projections.)

b. Among the test trucks, wheel wear on this truck was relatively more significant (see Table 3-2).

3.1.3 Dresser DR-1 Truck (Figure 1-4)

a. This particular truck seem to improve wheel wear. However, visual inspection indicated that outboard lateral thrust lugs and longitudinal stop surfaces of the bearing adapters experienced higher than average wear, as did the mating pedestal jaw lug surfaces. Since the wear on the bearing adapter occurred just outside of the point where this parameter is measured, the data base does not accurately portray this condition. The pedestal jaws of the DR-1 are enlarged to allow greater axle movement for steering, which might account for the increased wear.

b. All outboard bolster gibs wore approximately twice as fast as other trucks. There is no readily apparent reason for the unusual gib wear. The wear patterns on this truck indicate that the side frames are being thrust outward and are reacting against the bearing adapters and outboard bolster gibs. The underlying cause of the force driving the side frames out is not known at this time; however, the only other interfaces with the side frames are the bottom of the spring group and the unit brake beam hangers. It seems reasonable that this wear is not caused by tramming or a dynamic mode since the wheels appear to be nearly new. This condition of the side frames being thrust outward may be present in the other trucks yet not appear as wear. The DR-1 is unique in that there is relative motion between the bearing adapters and the side frame as part of the design and any off balance lateral force would appear as wear.

c. Among the test trucks, wheel wear on this truck was relatively less.

3.1.4 Barber S-2 Heavy Duty With C-PEP (Figure 1-5)

a. There is no exceptional wear of a measurable quantity to report on this truck. Most of the wear occurred in an area that was not expected, i.e., friction casting side surfaces. Since these surfaces were not intended to be measured, no data are available to document this condition. It may, however, eventually affect the vertical and sloping face data, as they are indexed within their measurement fixture from one of the "non-wearing" side surfaces.

b. One maintenance difficulty noticed with the Barber S-2 Heavy Duty test truck was its tendency to shed its welded-on wear plates from the friction casting pockets of the bolster. This kind of problem is usually corrected by bolting on the plates in addition to edge-welding them; however, there is no provision for that technique to be used in the bolster pocket and, therefore, this problem is likely to continue.

c. Wheel wear patterns seemed rather favorable for a non-steering truck (see Table 3-2).

3.1.5 ASF Ride Control Truck (Figure 1-6)

a. All bolster-to-side frame interfaces seemed to wear about one-third faster than other trucks.

b. Wheel wear data is shown in Table 3-2.

3.1.6 Barber-Scheffel Truck (Figure 1-7)

a. Unusual wheel wear patterns on this truck were noted. All metal worn off or displaced from the tread was mainly from the tapered tread surface on the field side of the wheels indicating, perhaps, minimal flange contact (see Figure 3-6).

b. All four of the tubular cross struts between paired shear pad housings were replaced in the course of the program. These were not a measured item; hence, it was not recorded in the wear data base. Due to what was described as a manufacturing oversight, welds used to secure an end cap to the cross tube sheared off. Replacement members utilize an improved weld detail plus a plug weld through the tube wall to the cap; to date, none of these new cross struts have failed.

3.1.7 Devine-Scales Truck (Figure 1-8)

As noted in Section 1, the Devine-Scales truck was removed from the wear program because some components wore out exceedingly fast and were not able to withstand the shock loads from humping that occurred in switching and train assembly at each end of the coal train's run. The trucks were delivered to Las Vegas in July, 1979. However, it was not until February, 1980 that all of the correct parts were shipped to the RIP track in Las Vegas so that the trucks could enter service. They ran until June, 1980, at which time they were removed because of excessive wear on some components. The following list describes the parts which had to replaced.

Part(s)	Reason
1 frame	Improper manufacturing clearance between wheel and frame prevented assembly of truck
8 subframes	Excessive abrasive wear against saddles and friction blocks
8 brake beam hangers	Improper brake beam alignment
16 stainless steel pins	Broken welds to other components
16 brass bushings	Excessive plastic deformation
all plastic thrust bushings	Manufacturer's suggestion
2 side bearing pads	Excessive deformation around carbody side bearing plate rivets
32 subframe keeper bolts	Lost enroute due to stretched threads
1 side spring	Broken
8 brake shoes	Excessive uneven wear

In addition to the parts which have been replaced, the A-end frame had to be re-welded in places where cracks appeared.

3.2 EVALUATION OF MEASUREMENT TECHNIQUES

In general, the most reliable measurements were gathered by utilizing a special fixture or artificial reference planes to establish fixed surfaces relative to the wearing areas of measured components (see Appendix B for additional information on these fixtures). These devices furnished both a high quality surface against which tools could be gaged, and a surface that might be expected to remain fixed throughout continuing measurement cycles.

Although care was taken to ensure the validity of the measurement techniques, in some instances, measurements were initially made with tools which could not provide properly progressive readings throughout the program. For example, the ultrasonic gages had a much more limited application than had been anticipated, since they only work on a smooth surface with a homogenous cross section. In other cases, it became apparent, as the program proceeded, that some measurements were redundant. The following paragraphs evaluate the measurements from these standpoints of success and usefulness.

3.2.1 Unsuccessful Measurements

a. Spring free height. In seeking to determine if truck behavior was materially affected as the spring coils acquired a "set" in lessened free (unloaded) height, spring coil measurements were made with a fixture which did not physically index the coil relative to the measuring surfaces. In practice, it became more of a record of where the spring came to rest as it and the measuring fixture tipped around on the flattened coil end surfaces (see Figure 3-8).

b. Side frame column spacings, pedestal jaw lug-to-lug, jaw-to-jaw, and lug lateral width readings. Lack of a fixable measuring point and mistaken assumptions about where wear would actually occur seriously handicapped these readings. Even when no wear was present, tapered or crowned casting surfaces made tool placement uncertain at best. As points wore in these areas, it often occurred at places other than where the initial measurements were made. Continuity between initial measurements and cyclical readings was sporadic, and therefore these results are somewhat suspect. Photographs, contour profiles, or precise locating fixtures would have been more beneficial. Figures 3-9 and 3-10 illustrate these measurements.

c. Carbody center plate diameters and wear axes. This is another example of a "free-handed" technique which varied at each endeavor. Lack of certifiable reference points was the greatest shortcoming.

d. Assembled carbody clearances. These vary endlessly as a car and its trucks interact, and primarily record where each particular carset comes to rest. It is somewhat useful as a check against other cumulative dimensions, i.e., gib thickness + column spacing + gib thickness.

3.2.2 Measurements with Qualified Success

a. Brake shoes. These measurements can be extremely valuable if taken more frequently. However, the original brake shoes generally wore out between measurement cycles. The brake shoes which Wyle installed during the measurement process were painted silver on one end and numbered. When the distance between measurement cycles was increased beyond 25,000 miles, these inventoried shoes did not return with the unit train. Wear on brake shoes could provide some indication of how well the car's brake rigging is functioning and whether the car is performing its share of train braking relative to the other cars (see Figure 3-11). Differences in brake shoe wear can be remarkable; one truck in the program (the Barber-Scheffel) was re-checked with a force measurement gage to ascertain that it was, in fact, applying its brakes, since only small wear was noted between cycles. Information on brake shoe wear is unavailable from any other source since no such records are maintained for a railroad's cars as a whole.

FIGURE 3-8. SPRING HEIGHT MEASUREMENT

FIGURE 3-9. LUG LATERAL WIDTH MEASUREMENT

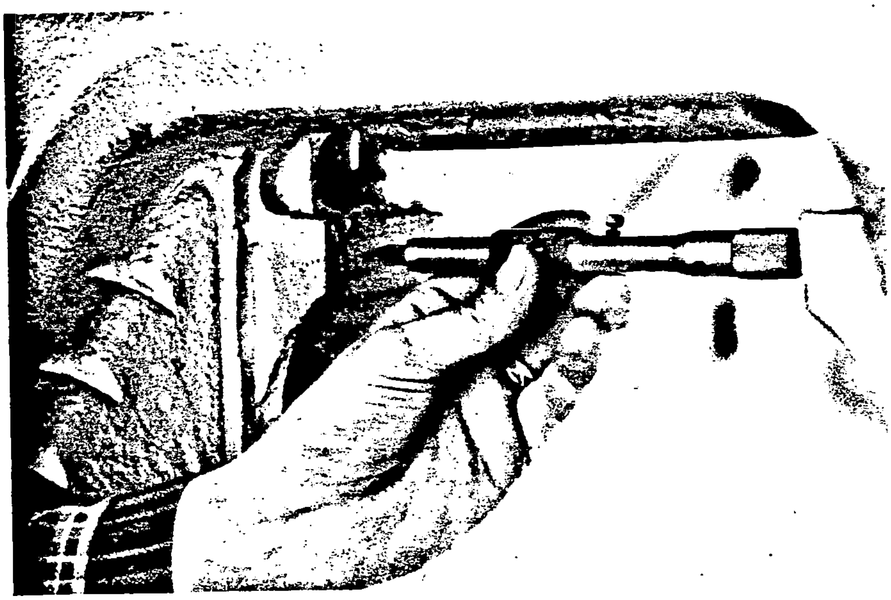


FIGURE 3-10. PEDESTAL JAW LUG TO LUG MEASUREMENT

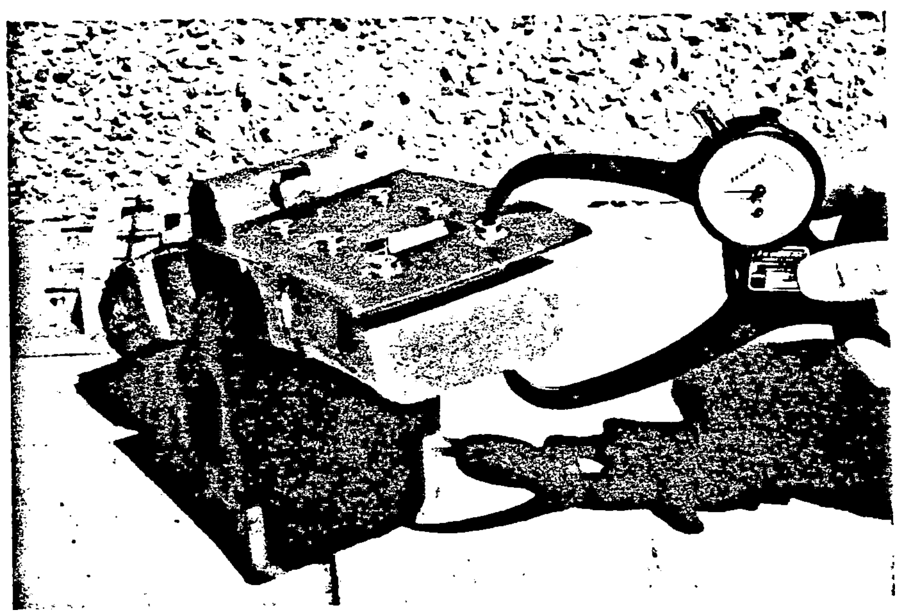


FIGURE 3-11. BRAKE SHOE WEAR MEASUREMENT

b. Friction castings. Mechanical measuring techniques using a fixed reference plane relative to the casting worked very well; problems occurred on some friction castings when the allegedly "non-wearing" side surfaces wore, thereby destroying the index holes that located the fixtures. Figure 3-12 shows friction casting and side pocket wear.

c. Center bowl liners. Except in the case of captured liners which are essentially an integral part of the truck bolster, this measurement seems to reveal little useful data. The circumferential progression of the indexing feature ground into the center hole reveals that the plate may turn somewhat, and the thickness dimensions may show progressive thinning. However, it is unknown how many times it turned between measurement cycles and at which point relative to the carbody center plate it was squeezed. This is an easy measurement to obtain if the data are justified.

d. Truck bolster center plates. These measurements are probably not justified if the truck uses a renewable wear liner. However, they would be valuable for data on a hardened bolster wear surface vs. a replaceable hardened liner covering a non-hardened surface, and they are easily obtained.

e. Truck side bearing diameters and cage base thicknesses (or equivalent substitutions). These are minor components of trucks which are of interest primarily as a comparison among a fairly great variety of side bearing types. It is quite simple to make these measurements.

f. Side frame column widths. These are taken with a large dial caliper which is somewhat difficult to position, especially as wearing surfaces become more and more tapered in service. Considerable room for error exists if care in instrument positioning is not observed (see Figure 3-13).

g. Wheel profiles. Wheel tread traces or profiles taken with a special device developed by Pullman-Standard are cleanly done and simple to make. Attachment to the wheel is straightforward and secure, and the profilometer is easily handled (Figure 2-5). It would, however, be desirable to have a better method of tracing the relationship of the front and back wheel surfaces to the wheel tread itself, as other dimensions taken could then be related to the wheel tread tape line, an indication of actual wheel tread diameter.

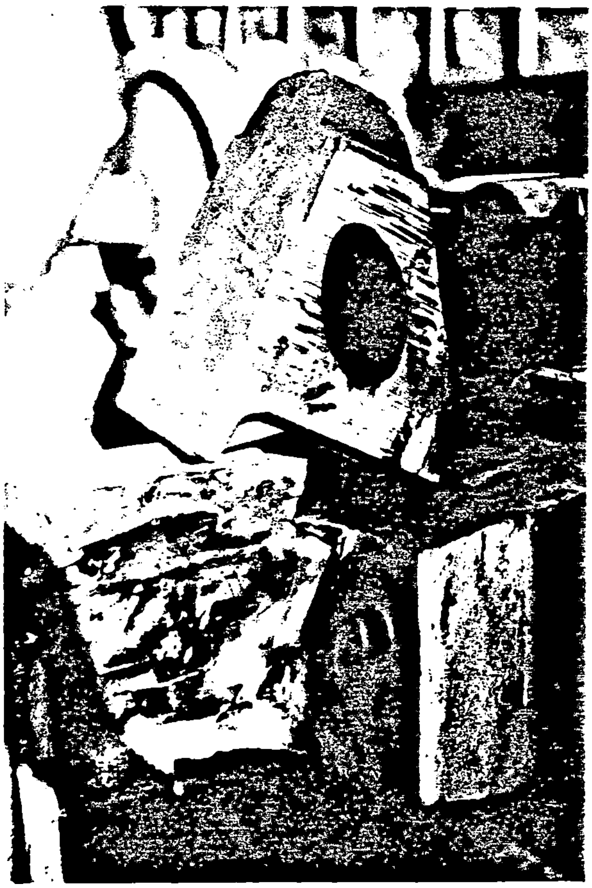


FIGURE 3-12. FRICTION CASTING AND SIDE POCKET WEAR

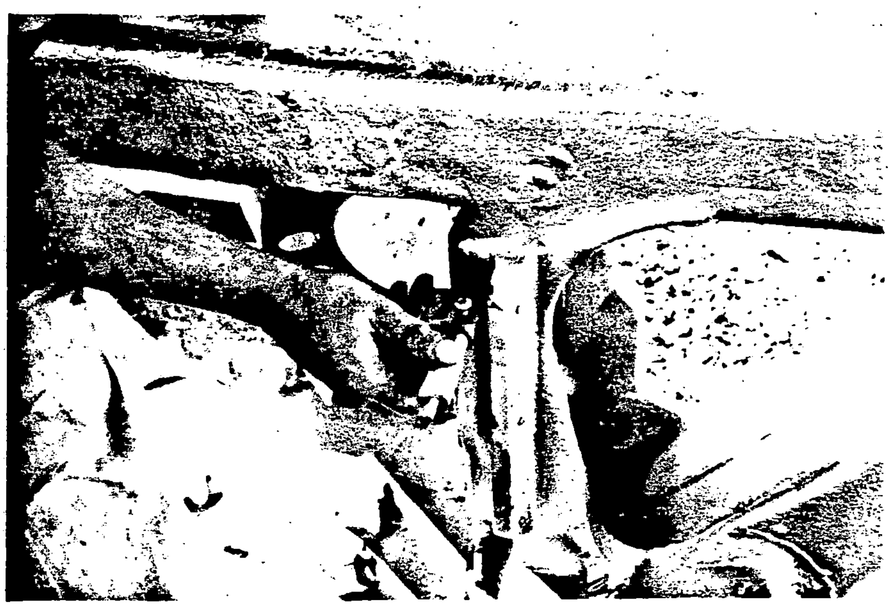


FIGURE 3-13. SIDE FRAME COLUMN WIDTH MEASUREMENT

3.2.3 Measurements With High Reliability

a. Truck bolster gibs and column width and spacing. These are a good index of comparative wear, and they are possible to measure accurately relative to fixed point locations (see Figure 3-14).

b. Bearing adapter crown height, lateral lugs, and longitudinal stop surfaces. With care, these dimensions can be accurately gathered, as shown previously in Figure 2-4. The most difficulty comes from operator inattention in positioning and holding the special fixture.

c. Side frame lugs, pedestal roofs, and side frame column wear plates. Each area has a special tool or fixture which ensures reliability of readings. The side frame lugs are indexed by carefully positioned round-headed buttons against which micrometer tips are keyed to the adjacent wearing surface; pedestal roofs and lugs are measured relative to a special fixture located by pointed "stand-offs" away from wearing surfaces. The column wear plate measurements can be confidently taken with an ultrasonic depth gage.

d. Wheels (other than profiles). Standard tools and gages are used on most wheel measurements. There should be no reason to suspect these data, although they are not recorded in the manner that railroads ordinarily use.

FIGURE 3-14. TRUCK BOLSTER GIB MEASUREMENT

3.3 TRUCK ASSEMBLY AND DISASSEMBLY RATINGS

The relative difficulty of working on the trucks to perform routine maintenance and repairs has a potential impact on the cost-effectiveness of the trucks. Since the trucks had to be disassembled and reassembled each time wear measurements were taken, it was possible to evaluate truck designs from the standpoint of time and effort required to make repairs.

An important factor in the ease of handling the trucks for repairs is weight; the heavier trucks are more cumbersome and time-consuming to work on and sometimes require special equipment. For example, the Devine-Scales truck had to be turned on its back for disassembly, which required either more steps and more time using the equipment at the RIP track, or the procurement of hoisting equipment more powerful than what was available at the facility. For comparative purposes, truck weights are shown in Table 3-4.

TABLE 3-4. ESTIMATED TRUCK WEIGHTS
WITH WHEELS,* BRAKE RIGGING, AND ACCESSORIES

Truck	Weight (lb)
National Swing Motion	23,000
Barber S-2	21,000
Dresser DR-1	22,250
Barber S-2 Heavy Duty with C-PEP	21,000
ASF Ride Control	21,000
Barber-Scheffel	23,000
Devine-Scales	24,000
MTS Maxiride 100	20,850

*2900 lb/wheelset

The advantages and disadvantages encountered while taking wear measurements are noted in Table 3-5. This table ranks the trucks from 1 to 8, from the easiest to work on to the most difficult. However, these ratings do involve a degree of subjective judgment and are provided only in the interest of making future endeavors similar to the Wear Data Collection Program easier to implement. A more objective evaluation of assembly/disassembly ratings might take into account the degree of disassembly (e.g., number of components) that a given truck will permit.

The evaluations described in Table 3-5 are based on the limited experience of four or five disassembly and assembly cycles. During the course of the program, several different machines were used to work on the trucks. The most difficult and dangerous implement used was a farm tractor with a backhoe boom equipped with a hook where the bucket would be. The hydraulic controls on this boom were unstable and very lively. The safest but most laborious method consisted of three pull jacks on a four-wheel A-frame. Later on in the program, the Union Pacific purchased a hydraulic crane with telescoping boom that proved to be the most satisfactory of the equipment used.

The work was carried out in the open air in temperatures often exceeding 115° F. Any strenuous activity was much more difficult than it would have been under more moderate climatic conditions. A task which could be performed by machine rather than by hand, even though requiring more time, was considered advantageous.

It is for these reasons that the following ratings may not concur with the findings of other test programs where indoor facilities and standard tools were used. Furthermore, the trucks were usually completely disassembled because of the nature of the task to be performed. Ordinarily, in the course of routine maintenance, complete disassembly would not be required and many of the more difficult components would not be disturbed. Therefore, the following ratings are not representative of the maintenance difficulty which would be encountered in revenue service.

TABLE 3-5. TRUCK ASSEMBLY AND DISASSEMBLY RATINGS (SHEET 1 OF 3)

TRUCK	DISADVANTAGES	ADVANTAGES
1) National Swing Motion		- Can be lifted with wheel hooks on chains - No gibs (making side frame to bolster interfaces easier to work with - Small friction castings
2) Barber S-2		- Simple design - Small friction castings
3) Barber S-2 Heavy Duty With C-PEP	- Large friction castings (making them harder to hold in position for side spring)	- Simple design
4) ASF Ride Control	- Special fixture required for pre-loaded friction castings	- Simple design
5) MTS Maxiride 100	- Needs lifting eyes on bolster - Requires metric tools - Requires spherical center plate (initial installation only) - Operating rod must pull along center line of car (initial installation only) - 100-ton jacks do not lift car high enough to roll truck underneath - Bearing adapters are very heavy, require forklift or two men to position on bearings	- Bolster/side frame are one piece - Simple design - Friction element is easy to handle - Fewer springs, easy to align - Brake beams need not be removed; no brake shoe key interference; side frame window opposite brake shoes - Relatively light weight

TABLE 3-5. TRUCK ASSEMBLY AND DISASSEMBLY RATINGS (SHEET 2 OF 3)

TRUCK	DISADVANTAGES	ADVANTAGES
6) Barber-Scheffel*	- Bolster must be blocked to avoid bending steering arms when truck is partially disassembled - Cross strut location makes removal of brake shoe keys difficult - Heavy - Requires large torque wrench/adapter/socket - Large friction castings	- Simple design
7) Dresser DR-1	- Blocking and alignment problems with steering arms - Blocking and alignment problems in simultaneously re-assembling side frame with bearing adapters, bolster gibs, and brake beams - Brake shoe key interference with steering arms - Special chain sling required to lower side frame past steering arm	- Small friction castings - Relatively light weight

* Assembled at beginning of program, not disassembled except for rolling out the wheelsets, removing the springs and friction blocks, replacing brake shoes, and corrective maintenance.

TABLE 3-5. TRUCK ASSEMBLY AND DISASSEMBLY RATINGS (SHEET 3 OF 3)

TRUCK	DISADVANTAGES	ADVANTAGES
8) Devine-Scales	- Requires grinder, torch, welder, bar, hammers, and many socket wrenches (4 hours min. to disassemble each) - Must be turned over - Extremely heavy, no lifting eyes - Heavy saddles, tight tolerance into subframe - Heavy subframe - Springs and friction castings hard to align - Steering pins require torch work to remove, tight tolerances, exceptional care required to keep sliding surfaces clean, white grease required - Wrench tolerances inadequate around most bolt heads - Brake beams extremely hard to remove, harder to replace	- Bolster/side frame are one piece

3.4 DEVELOPMENT OF A MEASUREMENT SCHEDULE

One of the goals of the program was to develop a measurement schedule. During the second measurement cycle, there were indications that certain measurements would not have to be taken as frequently as originally scheduled. Some of the surfaces, such as those on the side frame/pedestal adapters and the anti-rotation lugs, still had an intact coat of paint at the second measurement cycle, indicating negligible wear. With the amount of wear observed up to approximately 100,000 miles per truck in this program, it appears that cyclic measurements taken at 50,000-mile intervals would be just as adequate as measuring at 12,500-mile intervals with the exception of wheels which tend to wear more rapidly at first.

3.5 DATA SUPPLIED TO ECONOMIC ANALYSES

Data from the wear program has been made available for input to the TDOP economic cost/benefit analysis of Type II truck designs. Specifically, the wear data was used to address four points of interest to the economic analysis:

a. Percent change in wheel life
b. Percent change in the life of standard components
c. Determination of the ratio of standard component wear to nonstandard component wear
d. Percent change in truck repair time with different truck designs

SECTION 4 - CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

It is still too early in the wear program to describe definitively the component life of the several freight car truck designs being tested. As mileage accumulates upward to 250,000 miles (the projected end of the program), perhaps clearer results will be evident. However, on the basis of a comparison of flange and tread wear after approximately 100,000 miles, and linear extrapolation, it may be stated that the steering trucks are likely to achieve significant improvement in wheel wear as compared to non-steering trucks.

Another characteristic which the self-steering trucks share is relatively increased weight and complexity due to the additional guidance mechanisms. Although most railroad car department personnel are quite familiar with the assembly and disassembly of typical trucks, certain design features and maintenance procedures of the self-steering trucks will need to be more thoroughly understood before the full benefits of operating this type of equipment can be realized.

It is premature to try to describe the life of nonstandard components as a function of standard component life. No parts, either standard or nonstandard, wore out with the exceptions noted earlier in the report. Although some wear has been noted, it is difficult to predict when these parts will require replacement.

It should be noted that, in attempting to draw any conclusion from comparative wear characteristics, the data gathered here should always be used in conjunction with the findings of TDOP's performance testing program, and appropriate data from other controlled tests.

4.2 RECOMMENDATIONS FOR FUTURE PROGRAMS

Although all measurement points and components surveyed by this program were selected by careful study, it became apparent that not all preliminary assumptions or expectations were realistic. In the course of the program, several of the original planned measurements were either modified or eliminated altogether. In general:

a. Mechanical measurement tools replaced ultrasonic measurement techniques on castings where wall sections of varying thicknesses and complex internal shapes prevented reliable readings from being made.

b. Logistical considerations took precedence over the stated ideal, e.g., carrying several hundred pounds of small castings to a location where a reliable scale was available. Therefore, component weights, while a valuable indication of metal removed, were not taken after the second cycle. The difficulty of disassembling certain trucks, which would also then require careful reassembly, precluded the removal of certain components which would have been desirable to measure. And, as it became apparent that brake shoes did not survive the lengthening time periods between measurements, they were ignored.

c. Selected measurements that were not felt to be necessary were dropped as the program progressed (see section 3.2). In light of what has been learned about the value and practicality of making these measurements, they should probably not be used in future programs of this nature.

Experience thus far has shown that the forms used to record the wear measurements in the field should be upgraded so that measurements are grouped by the type of tool used rather than the location on the truck. It would also be helpful to show the expected values on the forms, along with a simplified diagram of the measurement locations on each component.

Another instance in which experience might dictate better decisions would be in the choice of site selection and working conditions. All work requiring heavy labor and equipment was done by members of the Union Pacific Railroad's Mechanical Department at the Las Vegas RIP track. Enough cannot be said in appreciation of their willingness to assist and further the aims of this project. However, because of the sensitive nature of the work, it was quickly determined that better working conditions and protection from the elements could have made a marked improvement in worker morale, efficiency, and effort. The extremes in heat and cold, exposure of tools and documents to the elements, and lack of adequate lighting in many cases served to lessen the effectiveness of the staff.

Similarly, equipment of a kind which the railroad would not ordinarily have available for its own work was occasionally required. For example, a three-axis overhead crane, instead of the rotating boom crane which was used, would have greatly aided truck disassembly and reassembly. Also, a steam cleaner for component parts and tools would have given a more thorough cleaning method than the compressed air and wire brush used, and hence would have provided more accurate measurements in some cases. Some work that was laboriously performed on the RIP track could have been matter-of-factly done at a shop facility.

Finally, railroad operation had to be given precedent over support of a research and development program. For this reason alone, the utilization of a shop or building facility and crew without conflicting commitments would have been more effective.

APPENDIX A

WEAR DATA COLLECTION PLAN

Federal Railroad Administration Contract No. DOT-FR-742-4277

TRUCK DESIGN OPTIMIZATION PROJECT (TDOP) PHASE II

TDOP WEAR DATA COLLECTION PLAN

October 6, 1978

CONTRACT NO. DOT-FR-742-4277		WYLE LABORATORIES SCIENTIFIC SERVICES AND SYSTEMS GROUP COLORADO SPRINGS, COLORADO			
PREPARED Dick Peacock					
APPROVED David Gibson DWG	9 Oct 78				
APPROVED Larry Johnson LJ	9 Oct 78				
APPROVED Klaus Cappel KLC	10 OCT '78				
PROGRAM MANAGER Dean de Benedet D.deB	10-10-78	Size A	Code Ident No. 2B360	C-901-0002-A	
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REVISION

LETTER	DESCRIPTION	DATE	APPROVAL
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1.0 INTRODUCTION

The TDOP Phase II Wear Data Collection Program will collect wear data on several Type I and Type II freight car trucks. The objectives of the program are to collect sample wear data, establish wear trends, evaluate wear measurement methods, develop a schedule for measurement occurrence, and provide data for economic models.

This document describes the overall plan for the obtaining, recording, storing and retrieval of the various data and lists the types of measurements and accuracies required. Detailed procedures and formats for taking and recording each measurement are contained in Wyle document C-901-0006-A, "TDOP Wear Measurement Procedures". This document will be revised by Wyle as field measurement experience dictates. A detailed description of the TDOP wear data base (including data organization, data files and retrieval) is contained in Wyle document C-901-0003-A, "TDOP Wear Data Base Description".

A limited wear data collection program using unit coal trains operating in actual revenue service over several railroad systems will be initiated as described herein. The program's measurement techniques have been developed through evaluation of existing railroad and industry measurement techniques as well as those being used on the Facility for Accelerated Service Testing (FAST) Program at the Transportation Test Center in Pueblo, Colorado. Initial verification sampling at close mileage intervals will be made to ensure that baseline data on early wear are preserved. The wear data will be entered into the TDOP data base and will be compared by engineering and economic analysts with wear data from other data sources (e.g., industry, AAR, and the FAST program).

Wear measurements will be taken primarily at the Union Pacific Repair-in-Place (RIP) Facility in Las Vegas, Nevada. Should an unplanned maintenance be required at other locations, this plan will provide FRA and contractor personnel with guidelines for taking measurements on the TDOP test articles.

2.0 BACKGROUND

Wear data will be collected on six types of freight car trucks. Two trucks of each type will be installed on 100-ton hopper cars and will run in two unit coal trains, the Carbondale/Sunnyside Unit West (CSUW) and the Kaiser Unit West (KUW) operating on a 1600-mile round trip between Utah and California. Three test cars wll be run in the CSUW train and three test cars in the KUW train. Except for these six 100-ton test cars, the rest of the unit train consists of 125-ton hopper cars. However, these 125-ton cars are normally filled to only the 100-ton level.

The unit trains will travel on Union Pacific, Santa Fe, and Denver and Rio Grande tracks. The unit coal trains will allow Wyle to collect data on both Type I and Type II trucks from service that is typical for unit train operation.

Both of the trains pass through Las Vegas, Nevada, and are easily accessible to Union Pacific's RIP track (see Figure 1). Most of the service will be on Union Pacific's main line class 4 track, with curves of up to 10 degrees. The 1600-mile round trip is completed in four days with the trains leaving at staggered, two-day intervals. The maximum speed of the trains will be about 50 miles per hour with an expected accumulation of 140,000 miles per year.

The six trucks to be tested are the American Steel Foundry (ASF) Ride Control truck, the Barber S-2 truck, the Barber S-2-HD Center Plate Extension Pad (C-PEP) truck, the Dresser DR-1 Steering Assembly truck, the Standard Car Radial Barber-Scheffel truck, and the National Casting Swing Motion truck.

The ASF Ride Control and the Barber S-2 will provide representative data on the Type I trucks. The Barber C-PEP represents a modified 100-ton truck, and is considered a Type II truck. This truck along with the DR-1, Barber-Scheffel, and Swing Motion trucks will provide wear information for Type II trucks. These last four trucks meet the critical elements of the proposed selection criteria for Type II trucks (i.e., feasibility of technical design, length of service experience, and availability).

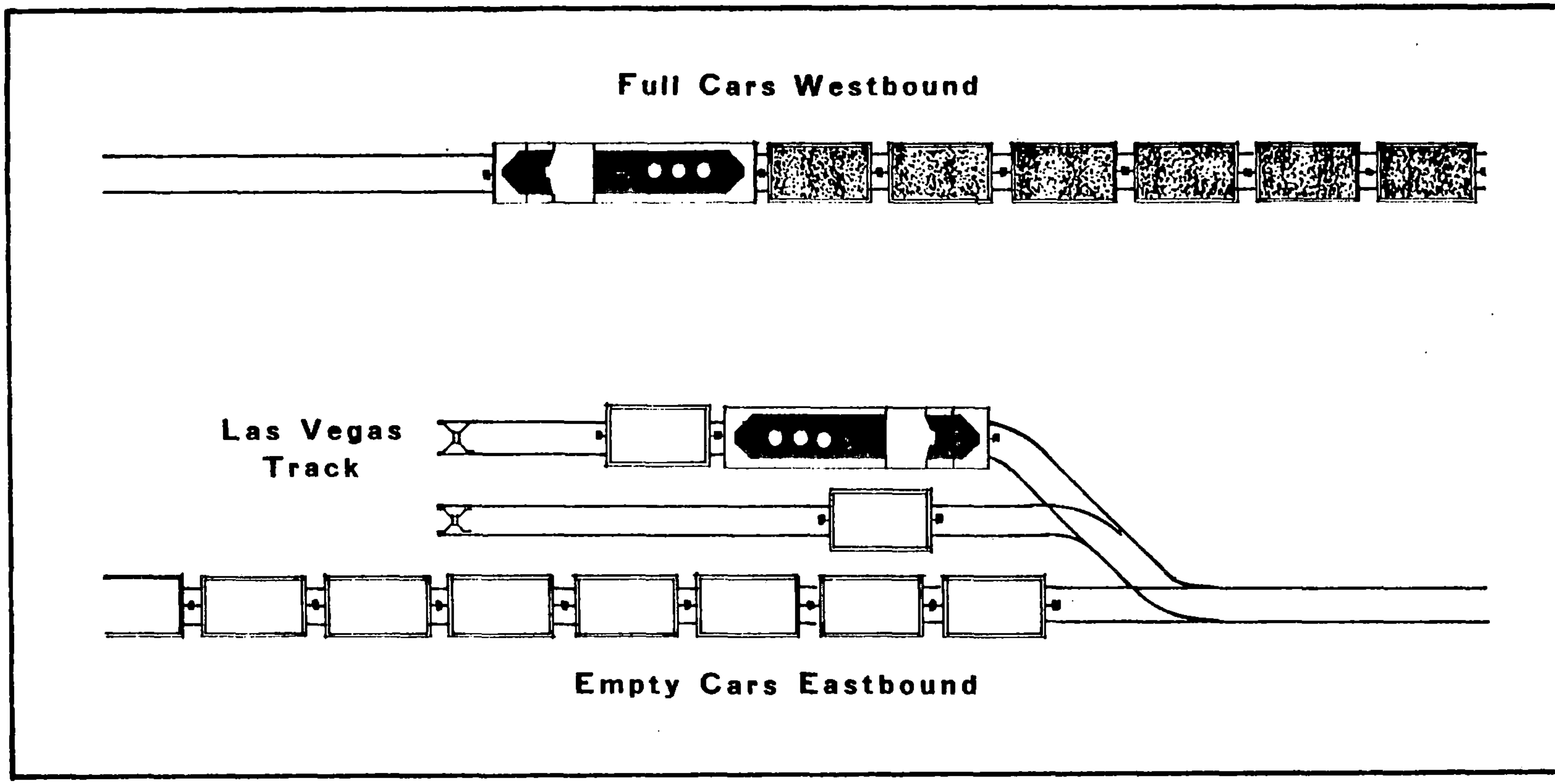

Figure 1. Union Pacific's RIP Track

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The six hopper cars will be delivered to UP's RIP track in Las Vegas. Measurements will be made of each truck and its components to define the initial values and characteristics. Upon completion of this initial task, three of the cars will be put into each of the unit trains. Approximately one month, or 12,500 miles later, the sequence of wear measurements will begin and one car set will be measured every day.

3.0 ORGANIZATIONAL RESPONSIBILITIES

Wyle has organized the TDOP Wear Data Collection Program as shown in Figure 2. The Field Task Leader will be responsible for overall coordination, scheduling, manpower allocation, and adherence to the plan objectives. Wyle will be assisted on this program by the Union Pacific Test Engineer who will coordinate the movement of the test railcars to the measurement location, and the availability of qualified personnel and equipment to safely disassemble and reassemble the test cars. The Union Pacific Test Engineer or one of his staff will also assist in performing measurements and quality control checks of the recorded data sheets.

4.0 MEASUREMENT PLAN

The field measurements will be accomplished at the RIP track where the carbody will be placed on jacks and the trucks removed. Components will be gaged and the measurements recorded.

The measurements taken will include wheel profiles, brake shoe wear, wear at the bearing adapters and pedestals, wear of the friction snubbers, bolster pockets, gibs, columns, centerplate, and side bearings. The truck will also be inspected for any damage or changes in configuration. The records from normal maintenance performed in the shop in Helper, Utah, will be correlated between any repairs or equipment change at Helper, and with the findings of the measurement program.

The Wear Data Collection Program will begin in January, 1979, and conclude in September, 1980. The accumulated mileage will be approximately 250,000 miles. The initial six different truck types will be in service for the duration of the program. In or near July, 1979, up to three additional Type II trucks will be placed in service. For

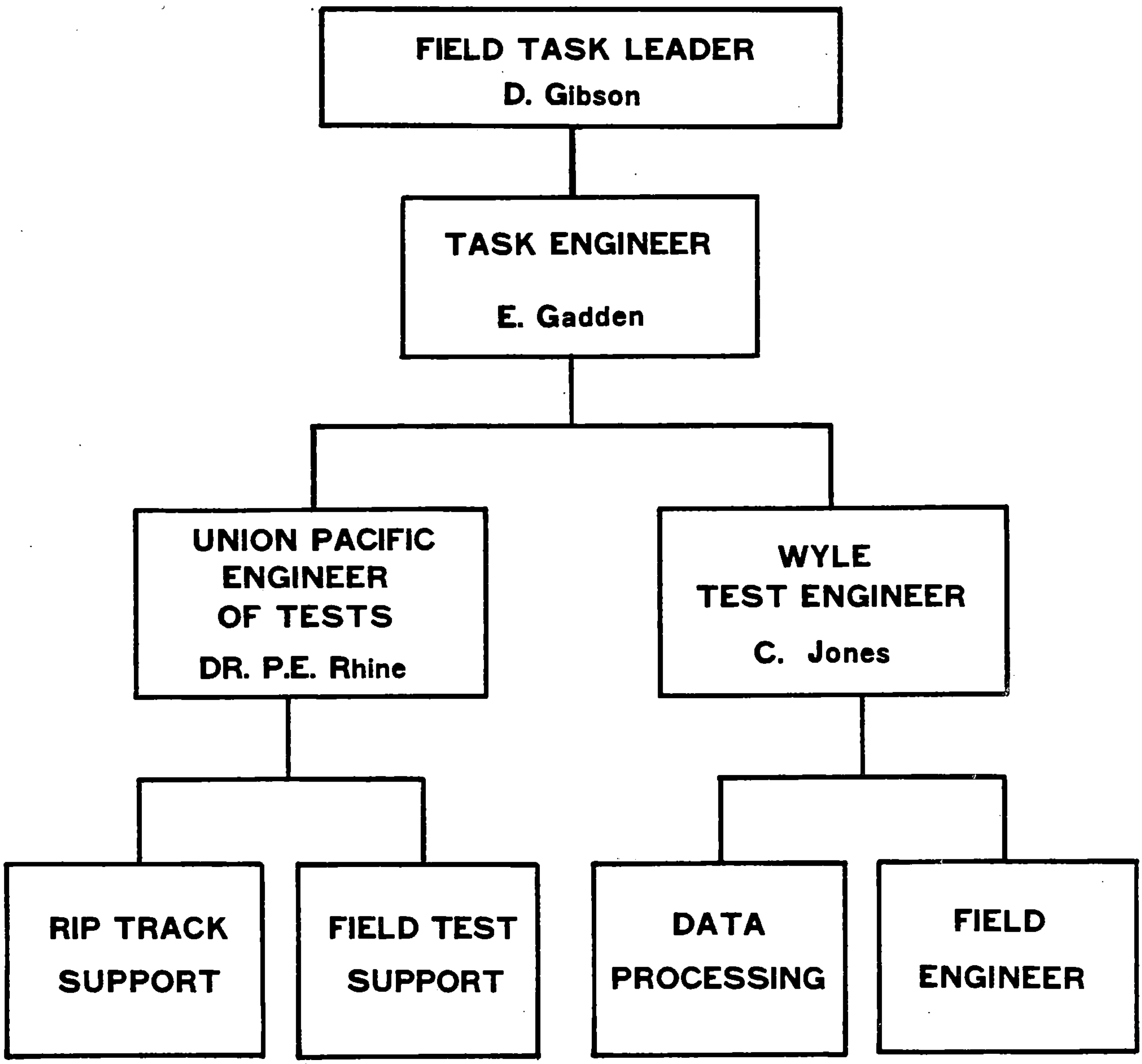


Figure 2. Wear Data Collection Organization

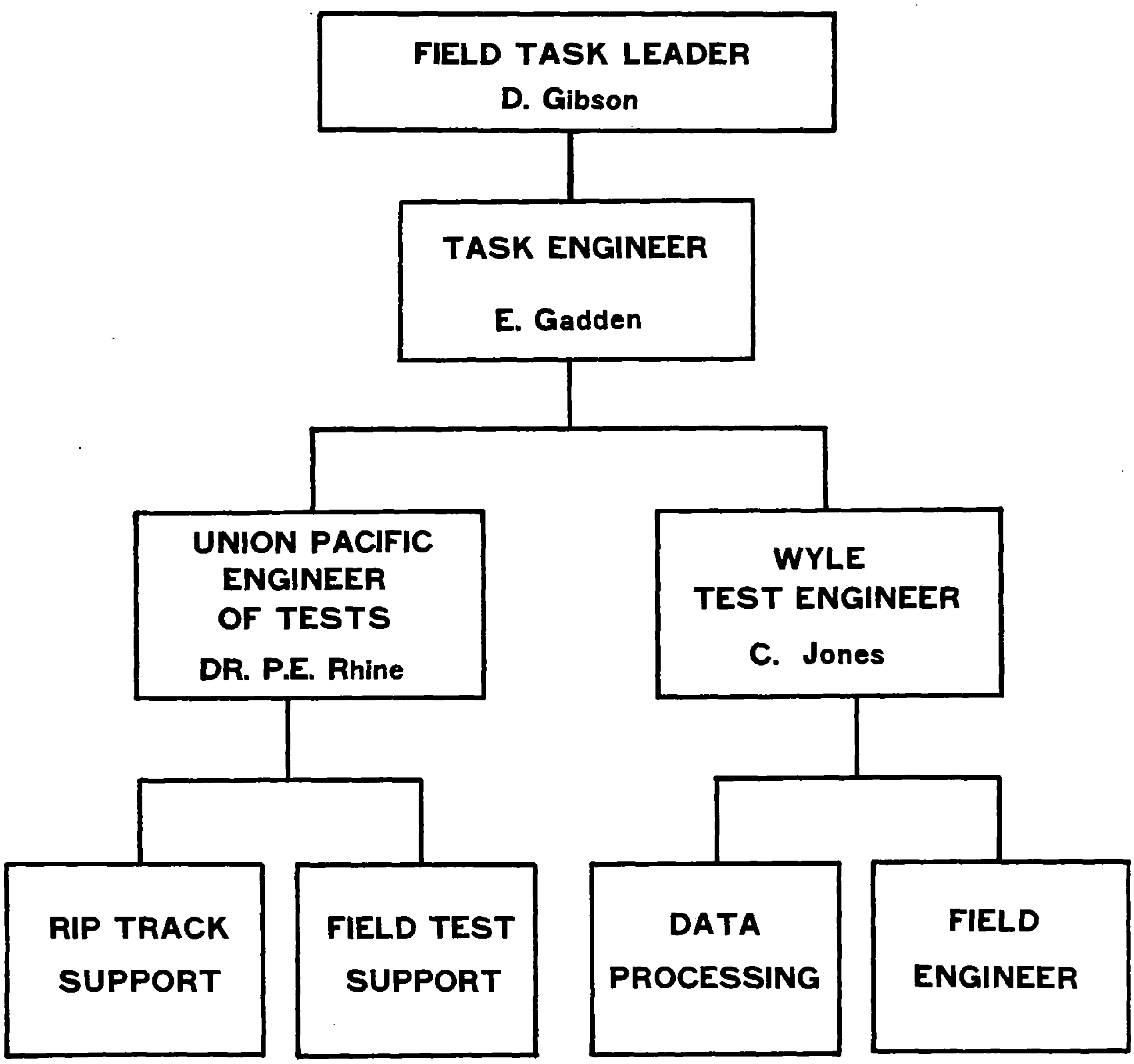


Figure 2. Wear Data Collection Organization

a truck to be added to the program, it must meet certain critical elements of the selection criteria for Type II trucks and be acceptable to the participating railroads for unit train service.

4.1 MEASUREMENT CYCLES AND SCHEDULE

Measurements will be taken in accordance with the following schedule.

Cyle #	Mileage	Planned Schedule
1	-0-	Jan. 79
2	12,500 ± 3200	Feb. 79
3	25,000 ± 3200	Mar. 79
4	37,500 ± 3200	Apr. 79
5	50,000 ± 3200	May 79
6	75,000 ± 4800	July 79
7	100,000 ± 4800	Sept. 79
8	125,000 ± 4800	Nov. 79
9	150,000 ± 4800	Jan. 80
10*	175,000 ± 4800	Mar. 80
11*	200,000 ± 4800	May 80
12*	225,000 ± 4800	July 80
13*	250,000 ± 4800	Sept. 80

4.2 FACILITY LOCATIONS

Although the measurements are scheduled to take place at the Union Pacific RIP track, special trips to the Helper, Utah, maintenance shops may be necessary if bad ordering of a test car requires a component exchange. Each car will be uniquely

*When wear rates on center plates or friction snubber shoes begin to increase at twice the rate estimated during the initial 100,000 to 125,000 miles, the samples will be taken at 12,500 miles rather than at 25,000-mile intervals to capture accelerated wear trends.

stenciled with instructions to maintenance shops to call collect the Wyle TDOP project office should the car be bad ordered. This will provide a mechanism for obtaining and entering appropriate reductions in accumulated mileage if required. When bad ordered for causes related to the trucks or wheelsets, a Wyle measurement team will be dispatched to the maintenance site within one working day to make the required measurements before maintenance or repairs are initiated. It will be necessary to make pre-test coordination and contractual arrangements with the railroads so that the maintenance shops are aware of the Wear Data Collection Program and will lend their cooperation to it.

4.3 MEASUREMENT TECHNIQUES

Where possible, the measurement of wear data will use the existing measurement fixtures, devices, or procedures available from industry, AAR or FRA. If new techniques not discussed in this plan are proposed, these techniques will be reviewed with the TDOP consultants for their comments and the COTR for approval before implementation. Technical discussions with AAR and the FAST program office have occurred in the development of the measurement techniques proposed. Both Wyle Laboratories and Union Pacific Railroad personnel will be fully trained and qualified for taking the measurements. All measurement equipment with detailed procedures for calibration and use is listed, along with data recording forms, in Wyle document C-901-0006-A, "TDOP Wear Measurement Procedures".

a. Ultrasonic thickness gage with templates

- Truck center plate horizontal wear liner
- Truck center plate wear ring (and angle of major wear axis)
- Side frame wear plate
- Side frame pedestal roof
- Side frame pedestal lug
- Side bearing cage base
- ASF friction casting wear faces
- Carbody center plate
- Carbody side bearing wear plate
- Bolster lateral stop face (National Swing Motion truck)
- Transom lateral stop face (National Swing Motion truck)

b. <u>Caliper/micrometer/feeler gage</u>

- Truck center plate diameter
- Gib thickness
- Bolster column width
- Inboard gib spacing
- Bolster column spacing
- Side frame pedestal lug width
- Side frame pedestal lug spacing
- Side frame pedestal jaw spacing
- Side frame pedestal jaw spreading
- Side frame antirotation lug thickness
- Side frame antirotation lug spacing
- Side frame column spacing
- Side frame column width
- Brake shoe thickness
- Side bearing roller diameter
- Bearing adapter longitudinal thickness
- Bearing adapter lug thickness
- Bearing adapter lug spacing
- Bearing adapter thrust shoulder thickness
- Friction casting wear face thickness
- Carbody center plate diameters (and angle of minor axis)
- Outboard gib clearance
- Inboard gib clearance
- Side bearing roller-to-carbody wear plate clearance
- Truck bolster-to-carbody bolster distance
- Snubber/stabilizer clearances (if used)
- Rocker seat trunnion thickness (National Swing Motion truck)
- Rocker seat bearing thickness (National Swing Motion truck)
- Bolster-to-transom lateral stop clearance (National Swing Motion truck)
- C-PEP free height (Barber S-2-HD C-PEP truck)
- C-PEP compressed height (Barber S-2-HD C-PEP truck)

- Steering arm shaft diameter (Dresser DR-1 truck)
- Steering arm bushing diameter (Dresser DR-1 truck)
- Bearing adapter elastomeric pad height (Dresser DR-1 truck)
- Cross arm thickness at crossover point (Barber-Scheffel truck)
- Elastomeric shear pad height (Barber-Scheffel truck)

c. Depth gage with indexing fixture

- Bearing adapter crown height
- Friction casting wear face thicknesses

d. AAR standard gages

- Wheel rim thickness
- Wheel flange height
- Wheel flange width
- Wheel circumference at tape line
- Wheel back-to-back distance

e. Contour gage

- Rocker seat trunnion (National Swing Motion truck)
- Rocker seat bearing (National Swing Motion truck)
- Side frame pedestal rocker seat (National Swing Motion truck)

f. Tape measure/scale/plumbob

- Spring squareness
- Spring free length
- Carbody center plate-to-center plate spacing
- Coupler-to-coupler length
- Railcar height
- Railcar length
- Railcar width

g. Beam bench scale (weights)

- Brake shoe
- Bearing adapter
- Friction casting

h. Special measurements

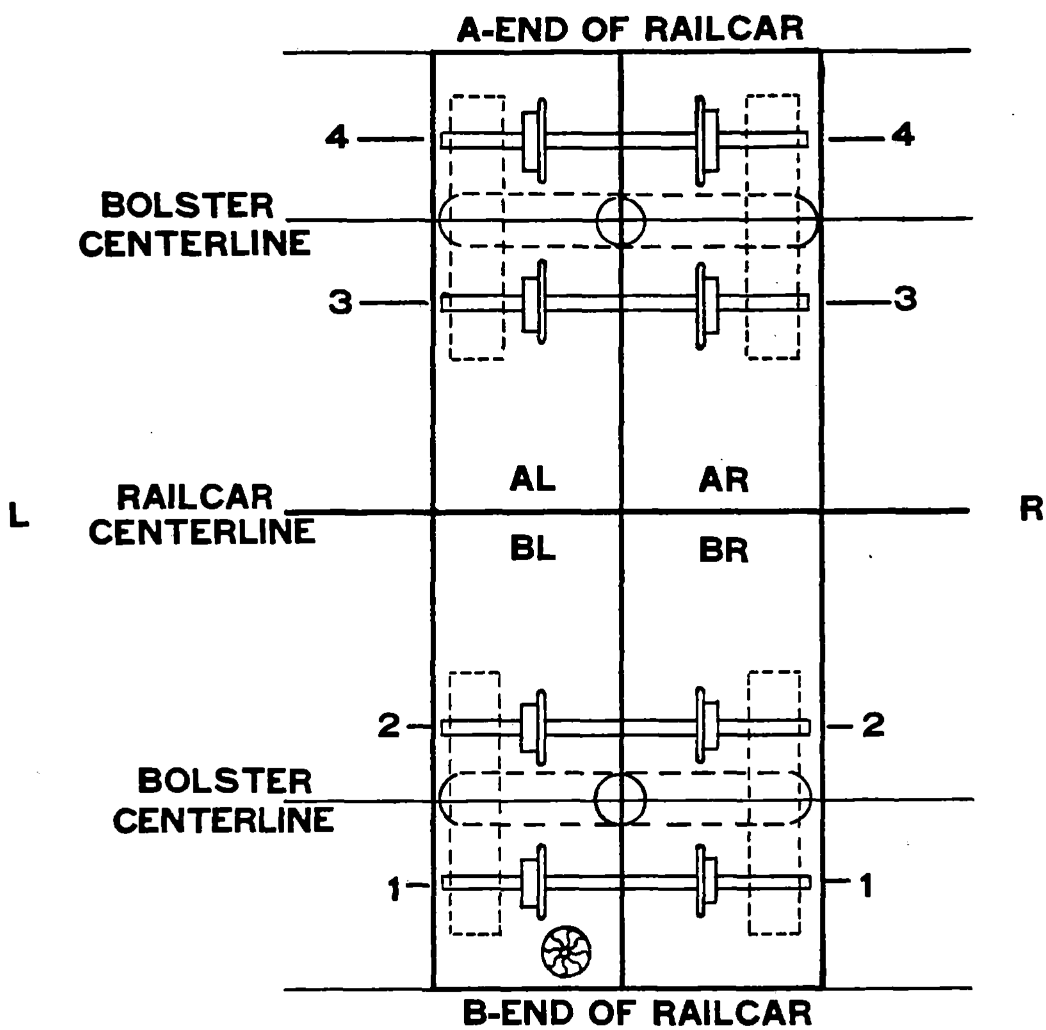
- Braking system equalization (Abex Hydra-Cell)
- Wheel profile (Pullman-Standard wheel profiler)

4.4 MEASUREMENT LOCATIONS

Wear measurements will be taken on the six types of trucks at the locations specified in the following subsections. Special features of some trucks may require additional measurements. Photographs of wear patterns will be taken at 50,000 mile intervals, starting at zero mileage up to the completion of the Wear Data Collection Program. Photographs will also be taken of any unique or unusual wear or damage noted during the measurement cycles.

The individual measurements will be recorded to a resolution of ±.001" for all measurements being made with ultrasonic thickness gages, calipers, micrometers, depth gages and feeler gages. Measurements being made using tape measures, scales and AAR gages will be recorded to the nearest graduation (e.g., 1/64 of an inch for wheel circumference, and 1/16 of an inch for center plate spacing). Weights will be recorded to the nearest ounce. The variance due to operator errors, instrument wear, fixture positioning, etc., shall be within the required plus or minus tolerances stated in the following subparagraphs. In some cases, actual measurements may exceed these tolerances. If so, corrective action will be taken to make the measurements meet the tolerances stated herein.

The accuracy resolution and repeatability of each measurement will be used to determine the number of times it is sampled during a measurement cycle. Initially, a minimum of two samples of each measurement will be taken. If the variation between the two measurements exceeds the stated measurement tolerance requirement (e.g., ±.005"), two additional measurements will be taken at that measurement location. After 50,000 miles, only one sample will be taken if the measurement can be made with a high degree of confidence. The locations of these measurements will be identified on the data forms per the AAR Interchange Rules Field Manual as shown in Figure 3.



When Looking Down From Top Of Railcar:	
Rotation Counterclockwise	= + Angle Rotation
Rotation Clockwise	= — Angle Rotation

Figure 3. AAR Standard for Component Location

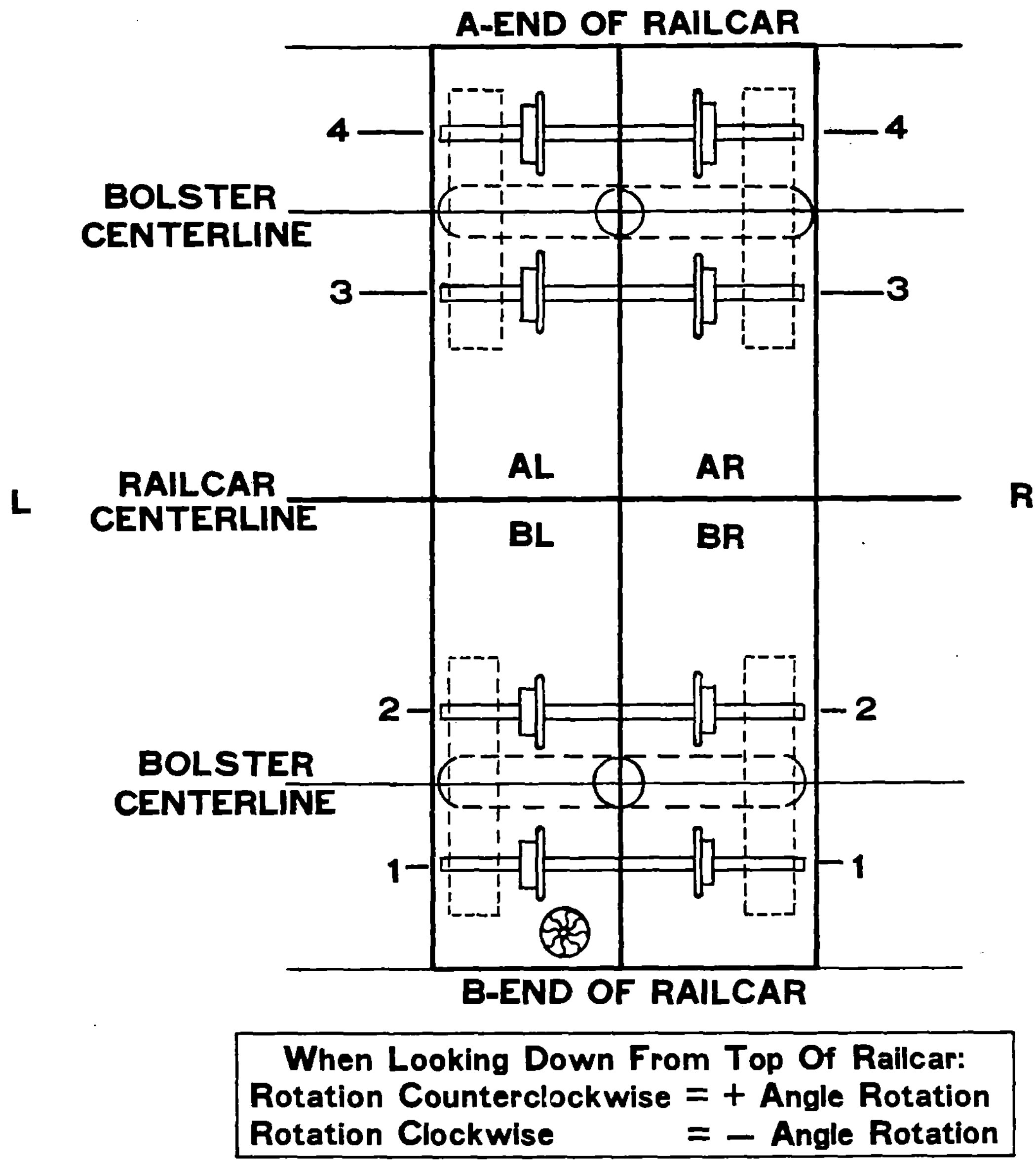


Figure 3. AAR Standard for Component Location

Measurement tolerances cited below are the total system root mean square (RMS) errors which are acceptable to acquire the wear data. The RMS error is the square root of the sum of the squares of the possible errors encountered in making the measurement.

4.4.1 Inventory Measurements

The following single time measurements will be taken on the railcar and truck components prior to initial service. Specification of a railcar component measurement implies identical measurements will be taken on all like components contained therein.

a. Truck center plate diameters (two points parallel to truck axes) (±.01")

b. Side frame column spacing between wear plates (six points/side frame) (±.03")

c. Wheel back-to-back distance (two points/wheelset) (±.03")

d. Bearing adapter thrust shoulder thickness (six points/adapter) (±01")

e. Spring squareness (four points/spring - unloaded length) (±.01")

f. Carbody center plate-to-center plate spacing (±1/4")

g. Coupler-to-coupler length (±1/2")

h. Railcar height above rail (one point - empty car) (±1/4")

i. Railcar length (one point) (±1/4")

j. Railcar width (one point) (±1/4")

k. Braking system equalization (±50 lb.)

l. Truck spring group layouts

m. Railcar cumulative mileage

n. Railcar/truck/component specification data (hardness, etc.)

4.4.2 Cyclic Measurements

These measurements will be taken in accordance with the schedule of Section 4.1. The approximate accured mileage at each measurement cycle will be recorded at the time of the measurement along with any anomalies in the test article configurations. Specification of a railcar component measurement implies identical measurements will be taken on all like components contained therein.

4.4.2.1 Car and Truck Measurements (Assembled-empty car)

a. Outboard gib clearance (one point/gib) ($\pm$.01")

b. Inboard gib clearance (one point/gib) ($\pm$.01")

c. Side bearing roller-to-carbody wear plate clearance (one point/roller) ($\pm$.01")

d. Truck bolster-to-carbody bolster distance (two points/bolster) ($\pm$.06")

e. Snubber/stabilizer clearances (one point - if used) ($\pm$.06")

4.4.2.2 Truck Bolster Measurements (Disassembled)

a. Center plate (see Figure 4)

- Wear ring thickness on longitudinal and lateral axes (four points) ($\pm$.005")
- Wear ring thickness on major and minor wear axes (four points) ($\pm$.005")
- Angle of major wear axis ($\pm 2^{\circ}$)
- Horizontal wear liner thickness on each of the four axes above (twenty-four points) ($\pm$.005")

b. Gib thickness (three points/gib) ($\pm$.01")

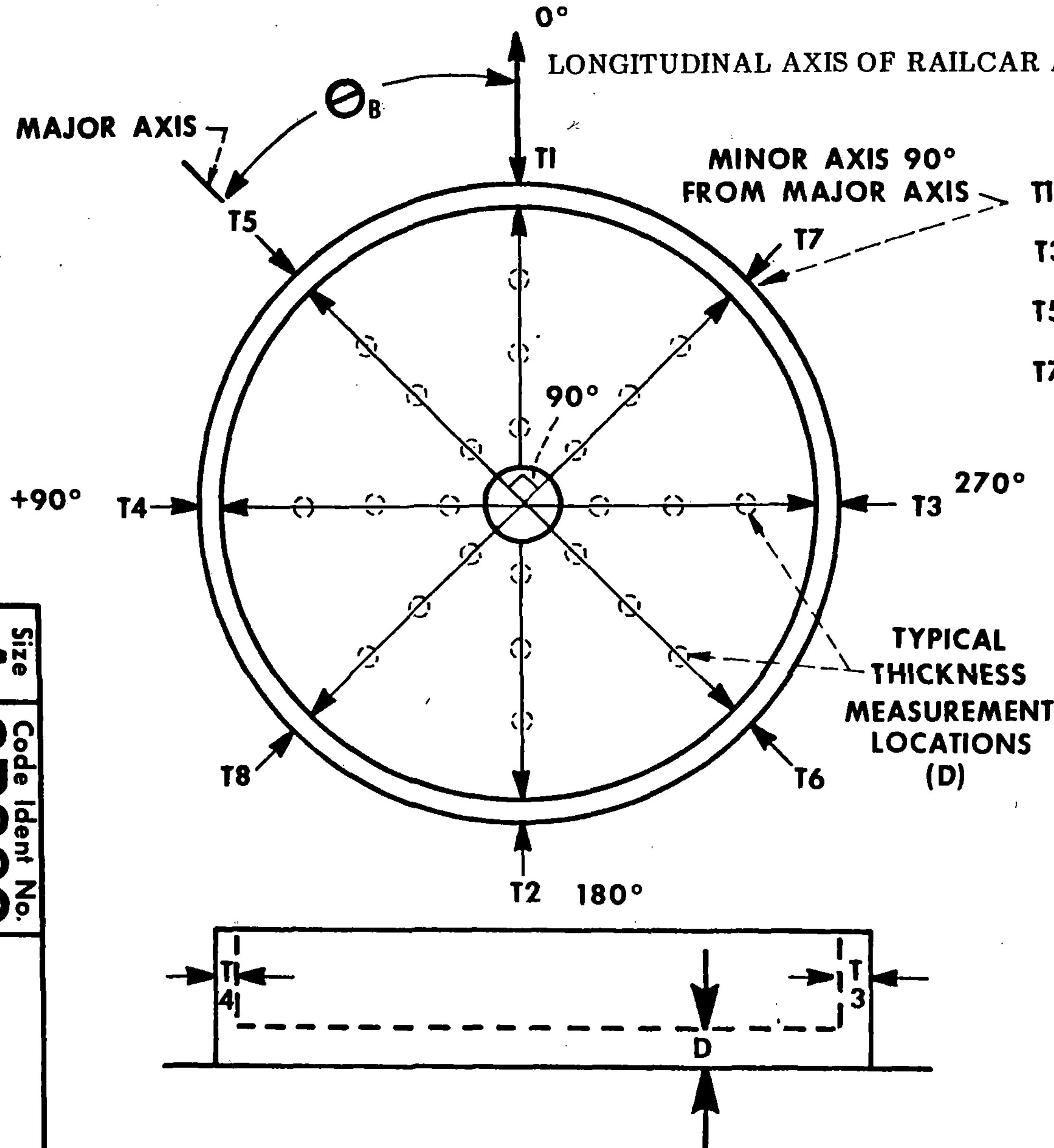
c. Column width between gib lateral stop faces (three points/gib pair) ($\pm$.01")

d. Inboard gib spacing across longitudinal stop faces (two points/gib pair) ($\pm$.01")

e. Column spacing across longitudinal stop faces (two points adjacent to outboard gibs, two points adjacent to inboard gibs) ($\pm$.01")

4.4.2.3 Truck Side Frame Measurements (Disassembled)

a. Pedestal lug thickness perpendicular to longitudinal stop face (three points/lug) ($\pm$.005")



T1 & T2 = LONGITUDINAL AXIS WEAR RING THICKNESS

T3 & T4 = LATERAL AXIS WEAR RING THICKNESS

T5 & T6 = MAJOR WEAR AXIS WEAR RING THICKNESS

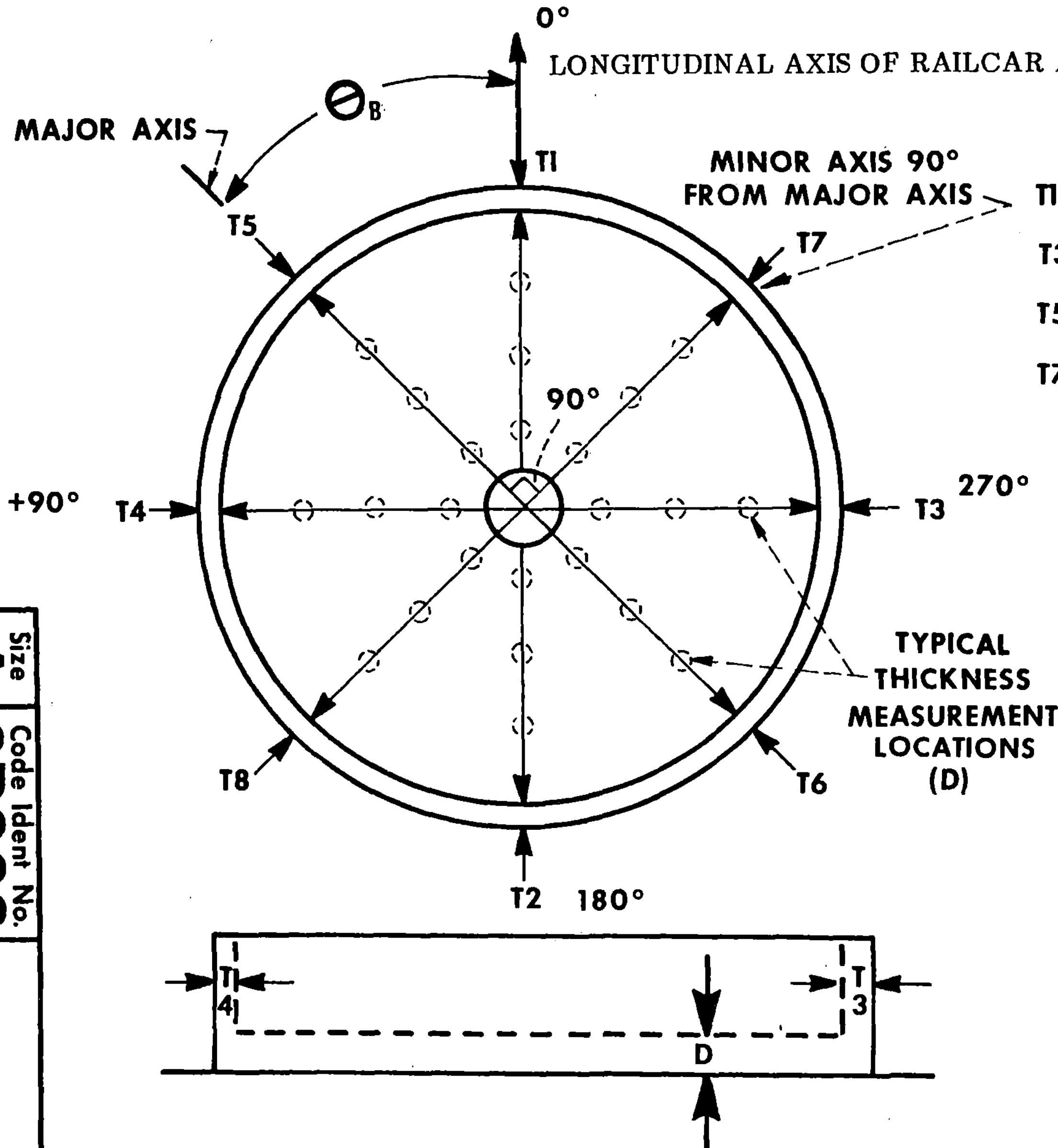
T7 & T8 = ORTHOGONAL AXIS TO MAJOR WEAR AXIS WEAR RING THICKNESS

Θ_B = MAJOR WEAR AXIS ANGLE WITH LONGITUDINAL AXIS (ASSUMED TO BE +45° AT START OF MEASUREMENT PROGRAM)

T = THICKNESS AS MEASURED WITH ULTRASONIC THICKNESS GAGE AT SPECIFIC LOCATIONS ON WEAR RING

D = THICKNESS AS MEASURED WITH ULTRASONIC THICKNESS GAGE AT 24 TEMPLATE LOCATIONS ON HORIZONTAL WEAR LINER

Figure 4. Center Plate Wear Measurements (Sheet 1 of 2)



T1 & T2 = LONGITUDINAL AXIS WEAR RING THICKNESS

T3 & T4 = LATERAL AXIS WEAR RING THICKNESS

T5 &T6 = MAJOR WEAR AXIS WEAR RING THICKNESS

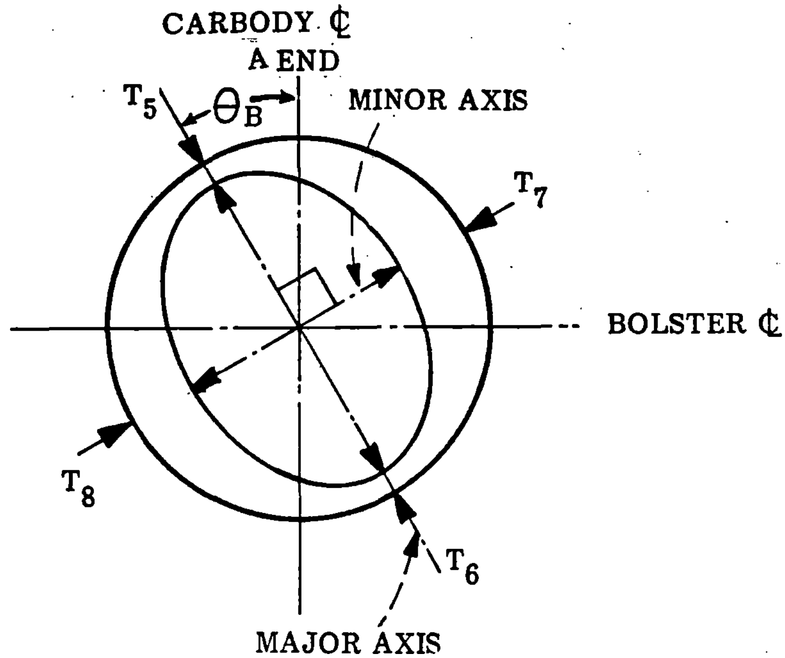
T7 & T8 = ORTHOGONAL AXIS TO MAJOR WEAR AXIS WEAR RING THICKNESS

Θ_B = MAJOR WEAR AXIS ANGLE WITH LONGITUDINAL AXIS (ASSUMED TO BE +45^{o} AT START OF MEASUREMENT PROGRAM)

T= THICKNESS AS MEASURED WITH ULTRASONIC THICKNESS GAGE AT SPECIFIC LOCATIONS ON WEAR RING

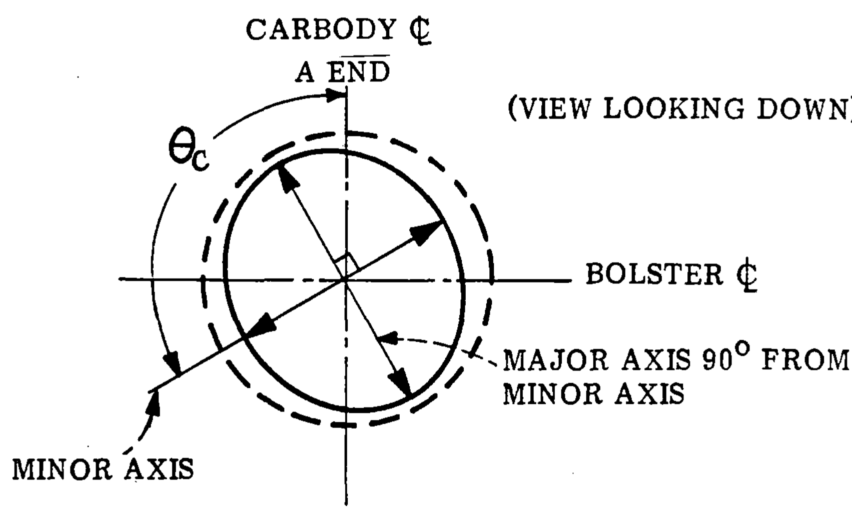
D = THICKNESS AS MEASURED WITH ULTRASONIC THICKNESS GAGE AT 24 TEMPLATE LOCATIONS ON HORIZONTAL WEAR LINER

Figure 4. Center Plate Wear Measurements (Sheet 1 of 2)



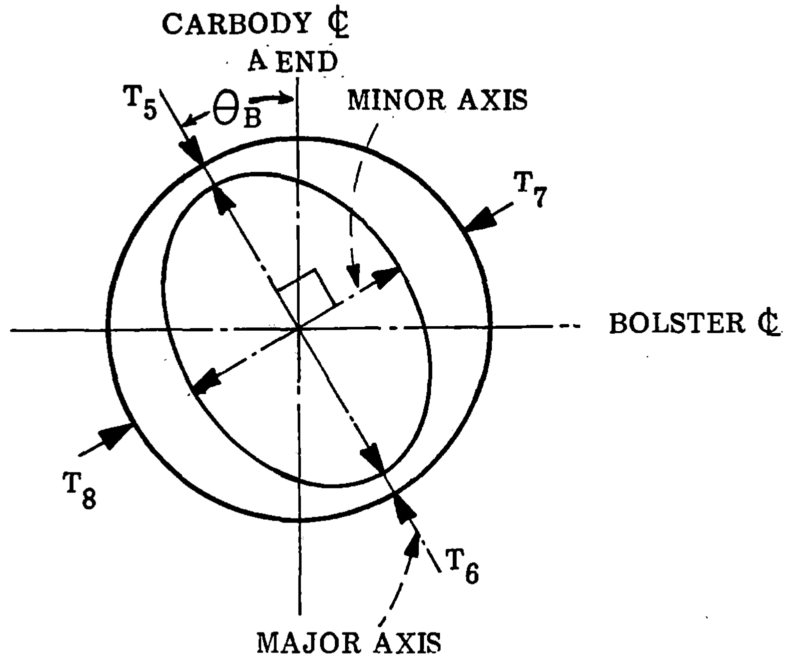
TRUCK BOLSTER CENTER PLATE MAJOR WEAR AXIS

DETERMINED BY MINIMUM THICKNESS MEASUREMENTS AT T_5 - AXIS PASSES THROUGH CENTER OF CENTER PLATE TO DETERMINE T_6



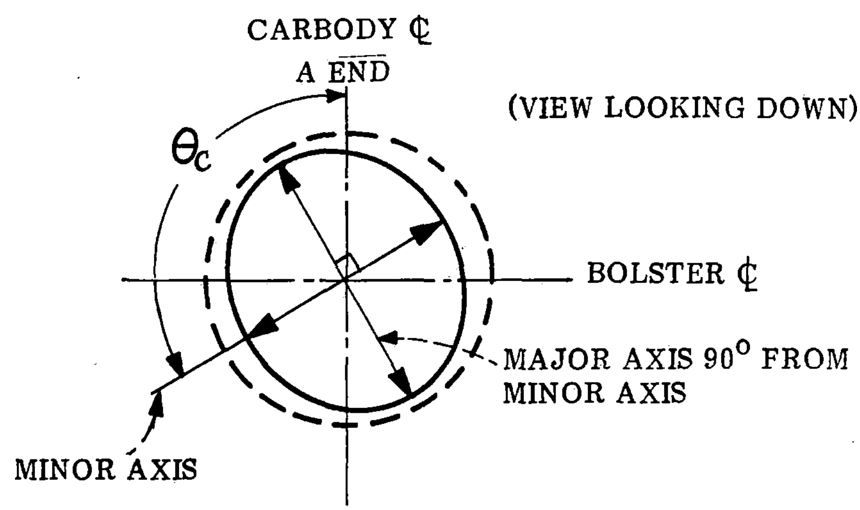
CARBODY CENTER PLATE MINOR AXIS
DETERMINED BY MINIMUM CENTER PLATE DIAMETER

Figure 4. Center Plate Wear Measurements (Sheet 2 of 2)



TRUCK BOLSTER CENTER PLATE MAJOR WEAR AXIS

DETERMINED BY MINIMUM THICKNESS MEASUREMENTS AT T_5 - AXIS PASSES THROUGH CENTER OF CENTER PLATE TO DETERMINE T_6



CARBODY CENTER PLATE MINOR AXIS
DETERMINED BY MINIMUM CENTER PLATE DIAMETER

Figure 4. Center Plate Wear Measurements (Sheet 2 of 2)

b. Pedestal lug width across lateral stop faces (one point/lug) (±.005")

c. Pedestal lug spacing between longitudinal stop faces (one point/lug pair) (±.005")

d. Pedestal jaw spacing between bearing contact points (three points/jaw) (±.005")

e. Pedestal jaw spreading at bottom of outer leg (two points between legs) (±.05")

f. Pedestal roof thickness (six points/pedestal) (±.005")

g. Wear plate thickness (nine points/wear plate) (±.005")

h. Antirotation lug thickness (three points/lug) (±.01")

i. Antirotation lug spacing between longitudinal stop faces (three points/lug pair) (±.01")

j. Column width (six points/side frame) (±.01")

4.4.2.4 Truck Component Measurements (Disassembled)

a. Brake shoe thickness (twelve points/shoe) (±.002")

b. Brake shoe weight before installation and after use (±1/2 ounce)

c. Side bearing roller minimum diameter at midpoint (one point/roller) (±.01")

d. Side bearing cage base thickness (one point/roller) (±.005")

e. Spring free length (one point/spring) (±.06")

f. Bearing adapter thickness across longitudinal stop faces between lugs (one point/adapter) (±.005")

g. Bearing adapter lug thickness across lateral stop faces (four points/adapter) (±.005")

h. Bearing adapter lug spacing between lateral stop faces (two points/ adapter) (±.005")

i. Bearing adapter crown height (six points/adapter) (±.005")

j. Bearing adapter weight (± 1/2 ounce)

k. Friction casting vertical wear face thickness (nine points/friction casting) (±.005")

l. Friction casting sloping wear face thickness (six to nine points/friction casting) (±.005")

m. Friction casting weight (±1/2 ounce)

4.4.2.5 <u>Carbody Measurements</u> (Disassembled)

a. Center plate (see Figure 4)

- Diameters parallel to longitudinal and lateral axes (two points) (±.01")
- Diameters parallel and perpendicular to minor axis (two points) (±.01")
- Angle of minor axis (±2^{o})
- Thickness on each of the four axes above (twenty-four points) (±.005")

b. Side bearing wear plate thickness (one point/roller) (±.005")

4.4.2.6 <u>Wheel Measurements</u>

a. Wheel profile (one point/wheel) (±.03")

b. Rim thickness (two points/wheel) (±.06")

c. Flange height (two points/wheel) (±.06")

d. Flange width (two points/wheel) (±.06")

e. Circumference at tape line (one point/wheel) (±.008")

4.4.2.7 <u>Type II Truck Additional Measurements</u>

a. National Swing Motion truck

- Rocker seat trunnion thickness (two points/trunnion) (±.005")
- Rocker seat trunnion contour (two points/trunnion) (±.03")
- Rocker seat bearing thickness (two points/bearing) (±.01")

- Rocker seat bearing contour (two points/bearing) (±.03")
- Bolster lateral stop face thickness (three points/stop)(±.005")
- Transom lateral stop face thickness (three points/stop) (±.005")
- Bolster-to-transom lateral stop clearance (one point/stop) (±.01")
- Side frame pedestal rocker seat contour (two points/rocker seat) (±.03")

b. Barber S-2-HD C-PEP truck

- C-PEP free height (two points/C-PEP) (±.01")
- C-PEP compressed height (two points/C-PEP) (±.01")

c. Dresser DR-1 truck

- Steering arm shaft and horizontal and vertical diameters (two points/shaft) (±.005")
- Steering arm bushing horizontal and vertical diameters (two points bushing) (±.005")
- Bearing adapter elastomeric pad height (two points/adapter) (±.01")

d. Barber-Scheffel truck

- Cross arm thickness at crossover point (one point/arm) (±.005")
- Elastomeric shear pad height (two points/shear pad) (±.01")

4.4.2.8 Narrative/Descriptive Recordings

a. General condition of railcar and truck components including any observed anomalies (i.e., cracks, replaced components, mislocated components)

b. Measurement difficulties encountered

5.0 WEAR DATA BASE

The TDOP Wear Data Base will be designed to collect data from multiple sources by truck type, manufacturer, load capacity, operational classifications, curve-to-tangent ratios, mechanical wear, and repair and maintenance costs. Data from participating railroads, the TDOP Wear Data Collection Program, and the FAST Program will be utilized. The data base will be developed by means of Wyle Laboratories' Interdata 8/32 computer using TOTAL as a data base management system. This system is ideal for the wear data base in that it allows for both fixed data files (master files) and variable files. Thus, fixed information such as truck manufacturer, type and nominal physical characteristics and specifications only need be recorded once in the data base. Variable data such as serial numbers of individual truck components, operating profiles, track characteristic measurements, maintenance manhours, component replacements, wear measurements, etc., can be entered into the variable data files as appropriate. Figure 5 shows the TDOP wear data flow. A description of the TDOP data base is contained in the Wyle document C-901-0003-A, "TDOP Wear Data Base Description".

6.0 DATA PRESENTATION

Wear data and wear rates will be plotted for components such as bolster center plate liners, side frame wear plates and bearing adapter crowns to identify accelerated wear rates and trends. Computer plots of wear data will be provided to the other TDOP task efforts.

7.0 WEAR DATA PROGRAM QUALITY CONTROL

7.1 FIELD QUALITY CONTROL

Each measurement will be performed once by each of two field engineers (see Figure 6). The first field engineer will start with a series of measurements. He will verbally call them out to the second engineer who will record them on a cassette recorder and manually record them on the first set of data sheets. The second field engineer will change places with the first and independently make the measurements while the first records the data on a second set of data sheets and a second cassette recorder.

After a complete measurement cycle on an individual truck is completed by both engineers, the measurements will be compared for agreement within accuracy limits. If they do not agree, they will be first checked against the voice recording for a possible error in form completion. If the data were accurately recorded on the form, the measurement will be repeated by each engineer and the measurements recorded on data sheets.

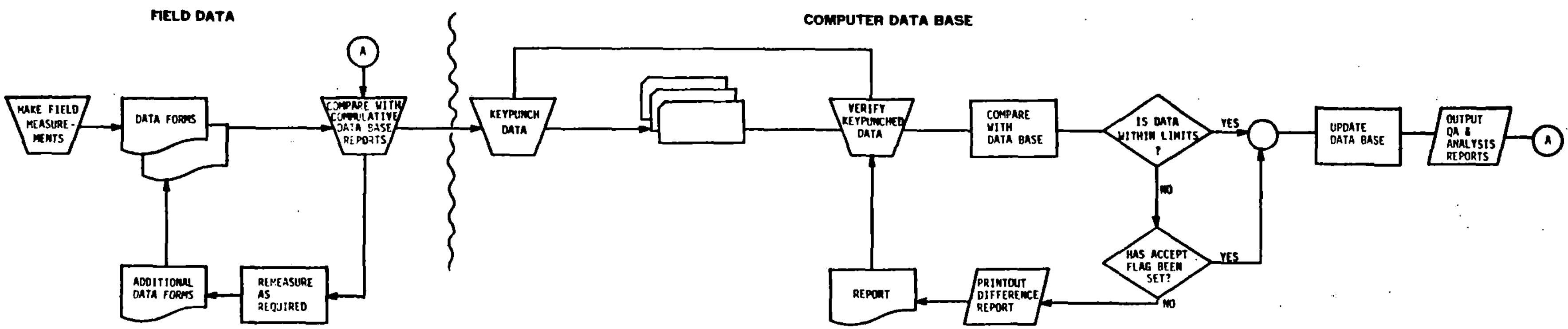


Figure 5. TDOP Wear Data Flow

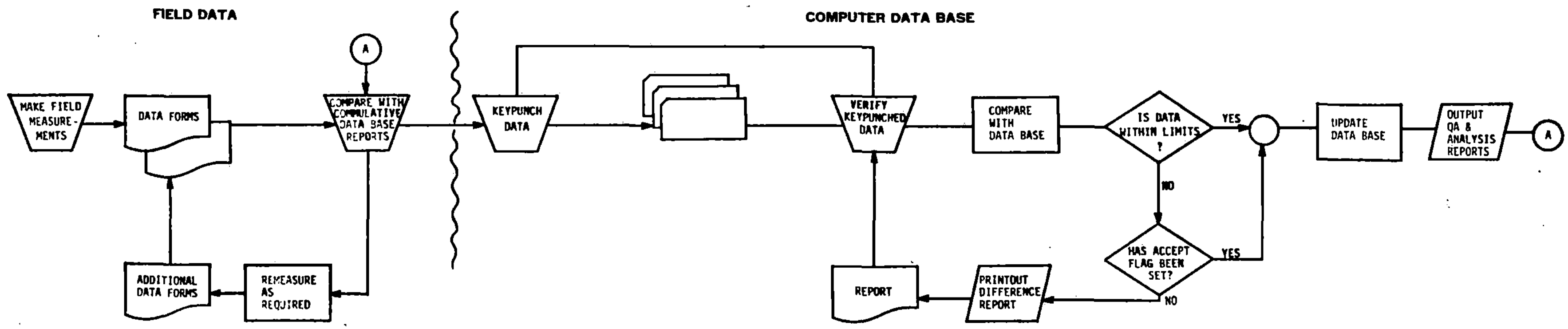


Figure 5. TDOP Wear Data Flow

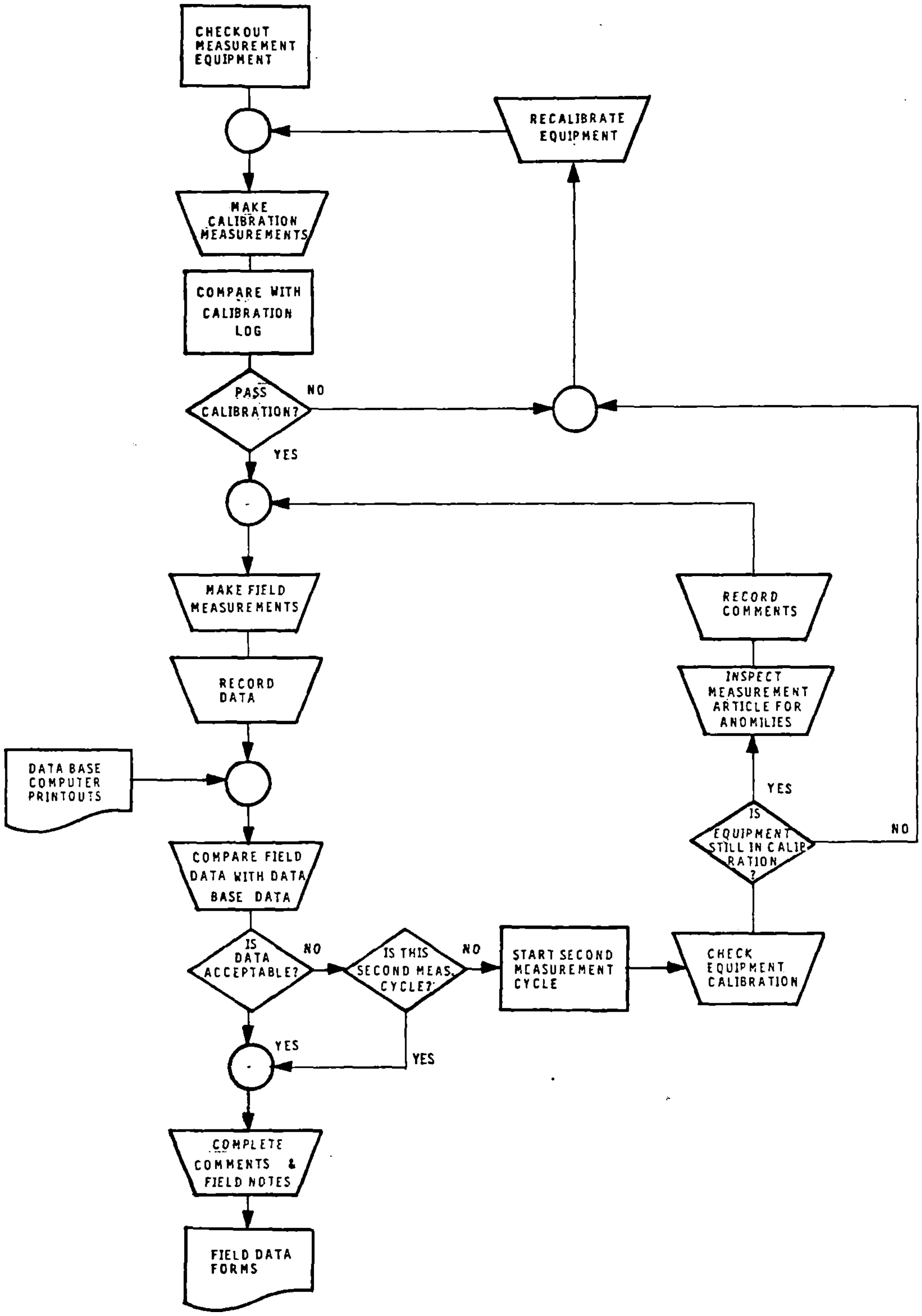


Figure 6. Field Data Collection Flow Chart

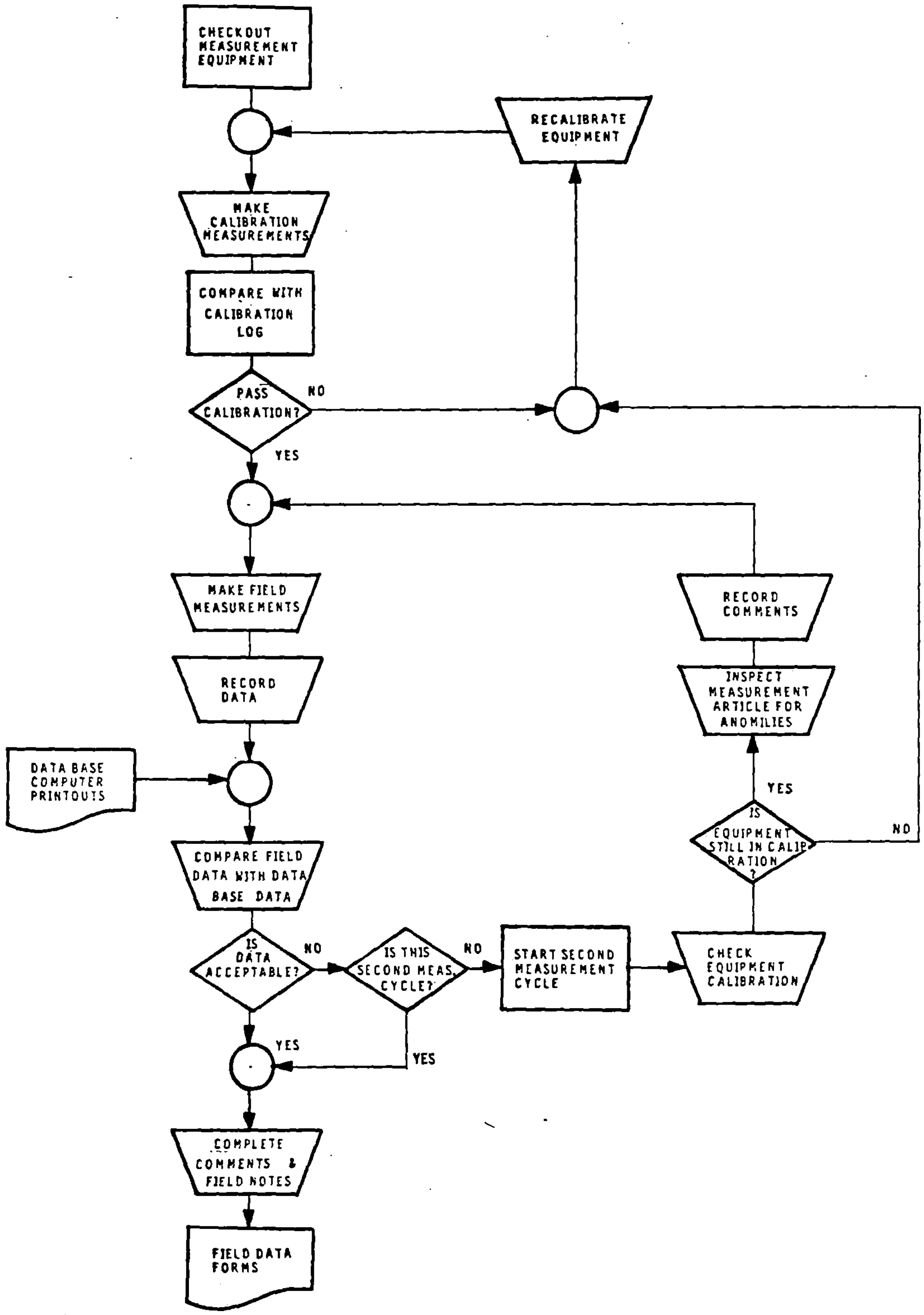


Figure 6. Field Data Collection Flow Chart

Before remeasuring, the data will be compared with a computer printout of previous measurement average values. Those measurements which have a significant variance or anomalies (e.g., wear plate increasing in thickness or wear rates double that of previous rates) will be remeasured by both engineers after instrument calibration checks.

Statistically, since the measurements represent separate samples of the same measurement, the accuracy of the average value should be improved by the factor of one divided by the square root of the number of samples. Thus, the average value for four measurement samples is twice as accurate as any one of the individual measurements.

The need for dual measuring will be evaluated after data have been collected after four months (approximately 50,000 miles of wear). If both field engineers had consistently recorded the same measurement within the prescribed accuracy limits, Wyle may elect to measure a wear point only once rather than twice.

7.2 PROJECT OFFICE QUALITY CONTROL

A data sheet will be reviewed by Wyle data processing personnel for proper format and coding. The data will be entered into the computer (see Figure 7). The computer printout will present, in tabular form, the following data:

a. New measurements
   - Averaged value
   - Exceeded tolerances

b. Averaged values of preceding measurements for each quantity measured

After the new data have been checked for accuracy and reasonableness, all readings for each data point will be averaged and entered into the data file.

8.0 REPORTS

At the completion of the TDOP Wear Data Collection Program, a report will be written which will describe the program, its collected data and data base, and provide selected plots of wear measurements and significant results. The contents of the data base will be recorded on computer magnetic tape and submitted to NTIS for public access.

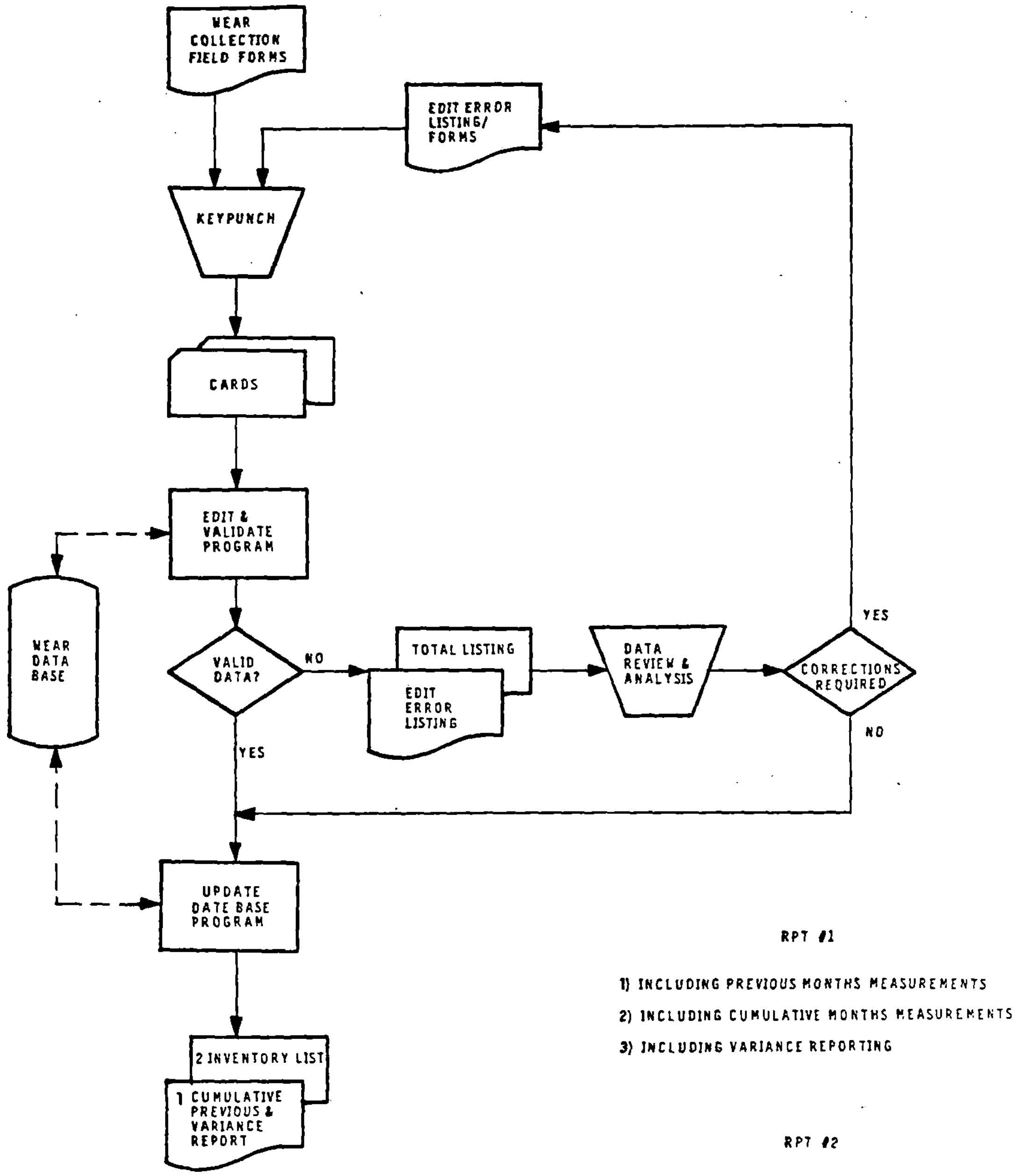
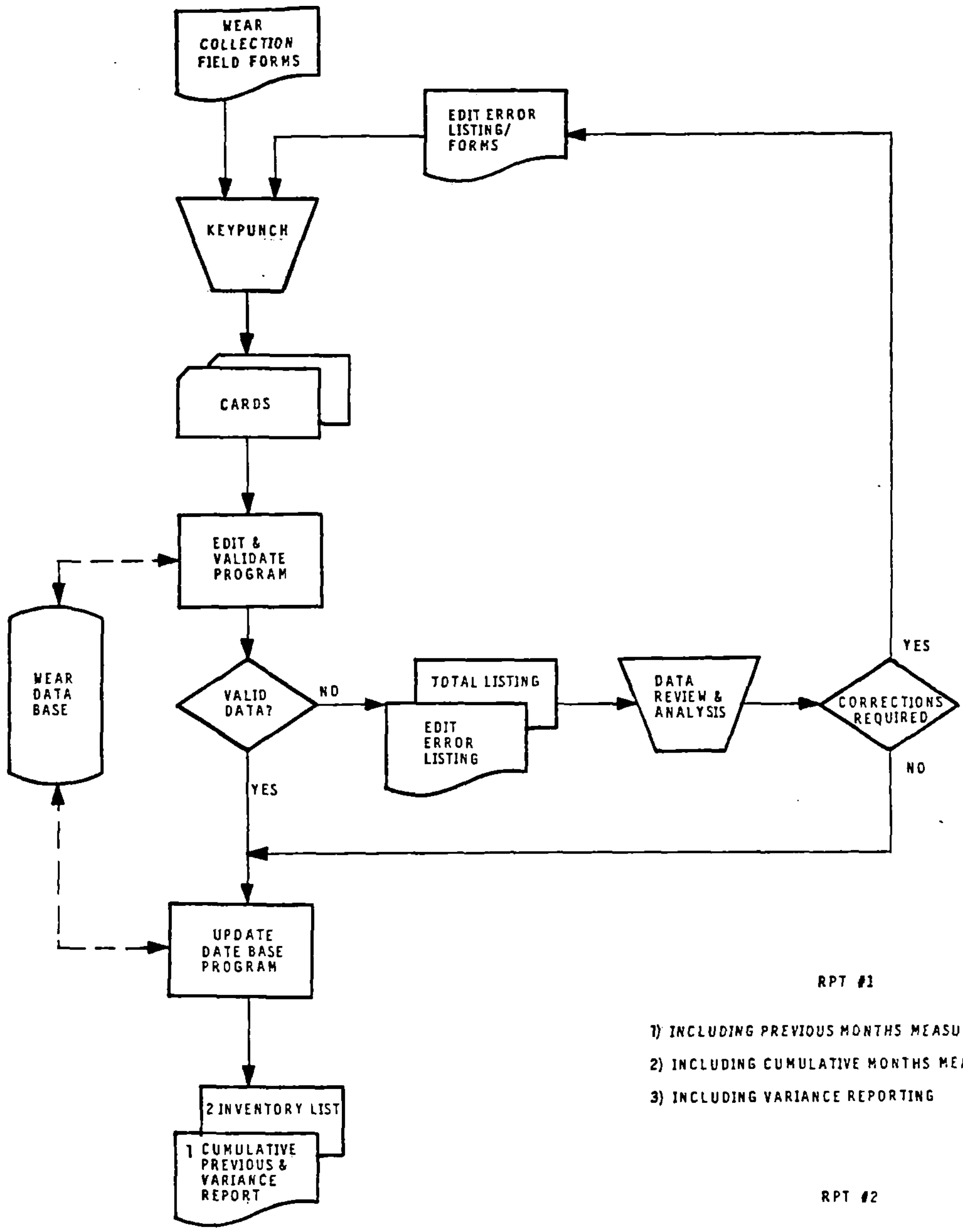


Figure 7. Project Office Data Flow



RPT #1

1) INCLUDING PREVIOUS MONTHS MEASUREMENTS
2) INCLUDING CUMULATIVE MONTHS MEASUREMENTS
3) INCLUDING VARIANCE REPORTING

RPT #2

1) ALL PARTS (WITH BASELINE MEASUREMENTS)
2) ALL NEWLY REPLACED PARTS (WITH BASELINE MEAS.)
3) MISC. PART NO. DATA

Figure 7. Project Office Data Flow

APPENDIX B

WEAR DATA COLLECTION PROCEDURE

TRUCK DESIGN OPTIMIZATION PROJECT (TDOP) PHASE II

WEAR DATA COLLECTION PROCEDURES

NOVEMBER 1979

(REVISED DECEMBER 1980)

CONTRACT NO. DOT-FR-742-4277			WYLE LABORATORIES SCIENTIFIC SERVICES AND SYSTEMS GROUP COLORADO SPRINGS, COLORADO		
PREPARED C. Jones/W. Schmidt	cJ /WRS				
APPROVED D. Gibson	DWG 11/26/79				
APPROVED					
APPROVED K. Cappel Technical Director	K.L.Cappel 11-30-79				
PROGRAM MANAGER G. Bakken	11-30-79		Size A	Code Ident No. 2B360	C-901-0006-A
NEXT ASSY	USED ON		Scale	Rev A	Sheet Title Page

REVISION

LETTER	DESCRIPTION	DATE	APPROVAL
A	GENERAL UPDATE TO REFLECT LATEST FIELD MEASUREMENT PROCEDURES. ADDED SHEETS i AND ii; RENUMBERED TABLE OF CONTENTS SEQUENTIALLY THEREAFTER. REMOVED SHEET 103. NOTE: ADDITIONS/DELETIONS OR MODIFICATIONS TO TEXT ARE INDICATED BY A VERTICAL BAR IN THE RIGHT PAGE MARGIN. PAGE COMPOSITIONS REARRANGED BY THESE REVISIONS ARE NOT SO DELINEATED.	12/01/80	GBD 2/12/81

ACTIVE SHEET RECORD

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ii		26		58		90	A				
iii	A	27		59	A	91					
iv	A	28		60	A	92					
v	A	29		61	A	93	A				
vi	A	30		62		94					
vii	A	31		63	A	95					
viii	A	32		64		96					
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8	A	40		72							
9	A	41		73	A						
10	A	42	A	74	A						
11	A	43		75	A						
12	A	44		76	A						
13	A	45	A	77							
14	A	46		78							
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16	A	48	A	80							
17		49	A	81							
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22		54		86							
23		55		87							

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Scale	Rev	Sheet ii

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SECTION 1 - INTRODUCTION

1.1 BACKGROUND

The Wear Data Collection Program measures and records wear on several Type I and Type II freight car trucks and selected carbody/truck interfaces. This program is part of the Truck Design Optimization Project (TDOP) Phase II, sponsored by the Federal Railroad Administration (FRA). The test trucks operate in unit coal train service between the Kaiser Steel Mill in Fontana, California and mines located in both Colorado and Utah. All scheduled measurements are taken at the Union Pacific Railroad's Las Vegas, Nevada, yard, where a field office has been located adjacent to the repair-in-place (RIP) tracks. Dr. Kendall Shane, Engineer of Tests for Union Pacific Railroad, is responsible for coordination of all activities of this program insofar as they affect Union Pacific Railroad and the other two railroads, Santa Fe and Denver Rio Grande Western, over whose tracks the unit trains run. Hereafter in this document, the term "Union Pacific Railroad representative" shall refer to Dr. Shane or to any other employee of Union Pacific Railroad appointed to act in his behalf in matters relative to the Wear Data Collection Program.

This document contains the detailed wear measurement procedures and descriptions of the associated activities required to obtain and record all necessary truck and carbody measurements. Also included are descriptions of all required instruments and equipment, including the test cars, and a copy of each of the data recording forms.

The procedures were developed through participation in the initial set-up and measurement of the six truck types originally included in the Wear Data Collection Program. These six trucks are the National Swing Motion, Barber S-2-C, Dresser DR-1, Barber S-2-HD with C-PEP, ASF Ride Control, and Barber-Scheffel. A seventh truck, the Socimi/MTS Maxiride is anticipated to be placed in the program in early 1981. The measurement procedures on the trucks were verified during the first cyclic measurements after approximately 12,500 miles of service. Any future inclusion of different truck types will necessitate appropriate revision to this document to include additional techniques, procedures, data forms, and equipment that may be required.

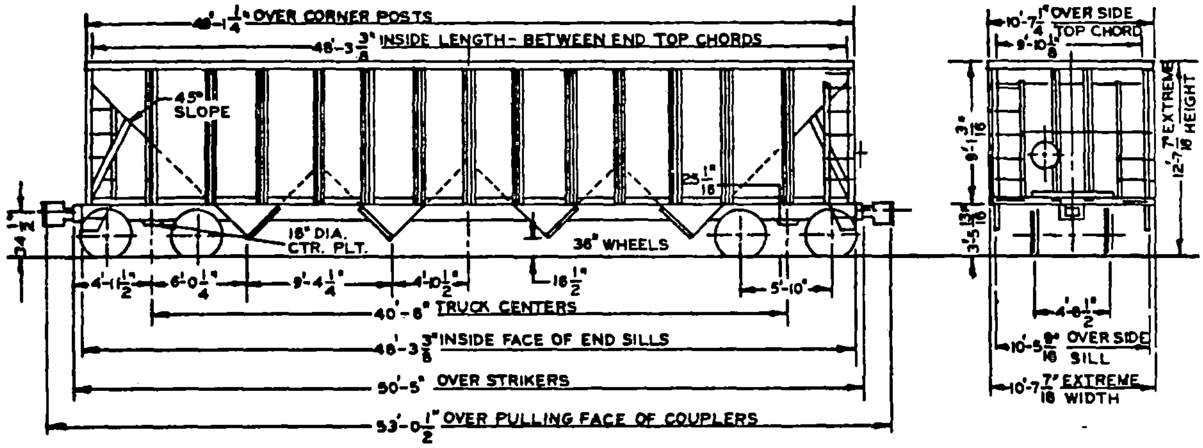
1.2 TEST CARS

Cars employed in the Wear Data Collection Program are furnished by Union Pacific Railroad. They are all 100-ton nominal capacity, open-top, self-clearing hopper cars having fixed sides and ends and a bottom consisting of four divided hoppers with doors hinged crosswise. The AAR code is "H250" and the mechanical designation is "HT." Service in the unit coal trains used for the Wear Data Collection Program requires a remote retainer valve and separate retainer air line, features which limit the acceptable cars of this type in the Union Pacific fleet to what is designated by the railroad as classes "H-100-10," "H-100-11," and "H-100-12." Acceptable car numbers encompassed by these classes are UP37200 through UP38699. Pertinent physical characteristics of these cars are given in Figure 1.1.

All of these cars were originally configured with center plate extension pads (C-PEP) and rod-under braking utilizing 8- by 14-inch levers. Test trucks having other than rod-under braking require car modifications including removal of any interfering C-PEP wear plates and substitution of a larger diameter brake cylinder to maintain equivalent braking forces. These modifications are discussed as they apply to set-up of the various trucks in Section 2.6.2.

1.3 TEST TRAINS AND MILEAGE ASSESSMENT

Test cars are operated in two unit coal trains, the Kaiser Unit (KU), also referred to as the "Sunnyside Coalliner Regular Unit Coal Train," and the Carbondale/Sunnyside Unit (CSU), also referred to as the "Combination Carbondale/Sunnyside Supplemental Unit Coal Train." The KU train makes approximately seven and a half round trips of 1600 miles each per month and the CSU train approximately six round trips of 2120 miles each per month. Routes of these trains are shown in Figure 1.2. Both trains travel an identical route between the steel mill in California and a location about 20 miles past Helper, Utah, where the KU train is diverted to the mines (about 17 miles beyond). The CSU train route extends approximately 260 miles eastward from this point to mines located in Carbondale, Colorado. Because of the route commonality, cars are frequently exchanged between the KU and CSU trains at Helper, Utah, making a count of the accumulated mileages difficult.



500 M LB. DRAFT RATING

EQUIPPED WITH REMOTE CONTROL RETAINER VALVE

LENGTH INSIDE	48'-3 3/8"
WIDTH INSIDE	9'-10 1/8"
CUBIC CAPACITY-LEVEL FULL	3625 CU. FT.
WT. OF EACH TRUCK	10,500 LBS.
LT. WEIGHT OF CAR-COMPLETE EST.	65,000 LBS.
SUPERSTRUCTURE-RIVETED CONSTRUCTION	CAR BUILDER
UNDERFRAME-RIVETED CONSTRUCTION	"
CENTER OF GRAVITY ABOVE RAIL-LIGHT CAR	52.05
" " " " " -LOADED CAR	90.42

CAR BUILDER	NO. CARS BUILT	YEAR BUILT
BETH.	SEE TEXT	1975

MIN. CURVE NEGOTIABLE COUPLED TO BASE CAR 178 FT. RADIUS

ACI LABELS	INFO. INC.
AIR BRAKE 8 1/2" X 12"	NYAB-WABCO
ANGLE COCK	SMITH
AXLES 6 1/2" X 12"	BETHLEHEM
BOTTOM ROD GUARDS	CRECO
BRAKE BADGE PLATE	SHENANGO
BRAKE BEAM	ASF, CRECO, CLARK, BUF., DAVIS
BRAKE BEAM WEAR PLATE	MIDWEST FORG.
BRAKE CYLINDER PUSH ROD	SCHAEFER
BRAKE LEVER & CONN.	SCHAEFER
BRAKE PIPE CLAMPS	ILL. RY. EQUIP.
BRAKE REGULATOR	SAB
BRAKE ROD JAWS	SCHAEFER
BRAKE SHOES - HF COMP.	WABCO
BRAKE SHOE KEYS	ABEX
CTR. PLT. EXT. PAD-C-PEP	STD. CAR TRUCK
CTR. PLT. - BODY	BUCKEYE
CORNER CAP	SCHAEFER
COTTERS "LOCKTITE"	GUSTIN-BACON
COUPLER "TYPE E"	ASF, McCON-TORLEY
COUPLER RELEASE RIGGING	STD. RY. EQUIP.
COUPLER YOKE	McCON-TORLEY

CROSSOVER PLATFORM	US. GYPSUM
DEAD LEVER BRACKET	PITT. FORG.
DEFECT CARD HOLDER	WESTERN RY. EQUIP.
DOOR FRAMES, HINGES & LOCKS	WINE RY. APPL.
DRAFT GEAR	MINER, NAT'L, CARDWELL
DRAFT SILL CASTINGS	BUCKEYE
HANDBRAKE	MIN., ELLCON, AJAX, UNIV., KLAS.
INSIDE BRACE FOOT	MIDLAND ROSS
ROLLER BEARINGS 6 1/2" X 12"	TIMKEN, HYATT, BRENCO
ROLLER BEARING ADAPT.	R.H. LITTLE, HAY, ALB.
ROLLER BEARING RETAINER KEYS	BETHLEHEM
TRUCK BOLSTER	SCULLIN, ASF.
TRUCK SIDE BEARINGS	A. STUCKI
TRUCK SIDE FRAME	SCULLIN, ASF.
TRUCK SPRINGS D-5	MILLER, COLT, UNION, ALCO
TRUCK STABILIZERS S-2-C	STD. CAR TRUCK
WHEELS 2WR J-36	BETHLEHEM

FIGURE 1.1. TDOP PHASE II WEAR DATA COLLECTION PROGRAM TEST CARS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 3

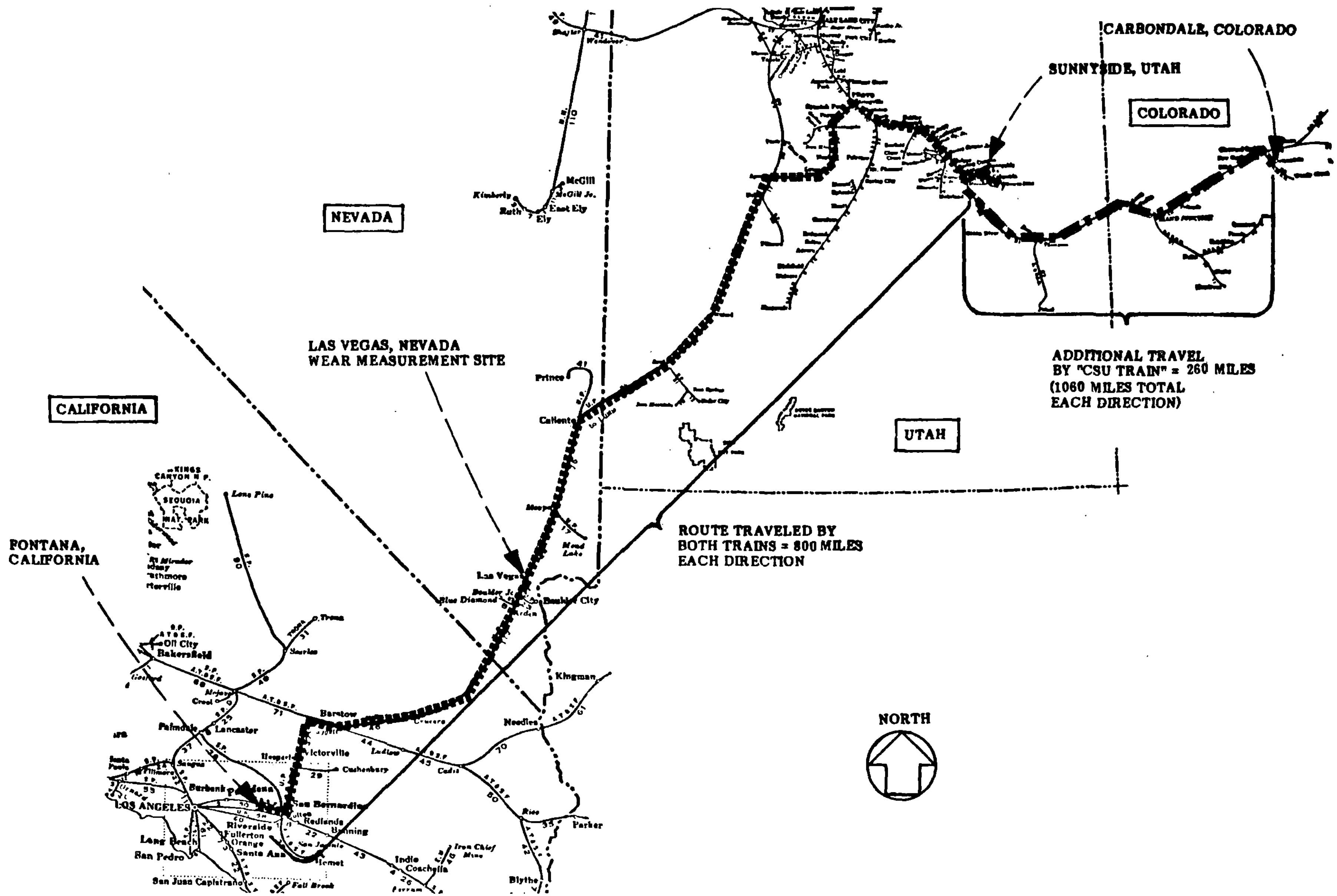


FIGURE 1.2. ROUTE OF UNIT COAL TRAINS "KU" AND "CSU"

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 4

Individual car mileages are determined by a computer print-out provided by the Union Pacific that lists by number the daily location of each car on the Union Pacific system. Called the "weekly jumbo," this listing summarizes at week's end (Sunday) the locations of each car for the preceding seven days. Using this listing and a railroad atlas, accumulated mileages can be calculated for each test car, provided that service in either the KU or CSU trains is maintained.

Direct-reading odometers were mounted on the axles of the trucks at the time of the first cyclic measurements. These were installed as a backup for mileage determination since occasionally the test cars were inadvertently transferred out of the Union Pacific System to service over the tracks of another railroad. The total mileage for these test trucks exceeds the odometer indications by the amounts accumulated between service introduction and the odometer installation. It is anticipated that odometers will be installed during the initial set-up and measurement activities to any new truck types that may be added to the Wear Data Collection Program.

1.4 MEASUREMENT CYCLES

Truck and carbody measurements are taken at the time each truck type enters service and at selected mileage intervals thereafter. Initially, the intervals between measurement cycles will be approximately 12,500 miles. Mileage accumulations between each of the subsequent measurement cycles will be chosen by the TDOP Project Office, and based on wear trends established from all preceding measurements. It is anticipated these intervals will normally be multiples of 12,500 miles.

There are two categories of measurements - inventory and cyclic. Inventory measurements are taken at the time each truck type enters service. In general, these are of record-keeping significance only and are not expected to change with service. Cyclic measurements are taken at each measurement cycle (except as specified in Section 3) and provide the data required to assess wear on trucks, truck components, and truck/car interfaces.

1.5 FACILITIES

The Wyle Laboratories TDOP field office in Las Vegas is provided by Union Pacific Railroad through a lease arrangement. It is located at the east end of the yard between repair tracks RIP-3 and RIP-4. The mailing address for packages and correspondence is "Wyle Laboratories, c/o General Car Foreman, Union Pacific Railroad, 201 Claim Avenue, Las Vegas, Nevada, 89106."

The office provides adequate space for clerical tasks and also serves as a secure storage area for instruments and smaller equipment. A large, fenced yard west of the field office provides a storage place for larger items, such as trucks and wheelsets.

1.6 INSTRUMENTS AND EQUIPMENT

Table 1.1 contains a listing of instruments and equipment fabricated or purchased for use in the Wear Data Collection Program. Not all items listed are used at present. Also, some expendable items such as paint and tape are not listed in Table 1.1 but are included by name or inference in the procedures.

Data forms were designed to facilitate measuring and recording data. In general, multiple measurements on a single component (e.g., side frames) or multiple measurements employing a common piece of equipment (e.g., ultrasonic thickness gages) are grouped together on a common form. The forms were constructed so as to have the widest possible application to the various truck types originally included in the wear program. Special forms were made when necessary to record features unique to a particular truck, where the general forms proved not to be applicable, and for the additional special measurements unique to the Type II trucks. Copies of all data forms are included in Section 4 after the procedural description of the corresponding measurements.

TABLE 1.1. TOOL LIST FOR TRUCK MEASUREMENTS

MEASURING DEVICE	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006	REMARKS
Telescoping Gage	Starrett 579-B, ½" to 3/4" range	●	●	●	●	●	●	
Telescoping Gage	Starrett 579-C, 3/4" to 1¼" range	●	●	●	●	●	●	Modified per Wyle SK-060779.1-A
Small Hole Gage Set	Starrett 829-E 1/8" to ½" range	●	●	●	●	●	●	
Digital Outside Micrometer Set	Mitutoyo 193-925 0" to 6" range	●	●	●	●	●	●	
Digital Outside Micrometer Set	Mitutoyo 193-927 6" to 12" range	●	●	●	●	●	●	
Tubular Inside Micrometer	Mitutoyo 133-232 11" to 12" range							
Tubular Inside Micrometer	Mitutoyo 133-231 10" to 11" range							
Tubular Inside Micrometer	Mitutoyo 133-230 9" to 10" range	●	●	●	●	●	●	
Tubular Inside Micrometer	Mitutoyo 133-228 7" to 8" range	●	●	●	●	●	●	
Dial Calipers	Fowler 52-040-024 0" to 24" range	●	●	●	●	●	●	
Dial Depth Gage	Kafer-SP1 02-20-75 1" travel, 0" to 7" range	●	●	●	●	●	●	
Lock Joint Inside Calipers	Starrett No. 39 6" leg size, approx. 9" capacity							
Thickness Gage	Starrett No. 467 .0015 to .200 leaves							
Outside Measuring Caliper with Dial Gage (Squeeze Type)	Federal Products Corp. No. 49P-1 0" - 3" jaw diametral capacity at 0" - 4" depth	●	●	●	●	●	●	

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

TEMPLATES	PART OR DRAWING NO.	USED ON CAR NO.							REMARKS
		001	002	003	004	005	006		
Center Bowl Mechanical Depth Measurement Template Assy.	C-701-0024-E-09	●	●		●	●	●		Mechanical depth gage readings
16" Bolster Center Plate Template	C-701-0013-A-03	●	●	●	●	●	●		For ultrasonic readings on trucks with horizontal wear liners only; for radial indexing readings on all trucks
Side Frame Column Wear Plate Measurement Template	C-701-0018-A-01	●							For ultrasonic readings on Swing Motion trucks only
Friction Casting Wear Measurement Template (ASF Ride Control Shoe Vertical Face)	C-701-0018-A-02					●			For ultrasonic readings on ASF friction castings only
Side Frame Column Wear Plate Measurement Template	C-701-0018-A-03		●	●	●	●	●		For ultrasonic readings on all trucks except National Swing Motion
Friction Casting Measurement Template Assy. (ASF Ride Control Shoe Sloping Face)	C-701-0019-A-09					●			For ultrasonic readings on ASF friction castings only
Spring Squareness Measurement Template (for initial inventory measurements)	C-701-0023-A-01	●	●	●	●	●	●		Used with 12" General steel rule (modified), graduated 50ths - 100ths
Brake Shoe Measurement Location Drill Template	SK-O61379.1-A	●	●	●	●	●	●		Used with Federal dial calipers
Spring Single Height Measurement Fixture (for cyclical measurements)	C-701-0053-A -01	●	●	●	●	●	●		Used with Kafer-SP1 dial depth gage and spring squareness template C-701-0023-A-01

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

FIXTURES	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006		REMARKS
Roller Bearing Adapter Wear Measurement Assy.	C-701-0016-E-01	●	●		●	●	●		
Roller Bearing Adapter Wear Measurement Assy.	C-701-0041-E-01			●					
Depth Gage Indexing Fixture Assy. (Friction Casting Vertical Face)	C-701-0021-E-09	●	●	●					5½" wide Barber type friction castings only (S.C.T. No. 3973 typ.)
Depth Gage Indexing Fixture Assy., Friction Casting Sloping Face	C-701-0022-E-09	●	●	●					5½" wide Barber type friction casting only (S.C.T. No. 3973 typ.)
Depth Gage Indexing Fixture, Barber 834-B Friction Casting	C-701-0027-E-09				●		●		Barber type friction casting (S.C.T. No. 834-B only)
Pedestal Roof Mechanical Wear Measurement Fixture	C-701-0026-E-09 (9" wide with short pins)				●		●		
Pedestal Roof Mechanical Wear Measurement Fixture	C-701-0026-E-19 (7" wide with long pins)	●	●	●		●			

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

AAR GAGES	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006		REMARKS
Steel Wheel Finger Gage	Pratt & Whitney List No. 734	●	●	●	●	●	●		Modified for special measurements per SK-061379.2-A
Steel Wheel Circumference Tape	Pratt & Whitney List No. 719	●	●	●	●	●	●		
Tread and Flange Contour Gage - Narrow Flange Wheels	Pratt & Whitney G-700 C-394								
Master Gage for Above	Pratt & Whitney G-700 C-395								
Tread and Flange Contour Gage - Wide Flange Wheels	Pratt & Whitney G-700 C-570								
Master Gage for Above	Pratt & Whitney G-700 C-571								
Lateral Gage	Pratt & Whitney List No. 713								

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

MANUFACTURER'S SPECIAL OR PROPRIETARY EQUIPMENT	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006		REMARKS
Brake Shoe Force Measurement Instruments	Abex Hydra-Cell	●	●	●	●	●	●		Rented from Abex; for initial set-up o
Wheel Profilometer with Accessories		●	●	●	●	●	●		Loaned by TSC
Wheel Back-To-Back Measuring Gage		●	●	●	●	●	●		Loaned by TSC
Axle-Mounted Revolution Counters	Engler Instruments Revo-Count, 36" diameter	●	●	●	●	●	●		
ASF Friction Shoe Removal/Installation Fixture with Accessory Machined Parts	C-701-0031-E-01					●			Fabricated per AS maintenance manu dimensions

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

MISC. EQUIPMENT	PART OR DRAWING NO.	USED ON CAR NO.						REMARKS
		001	002	003	004	005	006	
Bench Beam Scale	McMaster-Carr 1790T27 0-125 lb capacity	●	●	●	●	●	●	
Ultrasonic Digital Thickness Gage with Accessories	Nortec NDT-124	●	●	●	●	●	●	
Ultrasonic Digital Thickness Gage with Accessories	Nortec NDT-131D							
Heavy Duty Tapewriter	Dymo No. 1011							
Dymo Labelmaker	Dymo No. 1720 or equiv.							Component inventory and tool labeling
¼" Electrical Drill	Black & Decker No. 7056	●	●	●	●	●	●	Initial marking and set-up only
3/8" Electric Drill with Recharger	SKIL No. 2002							
Electric Vibro-Etch Marking Tool with Carbide Point	Ideal #11-111	●	●	●	●	●	●	Brake shoe marking
Hydraulic Jack, 3-Ton Capacity	Montgomery Ward	●				●		Used with ASF shoe fixture C-701-0031-E-01 and to jack bolster for transom stop measurement on National Swing Motion
"Secutive" Recorder with Microphone and Accessories	Sony BM-11	●	●	●	●	●	●	
Camera, SLR, 35mm with 50mm Lens and Accessories		●	●	●	●	●	●	

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

MISC. EQUIPMENT	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006		REMARKS
Gothic Steel Letter Stamps	¼" character height	●	●	●	●	●	●		Inventory marking only
Gothic Steel Number Stamps	¼" character height	●	●	●	●	●	●		Inventory marking only
Pocket Scriber	Starrett No. 70B	●	●	●	●	●	●		Inventory marking only
Cold Chisel	Williams No. C-16	●	●	●	●	●	●		Inventory marking only
Pin Punches	Williams No. P-32	●	●	●	●	●	●		Inventory marking only
Hex Socket 2¼" x 3/4" Drive	Snap-On No. 5572						●		For initial set-up on Barber-Scheffel trucks
Straight Edge	Starret precision ground flat stock No. 496 3/16" x 1" x 18"	●	●	●	●	●	●		Inventory marking only
Hand Drilling Hammer	Craftsman 9HT38311	●	●	●	●	●	●		Inventory marking only
Steel Square	Stanley 45-012	●	●	●	●	●	●		Inventory marking only
C-Clamps	Hargrave No. 540-P	●	●	●	●	●	●		Positioning ultrasonic transducer templates
Spring Clamps	Hargrave No. 3	●	●	●	●	●	●		
Tape Measures	Stanley 25' and 100' lengths	●	●	●	●	●	●		
Steel Machinist's Rules	General 12", graduated 50ths - 100ths, 16ths - 32nds	●	●	●	●	●	●		Used with wheel finger gage
Wire Brushes	Misc. sizes	●	●	●	●	●	●		Used to clean scale or dirt from components before measuring
Bench Brush		●	●	●	●	●	●		

TABLE 1.1 TOOL LIST FOR TRUCK MEASUREMENTS (CONT.)

MISC. EQUIPMENT	PART OR DRAWING NO.	USED ON CAR NO. 001	002	003	004	005	006		REMARKS
Putty Knives		●	●	●	●	●	●		Clean-up of components before measurements
Screwdrivers	Misc. Sizes	●	●	●	●	●	●		
Electricians Pliers		●	●	●	●	●	●		
Slip Joint Pliers		●	●	●	●	●	●		
Contour Gage	Coastal No. 4521								
Thread Sealer	Loctite No. 271	●	●	●	●	●	●		
Safety Can for Flammable Liquids	Justrite #10301	●	●	●	●	●	●		Clean-up of components before measurements
Rotary File	Nicholson 50123	●	●	●	●	●	●		
<u>Union Pacific Railroad Equipment/Supplies</u>									
Aluminum Paint		●	●	●	●	●	●		Used in initial set-up
Paint Spray Gun		●	●	●	●	●	●		Used in initial set-up
Air Motor Grinder		●	●	●	●	●	●		Used in initial set-up

SECTION 2 - PREPARATION AND INVENTORY MEASUREMENTS

A number of essential tasks must be performed prior to placing each truck in the Wear Data Collection Program. These are described in detail in the following paragraphs.

2.1 RAILROAD APPROVALS

Approvals must be obtained in writing from the three responsible railroads - the Union Pacific, Santa Fe, and Denver Rio Grande Western - before accepting any truck type not previously approved for interchange service. This requirement is likely to apply to any Type II truck considered for the program. Upon request from the TDOP Project Office, the Union Pacific Railroad representative coordinates efforts to obtain the required approvals. Copies of these approvals are forwarded to the FRA.

2.2 TDOP CAR ACCEPTANCE AND IDENTIFICATION

Cars for the wear data collection program are selected from the Union Pacific fleet according to criteria discussed in paragraph 1.2. Prior to acceptance, each carbody center plate is inspected and measured in accordance with procedures defined in paragraph 2.6.3. Evidence of damage such as may arise from a broken truck bolster vertical wear ring is cause for rejection of a potential test car. In the absence of this, any carbody center plate that exhibits an "out-of-circular" condition (difference between maximum and minimum diameters) at either ½ inch or 1½ inches above the lower planar surface in excess of .032 inches is cause for rejection of a potential test car.

Each test car in the wear program has an identifying placard containing the following information affixed to each side near the corners (four places total):

TDOP TEST CAR

IF THIS CAR IS BAD ORDERED FOR ANY REASON, CALL COLLECT TDOP PROJECT OFFICE, WYLE LABORATORIES (303) 597-4500.

In addition, handling instructions are stenciled on each left hand carbody side, between the second and third body panel ribs, on a bright yellow painted field approximately 4 ft square (two places total):

TEST CAR ASSIGNED TO KAISER UNIT COAL SERVICE ONLY.

Character height, placard size, and material are selected by Union Pacific to be compatible with conditions and available space on the test cars.

The following numbers identify the cars used in the test program.

TDOP CAR NO.	UNION PACIFIC CAR NO.	TRUCK TYPE	DATE ENTERED SERVICE
001	38192	National Swing Motion	4-4-79
002	37708	Barber S-2-C	4-8-79
003	38051	Dresser DR-1	4-8-79
004	38497	Barber S-2-HD with C-PEP	4-4-79
005	38080	ASF Ride Control	4-4-79
006	38243	Barber-Scheffel	4-4-79

2.3 INITIAL TRUCK AND WHEELSET PREPARATION AND IDENTIFICATION

Sideframes, bolsters, and all other substantive truck components are spray painted with an approved aluminum paint prior to initial measurement and assembly. The words "test truck" are then stenciled in black paint letters a minimum of 1 inch high in at least two prominent locations on each side frame and bolster. Appropriate Association of American Railroads (AAR) locational designations (R1, R2, L3, L4, BR, BL, AR, and AL) are stenciled in black paint characters a minimum of 1 inch high in the following locations such that each will be visible on the assembled truck: 1) above or adjacent to each pedestal, 2) on the top surface of each bolster adjacent to and outboard from each side bearing roller (or side bearing if rollers not used), and 3) on both ends of each bolster. A contract inventory number of the following form is impression stamped in ¼-inch height Gothic characters on each side frame and bolster of the trucks.

$$\text{DOT-FR-742-4277-XX-}\begin{matrix}\text{A}\\\text{B}\end{matrix}\text{ - }\begin{matrix}\text{R}\\\text{L}\end{matrix}$$

The numbers corresponding to "XX" are provided by Wyle Laboratories inventory control and are the same for all components of a given truck. The letters "A" and "B" correspond to the designated car end location of the component when in the assembled and installed truck; "R" and "L" are marked on the side frames only, corresponding to the appropriate right and left side location in the assembled and installed truck.

In a similar manner, the words "test wheels" are stenciled in yellow paint letters a minimum of 1 inch high in at least four locations on each axle adjacent to the wheels. AAR locational designations (R1, R2, L3, L4, etc.) are stenciled in yellow paint characters a minimum of 1 inch high in at least two locations adjacent to each wheel on each axle and in one location on each roller bearing cap (preferably at a unique position such as the flat pad frequently provided adjacent to one of the three cap retainer screws). The radial location of this locational designator (R1, R2, R3, or R4) on each right side bearing cap determines the "1" location for that wheelset which is of significance when measuring the wheelsets and wheels as discussed in paragraph 3.4.9. To identify further the "1" location on each wheel, a depression is ground on the back (vertical) surface of each rim at the radial location established by the locational designator on the right hand bearing cap. This depression is approximately 1 inch wide and a maximum of 1/32 inches deep and is made with the spindle of the grinder pointing toward the axle and perpendicular to it. These ground areas are subsequently painted over with a stripe of yellow paint approximately 1 inch wide extending radially inward and onto the plate of the wheel approximately 4 inches. Diametrically opposite, an identical paint mark (minus the grinding) is made on each wheel to designate the "2" location for subsequent wheel measurements. The TDOP car number designation is indicated as defined in paragraph 2.2 (e.g., CAR 003) one place at the midpoint of each axle using stick-on characters approximately 1 inch high (available from Union Pacific Railroad at the RIP track).

2.4 COMPONENT PREPARATION AND IDENTIFICATION

Various truck components must be marked and some must have indexing features incorporated for acceptance of measurement fixtures. These activities are performed prior to initial measurement or truck assembly. Component identification markings, except for springs, are impression-stamped on nonwearing surfaces. These identifications are generally of the form "R3002000" where "R3" is the AAR locational designator, "002" is the TDOP car number (as defined in paragraph 2.2) and "000" is the component replacement number (000 = original, 001 = first replacement, etc.). Specifics of component identification and incorporation of indexing features are detailed in the following paragraphs.

2.4.1 Friction Castings

Several measurement techniques are employed for the various friction casting configurations. Procedures for preparation and identification of these friction castings are given below.

a. Single-sloping surface types having a $5\frac{1}{2}$-inch face width (used on Barber S-2-C, Dresser DR-1, and National Swing Motion trucks) or a $5\frac{1}{4}$-inch face width (used on Devine-Scales trucks). The C-701-0021-E-09 and C-701-0022-E-09 depth gage indexing fixtures are used with a dial depth gage to measure the vertical and sloping faces, respectively, of these friction castings. Three $\frac{1}{4}$-inch diameter blind holes are drilled in each of the two sides of these friction castings to provide a means of attaching the indexing fixtures in repeatable locations. This is accomplished in an identical manner for both the vertical and sloping face fixtures as shown in Figures 2.1 and 2.2. Gage blocks are first placed between the appropriate face and fixture as shown. After centering the friction casting by its width within the fixture, C-clamps (not shown) are used to maintain location. Prior to drilling it is determined, as applicable, that either the bottom edge of the C-701-0021-E-09 fixture is opposite the bottom edge of the vertical face or the top edge of the C-701-0022-E-09 fixture is opposite the top edge of the sloping face. The two adjacent holes are then drilled only to a depth sufficient to obtain the full diameter hole in the friction casting. A cobalt or carbide-tipped drill is required to penetrate the hardened material of

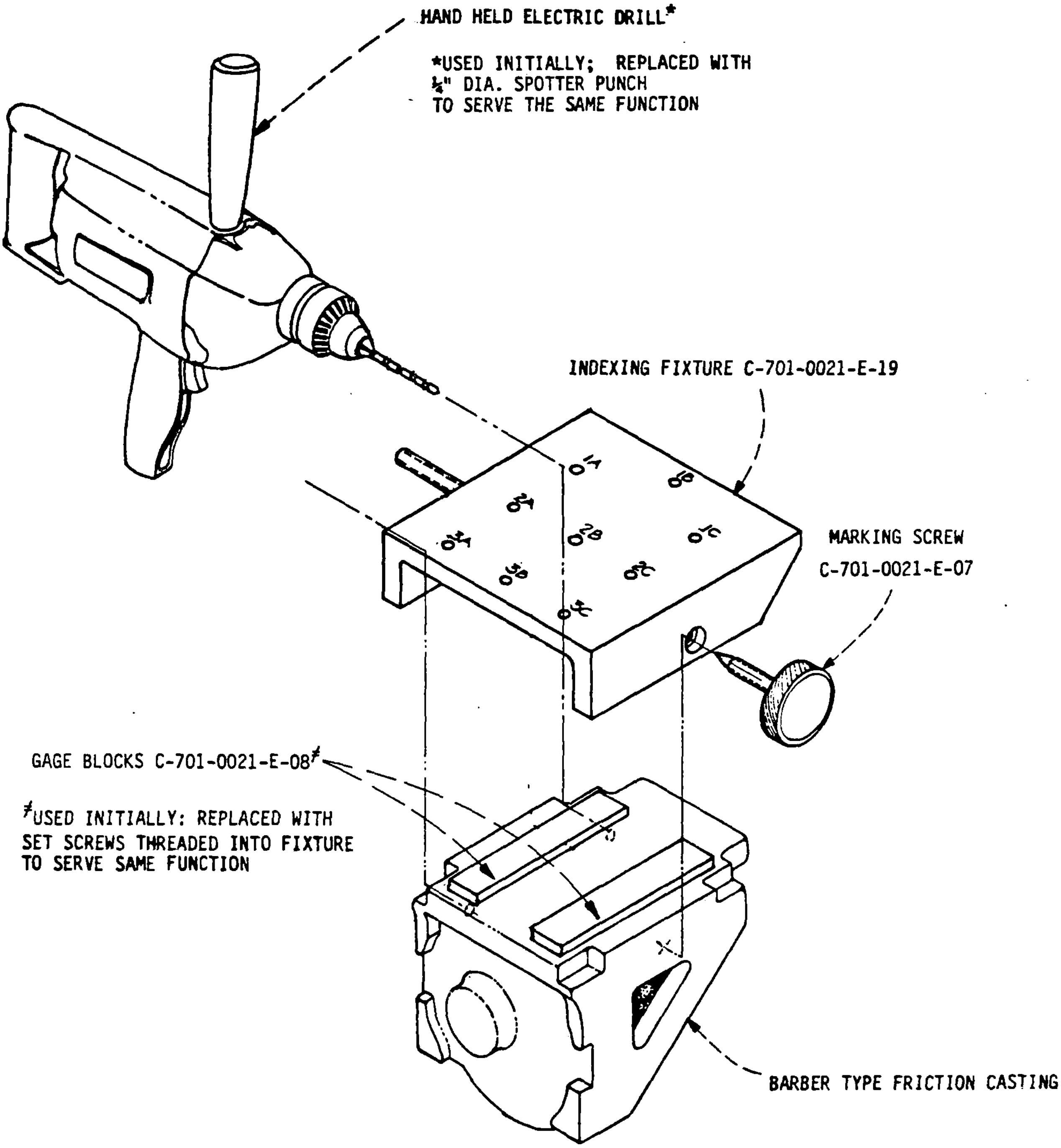


FIGURE 2.1. MARKING AND DRILLING OF BARBER FRICTION CASTING
VERTICAL FACE

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale NONE	Rev	Sheet 19

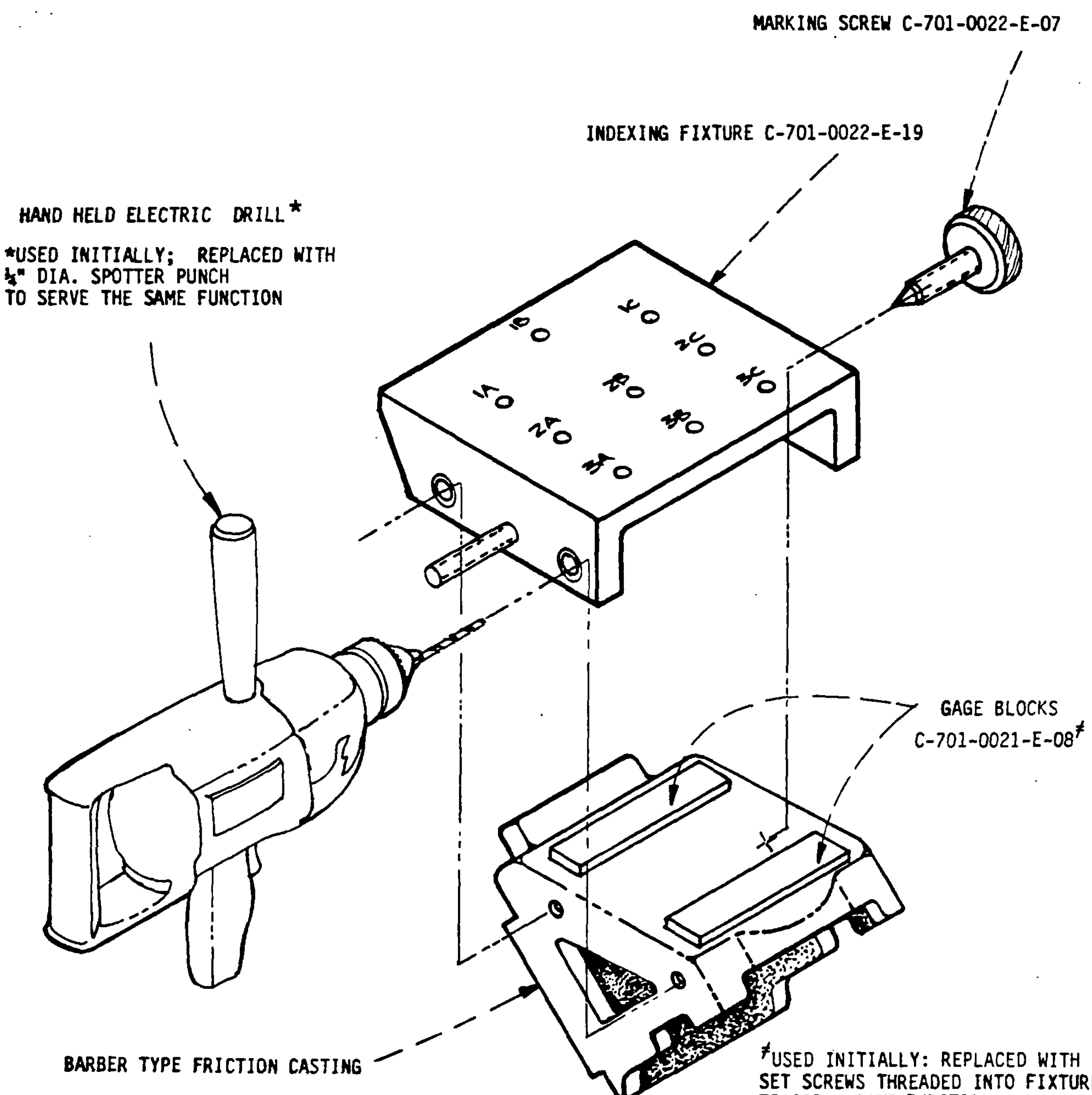


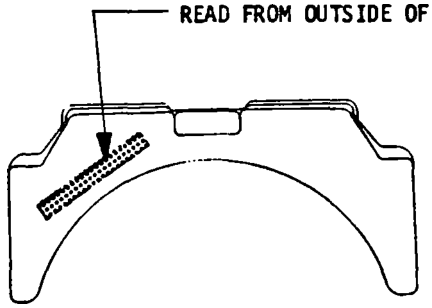
FIGURE 2.2. MARKING AND DRILLING OF BARBER FRICTION CASTING
SLOPING FACE

some friction castings. Location of the single, opposite-side hole is obtained in each case using the pointed marking screw. The indication from this marking screw will be more pronounced if a piece of soapstone is first rubbed on the side of the friction casting. After advancing the marking screw until contacting the friction casting, the indexing fixture is carefully removed and a center punch employed to indicate the hole location. This blind hole is drilled using care to maintain perpendicularity with the side surface. Component identification is impression-stamped in the location shown in Figure 2.3 (side optional) after first preparing the surface by grinding to provide better contrast.

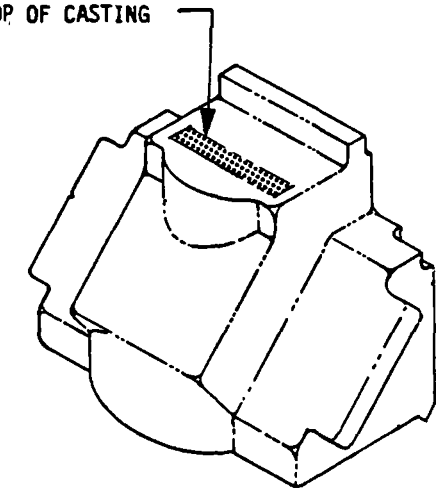
b. Single-sloping surface types having a 6½-inch face width (used on Barber S-2-HD/C-PEP and Barber-Scheffel trucks). The C-701-0027-E-09 depth gage indexing fixture and dial depth gage are used to measure the vertical and sloping faces of these friction castings. This fixture is self-indexing from nonwearing features of the friction casting; no special preparation of the casting is required other than identification marking, which is impression-stamped in accordance with Figure 2.3 (side optional) after first preparing the surface by grinding to provide better contrast. When setting up the indexing fixture, however, the following procedures must be followed to properly index the castings for repeatable location; a careful study of Figure 2.4 will be helpful.

Step 1. Trial position the three set screws (F/N 15) in the fixture base so that a typical casting will lay on its nonwearing side surface without wobbling. Due to the tapered side of the casting, the set screws must be adjusted to differing lengths to approximately level the casting. Note from Figure 2.4 (Zone E/F-6) the positioning of the casting when placing it into the fixture as opposed to its measuring procedure location.

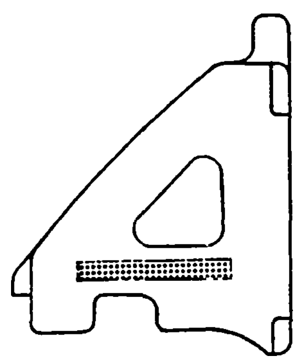
Step 2. Run in the set screw (F/N 13) between measurement locations 2B and 3B until it is snug against the face of the casting. This set screw will force the oval core hole surface at the casting center against an alignment pin (F/N 10) and tend to cause the



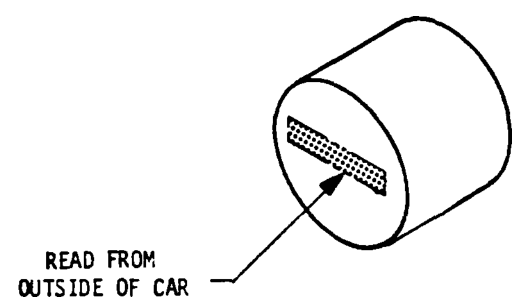
6½" x 12" BEARING ADAPTER



ASF FRICTION CASTING



BARBER FRICTION CASTING



SIDE BEARING ROLLER

TYPICAL STAMPED NOMENCLATURE:

"R3 002 000"

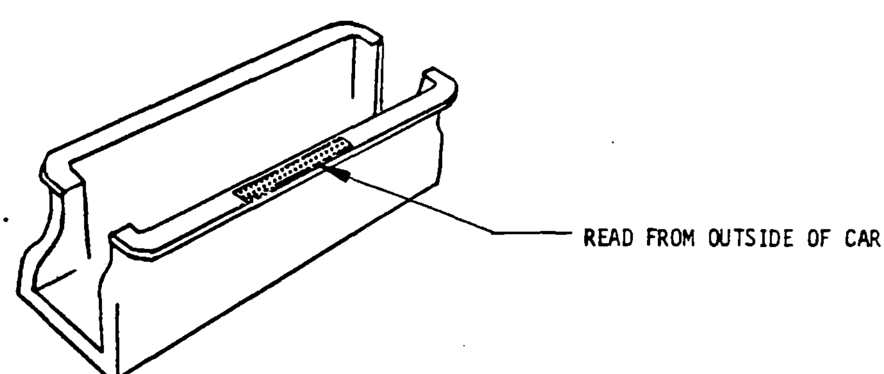
REPLACEMENT NUMBER:

000 = ORIGINAL

001 = 1ST REPL, ETC.

TDOP CAR NUMBER

COMPONENT LOCATION



SIDE BEARING ROLLER CAGE

FIGURE 2.3. LOCATION OF IMPRESSION STAMPING ON COMPONENTS

(NOTE: ALL STAMPING TO BE HIGHLIGHTED WITH BRIGHT YELLOW SPRAY PAINT)

SIZE	CODE IDENT NO.	
A	2B360	C-901-0006-A
SCALE	REV	SHEET 22

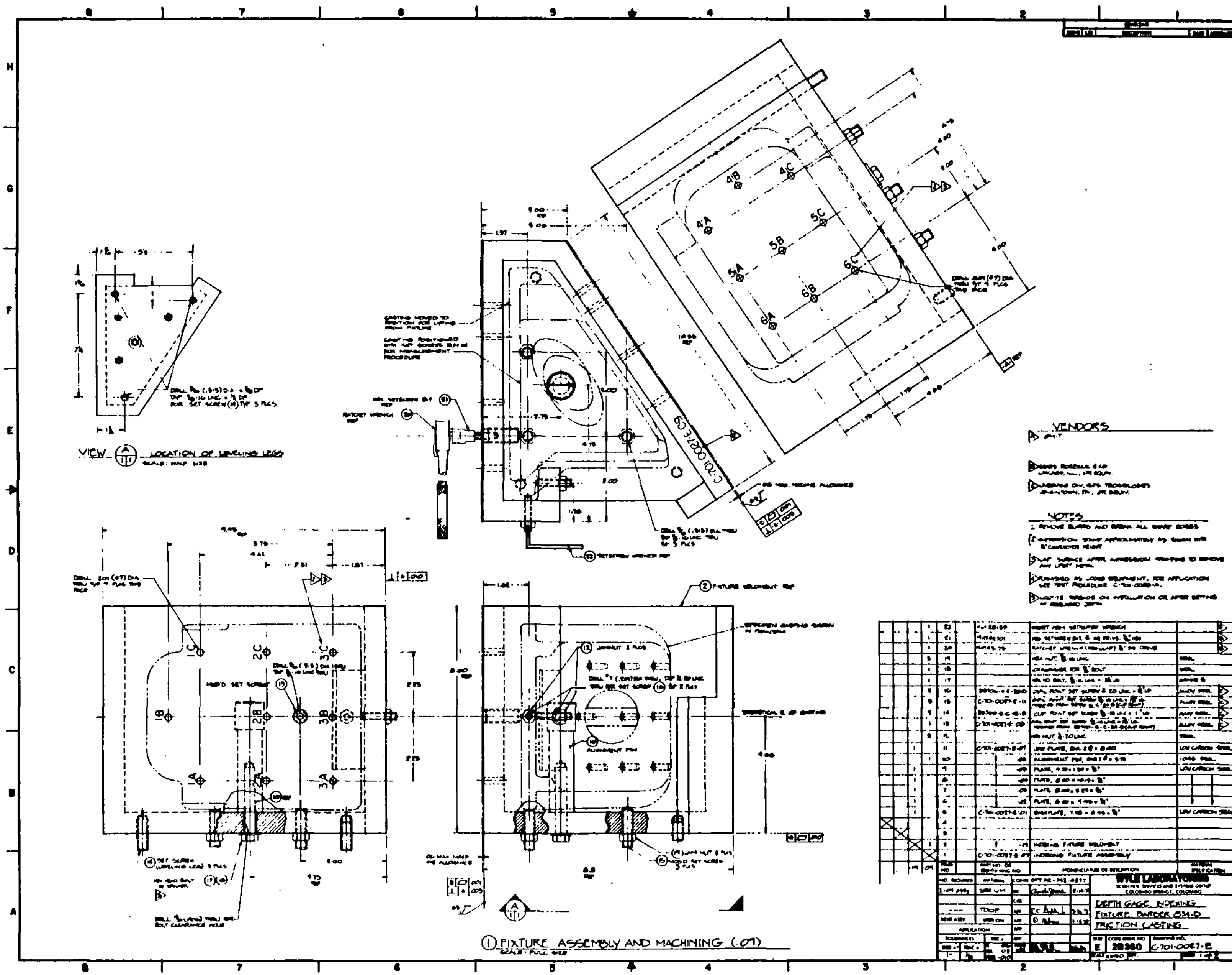


FIGURE 2.4. THE C-701-0027-E-09 DEPTH GAGE INDEXING FIXTURE

SIZE A | CODE IDENT NO. 2B360 | C-901-0006-A

SCALE | REV | SHEET

casting to rotate sideways within the fixture by applying an eccentric load.

Step 3. To counteract this rotation, set screws at the fixture jaw (F/N 16) must be tightened in two places against the bottom lip of the casting, until the casting rights itself and its vertical face aligns with the inside face of the fixture.

Trial and error with all castings to be measured in this fixture is necessary to obtain an average positioning of all set screws which will properly align the casting to give dependable measurements. (One excess casting of the manufacturer's lot was retained, measured, and stored for a future calibration check).

Step 4. Once all castings have been checked for fit, the set screw jam nuts (F/N 16 and 19) should be properly tightened and not reset for the duration of the project. With all fixed screws properly set and the adjustable screw backed into the front plate of the fixture, any casting may be easily slid toward the tapered end of the fixture cavity and lifted straight up for removal as soon as reinforcing fillets on the casting's lower lip clear both set screws at the jaw. The fixture is now ready for use.

c. ASF friction castings. The C-701-0018-A-02 and C-701-0019-A-09 friction casting wear measurement templates are used along with the ultrasonic digital thickness gage and squeeze type outside measuring caliper with dial gage, to measure the vertical and sloping faces, respectively, of the ASF friction castings. No special preparation is required other than identification marking which is impression-stamped in accordance with Figure 2.3 after first preparing the surface by grinding to provide better contrast.

2.4.2 Roller Bearing Adaptors

Bearing adaptor measurements are made using either the C-701-0016-E-02 or C-701-0041-E-02 roller bearing adaptor wear measurement assembly in conjunction with the dial depth gage, telescoping gages, and digital outside micrometers. No special preparation is required other than identification marking which is impression-stamped in accordance with Figure 2.3 after first preparing the surface by grinding to provide better contrast.

Setting up either measurement fixture requires that the fixture first be fitted to the bearing adaptor by orienting the outboard edge of the adaptor (with identification marking highlighted by yellow paint) and then seating the three fixture legs on the shouldered top surfaces of the adaptor lateral lug stops as shown in Figure 2.5. Set screws in the downward projecting locating plates are then run in against the casting. In the case of the C-701-0016-E-02 fixture, one adjustable plate also contacts the outboard lifting lug of the casting; it must be adjusted in two directions for initial set-up. In the case of the special C-701-0041-E-02 fixture for DR-1 bearing adaptors, a locating set screw on the lower right hand side by the longitudinal stop face measurement plate must be adjusted for lateral position. Before tightening the set screw jam nuts, both fixtures must be applied to all of the adaptors to be measured by either fixture and an average positioning obtained by trial and error which will suit every adaptor (standardizing bearing adaptors to those made by one manufacturer was necessary to avoid a more complex measurement fixture). After obtaining a final satisfactory average, jam nuts on the positioning set screws may be tightened and should not be reset for the duration of the program.

2.4.3 Brake Shoes

Composition brake shoes are measured both new and used employing the squeeze type outside measuring calipers with dial gage. Measurement point locations must first be established on the backing plate of each shoe. The SK-061379.1-A brake shoe measurement location drill template is placed over one end of the brake shoe back as shown in Figure 2.6. Using the ¼-inch inside diameter drill bushings, measurement locations shall be established without additional marking or drilling by locating one tip of the squeeze caliper jaws inside any bushing so as to contact the steel backing plate of the shoe; the opposing tip is positioned to contact the wearing surface of the brake shoe directly opposite the bushing, and "rocked" to get the minimum straight-line dimension between the two jaw tips. Identification marking is done with the electric vibro-etch marking tool in the composition material as indicated in Figure 2.6. After

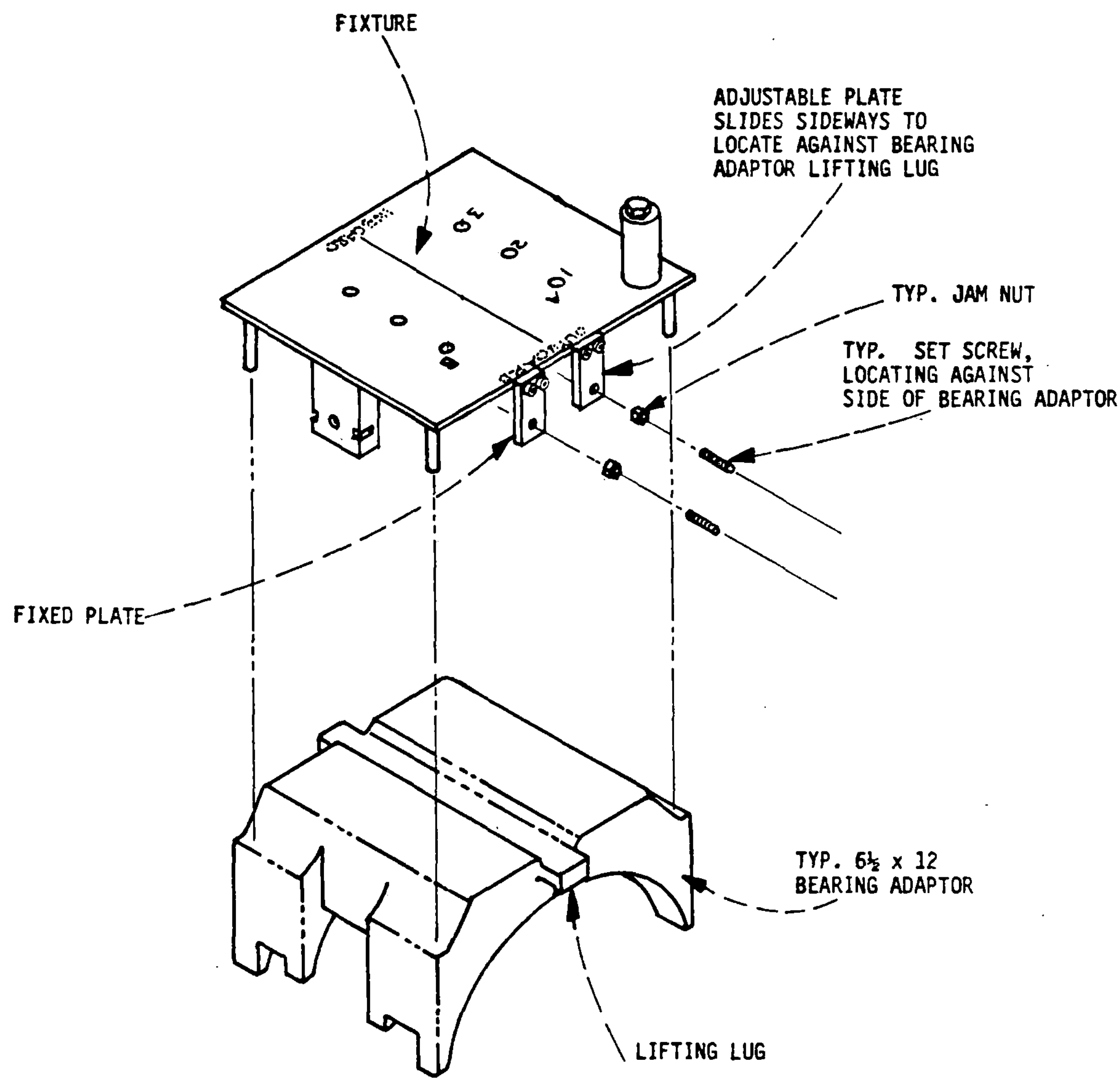
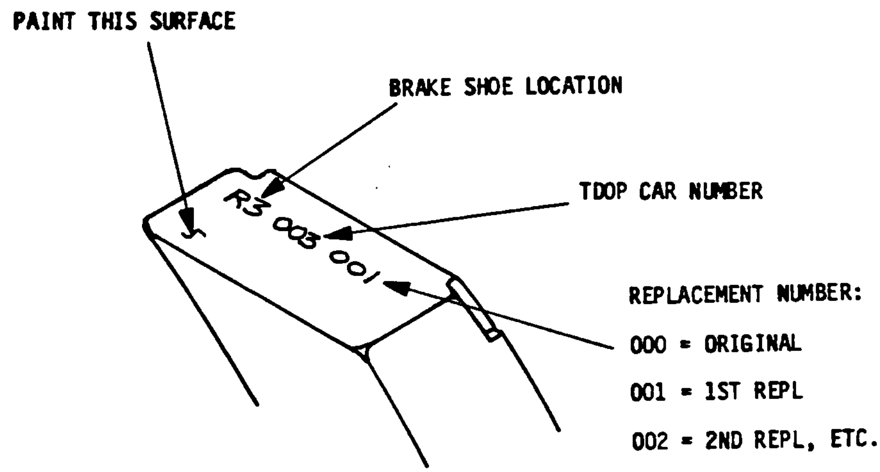


FIGURE 2.5. POSITIONING OF BEARING ADAPTOR MEASUREMENT FIXTURE C-701-0016-E-01

SIZE	CODE IDENT NO.	
A	2B360	C-901-0006-A
SCALE	REV	SHEET 26



VIBRO-ETCHING OF BRAKE SHOE I.D. NOMENCLATURE

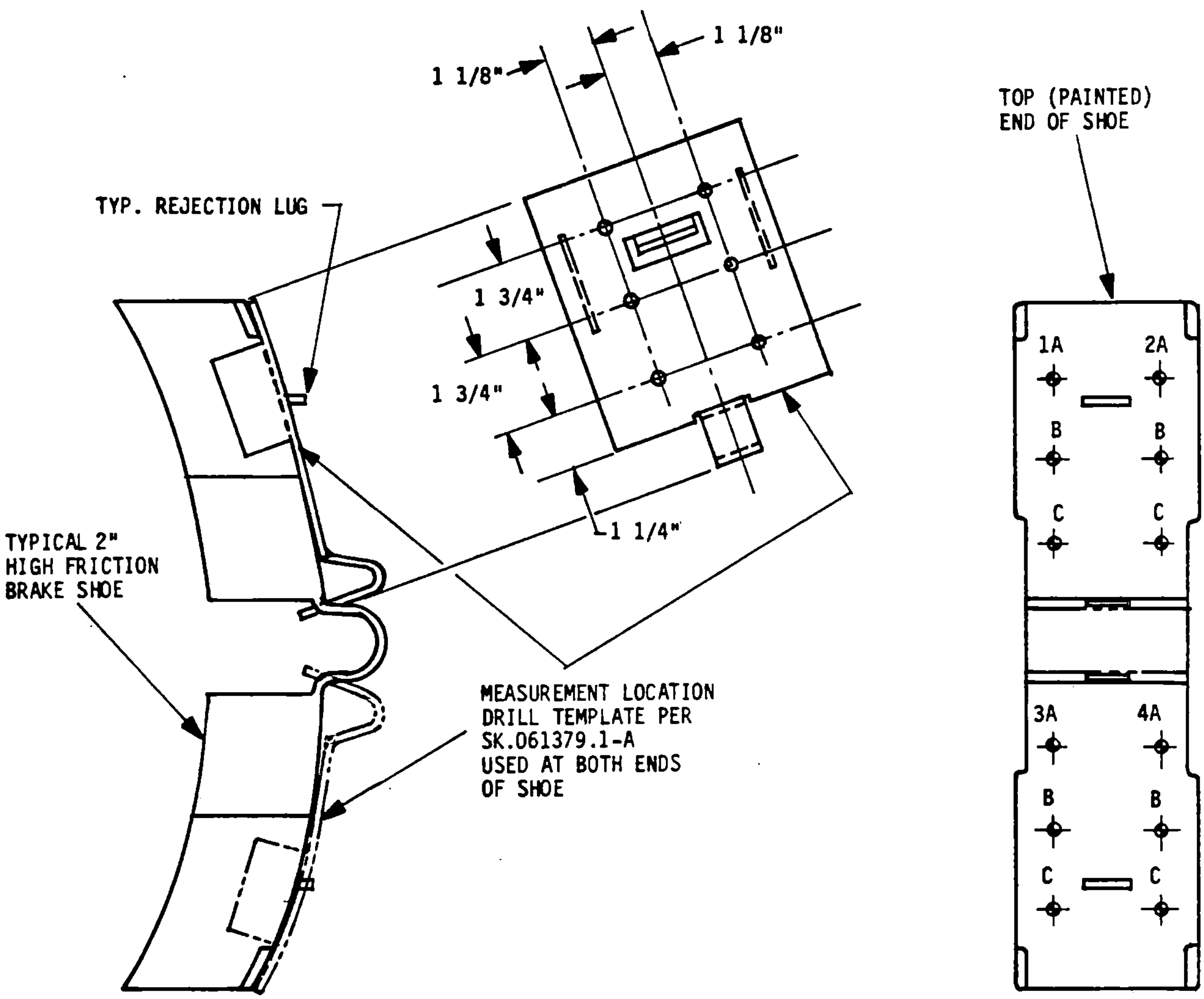


FIGURE 2.6. BRAKE SHOE IDENTIFICATION AND MEASUREMENT GRID

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 27

measuring, the marked end of the shoe is spray painted with heat resistant aluminum paint to further aid in recognition and identification.

2.4.4 Springs

Both side springs and load springs are measured using the C-701-0023-A-01 spring squareness measurement template and steel machinist's rule and require no initial preparation other than identification marking. Identification marking is done with a heavy duty tapewriter which embosses characters on self-adhering 3/8-inch wide aluminum tape. Tapes are embossed with an abbreviated code which does not include replacement number for the original springs. This code and the tape attachment location are shown in Figure 2.7. The tape is located past the flat bearing surface near the top of the spring to prevent crushing during service.

As an alternative marking method, a ball-tipped paint marker has been used to identify springs with the same code, in instances where tag tapes have failed between cycles.

2.4.5 Side Frame Pedestal Areas

These items are measured using the C-701-0026-E-09 or C-701-0026-E-19 pedestal roof mechanical wear measurement fixture in conjunction with the dial depth gage, telescoping gages, and digital outside micrometers. Both fixtures are identical in application in that they are located by placing three pointed legs in punched holes. Details of specific preparations are described below.

a. Barber-Scheffel side frame. The pedestal area of the Barber-Scheffel side frame is incorporated in the shear pad housing. The C-701-0026-E-09 fixture with 7/8-inch long pins is located approximately equidistant between the lugs and centered laterally as shown in Figure 2.8. While being held securely in this position, each leg is struck squarely with a hammer to transfer the point locations to the underside of the pedestal roof. Before removal, it is ascertained that all three points simultaneously engage the indentations thus made. The fixture is then removed and the indexing indentations made deeper by overstriking with a sharp transfer punch. All three points are again checked to verify that they can be simultaneously engaged.

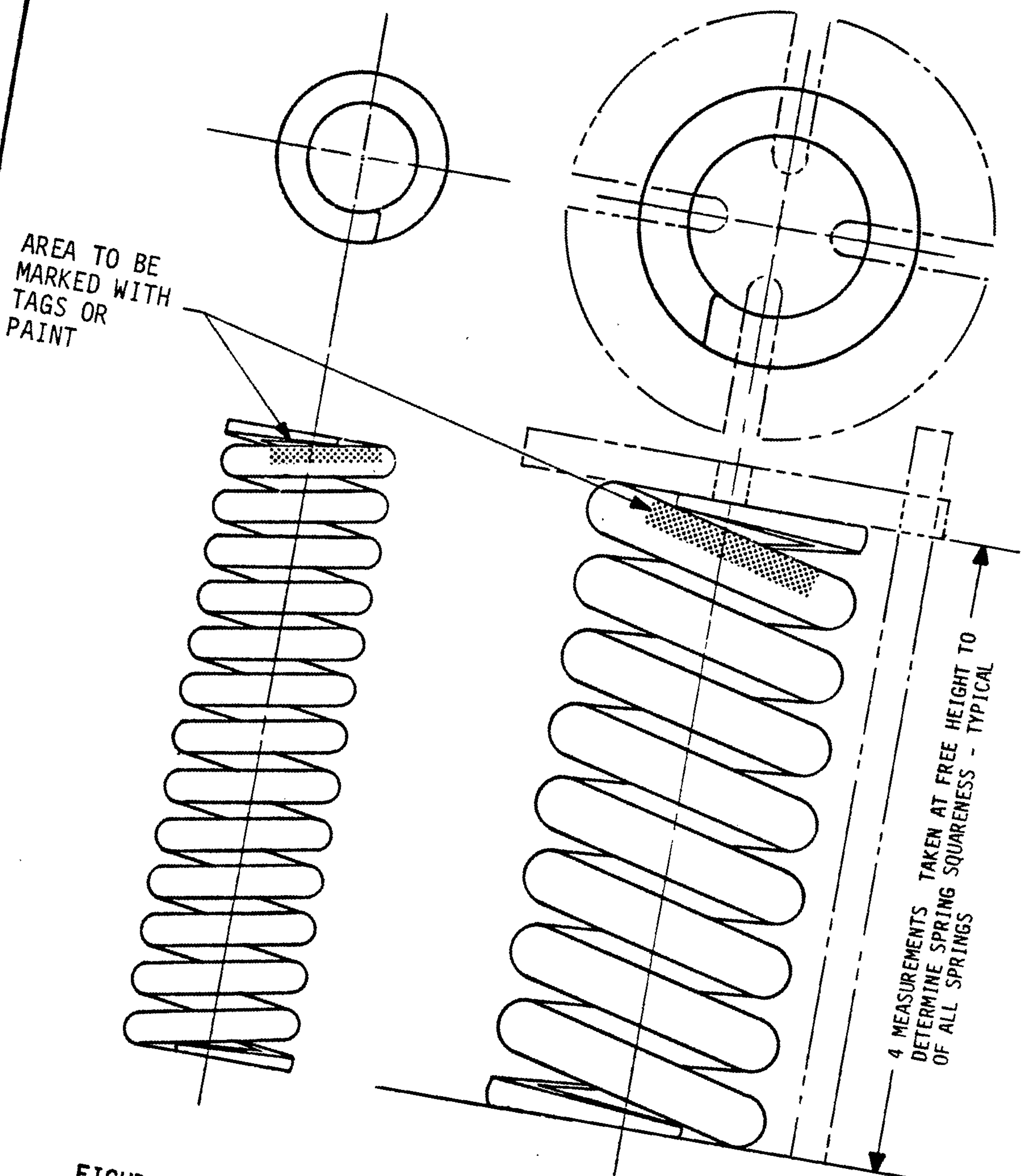


FIGURE 2.7. INITIAL MEASUREMENT AND MARKING OF SPRINGS

SIZE	CODE IDENT NO.	
A	2B360	C-901-0006-A
SCALE	REV	SHEET 29

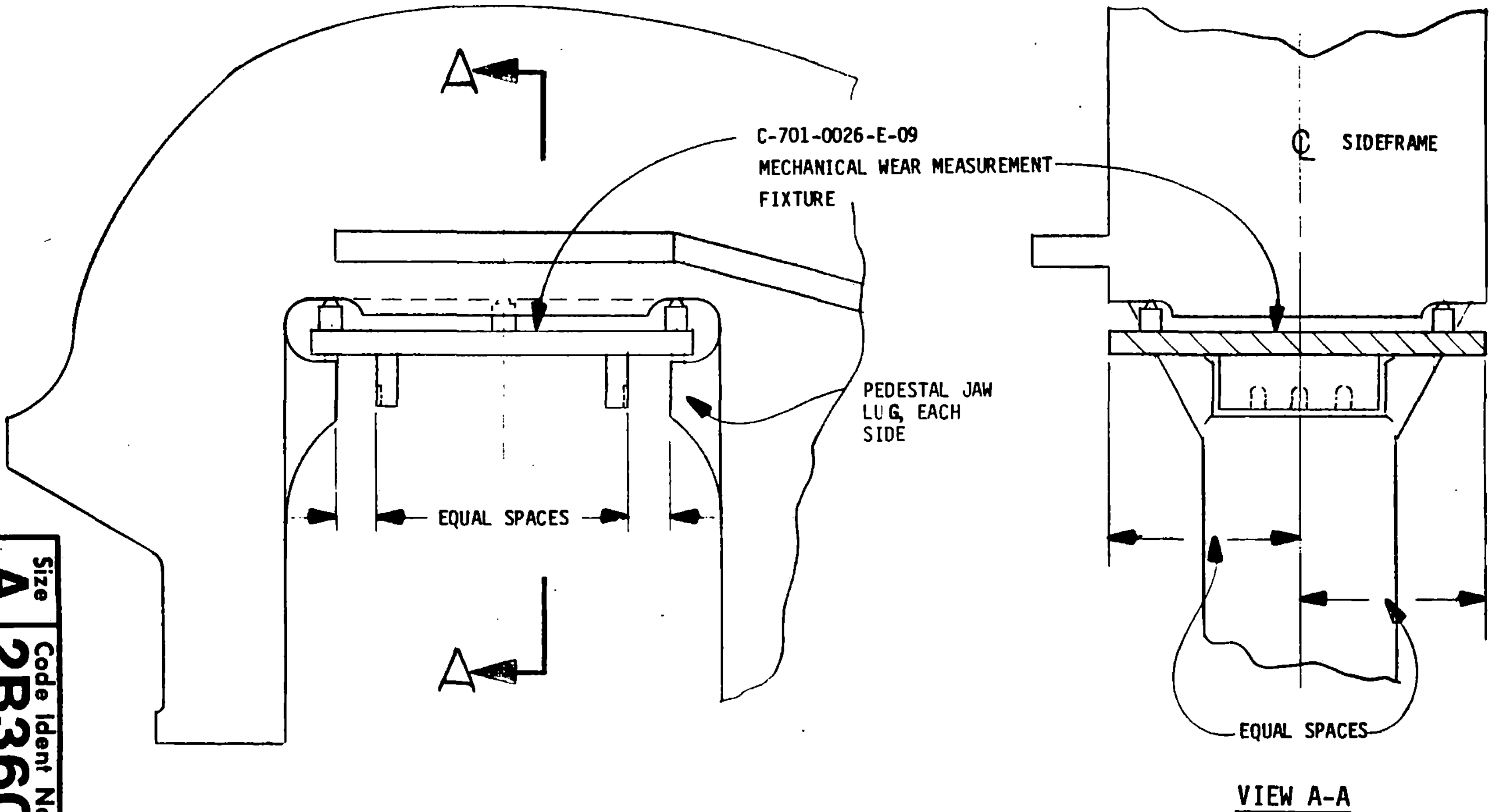


FIGURE 2.8. APPLICATION OF PEDESTAL ROOF FIXTURE TO BARBER-SCHEFFEL TRUCKS

b. Barber S-2-HD/C-PEP side frame The C-701-0026-E-09 fixture with 7/8-inch long pins is located approximately equidistant between the lugs and centered laterally as shown in Figure 2.9. Steel bars are welded to both sides of the side frame immediately above and parallel to each pedestal roof to provide the surfaces for locating the fixture for measurements. The vertical position of these bars is such that, when the pointed legs of the C-701-0026-E-09 fixture are engaged in the indentations the midheight of the longitudinal stop face of each lug is at the same height as the measurement slot tops as indicated in Figure 2.9. C-clamps (not shown) are used to position the bars before welding. After welding, the fixture is relocated in the position specified above and held securely while each leg is struck squarely with a hammer to transfer the point locations to the undersides of the two bars. Before removal, the three points should be checked to assure that they simultaneously engage the indentations. The fixtures are then removed and the indexing indentations made deeper by overstriking with a sharp transfer punch; the three points should again be checked.

c. Barber S-2-C, Dresser DR-1, National Swing Motion, and ASF Ride Control side frames. The C-701-0026-E-19 fixture with $1\frac{1}{2}$-inch long pins is located equidistant between the lugs and centered laterally in a manner similar to that shown in Figure 2.9. The procedure for location of this fixture is identical to that described for the C-701-0026-E-09 fixtures in (a) above.

2.4.6 Side Frame Anti-Rotation Lugs

On side frames so equipped, anti-rotation lug thicknesses are measured three places using digital outside micrometers. To provide a repeatable location for measurement, round head drive screws are installed on the back surfaces of all anti-rotation lugs as shown in Figures 2.10 and 2.11. A 1/8-inch diameter drill bit is used for the required holes, which are a maximum of 5/16 inches deep.

2.4.7 Bolster Gibs

In an identical manner to that described for side frame anti-rotation lugs, round head drive screws are installed three places in each inboard and outboard gib on trucks so equipped, as shown in Figure 2.12.

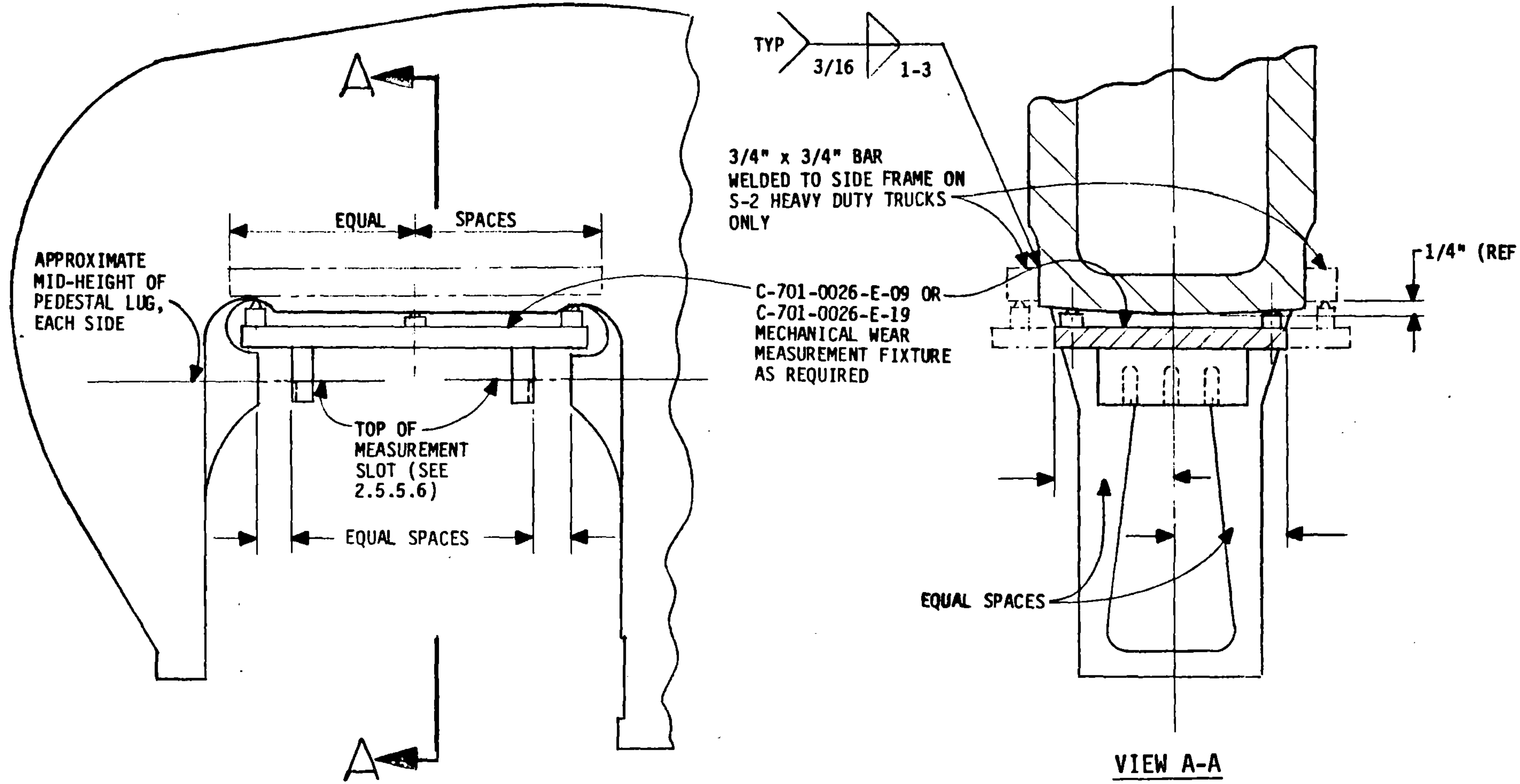
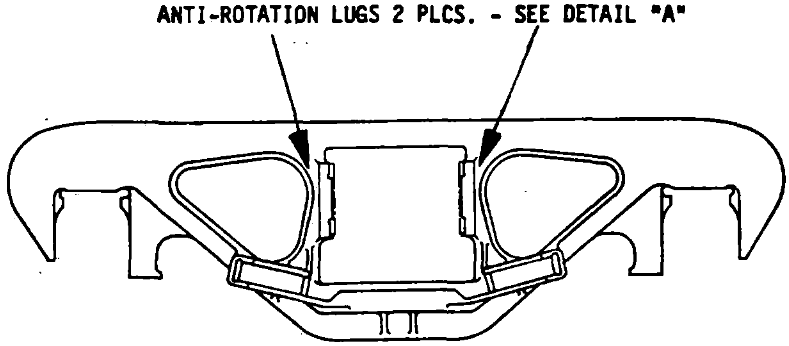
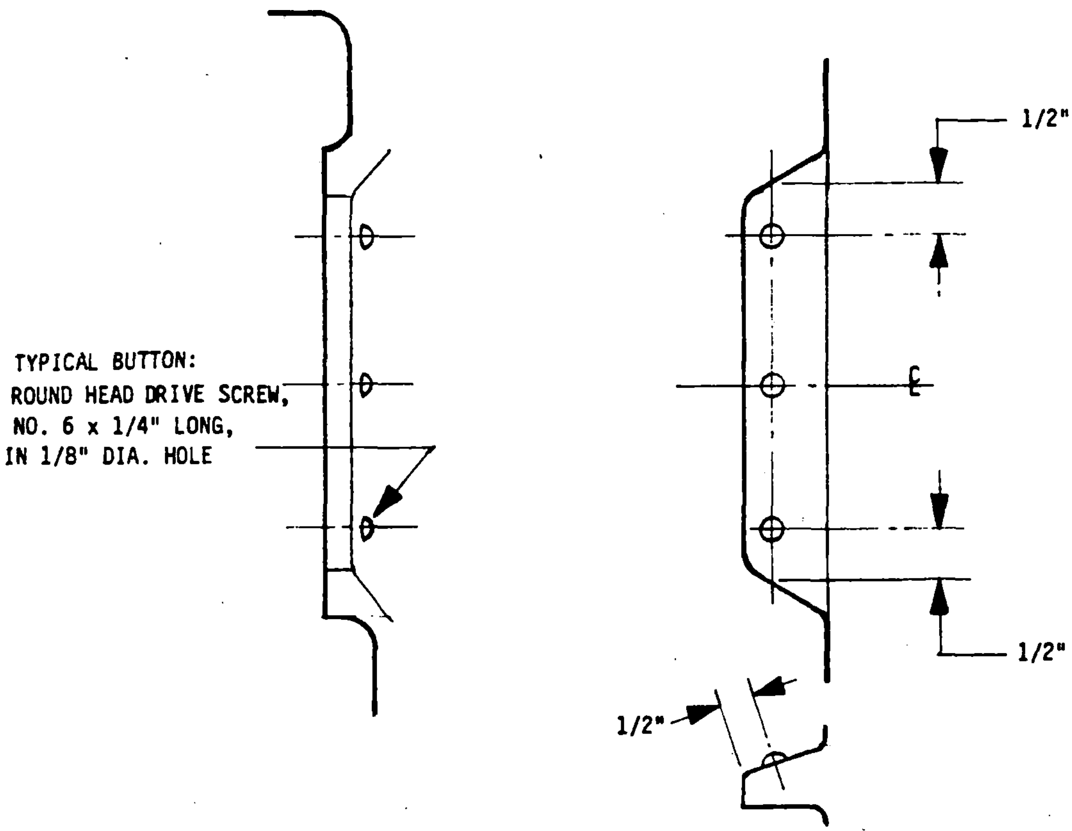


FIGURE 2.9. APPLICATION OF PEDESTAL ROOF FIXTURE TO BARBER S-2, S-2 HEAVY DUTY, DR-1, SWING MOTION, AND ASF TRUCKS



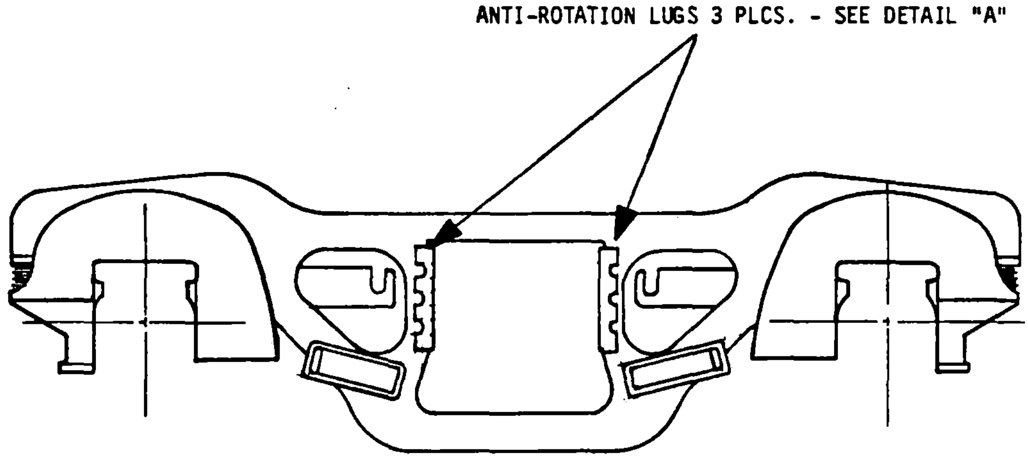
TYPICAL SIDE FRAME (INSIDE SURFACE)



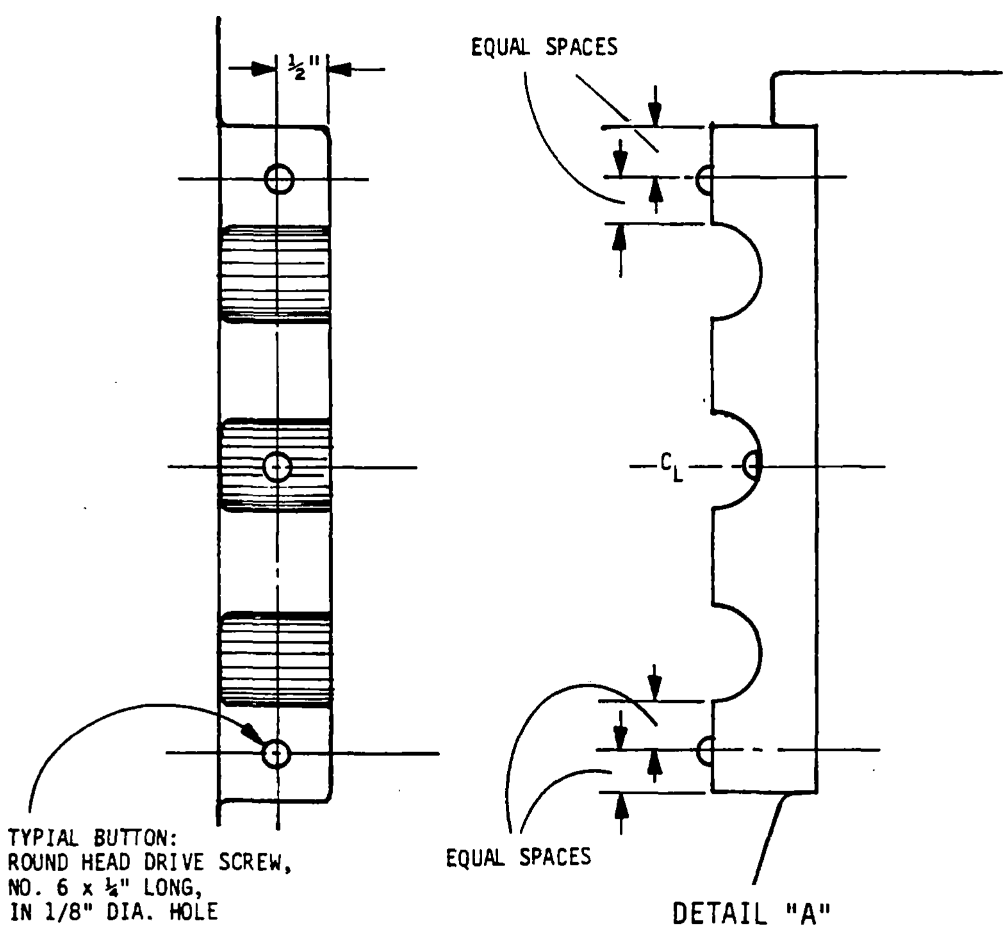
DETAIL "A"

FIGURE 2.10. APPLICATION OF LOCATING BUTTONS TO ANTI-ROTATION LUGS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 33



TYPICAL SIDE FRAME (INSIDE SURFACE)

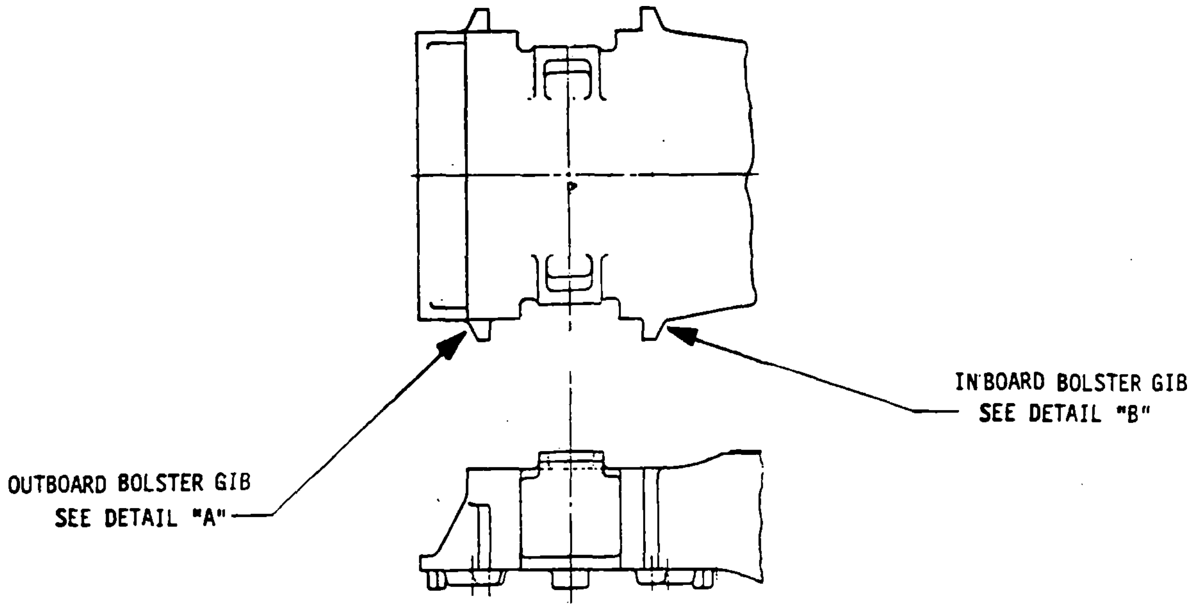


DETAIL "A"

FIGURE 2.11. APPLICATION OF LOCATING BUTTONS TO ANTI-ROTATION LUGS, BARBER-SCHEFFEL TRUCKS

Size	Code Ident No.	
A	2B360	C-901-0006-A

Scale	Rev	Sheet
		34



BOLSTER GIBS - TYPICAL EACH END OF BOLSTER

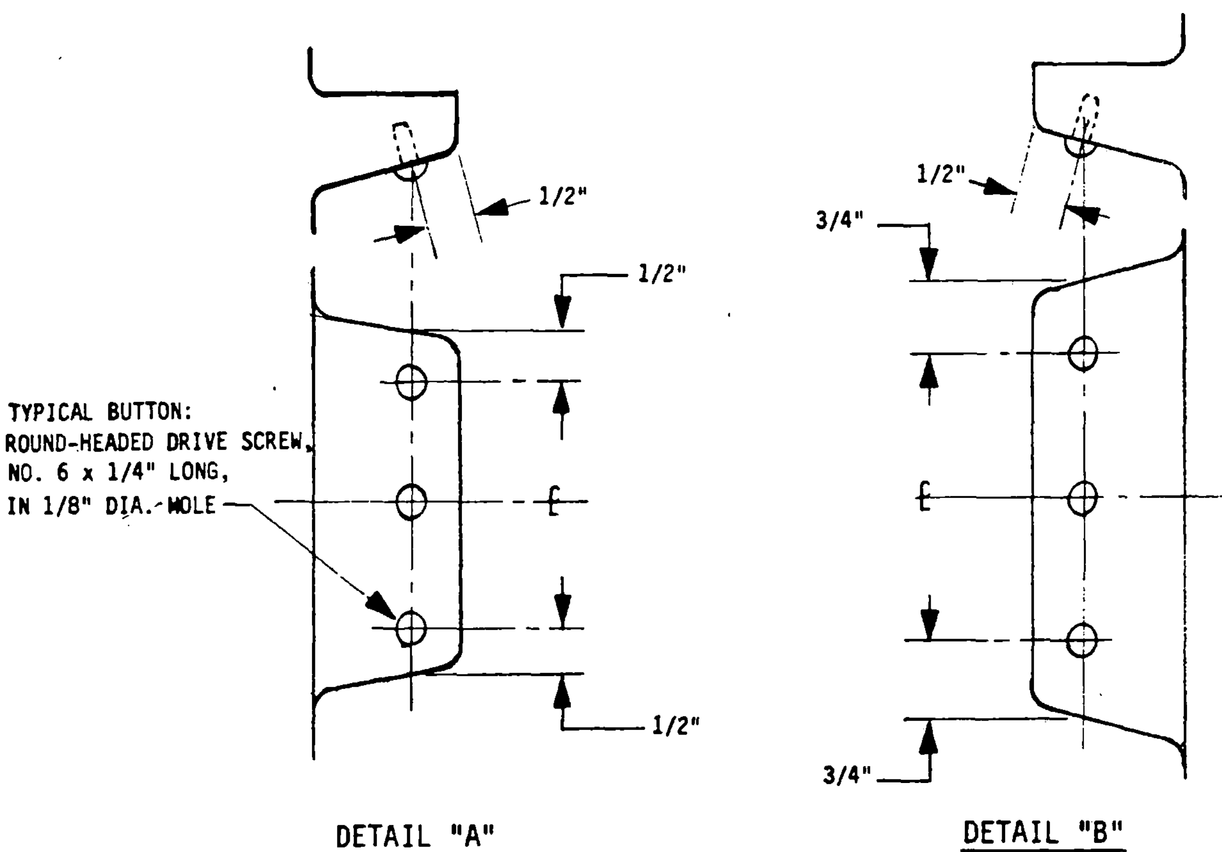


FIGURE 2.12. APPLICATION OF LOCATING BUTTONS TO BOLSTER GIBS

2.4.8 Bolster Center Plate

Various techniques are employed to measure components associated with the bolster center plate. The vertical wear ring and horizontal wear liner (if so equipped) are measured using the C-701-0013-A-03 16-inch bolster center plate template and the ultrasonic thickness gage. On trucks where the wear liner is not employed (or is removable), the horizontal surface of the bolster center plate is measured using the C-701-0024-E-09 center bowl mechanical depth measurement template assembly and the dial depth gage. For all truck bolsters, initial index marking of the bolster center plate is performed in accordance with Figure 2.13. Specific procedures for additional preparation and marking of the various bolster configurations are given below.

a. National Swing Motion, Barber S-2-C, Barber S-2-HD/C-PEP, ASF Ride Control, and Barber-Scheffel. The C-701-0024-E-09 center bowl mechanical depth measurement template assembly is used in conjunction with the dial depth gage to measure wear on the horizontal surface of the truck bolster center bowl. This template assembly is supported on three pointed legs which rest in punched holes in the top surface of the center bowl rims. To locate these holes, the C-701-0024-E-02 positioning hole template is placed on the top surface of the center bowl rim with the indexing notches aligned with the 0-degree position and chalk line axis as shown in Figure 2.13. To prevent motion during the subsequent punching operation, C-clamps are attached securely between the bolster windows and the top surface of the template. A spotter punch having ¼-inch diameter shank is placed in turn in each of the three locating holes and struck squarely with a hammer to transfer the point locations to the top of the center bowl rims. It is then determined that the three pointed legs of the measurement template assembly simultaneously seat in the three punch marks.

b. National Swing Motion, Barber S-2-C, ASF Ride Control. Thickness of the horizontal wear liners in these trucks is measured ultrasonically to determine wear. To provide both a location for identification marking and an indicator for rotation of the wear liner in service (index angle) a notch is ground in the outer periphery of each horizontal wear liner as shown in Figure 2.14. Car identification is vibro-etched in each plate using the abbreviated code shown.

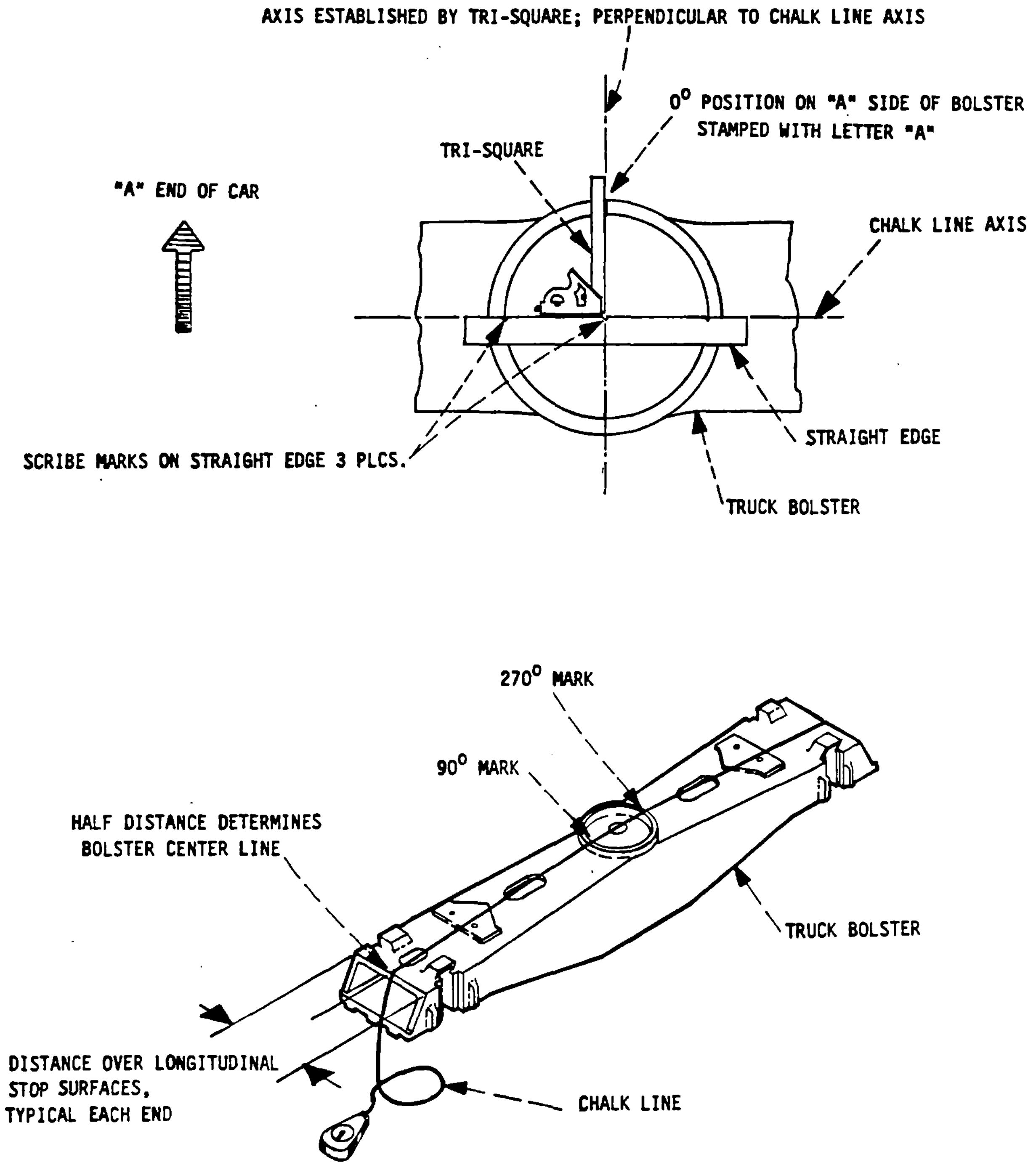


FIGURE 2.13. INITIAL INDEX MARKING OF BOLSTER CENTER PLATE

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 37

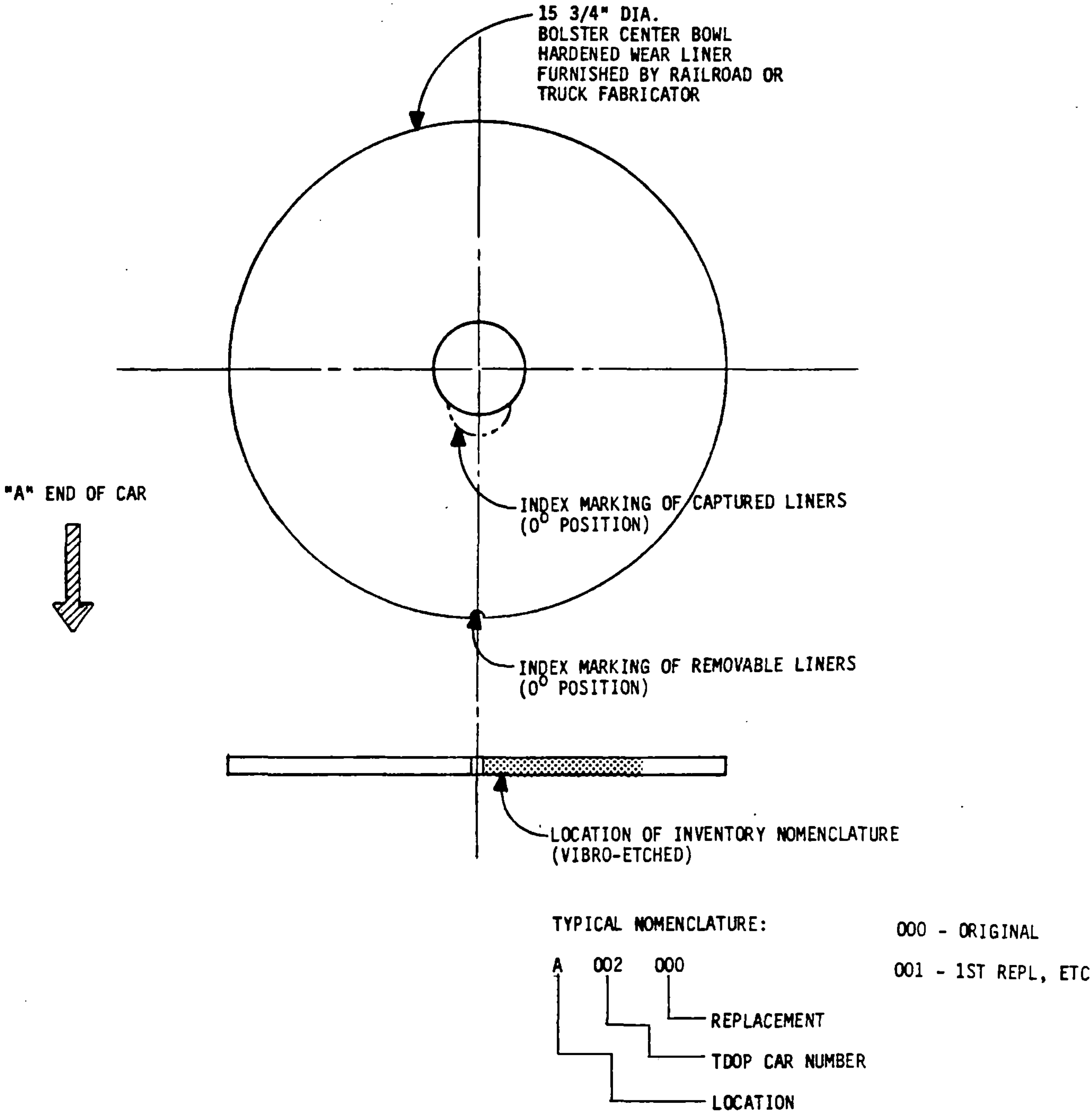


FIGURE 2.14. IDENTIFICATION MARKING OF WEAR LINERS

SIZE	CODE IDENT NO.	
A	2B360	C-901-0006-A
SCALE	REV	SHEET 38

c. Dresser DR-1 truck. Thickness of the horizontal wear liners is measured ultrasonically to determine wear, as for (b) above. Because the horizontal wear liner is captured by the vertical wear ring, the indexing notch is ground in place in the near hole periphery, as shown in Figure 2.14. No car identification is required for the DR-1 horizontal wear liners.

2.4.9 Side Bearing Rollers and Cages

Locational and identification markings for all side bearing rollers and cages are impression-stamped in accordance with Figure 2.3.

2.4.10 Special Components

Special components unique to the Type II trucks are marked as deemed appropriate to insure positive identification and prevent misassembly. The type of marking should be durable and, if possible, readily visible. Impression stamping should not be used in areas of high stress or where local surface deformations will impair function.

2.5 INITIAL TRUCK ASSEMBLY

In order to incorporate differing assembly procedures that may be required for the various Type II trucks in the Wear Data Collection Program, it is mandatory that initial assembly of each such truck be witnessed and supervised by a representative of the manufacturer. Provisions for technical support have been included with the truck purchase arrangements. Adequate drawings and supportive documentation must be obtained to assure truck compatibility with the test cars and to allow sufficient time to design and fabricate any unique measurement fixtures that may be required. As the time of initial assembly approaches, close coordination is essential to assure timely availability of the designated representative and thus avoid delays in initial truck assembly.

2.6 CAR/TRUCK INTERFACING

Special attention must be paid to the side bearing clearances and brake set-up during initial installation of the test trucks to each test car. The following paragraphs describe the procedures to be followed to assure proper installation of the test trucks.

2.6.1 Side Bearing Clearances

The clearance between each side bearing roller and the carbody side bearing must be ¼ ±1/16 inch. Because of cross level variations in the RIP track, this value cannot be checked with the trucks installed. The procedures of Figure 2.15 are followed to determine clearance and need, if any, for shimming. By holding a straightedge securely against the planar surface of the body center plate, the vertical distance to the midpoint of each body side bearing is measured using a machinist's rule. In a similar manner, the vertical distance from the planar surface of the truck bolster center plate to each side bearing roller is measured by use of a 24-inch calipers and machinist's rule. A single value for each side bearing roller pair is obtained by averaging the two readings. Removal of the horizontal wear liner (if possible) prevents error in measurements from a dished wear liner that will flatten in service when loaded. Any shims required by these measurements are made of steel and extend the full length and width of each side bearing cage beneath which they are placed.

2.6.2 Brake Set-Up

The Union Pacific Railroad representative coordinates any technical support required to set up brake arrangements different from those currently on the cars. The following is a summary of brake and carbody changes required for the various truck installations. Cars originally had rod-under braking, 8- by 14-inch levers, and 8½-inch diameter brake cylinders.

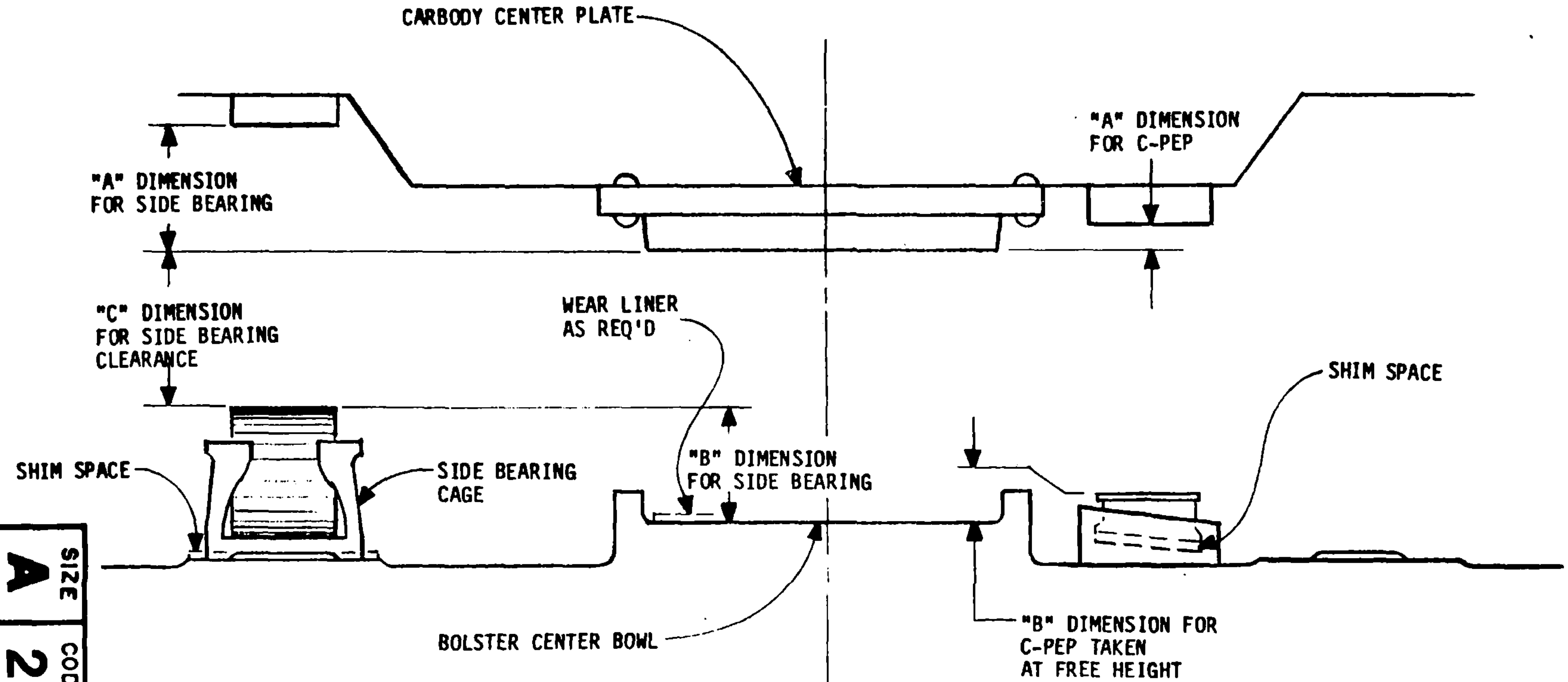
a. National Swing Motion trucks. Replaced original levers with 8- by 16-inch levers connected in rod-through configuration. Relocated dead lever body brackets between trucks, welded to center sill. Removed two C-PEP wear plates to accommodate application rod. Replaced original cylinder with 10-inch diameter cylinder. Changed lengths of application rods and dead lever devices.

b. Barber S-2-C trucks. Same as (a) above.

c. Dresser DR-1 trucks. Same as (a) above except dead lever brackets located on inner steering arms and welded to center sill, between trucks.

d. Barber S-2-HD/C-PEP trucks. No change in configuration.

e. ASF Ride Control trucks. No change in configuration.



SIDE BEARING CLEARANCE DETERMINATION:

A - B = C

IF "C" EXCEEDS 5/16", SHIM BENEATH SIDE BEARING CAGE;

IF "C" IS LESS THAN 3/16", USE CENTER BOWL WEAR LINER TO RAISE CARBODY SIDE BEARING RELATIVE HEIGHT

C-PEP PAD INSTALLATION:

A - B = 1/16"

IF GAP EXISTS BETWEEN "A" AND "B" SHIM BENEATH C-PEP ASSEMBLY TO PRELOAD TO REQUIRED DIMENSION.

FIGURE 2.15. CHECKING SIDE BEARING/C-PEP INSTALLATION

f. Barber-Scheffel trucks. Replaced existing live levers with 8- by 16-inch levers and existing dead levers with 10- by 20-inch special levers furnished by truck manufacturer.

After making these brake and carbody changes, or after initially installing an unmodified pair of new trucks, all brake shoe heads are fitted with an Abex Hydra-Cell hydraulic type load measuring device (Figure 2.16), and readings are taken according to the manufacturer's specifications. This determines whether all brake shoes are applying proper forces equally throughout the vehicle brake system, and verifies that the brake rigging operates properly before releasing the vehicle for road service.

2.6.3 Carbody Center Plate Preparation

The carbody center plates used are original equipment on the test vehicles and are not modified, except as necessary to return the center plates to as new condition as possible in the case of cracked welds or loose rivets occurring during previous service. Cars 001 through 006 have conventional center plates, attached to the draft sill by riveting and welding. After initial inspection, repair (if required) and acceptance, all carbody center plates are measured for record purposes as shown in Figure 2.17, giving four diametric measurement locations plus a fifth minimum diametric measurement (θ_c) that may or may not occur at the four marked locations. These measurements are taken at points ½ inch and 1½ inch above the lower planar surface of the center plate, making a total of 10 record dimensions per center plate.

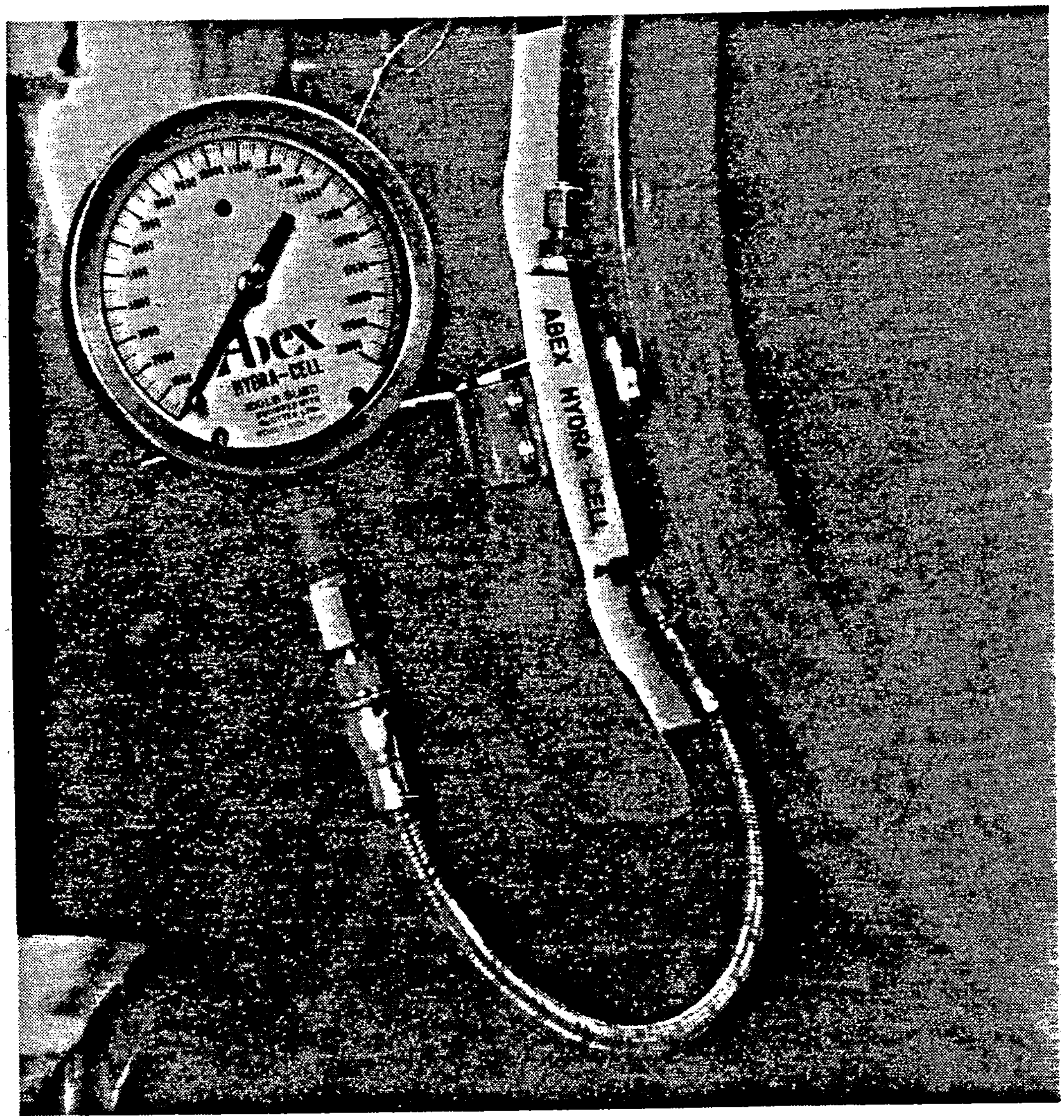


FIGURE 2.16. INSTALLATION OF ABEX HYDRA-CELL IN BRAKE HEAD

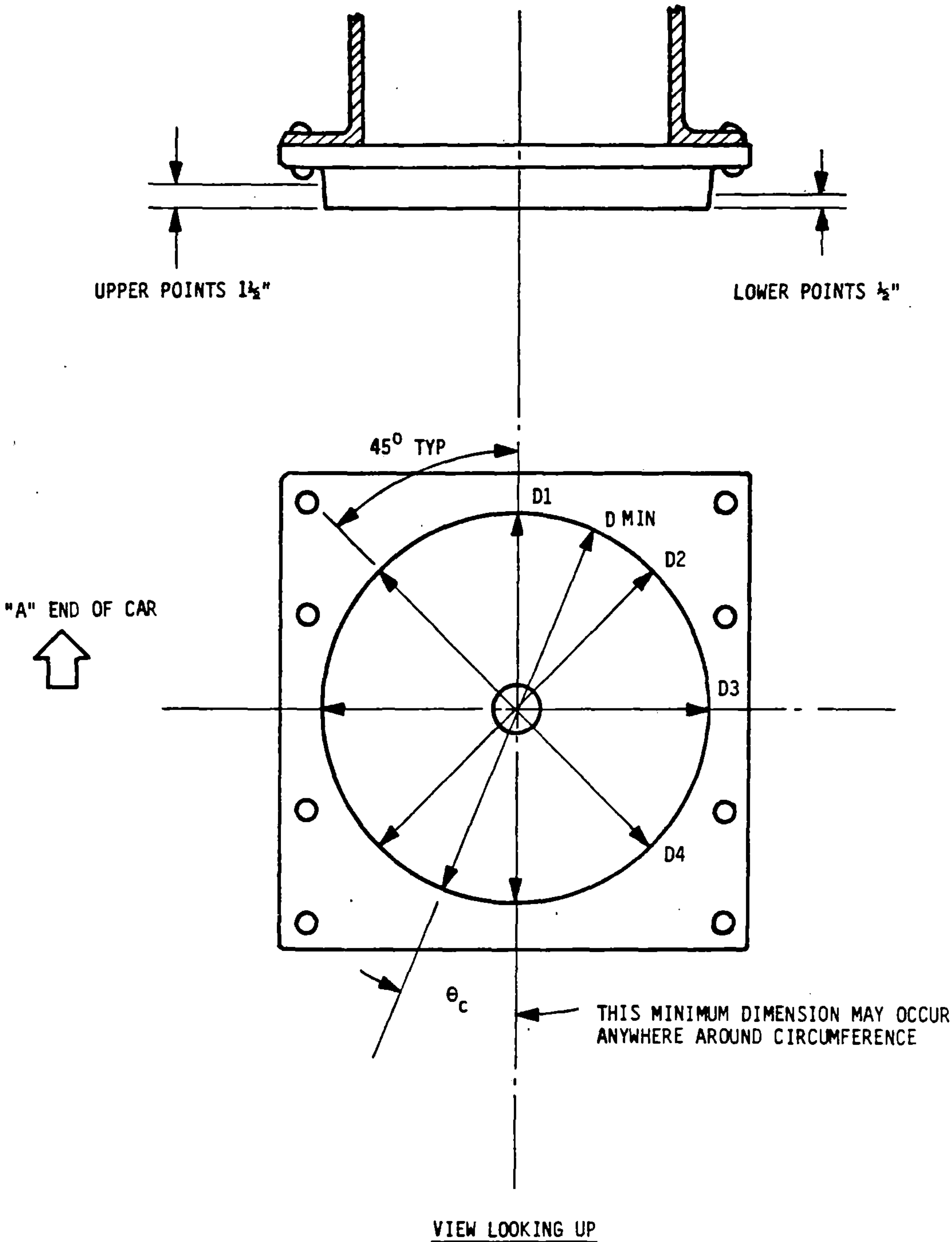


FIGURE 2.17. INITIAL MEASUREMENT OF CARBODY CENTER PLATES

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 44

SECTION 3 - CYCLIC MEASUREMENTS

The following paragraphs describe the step by step procedures for the measurement and collection of data at each wear measurement cycle. Depending on the type of truck being measured, different tools will be required. Table 1.1 consists of a list of tools stored at the RIP track and the cars on which they are used. To facilitate the measurement procedures, all forms pertaining to each particular truck type are arranged in numerical order within a check-listed folder, and marked off as a form is completed. Most measurements can be made in a logical working order, progressing as a truck is dismantled and proceeding toward the carbody measurements.

3.1 ASSEMBLED TRUCK CLEARANCES

Assembled truck clearances are not taken, although they were originally provided for in the initial procedures. Due to the redundancy of these measurements and the fact that they can change as the truck rolls only a short distance, they were frequently overlooked. Consequently, they appeared only sporadically in recorded data and were soon dropped altogether.

3.2 TRUCK DISASSEMBLY AND NEW BRAKE SHOE INVENTORY

The new brake shoes can be measured and marked before the truck is disassembled for measurement. The carmen at the RIP track are responsible for spotting the car over a concrete pad, jacking and blocking the car, removing the brake rigging from the truck, and disassembling the truck. The most efficient method of disassembly and assembly of some of the trucks is not obvious. In the event of trouble, paragraphs 3.2.1 - 3.2.4 describe the most efficient methods found to date for the National Swing Motion, DR-1, ASF Ride Control, and Barber-Scheffel trucks. While the truck is being disassembled, the new brake shoes designated to replace the used ones are prepared as described in paragraph 2.4.3. The new brake shoe measurements are recorded on form WD-016.

NOTE: Based on experience to date, as the trucks begin traveling in excess of 40,000 mileas between measurement cycles, brake shoes need not be measured, as "new shoes" will not return to be recorded as "used shoes", having been changed out and discarded en route.

3.2.1 Disassembly of National Swing Motion (001)

Step 1. Using bolster hooks, lift the bolster and side frames as a unit and roll the wheelsets out. Roll the wheelsets far enough along the track so that the axle-mounted odometer is not damaged when removing side frames. Watch for the bearing adaptors, which will come down while riding on top of the roller bearings and fall off unexpectedly as the wheels are moved. Remove bearing adaptors and stack to the side of the track. Also, on this truck, watch for broken pedestal rocker seat castings that may be loose, dropping out of the pedestal jaws as the bearing adaptors are lowered.

Step 2. With the side frames hanging from the bolster, remove the load and side springs, and friction castings.

Step 3. Lower the bolster into the transom and chain them together.

Step 4. Raise the bolster and transom as a unit and block between the transom and the ground. The two pieces may be left together and measurements made on the bolster lateral stops, etc., by placing a small hydraulic jack below each end of the bolster and separating the two pieces vertically to allow work.

Step 5. Remove brake beams as they come loose when one side frame is removed, and place the side frames to either end of the bolster.

Assembly is the reverse of these procedures.

3.2.2 Disassembly of DR-1 (003)

Step 1. Place two blocks 7 to 8 inches in height under the truck bolster on either side of the bottom rod.

Step 2. Lift the bolster with the bolster hooks and remove the springs and friction castings.

(NOTE: Bearing adaptors are bolted to the steering arms and should not be unbolted, since the bolts are torqued close to the ultimate yield point of the threads. Refer to the manufacturer's instructions if it is necessary to remove these parts for replacement purposes.)

With the truck still suspended, remove the outboard load springs only.

Step 3. Lower the truck to the ground. The side frames should spread outward allowing removal of the brake beams.

Step 4. Raise the truck by the bolster and remove the remaining springs and friction castings. Place blocks under the bearing adaptor ends of the steering arms in preparation of chain removal.

Step 5. Block under the bolster so that when it is resting on the blocks, the steering pin and socket are supported by the bolster casting. Set the bolster down and remove the chains.

Step 6. Remove the side frames by lifting them vertically with a chain sling to a sufficient height to clear the bolster gibs. Some rocking of the steering arms may be required to release the bearing adaptors from the side frame pedestal jaws. Place the side frames to either end of the bolster. Wheel hooks cannot be used safely because one pair of hooks will be dislodged by contacting the steering arms along the inside face of the side frame.

Step 7. Using the special lifting hooks suggested by Dresser, prepare to disassemble the steering arms. Attach one hook into each cast window on top of either side of the arm "wishbone" and connect the lifting eye of both hooks with a chain, forming a sling. This will properly balance the arms for removal.

As an alternative, wrap lifting chains around one set of steering arms roughly 2 inches toward the bearing adaptor from the windows in the top of the steering arm casting. This is approximately where the steering arm casting balances when suspended from the chains.

Step 8. Unplug the steering arms and place them on the ground.

Assembly is the reverse of these procedures. Extreme care is required to align the steering arm pins and pull the mating pieces together.

3.2.3 Disassembly of ASF Ride Control (005)

Step 1. Prior to disassembling the truck, it is advantageous to drive down and pin the winged friction castings of this truck in a free and clear position. With the assistance of a carman and a standard railroad Z-bar, push down the casting from the top so that its side opening coincides with a hole cast through both sides of the bolster friction shoe pocket. When low enough that a smooth, tapered drift approximately 12 inches long can be pushed freely through the casting and into the opposite bolster pocket side opening, the Z-bar can be released and the drift will restrain the friction casting and spring from applying pressure to the side frame column wall when removing side frames.

Step 2. Remove wheelsets, bearing adaptors, load spring groups, and side frames in the usual manner.

Step 3. To remove friction castings and side springs from the bolster, apply installation fixture C-701-0031-E-09 to the bolster, along with a 3-ton capacity hydraulic jack. Apply force against the top of the shoe using the C-701-0031-E-11 jack base between the jack and shoe until the drift can be easily removed. At this time the jack can be slowly released and the casting and spring removed without danger of suddenly releasing a compressed spring.

Assembly is the reverse of these steps.

3.2.4 Disassembly of Barber-Scheffel (006)

Step 1. Using bolster hooks, lift the bolster and side frames as a unit and roll the wheelsets out from the truck. Remove and stack bearing adaptors out of the way.

Step 2. Set the truck down, either with the side frames resting directly on the ground or with the shear pad housings supported on special stands provided by the truck manufacturer. Use of these stands is optional and is not required unless the truck is to be completely disassembled.

Step 3. Lift the bolster, allowing the spring groups and friction castings to be removed. Before lowering the bolster, insert two 6 9/16-inch long wooden blocks beneath each end of the bolster casting to avoid bending the cross arm assembly running through the windows below the center bowl. It is not necessary to remove the brake beams.

This is as far as the truck can be broken down for ordinary cyclical measurements, since dismantling the crossarms, struts, and shear pad housings necessitates a lengthy resquaring and reassembly process. In this case, the manufacturer's assembly manual and drawings should be used.

3.3 BOLSTER MEASUREMENTS

The bolster measurements include center bowl wear liner thicknesses, side bearing cages, side bearing diameters, column widths, and gib and transom thicknesses where applicable.

3.3.1 Center Bowl Measurements

The center bowl measurements are taken with the ultrasonic thickness gage and by means of the dial depth gage in conjunction with the C-701-0024-E-9 template assembly.

The center bowl must be cleaned to remove the center plate lubricant. This is done by scraping the exposed surfaces with a putty knife, removing as much of the loose lubricant as possible with a bench brush, and then washing the center bowl with solvent.

The horizontal wear liner is measured by placing the 16-inch center plate measurement template assembly (C-701-0017-C-09) in the center bowl and lining up 0 degrees with the punched index mark on the wall surrounding the center bowl. The ultrasonic thickness gage is used to measure twelve locations numbered 1A-4C. The template is rotated 45 degrees counterclockwise and twelve more thicknesses numbered 1D-4F are measured. These are recorded on form number WD-012. The liner index angle (reading 1K) referred to on form WD-012 is found by locating the ground groove on the edge of the horizontal wear liner and measuring its angular displacement with respect to the truck axis. The vertical wear liner is measured in eight places halfway between top and bottom with the ultrasonic thickness gage. The eight locations around the perimeter are found by advancing the protractor arm on the center bowl template from 0 degrees to 315 degrees by 45-degree increments, and coincide with the axial locations of the wear liner measurements. Calibrate the ultrasonic gage on the .200-inch and .500-inch step blocks using a 2.25-MHz dual transducer. With the transducer leads pointing up, record the measurements as readings 1T-8T on form WD-012.

Once the wear liner has been measured, it is removed, except on the DR-1 where it is captured by the vertical wear liner, and the center bowl is again cleaned. The center bowl mechanical depth measurement template assembly (C-701-0024-E-09) is placed and located by the index marks over the center bowl. The dial depth gage is used to measure the relative thickness in 24 places. The data are recorded on form WD-013. The wear liner is returned to the center bowl with the liner index mark set to 0 degrees.

3.3.2 Side Bearing Measurements

The side bearings are measured for their minimum diameter using a 3 to 4-inch micrometer and recorded on form WD-014. The cage base thickness is measured with the ultrasonic thickness gage at the point of maximum wear before the side bearings are replaced. The cage base thickness is recorded on the same form.

3.3.3 Column and Gib Spacing

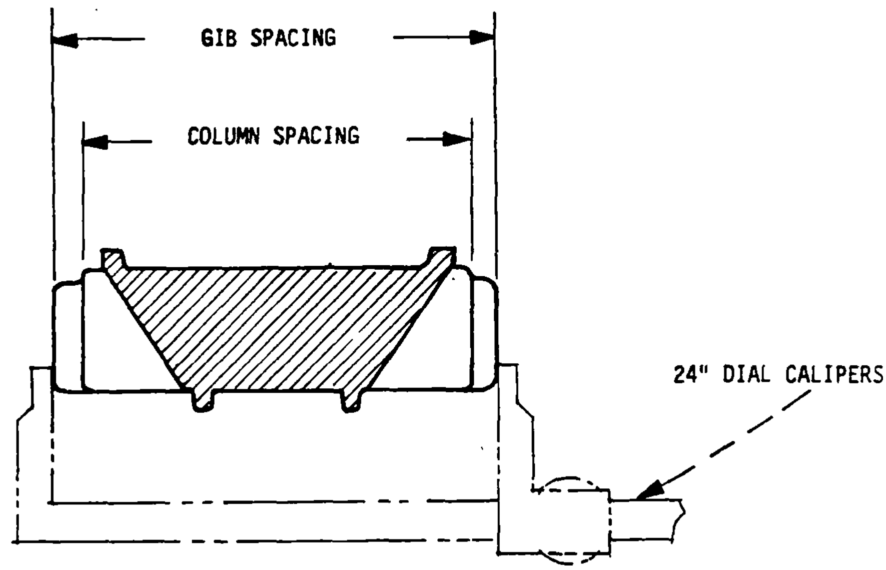
The column spacing is taken with the 24-inch dial calipers at two points between the gibs, 1 inch below the top edge and 1 inch above the bottom edge. The gib spacing is also taken 1 inch above and below the edges with the 24-inch dial calipers. See Figure 3.1. The numbers are recorded on form WD-021.

3.3.4 Other Bolster Measurements Particular to Specific Trucks

The special measurements for the National Swing Motion, DR-1, Barber S-2-HD, Barber-Scheffel trucks are outlined below.

3.3.4.1 National Swing Motion. The National Swing Motion truck has no bolster gibs. The gib entries on form WD-021 are left blank when measuring this truck. The rocker seat thickness is measured in two places, one on each ear, using the Federal dial calipers. Each rocker seat bearing is measured in one place where the wear is most apparent (see Figure 3.2). Bolster stops are utilized on the National Swing Motion to confine the bolster relative to the transom. The bolster stops are located about 18 inches inboard of the spring groups on the underside of the bolster. A 3-ton hydraulic jack is used to lift first one side then the other of the bolster high enough to measure the bolster stop thickness. The Federal dial calipers are used to obtain the thicknesses. The transom stops are readily accessible from above and the Federal dial calipers are used to measure their thicknesses (see Figure 3.3). All of the measurements in this paragraph are recorded on form WD-A-04.

3.3.4.2 Dresser DR-1. The DR-1 truck requires special measurements of the steering arm pin and socket and of the elastomeric pads between the side frame and bearing adaptor. The steering arm pin is measured with a digital 1 to 2-inch micrometer



SECTION A-A

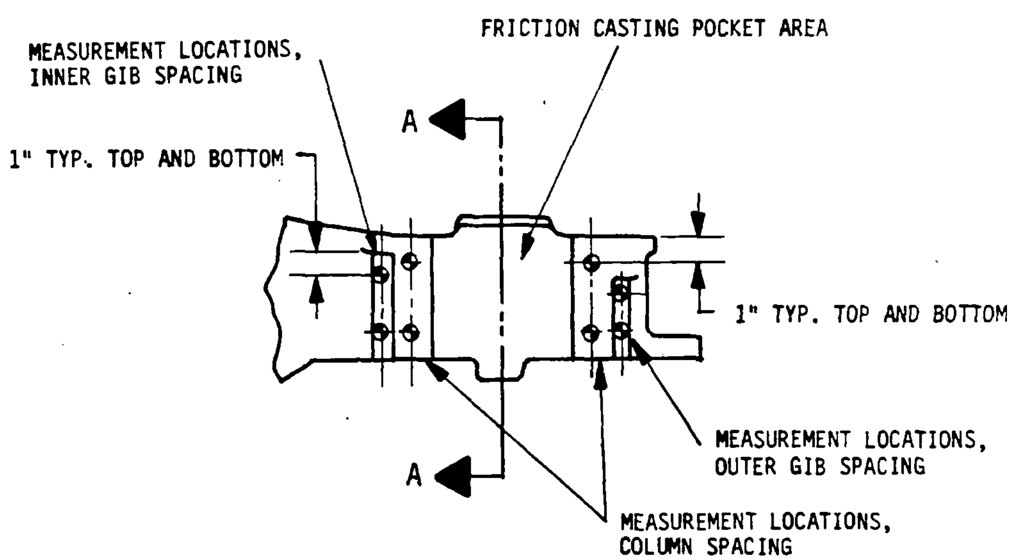


FIGURE 3.1. COLUMN AND GIB SPACING

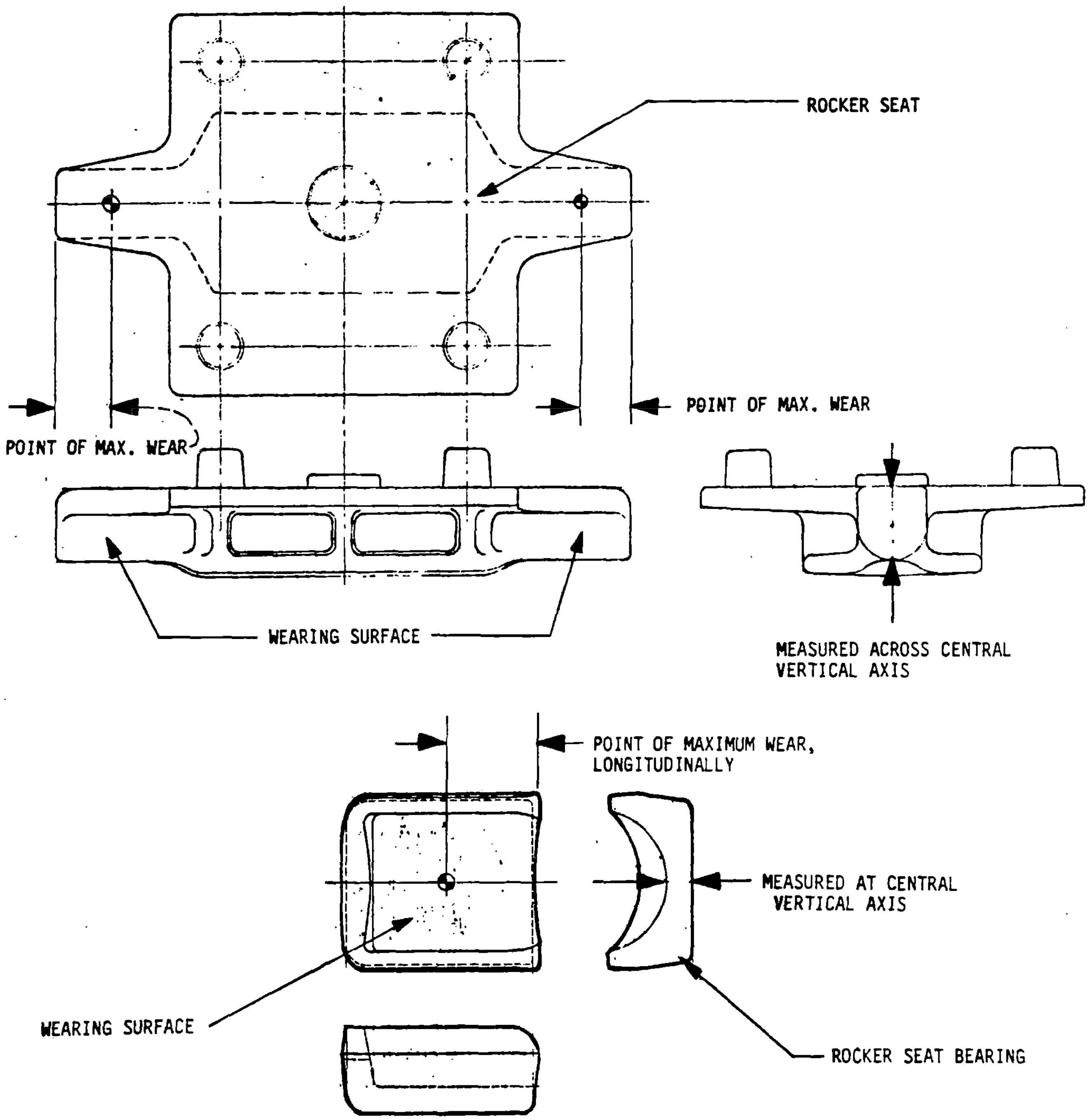


FIGURE 3.2. ROCKER SEAT AND BEARING MEASUREMENTS
NATIONAL SWING MOTION TRUCKS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 53

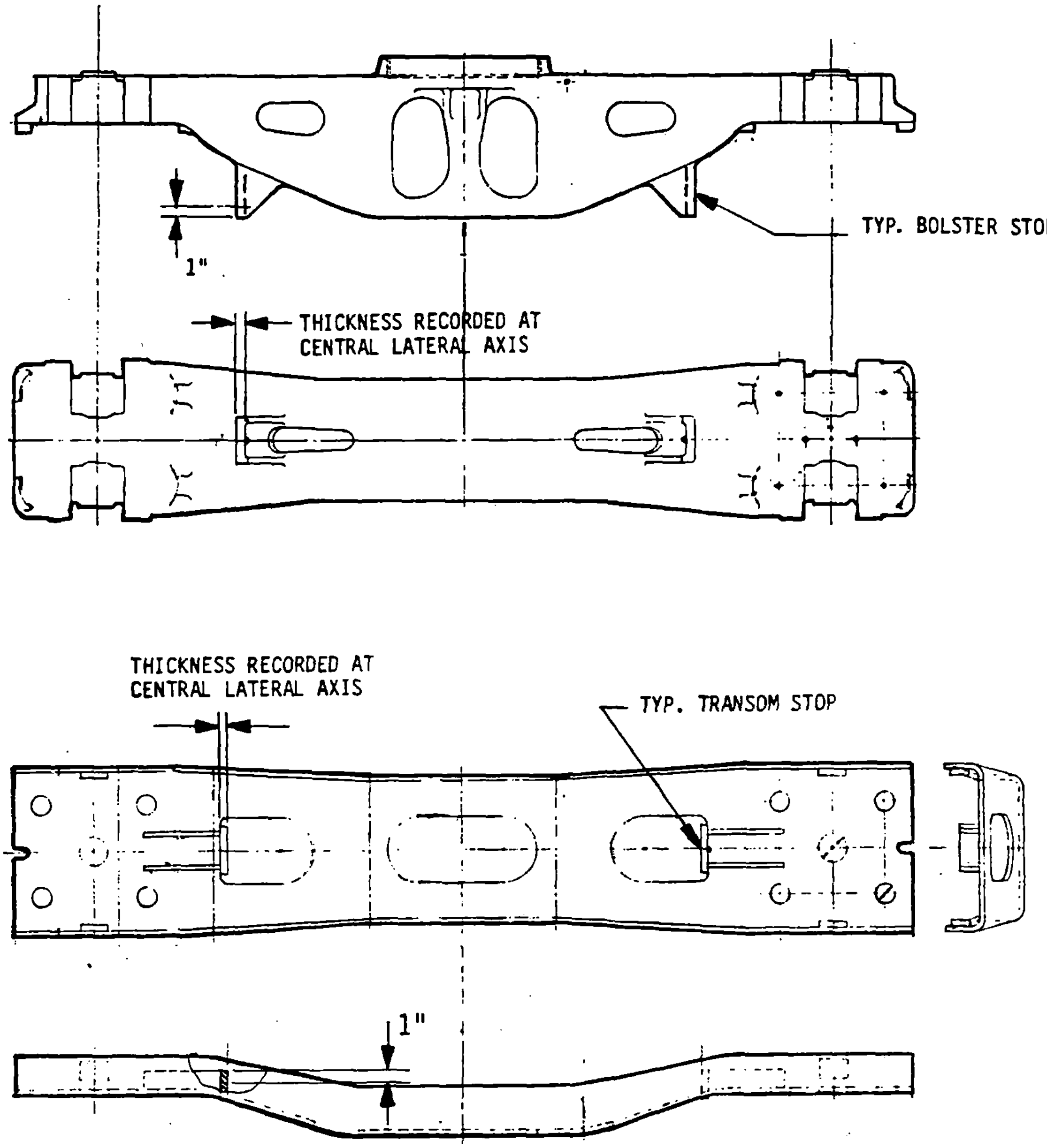


FIGURE 3.3. TRANSOM AND BOLSTER STOP MEASUREMENTS
NATIONAL SWING MOTION TRUCKS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 54

inserting the lock joint inside calipers into the socket and reading the distance between the arms with the micrometer. Two measurements of the socket diameter are taken, one in the horizontal direction and one in the vertical direction. Each elastomeric shear pad is measured in two places directly over the crown of the roller bearing 1 inch from the left and right sides. The Federal dial calipers are used. All of the measurements in this paragraph are recorded on form WD-A-05.

3.3.4.3 Barber S-2 Heavy Duty. The Barber S-2 Heavy Duty truck is equipped with center plate extension pads. The heights of these pads are measured in their extended and compressed states, by recording measurements as shown in Figure 3.4. These measurements are recorded on form WD-A-07.

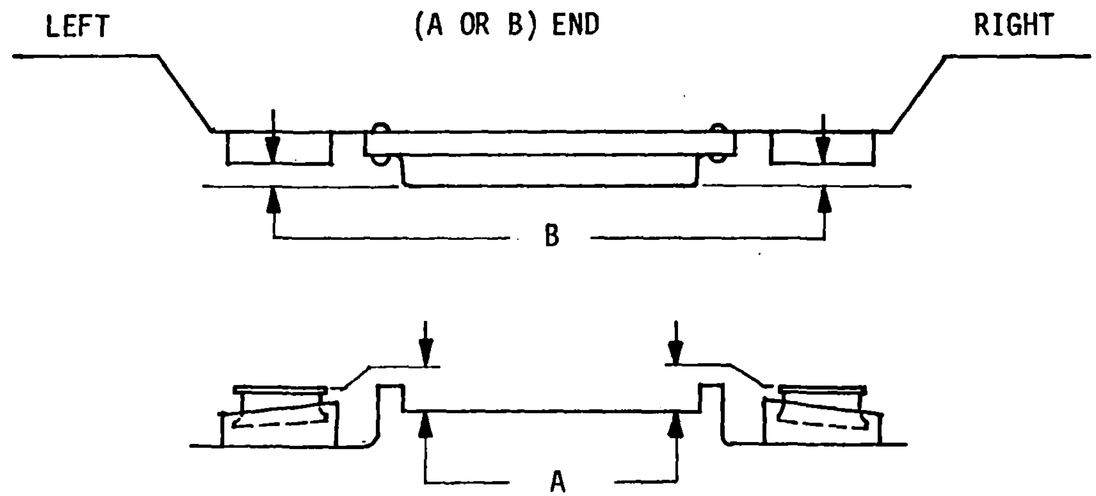
3.3.4.4 Barber-Scheffel. The Barber-Scheffel truck is equipped with elastomeric shear pads between the bearing adaptors and the side frame. Space exists on form WD-A-06 for the thickness of these pads, but the truck must be disassembled to measure them. Consequently, they are not measured on a cyclic basis.

3.4 SIDE FRAME MEASUREMENTS

The side frame measurements consist of the inner and outer pedestal jaw lug relative thicknesses, the pedestal roof relative height, the anti-rotation lug thickness, the width of the columns, the lateral width of the pedestal jaw inner and outer lugs, the pedestal jaw lug to lug spacing, the jaw to jaw spacing, the anti-rotation lug spacing, and the side frame column wear plate thickness.

3.4.1 Measurements Pertaining to the Pedestal Roof Mechanical Wear Measurement Fixtures

The pedestal roof indexing fixture assembly is positioned in the punched impressions on the pedestal roof and is secured by hooking a screen door spring to the template and stretching it over the top of the side frame. Table 3.1 itemizes which fixture/pin combination is used to measure each type of pedestal roof.



COMPRESSED HEIGHT = A - B

FREE HEIGHT = A

FIGURE 3.4. C-PEP FREE AND COMPRESSED HEIGHTS

Table 3.1 Fixture/Pin Combinations for Pedestal Roof Measurements

	Narrow Assembly C-701-0026-E-19 With 1½" Long Pins	Wide Assembly C-701-0026-E-09 With 7/8" Long Pins
CAR 001	●	
002	●	
003	●	
004		●
005	●	
006		●

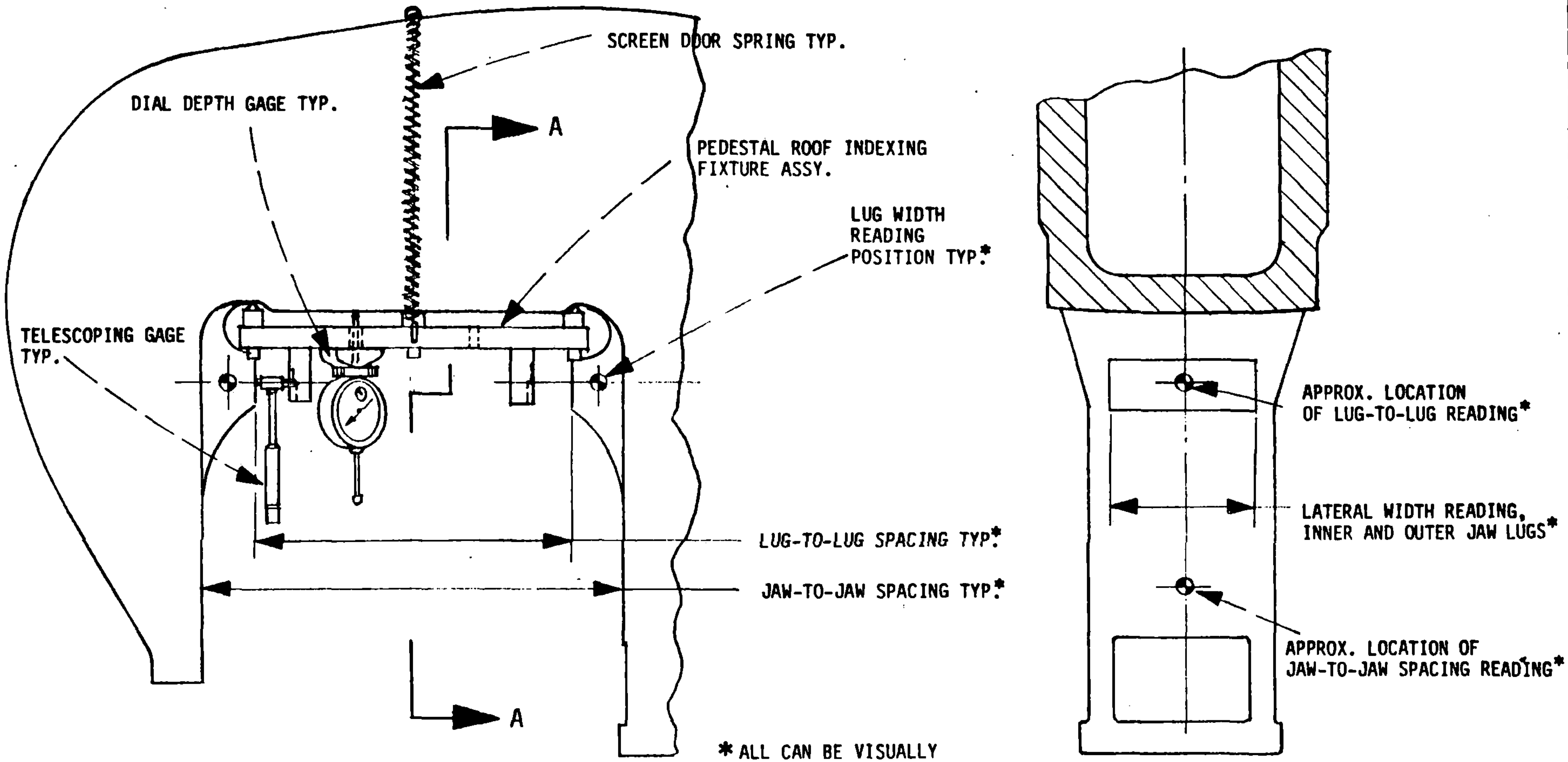
(Note: Each pin is engraved at its back end with a letter corresponding to an engraved letter on the bottom of the fixture assembly to insure that readings can be related correctly to previous measurements.)

The outer and inner lug relative thicknesses are taken in three places per lug by sliding a T-gage between the lug and the milled grooves on the side of the template which most nearly aligns with the center of the lug (see Figure 3.5). The T-gage is locked in position and extracted, and a 0 to 1-inch micrometer is used to take the reading. The pedestal roof relative height measurements are taken with a dial depth gage through the six holes numbered 1A-3C. All measurements described in this paragraph are recorded on form WD-017.

3.4.2 Anti-Rotation Lug Thickness and Column Width

The anti-rotation lugs are located on the inboard side of the side frame column and rest against the inner bolster gibs when the truck is trammed.

Three round-headed cap screws which have been pressed into the side of the lug away from the bolster (refer to Figure 2.8) serve as a reference point for the 1 to 2-inch micrometer to measure the thickness of the lugs. The column width measurements are taken with a 9 to 10-inch inside micrometer in three places opposite the round-headed cap screws. The anti-rotation lug and column width measurements are recorded on form WD-017.



* ALL CAN BE VISUALLY LOCATED BY FINDING CONTACT POINTS OF BEARING ADAPTER AND ROLLER BEARING HOUSING, EACH JAW

VIEW A - A
(FIXTURE OMITTED)

FIGURE 3.5. PEDESTAL JAW ROOF MEASUREMENT LOCATIONS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 58

3.4.3 Pedestal Lugs, Jaw-to-Jaw, and Anti-Rotation Lug Spacing

The inner and outer pedestal jaw lug lateral width measurements are taken with a 3 to 4-inch micrometer at one place on each lug where the wear appears to be greatest. The lug-to-lug spacing is taken with a 7 to 8-inch tubular inside micrometer, in one place where the bearing adaptor appears to have been making contact. The jaw spacing is taken with a 10 to 11-inch tubular inside micrometer held horizontally where the roller bearing cup appears to be making contact with the jaws (see Figure 3.5). The anti-rotation lug spacing is taken with the 24-inch dial calipers in three places per lug set opposite the cap screws, reading as an inside measurement with the outward facing tips of the caliper jaws and adding .800 inches to the reading obtained, as shown in Figure 3.6. All of the measurements in this paragraph are recorded on form WD-018.

(Note: For car 001, forms WD-017 and WD-018 are replaced by form A-01.)

3.4.4 Column Wear Plate Thickness

The column wear plate thickness is measured with the ultrasonic thickness gage. The transducer location template (part # C-701-0018-A-03 for cars 002 through 006 or C-701-0018-A-01 for car 001) is held against the wear plate with spring clamps, where possible, or with magnets placed against the face of the template, clamping it to the steel wearplate. The transducer is placed in each hole in the template and the thickness recorded on form WD-019. In some cases, a hole in the template is located over a bolt holding the wear plate to the column; in these instances, the ultrasonic reading for the location is ignored.

(Note: For car 001, form WD-019 is replaced by form A-02.)

3.4.5 Spring Free Height Measurement

The spring free height measurement is taken by using two fixtures and the dial depth gage. The spring is placed over the 6.320" high post on the spring center locating base, C-701-0053-A-01. The spring squareness template C-7012-0023-A-01 is laid on top of the spring. Three or four inches of extension rods are attached to the plunger on the dial depth gage. The spring height is determined by measuring the distance from the top of the squareness template to the top of the post with the depth gage and adding 6-inches to the result (See Figure 3.7). The measurements are recorded on the forms numbered WD-024. At this point, spring identification nomenclature should be checked and clarified or replaced, if necessary, to insure legibility and permanancy.

3.4.6 Component Weights

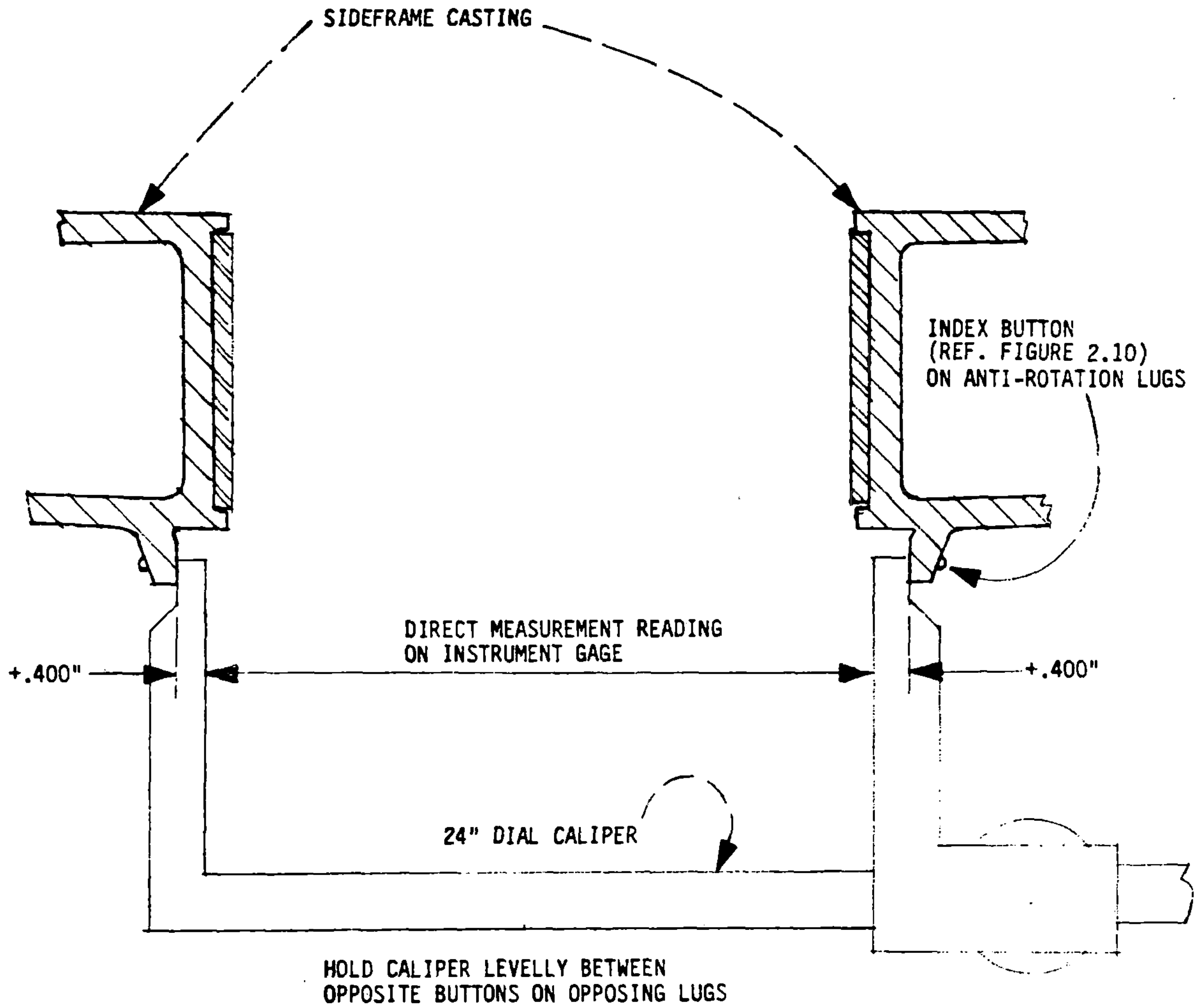
Several of the smaller truck components are weighed besides having their dimensions taken. A 0 to 125-lb balance beam scale is located in the shed and must be level before use. The friction castings, brake shoes, and bearing adaptors (except bearing adaptors for the DR-1 truck) must be transported to the shed to be weighed. In the case of all components, the weight is recorded in ounces. The weight of the friction castings is recorded on form WD-023, the bearing adaptors on WD-022, and the used brake shoes on form WD-015.

3.4.7 Bearing Adaptor Measurements

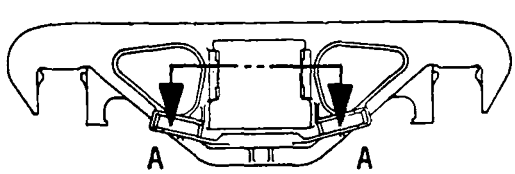
3.4.7.1 Swing Motion, Barber S-2, Barber S-2 HD/C-PEP, ASF, and Barber-Scheffel Trucks. Bearing adaptors on these trucks are loose items and can be measured by the roller bearing adaptor wear measurement template assembly, C-701-0-016-E-01, plus the dial depth gage with and without its 1-inch extension, T-gages, and a 0 to 1-inch micrometer. All bearing adaptors used are standard $6\frac{1}{2}$ x 12 "Abex Blue," for compatibility with the measurement template assembly (MTA).

Begin by orienting the bearing adaptor with its outboard side (impression-stamped and painted) toward the reader on a level, sturdy work surface.

Orient the MTA with its stamped outboard side toward the reader and locate its three legs on the flat shouldered surfaces of the bearing adaptor at three of the four corners. Slide the MTA toward the inboard side of the set-up until the set screws of the locating plates contact the outboard side of the adaptor, and then to the left until the adjustable locating plate limits its motion in that direction against the outboard



VIEW A - A THRU SIDEFRAME



TYPICAL SIDE FRAME (INSIDE SURFACE)

FIGURE 3.6. ANTI-ROTATION LUG SPACING MEASUREMENT

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev A	Sheet 61

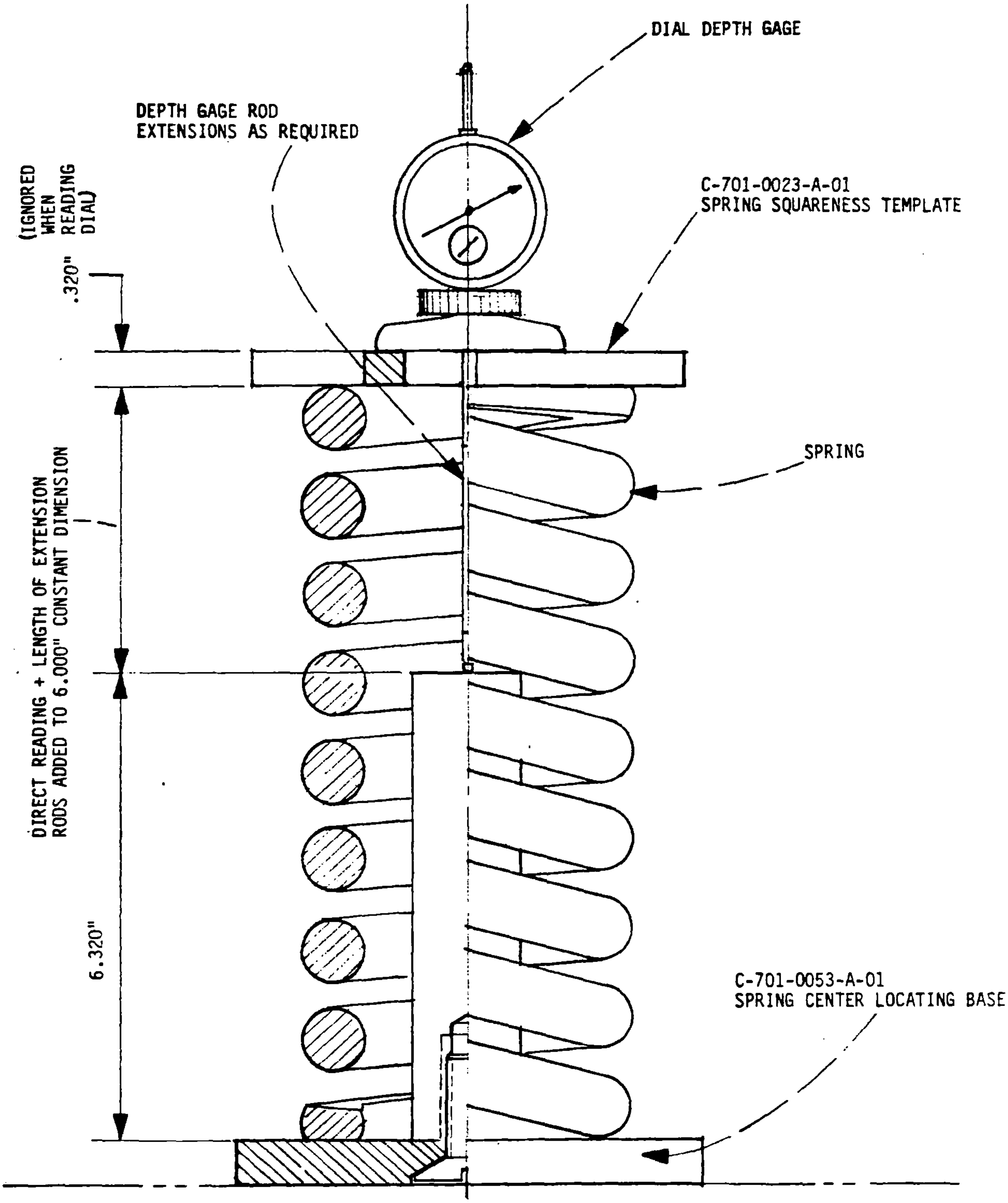


FIGURE 3.7. SPRING FREE HEIGHT MEASUREMENTS

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev	Sheet 62

lifting lug . Having done this, the MTA will be centered over the crown of the bearing adaptor with its side plates correctly positioned between the recessed surfaces that are the longitudinal and lateral stop faces of the adaptor ends. See Figure 3.8 for typical measurement locations.

Crown relative height readings are taken through the six holes stamped 1A-3B with the dial depth gage minus extension rods. Longitudinal stop relative thickness readings are taken, one per side, through the two holes marked 6A and 6B centered on the side plates, using the dial depth gage and its 1-inch extension rod. Lug lateral face relative thickness readings are made with the 3/4 to 1¼-inch range T-gage, modified per Wyle SK-060779.1-A to fit the side plate slots marked 4A-5B, and the 0 to 1-inch micrometer.

When using the T-gages or taking dial gage readings through the side plates, it is usually necessary to hold down the MTA with a forearm across the top plate while manipulating the gages, securing against movement that would invalidate lateral and longitudinal readings.

All these bearing adaptor readings are recorded on form WD-022.

3.4.7.2 DR-1 Trucks. Bearing adaptors on these trucks are rigidly bolted to the steering arms and should not be removed unless required for complete replacement of a worn-out component. To measure adaptors, the special MTA C-701-0041-E-01, and the same gages described in paragraph 3.4.7.1 are used.

Locate the outboard side of the MTA toward the reader, seating on the shouldered surfaces of the adaptor, and shoving to the inboard side until the set screws on the outboard locating plates contact the adaptor. Gage readings are made as described in paragraph 3.4.7.1 and also recorded on form WD-022.

3.4.8 Friction Casting Measurements

3.4.8.1 National Swing Motion, Barber S-2, and DR-1 Trucks. These trucks all use a single-sloping face type friction casting, similar to Standard Car Truck Company's type 787-C, with a 5½-inch face. The same fixtures that were used to mark indexing holes in the nonwearing side surfaces are used to take dimensional readings. The

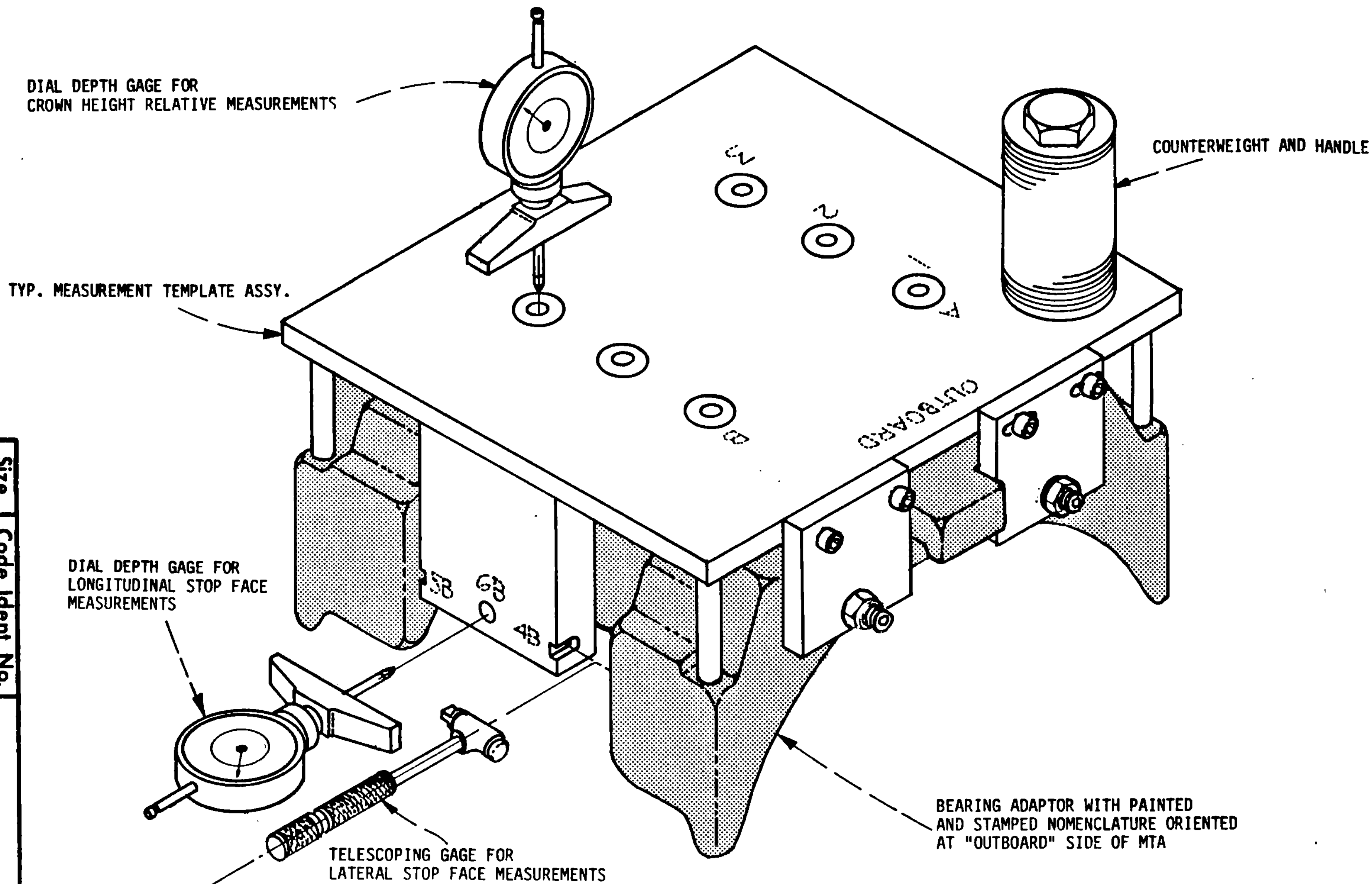


FIGURE 3.8. TYPICAL MEASUREMENTS OF BEARING ADAPTOR SURFACES

C-701-0021-E-09 depth gage indexing fixture assembly configured with its locating screw, pins, spring, and pin retainer is used on the vertical face; the C-701-0022-E-09 fixture is used on the sloping face of the casting. For convenience in aligning the indexing pins with their matching drilled holes, small set screws have been placed in the inside face of the fixture plates. These screws are only for approximate location when placing the fixtures over the castings, and will allow the assembly to rest momentarily on the casting face so that the pins may be started into the holes. When all pins are properly positioned and tightened, the fixture will lift slightly as it seats, the set screws no longer contacting the casting face. To do so could affect readings made with the fixtures.

All measurements taken through both fixtures are made with a dial depth gage, 0 to 1-inch range as shown in Figures 3.9 and 3.10 and recorded on form WD-023.

3.4.8.2 Barber S-2 HD/C-PEP and Barber-Scheffel Trucks. A slightly larger casting with a 6½-inch wide face is used on both types of trucks, identified as 834-B of Standard Car Truck. One C-701-0027-E-09 depth gage indexing fixture is used to take all vertical and sloping face measurements on each casting. At initial set-up, no indexing holes are drilled into this type of friction casting; instead, three set screws in the base of the fixture are positioned to contact a nonwearing side of the casting, and the length of the set screws adjusted to correct for the tapered side surface of the casting. Thus, supported levelly, a set screw is turned into the flat (vertical) face of the casting which forces it back into contact with three indexing points that automatically locate the casting in the two horizontal axes. It is only necessary to turn the adjustable screw into a finger tight condition to capture the casting; excessive tightening with a wrench may bend the central alignment point out of a vertical position and influence readings made inwardly from two sides.

All measurements made with this fixture are taken with the dial depth gage, with and without its 1-inch extension rod, as shown in Figure 3.11. Measurements are recorded on form WD-023.

3.4.8.3. ASF Ride Control Trucks. A special shoe which will only fit an ASF Ride Control bolster pocket is used here. Ultrasonic readings can be made at all but two

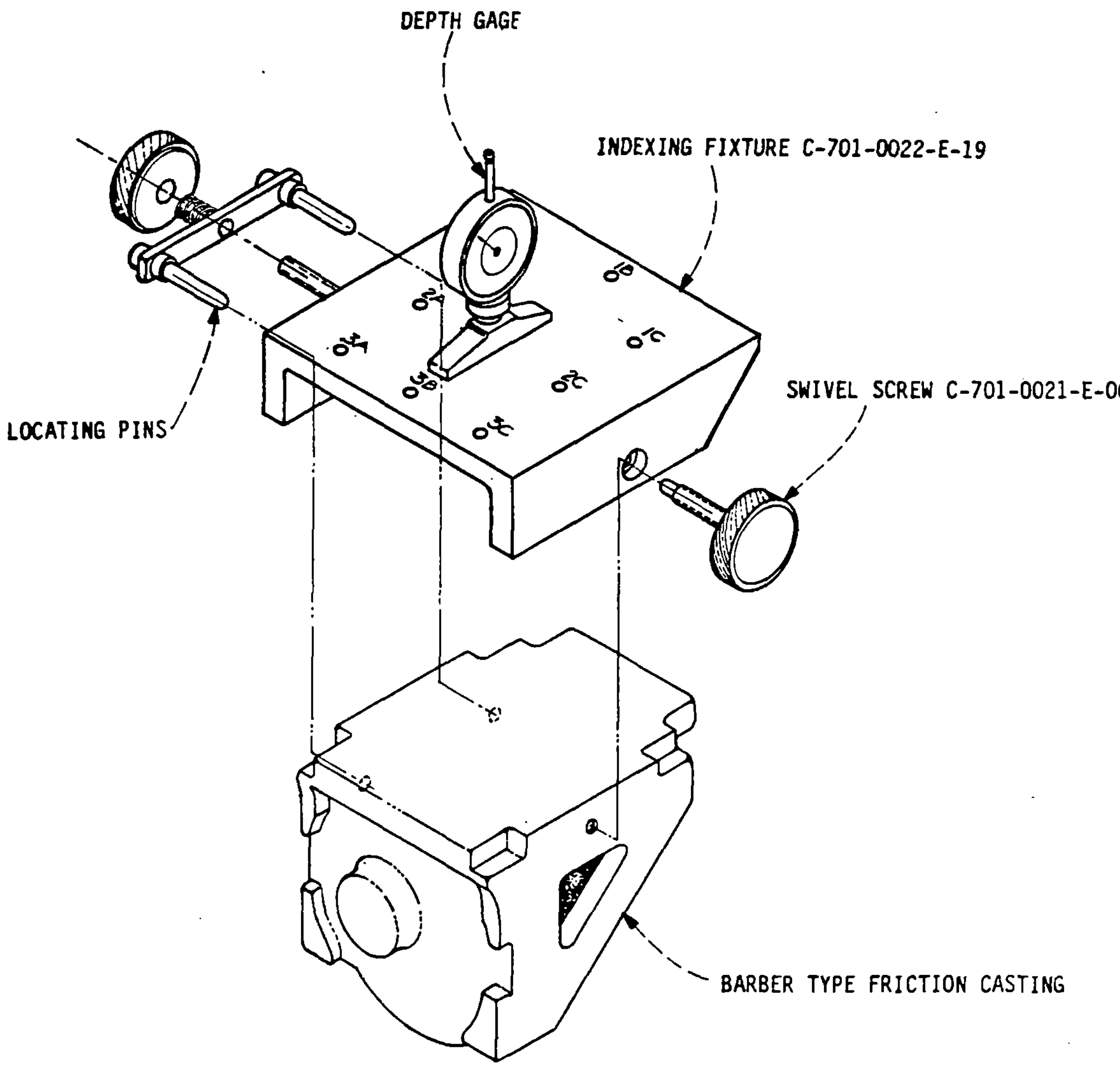


FIGURE 3.9. APPLICATION OF DEPTH GAGE INDEXING FIXTURE ASSEMBLY TO BARBER FRICTION CASTING VERTICAL FACE

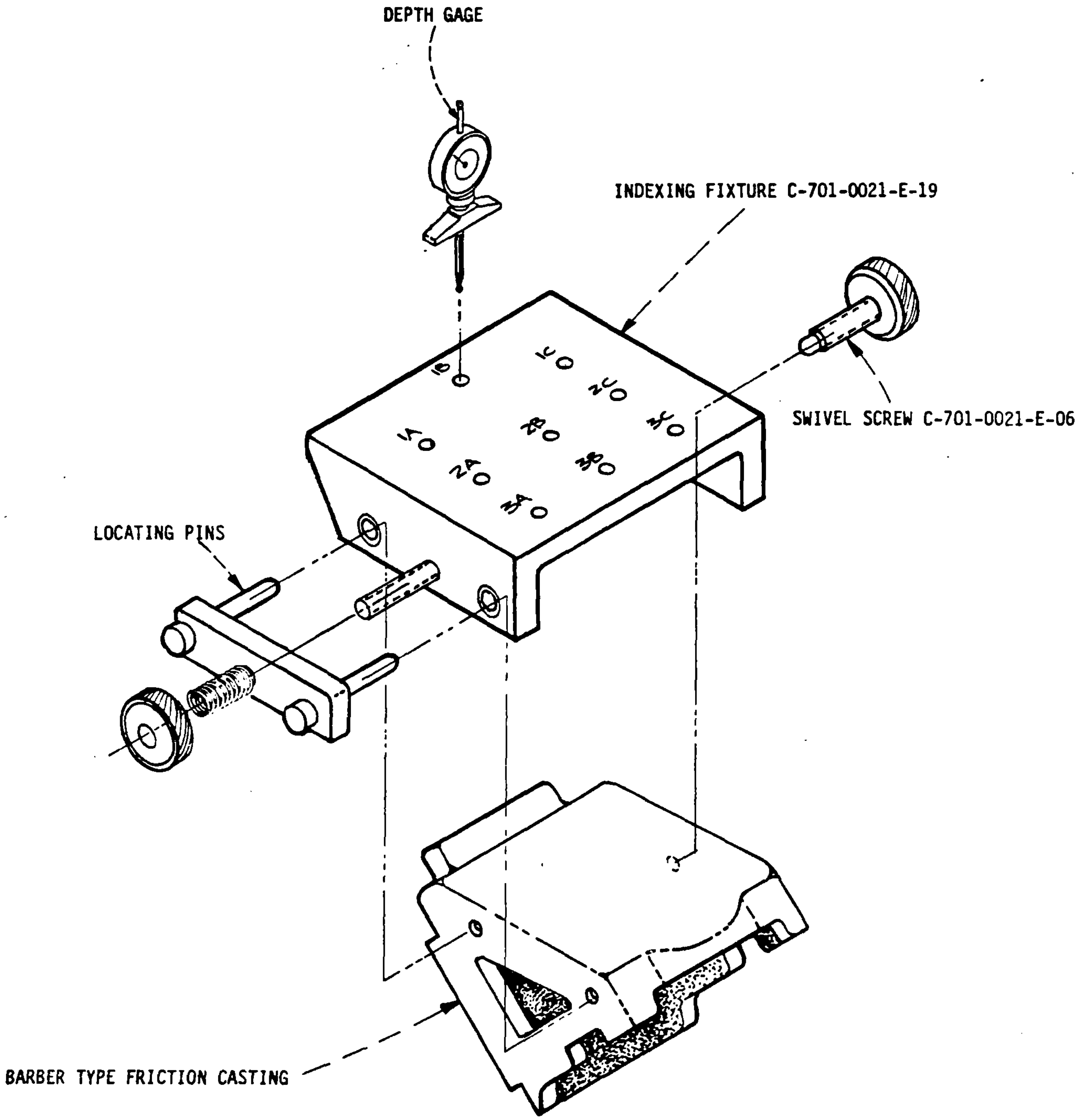


FIGURE 3.10. APPLICATION OF DEPTH GAGE INDEXING FIXTURE ASSEMBLY TO BARBER FRICTION CASTING SLOPING FACE

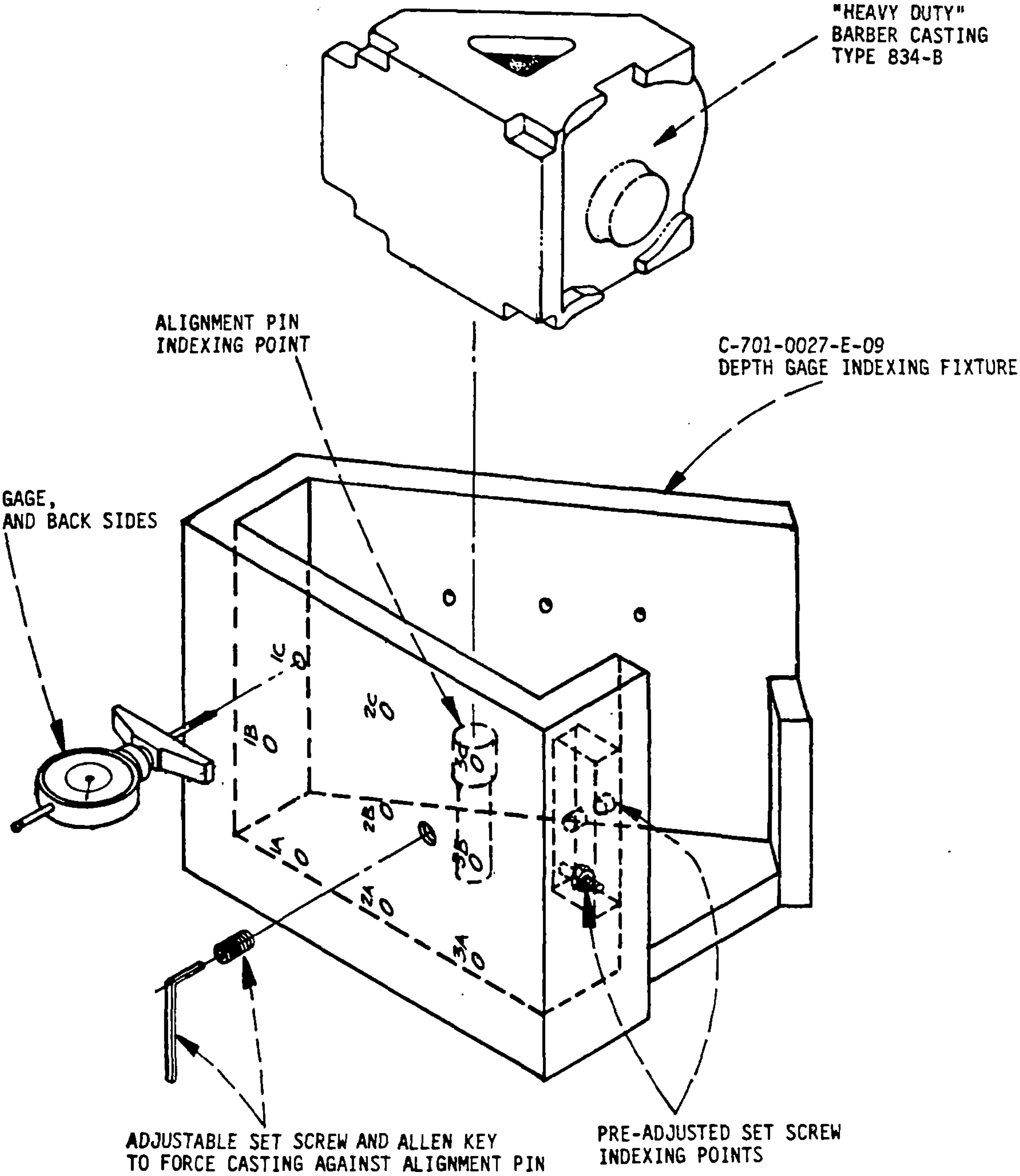


FIGURE 3.11. DEPTH GAGE INDEXING FIXTURE FOR RELATIVE WEAR MEASUREMENTS ON BARBER TYPE 834-B FRICTION CASTINGS

locations on the vertical face, so two locational templates, C-701-0018-A-02 for the vertical face and C-701-0019-A-09 for the wings, are used. By careful propping and shimming, the shoe may be supported to level either the vertical or sloping wings and facilitate the placement of both templates. In addition, a small C-clamp or spring clamp will help in holding the templates while instruments are used.

To position either template, center it on the casting for approximate side-to-side location and then seat the turned-down locating edge firmly against the piece. See Figures 3.12 and 3.13. No scribe marks are provided for alignment, but the template nearly matches the available flat casting surface; there is almost no error possible.

Calibrate the ultrasonic depth gage on the .200-inch and .500-inch step blocks using the 2.5-MHz dual transducer. The only readings that cannot be made with this instrument are the 1A and 1C positions; since a projecting lip behind these locations is available, these two measurements are taken with a squeeze-type dial caliper, positioned approximately with one tip through the transducer locating hole in the template, and the other tip on the back of the casting placed as levelly as possible with the front tip. The calipers are then gently "rocked" to obtain the minimum straight line distance between the two tips and the reading recorded, using form A-03.

3.4.9 Wheel Measurements

Wheel measurements consist of one profile per wheel, finger gage readings in two places, a wheel tape circumference reading, and the front-to-front distance at the location of the profile. The wheel profiles are traced onto 4 by 6-inch cards using the Pullman profilometer. Experience has shown that great care must be taken to insure that the profilometer is positioned squarely on the wheel. The profiles are to be taken at the point on the circumference where the groove has been ground inboard of the flange. See paragraph 2.3 for a further description of the groove. The finger gage readings are taken in two places on the wheel. The "1" position referred to on the form is located opposite the groove and the "2" position is located 180 degrees away. The finger gage is used to take three measurements: rim thickness, flange height, and flange width (see Figure 3.14). These numbers are recorded on form WD-026. Before the wheel tape can be used, the wheel tread must be elevated from the surface of the rail. This is done by rolling the flange up on an obstruction placed along side the rail.

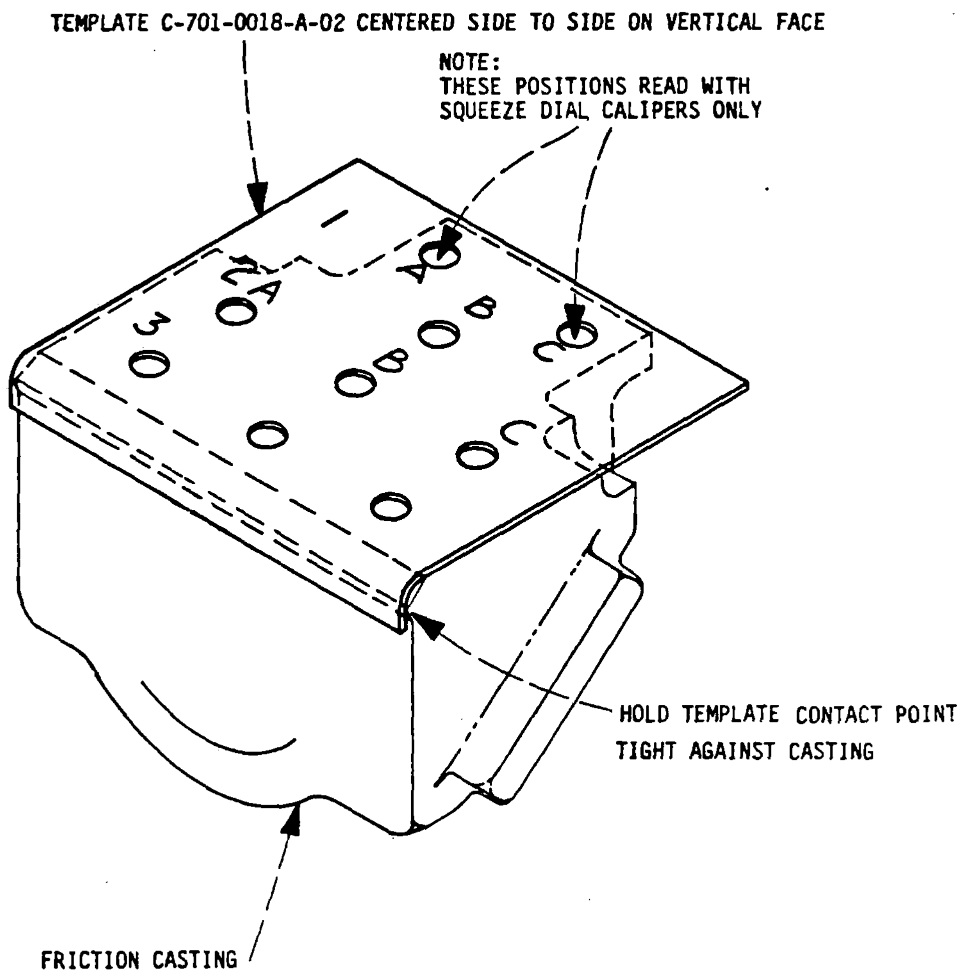


FIGURE 3.12. ULTRASONIC THICKNESS TEMPLATE LOCATION - VERTICAL FACE OF ASF FRICTION CASTING

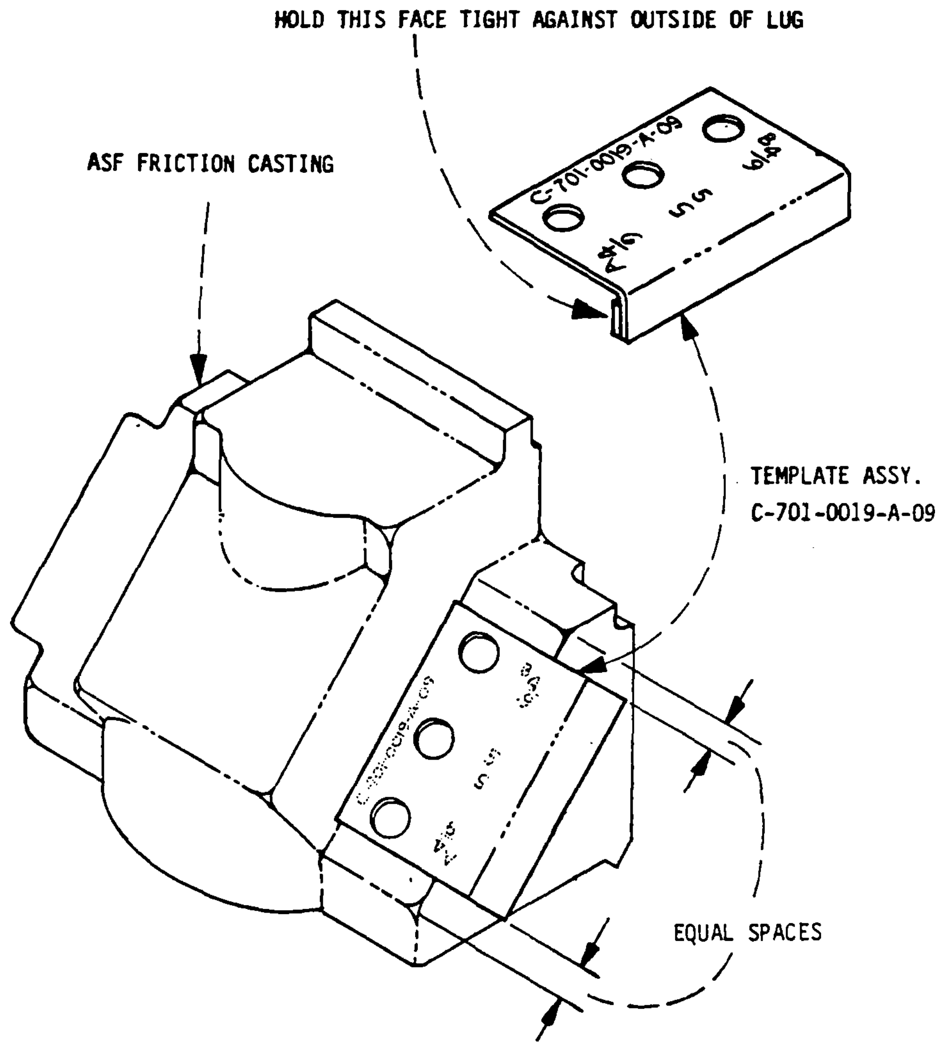


FIGURE 3.13. ULTRASONIC THICKNESS TEMPLATE LOCATIONS - SLOPING FACE OF ASF FRICTION CASTING

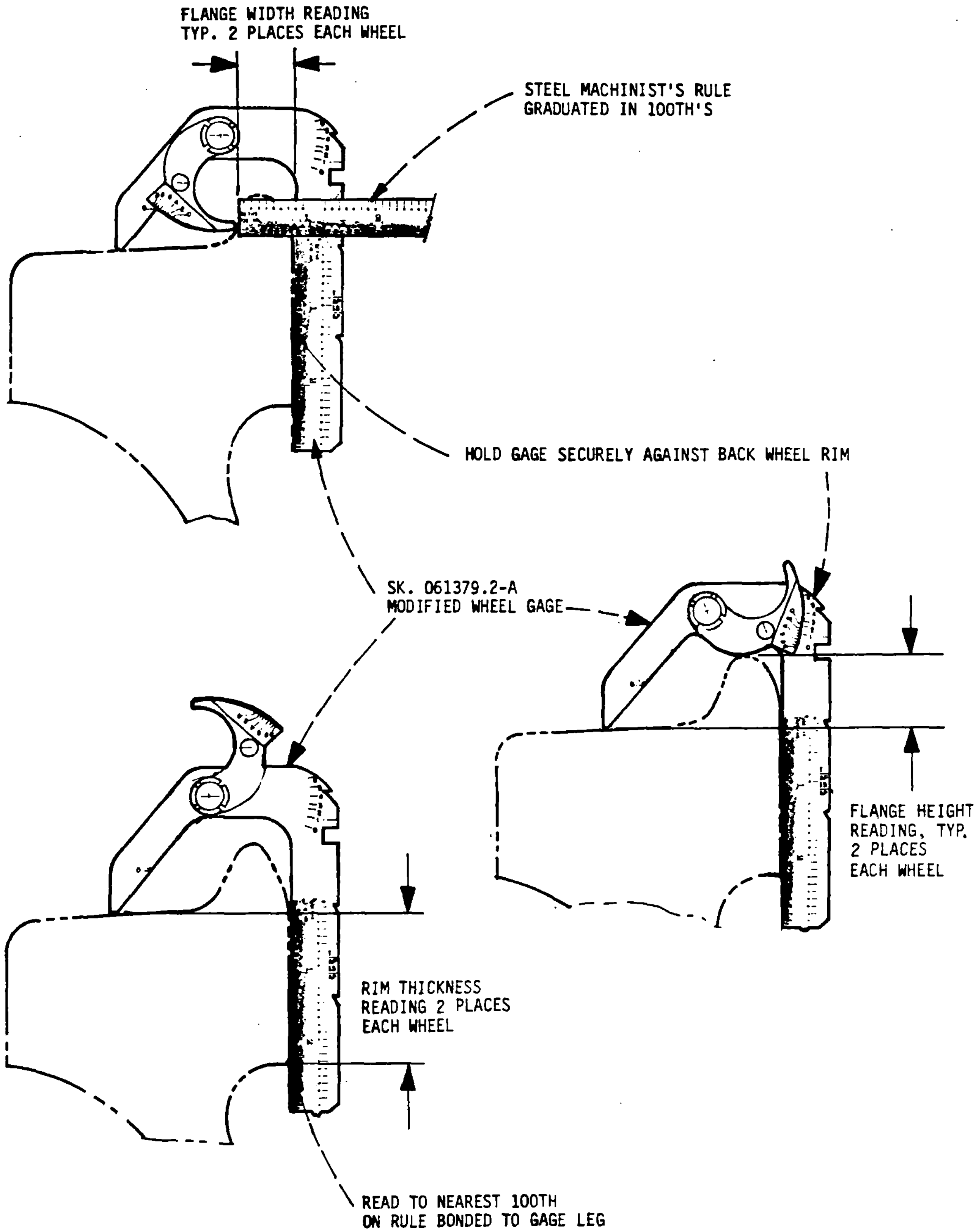


FIGURE 3.14. USE OF MODIFIED WHEEL GAGE FOR WEAR MEASUREMENT READINGS

The tape size is read from the tape and is converted to inches according to the table on the back of form WD-026. The circumference, in inches, is recorded on the front of the same form.

Two additional measurements are also recorded on this form, a tread thickness measurement taken with a 5 to 6-inch digital micrometer (see Figure 3.15) at both the "1" and "2" positions, and the wheel mileage which is read from the R1 wheel hub odometer. In the case of replacement wheelsets that have less mileage than the odometer indicates, interpolate the mileage for that particular wheelset from replacement records and enter that figure in the space provided.

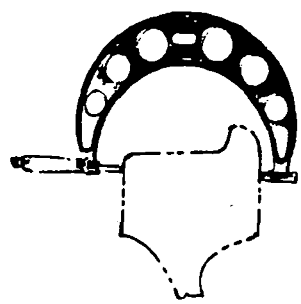


FIGURE 3.15. USE OF MICROMETER FOR TREAD THICKNESS

3.4.10 Carbody Bolster Measurements

The carbody bolster measurements consist of finding the diameter of the center plate in four axes 45 degrees apart as shown in Figure 2.14 and measuring the thickness of the side bearing plates.

The carbody center plate is measured with the 24-inch dial calipers in a minimum of four indexed places. There are eight index marks painted around the perimeter of the center plate on the carbody bolster at 45-degree intervals. The diameter of the center plate is measured between diametrically opposite index marks at two different levels. The upper level is $1\frac{1}{2}$ inches from the plane of the bearing surface of the center plate. The lower level is 1/2 inch from the plane of the bearing surface of the center plate. Besides measuring the diameter at the four axes indicated above, the minimum diameter at both levels is determined along with the angle where each minimum diameter occurs.

The side bearing plate thickness is measured with the ultrasonic thickness gage in two places using the side bearing plate template C-701-0045-A positioned as shown in Figure 3.16. All these carbody bolster measurements are recorded on form WD-027.

3.5 RETURNING THE TRUCK TO SERVICE

The assistance of the carmen and a hoist are needed for truck reassembly. When the truck is reassembled, including brake shoes, slack in the brake rigging may be obtained by actuating the car's brake system with a rip track air brake test cart. This causes the slack adjustor to extend the operating rods toward the car ends, allowing the live brake lever to be aligned with the operating rod clevis and its pin inserted with a minimum of effort. Otherwise, the operating rod must be pulled out manually with a chain hoist. After obtaining slack, the truck can be rolled underneath the car and positioned with its center pin. (Note: Center pins are not used on car 006.) The car is then lowered onto its truck, after placing three center bowl lubricant pads equidistantly around the bolster center bowl. Before releasing the truck, all components are checked to see that they have been replaced in their correct positions, as determined by the paint marking or impression stamping on the respective parts, and have seated properly (i.e., bearing adaptors seated correctly on roller bearing races, friction castings unpinned, springs properly vertical and seated, and side bearings correctly oriented; brake shoes must have their silver end pointed up).*

At the completion of these steps, the air brakes must be checked for proper operation by a rip track air man. If the car's In Date Test stenciling is over six months old, it will be updated by the air man and the car is then released for unit train service. The used brake shoes are measured at this time using the Federal dial calipers and brake shoe measurement location template SK-061379.1-A, and recorded on form WD-015.*

*See Section 3.2

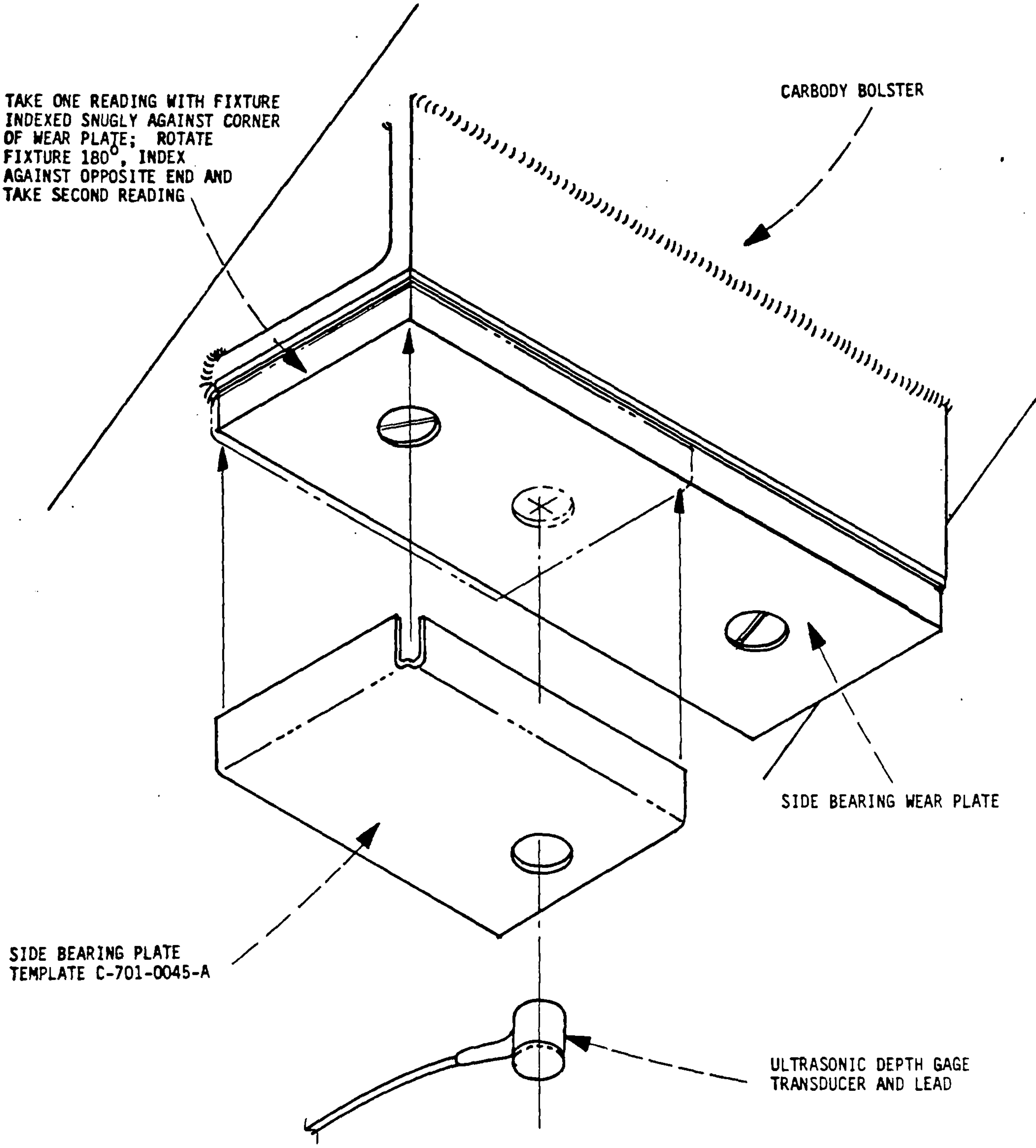


FIGURE 3.16. POSITIONING OF SIDE BEARING PLATE TEMPLATE

Size	Code Ident No.	
A	2B360	C-901-0006-A
Scale	Rev A	Sheet 75

SECTION 4 - WEAR DATA COLLECTION FORMS

This section contains the forms used to record wear data during both inventory and cyclic measurements. The initial inventory form (WD-I-01) is used only at the beginning and end of the program, and whenever a wheelset is replaced. Form WD-011 is no longer used. Forms WD-012 through WD-017 are used during cyclic measurements and are applicable to all trucks. Forms WD-028 and WD-029 are for load and side spring squareness measurements taken at the beginning and end of the program and whenever a spring is replaced. Forms WD-A-01 and WD-A-02 replace the standard forms for the National Swing Motion truck because of differences in the side frames and bolster of this truck. Form WD-A-003 replaces WD-023 for the ASF friction casting. Measurements particular to a specific truck type are recorded on forms WD-A-05 through WD-A-07.

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - I-01

INITIAL INVENTORY
TRUCK COMPONENTS AND WHEEL SETS
SPACINGS AND DIAMETERS

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER: CODE NUMBER (1–6)	LOC (7–9)	CAR	REPL (10–15)	SIDE FRAME COLUMN SPACING - OUTBOARD (INCHES)			SIDE FRAME COLUMN SPACING - INBOARD (INCHES)		
FJ3ØØØ	BRØ			1S	2S	3S	4S	5S	6S
FJ	BLØ								
FJ	ARØ								
FJ	ALØ								

PART NUMBER				TRUCK BOLS. C.P. LONGIT. DIA. (INCHES)	TRUCK BOLS. C.P. LAT. DIA. (INCHES)
FGØØØØ	BØØ			1D	2D
FGØØØØ	AØØ			1D	2D

PART NUMBER				WHEEL OUTSIDE-TO-OUTSIDE DISTANCES (INCHES)	
FN1ØØØ	BØ1			1G	2G
FN	BØ2				
FN	AØ3				
FN	AØ4				

PART NUMBER				ASSEMBLED CAR SIDE BRG CLEAR.
FHØØØØ	BRØ			1C
FH	BLØ			
FH	ARØ			
FH	ALØ			

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

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ASSEMBLED TRUCK SIDE STOP CLEARANCES

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 011

OUTBOARD AND INBOARD GIBS: S-2, S-2-HD, DR-1 AND ASF
INBOARD GIBS ONLY: BARBER-SCHEFFEL
BOLSTER/TRANSOM STOPS: SWING MOTION

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ____ OF ____ DATE ____________
PROJ/ACT # ____________

PART NUMBER					OUTBD GIB CLEARANCE	INBOARD GIB CLEARANCE	COMMENTS
CODE	NUMBER	LOC	CAR	REPL	(INCHES)	(INCHES)	
F F	1 Ø Ø Ø	B R 1			1 G	2 G	
F F		B R 2					
F F		B L 1					
F F		B L 2					
F F		A R 3					
F F		A R 4					
F F		A L 3					
F F		A L 4					

PART NUMBER					BOLSTER STOP CLEARANCE
CODE	NUMBER	LOC	CAR	REPL	(INCHES)
F F	2 Ø Ø Ø	B R Ø			1 S
F F		B L Ø			
F F		A R Ø			
F F		A L Ø			

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WYLE LABORATORIES

TDOP PHASE II

WEAR DATA COLLECTION PROGRAM

FORM WD - 012

TRUCK BOLSTER CENTER PLATE LINERS

HORIZONTAL LINER THICKNESS & CLOCKING (IF USED)

WEAR RING THICKNESS

TDOP CAR # ________

RECORDED BY ________

CHECKED BY ________

PAGE ___ OF ___ DATE ______

PROJ/ACT # ________

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	LINER THICK. TRUCK AXES (INCHES)	LINER THICK. ± 45° AXES (INCHES)	RING THICK. TRUCK AXES (INCHES)	RING THICK. ± 45° AXES (INCHES)	LINER INDEX ANGLE (DEGREES)	COMMENTS
EJ	ØØØØ	BØØ			1A	1D	1T	5T	1K	
EJ		B			1B	1E	2T	6T		
EJ		B			1C	1F	3T	7T		
EJ		B			2A	2D	4T	8T		
EJ		B			2B	2E				
EJ		B			2C	2F				
EJ		B			3A	3D				
EJ		B			3B	3E				
EJ		B			3C	3F				
EJ		B			4A	4D				
EJ		B			4B	4E				
EJ		B			4C	4F				
EJ		A			1A	1D	1T	5T	1K	
EJ		A			1B	1E	2T	6T		
EJ		A			1C	1F	3T	7T		
EJ		A			2A	2D	4T	8T		
EJ		A			2B	2E				
EJ		A			2C	2F				
EJ		A			3A	3D				
EJ		A			3B	3E				
EJ		A			3C	3F				
EJ		A			4A	4D				
EJ		A			4B	4E				
EJ		A			4	4F				

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 013

TRUCK BOLSTER CENTER PLATE
HORIZONTAL SURFACE
RELATIVE HEIGHT

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ____________
PROJ/ACT # ____________

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	RELATIVE HT. TRUCK AXES (INCHES)	RELATIVE HT. ±45° AXES (INCHES)	COMMENTS
F G	1 Ø Ø Ø	B Ø	Ø		1 A	1 D	
F G		B			1 B	1 E	
F G		B			1 C	1 F	
F G		B			2 A	2 D	
F G		B			2 B	2 E	
F G		B			2 C	2 F	
F G		B			3 A	3 D	
F G		B			3 B	3 E	
F G		B			3 C	3 F	
F G		B			4 A	4 D	
F G		B			4 B	4 E	
F G		B			4 C	4 F	
F G		A			1 A	1 D	
F G		A			1 B	1 E	
F G		A			1 C	1 F	
F G		A			2 A	2 D	
F G		A			2 B	2 E	
F G		A			2 C	2 F	
F G		A			3 A	3 D	
F G		A			3 B	3 E	
F G		A			3 C	3 F	
F G		A			4 A	4 D	
F G		A			4 B	4 E	
F G		A			4 C	4 F	

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 014

TRUCK SIDE BEARING
ROLLER DIAMETER & CAGE BASE THICKNESS

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER: CODE (1–2)	NUMBER (3–6)	LOC (7–9)	CAR (10–12)	REPL (13–15)	ROLLER MIN DIAMETER (INCHES) (16–20)	COMMENTS (21–80)
F B	Ø Ø Ø Ø	B R 1			1 D	
F B	▲ ▲ ▲ ▲	B R 2	▲ ▲ ▲		▲ ▲	
F B		B L 1				
F B		B L 2				
F B		A R 3				
F B		A R 4				
F B		A L 3				
F B	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼		▼ ▼	
					CAGE BASE THICKNESS (INCHES)	
F A	Ø Ø Ø Ø	B R 1			1 T	
F A	▲ ▲ ▲ ▲	B R 2	▲ ▲ ▲		▲ ▲	
F A		B L 1				
F A		B L 2				
F A		A R 3				
F A		A R 4				
F A		A L 3				
F A	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼		▼ ▼	

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD- 015

BRAKE SHOE
THICKNESSES AND WEIGHT
(USED)

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					THICKNESS (INCHES)				WEIGHT (OUNCES)	COMMENTS
CODE	NUMBER	LOC	CAR	REPL						
BE	ØØØØ	BR1			1 A	2 A	3 A	4 A	1 W	
BE		BR1			B	B	B	B		
BE		BR1			C	C	C	C		
BE		BR2			A	A	A	A	1 W	
BE		BR2			B	B	B	B		
BE		BR2			C	C	C	C		
BE		BL1			A	A	A	A	1 W	
BE		BL1			B	B	B	B		
BE		BL1			C	C	C	C		
BE		BL2			A	A	A	A	1 W	
BE		BL2			B	B	B	B		
BE		BL2			C	C	C	C		
BE		AR3			A	A	A	A	1 W	
BE		AR3			B	B	B	B		
BE		AR3			C	C	C	C		
BE		AR4			A	A	A	A	1 W	
BE		AR4			B	B	B	B		
BE		AR4			C	C	C	C		
BE		L3			A	A	A	A	1 W	
BE		AL3			B	B	B	B		
BE		AL3			C	C	C	C		
BE		AL4			A	A	A	A	1 W	
BE		AL4			B	B	B	B		
BE		AL4			1 C	2 C	3 C	4 C		

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD- 016

BRAKE SHOE
THICKNESSES AND WEIGHT
(NEW)

TDOP CAR #________
RECORDED BY________
CHECKED BY________
PAGE___ OF___ DATE____
PROJ/ACT #________

PART NUMBER					THICKNESS (INCHES)				WEIGHT (OUNCES)	COMMENTS
CODE	NUMBER	LOC	CAR	REPL						
BE	ØØØØ	BR1			1A	2A	3A	4A	1W	
BE		BR1			B	B	B	B		
BE		BR1			C	C	C	C		
BE		BR2			A	A	A	A	1W	
BE		BR2			B	B	B	B		
BE		BR2			C	C	C	C		
BE		BL1			A	A	A	A	1W	
BE		BL1			B	B	B	B		
BE		BL1			C	C	C	C		
BE		BL2			A	A	A	A	1W	
BE		BL2			B	B	B	B		
BE		BL2			C	C	C	C		
BE		AR3			A	A	A	A	1W	
BE		AR3			B	B	B	B		
BE		AR3			C	C	C	C		
BE		AR4			A	A	A	A	1W	
BE		AR4			B	B	B	B		
BE		AR4			C	C	C	C		
BE		AL3			A	A	A	A	1W	
BE		AL3			B	B	B	B		
BE		AL3			C	C	C	C		
BE		AL4			A	A	A	A	1W	
BE		AL4			B	B	B	B		
BE		AL4			1C	2C	3C	4C		

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 017

SIDE FRAME
THICKNESS & SPACING - I

TDOP CAR # ________
RECORDED BY ________
CHECKED BY ________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ________

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	OUTER LUG RELATIVE THK. (INCHES)	INNER LUG RELATIVE THK. (INCHES)	PEDESTAL ROOF REL. HEIGHT (INCHES)		ANTIROT. LUG THICKNESS (INCHES)	COLUMN WIDTH (INCHES)	COMMENTS
FJ	ØØØØ	BR1			1O	2O	1A	1B	1T	1W	
FJ		BR1			M	M	2	2	2	2	
FJ		BR1			I	I	3	3	3	3	
FJ		BR2			O	O	1	1	1	1	
FJ		BR2			M	M	2	2	2	2	
FJ		BR2			I	I	3	3	3	3	
FJ		BL1			O	O	1	1	1	1	
FJ		BL1			M	M	2	2	2	2	
FJ		BL1			I	I	3	3	3	3	
FJ		BL2			O	O	1	1	1	1	
FJ		BL2			M	M	2	2	2	2	
FJ		BL2			I	I	3	3	3	3	
FJ		AR3			O	O	1	1	1	1	
FJ		AR3			M	M	2	2	2	2	
FJ		AR3			I	I	3	3	3	3	
FJ		AR4			O	O	1	1	1	1	
FJ		AR4			M	M	2	2	2	2	
FJ		AR4			I	I	3	3	3	3	
FJ		AL3			O	O	1	1	1	1	
FJ		AL3			M	M	2	2	2	2	
FJ		AL3			I	I	3	3	3	3	
FJ		AL4			O	O	1	1	1	1	
FJ		AL4			M	M	2	2	2	2	
FJ		AL4			I	I	3	3	3	3	

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 018

SIDE FRAME
THICKNESS & SPACING - II

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	OUTER LUG LAT. WIDTH (INCHES)	INNER LUG LAT. WIDTH (INCHES)	LUG-TO-LUG SPACING (INCHES)	JAW SPACING AT BRG. CENTER (INCHES)
FJ	1ØØØ	BR1			4T	5T	1L	1S
FJ	▲▲▲▲	BR2	▲▲▲		▲▲	▲▲	▲▲	▲▲
FJ		BL1						
FJ		BL2						
FJ		AR3						
FJ		AR4						
FJ		AL3						
FJ	▼▼▼▼	AL4	▼▼▼		▼▼	▼▼	▼▼	▼▼

CODE	NUMBER	LOC	CAR	REPL	ANTIROT. LUG SPACING (INCHES)
FJ	2ØØØ	BRØ			1S
FJ	▲▲▲▲	BRØ	▲▲▲	▲▲▲	2▲
FJ		BRØ		▼▼▼	3
FJ		BLØ			1
FJ		BLØ		▲▲▲	2
FJ		BLØ		▼▼▼	3
FJ		ARØ			1
FJ		ARØ		▲▲▲	2
FJ		ARØ		▼▼▼	3
FJ		ALØ			1
FJ		ALØ		▲▲▲	2
FJ	▼▼▼▼	ALØ	▼▼▼	▼▼▼	3▼

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 019

TRUCK SIDE WEAR PLATE
THICKNESSES

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ____ OF ____ DATE ________
PROJ/ACT # ____________

PART NUMBER: CODE (1–2)	NUMBER (3–6)	LOC (7–9)	CAR (10–12)	REPL (13–15)	WEAR PLATE THICKNESS (INCHES) (16–23)	(24–31)	(32–39)	COMMENTS (40–80)
F K	Ø Ø Ø Ø	B R 1			1 A	1 B	1 C	
F K		B R 1			2	2	2	
F K		B R 1			3	3	3	
F K		B R 2			1	1	1	
F K		B R 2			2	2	2	
F K		B R 2			3	3	3	
F K		B L 1			1	1	1	
F K		B L 1			2	2	2	
F K		B L 1			3	3	3	
F K		B L 2			1	1	1	
F K		B L 2			2	2	2	
F K		B L 2			3	3	3	
F K		A R 3			1	1	1	
F K		A R 3			2	2	2	
F K		A R 3			3	3	3	
F K		A R 4			1	1	1	
F K		A R 4			2	2	2	
F K		A R 4			3	3	3	
F K		A L 3			1	1	1	
F K		A L 3			2	2	2	
F K		A L 3			3	3	3	
F K		A L 4			1	1	1	
F K		A L 4			2	2	2	
F K		A L 4			3	3	3	

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 020

TRUCK BOLSTER

GIB THICKNESS AND COLUMN WIDTH

TDOP CAR # ________
RECORDED BY ________
CHECKED BY ________
PAGE ___ OF ___ DATE ________
PROJ/ACT # ________

PART NUMBER					OUTBOARD GIB THICKNESS	INBOARD GIB THICKNESS	COLUMN WIDTH	COMMENTS
CODE	NUMBER	LOC	CAR	REPL	(INCHES)	(INCHES)	(INCHES)	
F F	Ø Ø Ø Ø	B R 1			1 T	4 T	1 W	
F F		B R 1			2	5	2	
F F		B R 1			3	6	3	
F F		B R 2			1	4	1	
F F		B R 2			2	5	2	
F F		B R 2			3	6	3	
F F		B L 1			1	4	1	
F F		B L 1			2	5	2	
F F		B L 1			3	6	3	
F F		B L 2			1	4	1	
F F		B L 2			2	5	2	
F F		B L 2		▼ ▼ ▼	3	6	3	
F F		A R 3			1	4	1	
F F		A R 3			2	5	2	
F F		A R 3			3	6	3	
F F		A R 4			1	4	1	
F F		A R 4			2	5	2	
F F		A R 4			3	6	3	
F F		A L 3			1	4	1	
F F		A L 3			2	5	2	
F F		A L 3			3	6	3	
F F		A L 4			1	4	1	
F F		A L 4			2	5	2	
F F	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼	▼ ▼ ▼	3	6	3	

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 021

TRUCK BOLSTER
COLUMN AND GIB SPACING

TDOP CAR # ____
RECORDED BY ____
CHECKED BY ____
PAGE ___ OF ___ DATE ____
PROJ/ACT # ____

PART NUMBER					OUTBOARD COLUMN SPACING	INBOARD COLUMN SPACING	INBOARD GIB SPACING	COMMENTS
CODE	NUMBER	LOC	CAR	REPL	(INCHES)	(INCHES)	(INCHES)	
F F	3 Ø Ø Ø	B R Ø			1 S	3 S	5 S	
F F	▲ ▲ ▲ ▲	B R Ø	▲ ▲ ▲	▲ ▲ ▲	2 ▲	4 ▲	6 ▲	
F F		B L Ø			1	3	5	
F F		B L Ø		▼ ▼ ▼	2	4	6	
F F		A R Ø			1	3	5	
F F		A R Ø		▲ ▲ ▲	2	4	6	
F F		A L Ø			1	3	5	
F F	▼ ▼ ▼ ▼	A L Ø	▼ ▼ ▼	▼ ▼ ▼	2 ▼	4 ▼	6 ▼	

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 022

BEARING ADAPTER
THICKNESSES, SPACING AND WEIGHT

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ____ OF ____ DATE ____
PROJ/ACT # ____

PART NUMBER: CODE NUMBER (1–6)	LOC (7–9)	CAR (10–12)	REPL (13–15)	CROWN RELATIVE HEIGHT (INCHES) (16–23)	(24–31)	(32–39)	LUG LAT. FACE RELATIVE THK. (INCHES) (40–47)	(48–55)	LONG. STOP REL. THK. (INCHES) (56–63)	WEIGHT (OUNCES) (64–71)	(72–80)
EYØØØØ	BR1			1A	2A	3A	4A	5A	6A	1W	
EY	BR1			B	B	B	B	B	B		
EY	BR2			A	A	A	A	A	A	1W	
EY	BR2			B	B	B	B	B	B		
EY	BL1			A	A	A	A	A	A	1W	
EY	BL1			B	B	B	B	B	B		
EY	BL2			A	A	A	A	A	A	1W	
EY	BL2			B	B	B	B	B	B		
EY	AR3			A	A	A	A	A	A	1W	
EY	AR3			B	B	B	B	B	B		
EY	AR4			A	A	A	A	A	A	1W	
EY	AR4			B	B	B	B	B	B		
EY	AL3			A	A	A	A	A	A	1W	
EY	AL3			B	B	B	B	B	B		
EY	AL4			A	A	A	A	A	A	1W	
EY	AL4			B	B	B	B	B	B		

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 023

FRICTION CASTING

THICKNESSES AND WEIGHT
(SINGLE SLOPING SURFACE TYPE)

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					VERTICAL FACE RELATIVE HEIGHT (INCHES)			SLOPING FACE RELATIVE HEIGHT (INCHES)			WEIGHT (OUNCES)	
CODE	NUMBER	LOC	CAR	REPL								
E N	ØØØ	B R 1			1 A	1 B	1 C	4 A	4 B	4 C	1 W	
E N		B R 1			2	2	2	5	5	5		
E N		B R 1			3	3	3	6	6	6		
E N		B R 2			1	1	1	4	4	4	1 W	
E N		B R 2			2	2	2	5	5	5		
E N		B R 2			3	3	3	6	6	6		
E N		B L 1			1	1	1	4	4	4	1 W	
E N		B L 1			2	2	2	5	5	5		
E N		B L 1			3	3	3	6	6	6		
E N		B L 2			1	1	1	4	4	4	1 W	
E N		B L 2			2	2	2	5	5	5		
E N		B L 2			3	3	3	6	6	6		
E N		A R 3			1	1	1	4	4	4	1 W	
E N		A R 3			2	2	2	5	5	5		
E N		A R 3			3	3	3	6	6	6		
E N		A R 4			1	1	1	4	4	4	1 W	
E N		A R 4			2	2	2	5	5	5		
E N		A R 4			3	3	3	6	6	6		
E N		A L 3			1	1	1	4	4	4	1 W	
E N		A L 3			2	2	2	5	5	5		
E N		A L 3			3	3	3	6	6	6		
E N		A L 4			1	1	1	4	4	4	1 W	
E N		A L 4			2	2	2	5	5	5		
E N		A L 4			3	3	3	6	6	6		

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 022

BEARING ADAPTER
THICKNESSES, SPACING AND WEIGHT

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					CROWN RELATIVE HEIGHT (INCHES)			LUG LAT. FACE RELATIVE THK. (INCHES)		LONG. STOP REL. THK. (INCHES)	WEIGHT (OUNCES)	
CODE 1	NUMBER 6	LOC 7 8	CAR	REPL 15	16 20	30	35	40 45	50 55	60	65 70	73 80
EY	ØØØØ	BR1			1A	2A	3A	4A	5A	6A	1W	
EY		BR1			B	B	B	B	B	B		
EY		BR2			A	A	A	A	A	A	1W	
EY		BR2			B	B	B	B	B	B		
EY		BL1			A	A	A	A	A	A	1W	
EY		BL1			B	B	B	B	B	B		
EY		BL2			A	A	A	A	A	A	1W	
EY		BL2			B	B	B	B	B	B		
EY		AR3			A	A	A	A	A	A	1W	
EY		AR3			B	B	B	B	B	B		
EY		AR4			A	A	A	A	A	A	1W	
EY		AR4			B	B	B	B	B	B		
EY		AL3			A	A	A	A	A	A	1W	
EY		AL3			B	B	B	B	B	B		
EY		AL4			A	A	A	A	A	A	1W	
EY		AL4			B	B	B	B	B	B		

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OUTER AND INNER LOAD SPRINGS

FREE LENGTH

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 024

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					FREE LGTH OUTER (INCHES)
CODE	NUMBER	LOC	CAR	REPL	
F M	3 Ø Ø Ø	Ø			1 L
F M		Ø			2
F M		Ø			3
F M		Ø			4
F M		Ø			5
F M		Ø			6
F M		Ø			7
F M	▼ ▼ ▼ ▼	Ø	▼ ▼ ▼		8 ▼

					FREE LGTH INNER (INCHES)
F M	1 Ø Ø Ø	Ø			1 L
F M		Ø			2
F M		Ø			3
F M		Ø			4
F M		Ø			5
F M		Ø			6
F M		Ø			7
F M	▼ ▼ ▼ ▼	Ø	▼ ▼ ▼		8 ▼

SEE REVERSE SIDE FOR SPRING GROUP ORIENTATION

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 025

OUTER AND INNER SIDE SPRINGS

FREE LENGTH

TDOP CAR # ________
RECORDED BY ________
CHECKED BY ________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ________

PART NUMBER					FREE LGTH OUTER	COMMENTS
CODE (1)	NUMBER (6)	LOC (7 8)	CAR	REPL (15)	(INCHES) (16 20)	30 35 40 45 50 55 60 65 70 73 80
F M	6 Ø Ø Ø	B R 1			1 L	
F M	▲ ▲ ▲ ▲	B R 2	▲ ▲ ▲		▲ ▲	
F M		B L 1				
F M		B L 2				
F M		A R 3				
F M		A R 4				
F M		A L 3				
F M	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼		▼ ▼	
					FREE LGTH INNER (INCHES)	
F M	7 Ø Ø Ø	B R 1			1 L	
F M	▲ ▲ ▲ ▲	B R 2	▲ ▲ ▲		▲ ▲	
F M		B L 1				
F M		B L 2				
F M		A R 3				
F M		A R 4				
F M		A L 3				
F M	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼		▼ ▼	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 026

WHEEL
RIM THICKNESS, FLANGE HEIGHT, FLANGE WIDTH AND CIRCUMFERENCE

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER: CODE NUMBER (1–6)	LOC (7–9)	CAR	REPL (15)	RIM THICKNESS (INCHES)	FLG HEIGHT (INCHES)	FLG WIDTH (INCHES)	CIRCUMFERENCE (INCHES)	TREAD THICK (INCHES)	MILEAGE
FNØØØØ	BR1			1T	1H	1W	1C	1Z	1M
FN	BR1			2	2	2		2Z	
FN	BL1			1	1	1	1C	1Z	1M
FN	BL1			2	2	2		2Z	
FN	BR2			1	1	1	1C	1Z	1M
FN	BR2			2	2	2		2Z	
FN	BL2			1	1	1	1C	1Z	1M
FN	BL2			2	2	2		2Z	
FN	AR3			1	1	1	1C	1Z	1M
FN	AR3			2	2	2		2Z	
FN	AL3			1	1	1	1C	1Z	1M
FN	AL3			2	2	2		2Z	
FN	AR4			1	1	1	1C	1Z	1M
FN	AR4			2	2	2		2Z	
FN	AL4			1	1	1	1C	1Z	1M
FN	AL4			2	2	2		2Z	

SEE REVERSE SIDE FOR FLANGE HEIGHT + WHEEL CIRCUMFERENCE CONVERSION VALUES

BODY CENTER PLATE
DIAMETERS AND WEAR AXIS ANGLE
BODY SIDE BEARING
THICKNESSES

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 027

TDOP CAR # ________
RECORDED BY ________
CHECKED BY ________
PAGE ___ OF ___ DATE ________
PROJ/ACT # ________

PART NUMBER: CODE (1)	NUMBER (6)	LOC (7 8)	CAR	REPL (15)	LOWER DIAMETER (INCHES) (16–20)	UPPER DIMETER (INCHES) (30)	UPPER MIN. DIAMETER (35)	UPPER WEAR AXIS ANGLE (40–45)	LOWER MIN. DIAMETER (50–55)	LOWER WEAR AXIS ANGLE (60)	COMMENTS (65–80)
F V	1 Ø Ø Ø	B Ø Ø			1 D	1 D	1 U	1 K	1 L	1 K	
F V	▲ ▲ ▲ ▲	B Ø Ø	▲ ▲ ▲	▲ ▲ ▲	2 ▲	2 ▲					
F V		B Ø Ø			3	3					
F V		B Ø Ø			4	4					
F V		A Ø Ø			1	1	1 U	1 K	1 L	1 K	
F V		A Ø Ø			2	2					
F V		A Ø Ø			3	3					
F V	▼ ▼ ▼ ▼	A Ø Ø	▼ ▼ ▼	▼ ▼ ▼	4 ▼	4 ▼					

CODE	NUMBER	LOC	CAR	REPL	SIDE BRG. THK. INCHES
F W	Ø Ø Ø Ø	B R 1			1 T
F W	▲ ▲ ▲ ▲	B R 2	▲ ▲ ▲	▲ ▲ ▲	▲ ▲
F W		B L 1			
F W		B L 2			
F W		A R 3			
F W		A R 4			
F W		A L 3			
F W	▼ ▼ ▼ ▼	A L 4	▼ ▼ ▼	▼ ▼ ▼	▼ ▼

SEE REVERSE SIDE FOR CENTER PLATE
DIAMETER AND WEAR AXIS ANGLE ORIENTATIONS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

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WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 028

INITIAL INVENTORY

OUTER AND INNER LOAD SPRINGS SQUARENESS

TDOP CAR # ______
RECORDED BY ______
CHECKED BY ______
PAGE ___ OF ___ DATE ______
PROJ/ACT # ______

PART NUMBER					SQUARENESSS OUTER (INCHES)				COMMENTS
CODE (1)	NUMBER (6)	LOC (7 8)	CAR	REPL (15)	16	20	30 35	40 45	50 55 60 65 70 75 80
F M	2 Ø Ø Ø	Ø			1 A	1 B	1 C	1 D	
F M	▲ ▲ ▲ ▲	Ø	▲ ▲ ▲		2 ▲	2 ▲	2 ▲	2 ▲	
F M		Ø			3	3	3	3	
F M		Ø			4	4	4	4	
F M		Ø			5	5	5	5	
F M		Ø			6	6	6	6	
F M		Ø			7	7	7	7	
F M	▼ ▼ ▼ ▼	Ø	▼ ▼ ▼		8 ▼	8 ▼	8 ▼	8 ▼	

					SQUARENESSS INNER (INCHES)				
F M	D Ø Ø Ø	Ø			1 A	1 B	1 C	1 D	
F M	▲ ▲ ▲ ▲	Ø	▲ ▲ ▲		2 ▲	2 ▲	2 ▲	2 ▲	
F M		Ø			3	3	3	3	
F M		Ø			4	4	4	4	
F M		Ø			5	5	5	5	
F M		Ø			6	6	6	6	
F M		Ø			7	7	7	7	
F M	▼ ▼ ▼ ▼	Ø	▼ ▼ ▼		8 ▼	8 ▼	8 ▼	8 ▼	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - 029

INITIAL INVENTORY
OUTER AND INNER SIDE SPRINGS SQUARENESS

TDOP CAR # ______
RECORDED BY ______
CHECKED BY ______
PAGE ___ OF ___ DATE ______
PROJ/ACT # ______

SQUARENESS OUTER (INCHES)

CODE		NUMBER				LOC			CAR			REPL			SQUARENESS OUTER (INCHES)								COMMENTS
F	M	4	Ø	Ø	Ø	B	R	1							1	S	2	S	3	S	4	S	
F	M					B	R	2															
F	M					B	L	1															
F	M					B	L	2															
F	M					A	R	3															
F	M					A	R	4															
F	M					A	L	3															
F	M					A	L	4															

SQUARENESS INNER (INCHES)

CODE		NUMBER				LOC			CAR			REPL			SQUARENESS INNER (INCHES)								COMMENTS
F	M	5	Ø	Ø	Ø	B	R	1							1	S	2	S	3	S	4	S	
F	M					B	R	2															
F	M					B	L	1															
F	M					B	L	2															
F	M					A	R	3															
F	M					A	R	4															
F	M					A	L	3															
F	M					A	L	4															

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-01

SIDE FRAME
THICKNESSES AND SPACINGS
(REPLACES TDOP FORMS WD - 017 AND 018 FOR NATIONAL SWING MOTION TRUCK ONLY)

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ________
PROJ/ACT # ____________

PART NUMBER: CODE (1)	NUMBER (6)	LOC (7-9)	CAR	REPL (15)	OUTER LUG RELATIVE THK. (INCHES) (16-23)	INNER LUG RELATIVE THK. (INCHES) (24-31)	PEDESTAL ROOF REL. HT. (INCHES) (32-39)	OUTER LUG LATERAL WIDTH (INCHES) (40-47)	INNER LUG LATERAL WIDTH (INCHES) (48-55)	LUG TO LUG SPACING (INCHES) (56-63)	JAW SPACING AT BRG. CENTER (INCHES) (64-71)	(72-80)
FJ	4ØØØ	BR1	ØØ1		10	20	2A	4T	5T	1L	1S	
FJ	▲▲▲▲	BR1	▲▲▲	▲▲▲	M	M	2B					
FJ		BR1			I	I						
FJ		BR2			O	O	2A	4T	5T	1L	1S	
FJ		BR2			M	M	2B					
F		BR2		▼▼▼	I	I						
FJ		BL1			O	O	2A	4T	5T	1L	1S	
FJ		BL1		▲▲▲	M	M	2B					
FJ		BL1			I	I						
FJ		BL2			O	O	2A	4T	5T	1L	1S	
FJ		BL2			M	M	2B					
FJ		BL2		▼▼▼	I	I						
FJ		AR3			O	O	2A	4T	5T	1L	1S	
FJ		AR3		▲▲▲	M	M	2B					
FJ		AR3			I	I						
FJ		AR4			O	O	2A	4T	5T	1L	1S	
FJ		AR4			M	M	2B					
FJ		AR4		▼▼▼	I	I						
FJ		AL3			O	O	2A	4T	5T	1L	1S	
FJ		AL3		▲▲▲	M	M	2B					
FJ		AL3			I	I						
FJ		AL4			O	O	2A	4T	5T	1L	1S	
FJ		AL4			M	M	2B					
FJ	▼▼▼▼	AL4	▼▼▼	▼▼▼	I	I						

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-02

TRUCK SIDE WEAR PLATE

(REPLACES TDOP FORM WD-019 FOR NATIONAL SWING MOTION TRUCK ONLY)

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ______

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	WEAR PLATE THICKNESS (INCHES)			WEAR PLATE THK OUTBOARD (INCHES)	WEAR PLATE THK INBOARD (INCHES)	COMMENTS
FK	1ØØØ	BR1	001		1A	1B	1C	1O	1I	
FK	▲▲▲▲	BR1	▲▲▲	▲▲▲	2▲	2▲	2▲	2▲	2▲	
FK		BR1			3	3	3	3	3	
FK		BR2			1	1	1	1	1	
FK		BR2			2	2	2	2	2	
FK		BR2			3	3	3	3	3	
FK		BL1			1	1	1	1	1	
FK		BL1			2	2	2	2	2	
FK		BL1			3	3	3	3	3	
FK		BL2			1	1	1	1	1	
FK		BL2			2	2	2	2	2	
FK		BL2		▼▼▼	3	3	3	3	3	
FK		AR3			1	1	1	1	1	
FK		AR3		▲▲▲	2	2	2	2	2	
FK		AR3			3	3	3	3	3	
FK		AR4			1	1	1	1	1	
FK		AR4			2	2	2	2	2	
FK		AR4			3	3	3	3	3	
FK		AL3			1	1	1	1	1	
FK		AL3			2	2	2	2	2	
FK		AL3			3	3	3	3	3	
FK		AL4			1	1	1	1	1	
FK		AL4			2	2	2	2	2	
FK	▼▼▼▼	AL4	▼▼▼	▼▼▼	3▼	3▼	3▼	3▼	3▼	

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-03

FRICTION CASTING
THICKNESSES AND WEIGHT
REPLACES TDOP FORM WD-023
FOR ASF RIDE CONTROL TRUCK ONLY

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER: CODE (1)	NUMBER (6)	LOC (7–9)	CAR	REPL (15)	VERTICAL FACE THICKNESS (INCHES) (16–)			SLOPING FACE THICKNESS (INCHES) (40–55)		WEIGHT (OUNCES) (56–63)	(64–80)
EN	1ØØØ	BR1	ØØ5		1A	1B	1C	4A	4B	1W	1A AND 1C READ BY
EN	▲▲▲▲	BR1	▲▲▲	▲▲▲	2▲	2▲	2▲	5▲	5▲		DIAL CALIPERS TYP
EN		BR1		▼▼▼	3	3	3	6	6		ALL CASTINGS
EN		BR2			1	1	1	4	4	1W	
EN		BR2		▲▲▲	2	2	2	5	5		
EN		BR2		▼▼▼	3	3	3	6	6		
EN		BL1			1	1	1	4	4	1W	
EN		BL1		▲▲▲	2	2	2	5	5		
EN		BL1		▼▼▼	3	3	3	6	6		
EN		BL2			1	1	1	4	4	1W	
EN		BL2		▲▲▲	2	2	2	5	5		
EN		BL2		▼▼▼	3	3	3	6	6		
EN		AR3			1	1	1	4	4	1W	
EN		AR3		▲▲▲	2	2	2	5	5		
EN		AR3		▼▼▼	3	3	3	6	6		
EN		R4			1	1	1	4	4	1W	
EN		AR4		▲▲▲	2	2	2	5	5		
EN		AR4		▼▼▼	3	3	3	6	6		
EN		AL3			1	1	1	4	4	1W	
EN		AL3		▲▲▲	2	2	2	5	5		
EN		AL3		▼▼▼	3	3	3	6	6		
EN		AL4			1	1	1	4	4	1W	
EN		AL4		▲▲▲	2	2	2	5	5		
EN	▼▼▼▼	AL4	▼▼▼	▼▼▼	3▼	3▼	3▼	6▼	6▼		

ADDITIONAL MEASUREMENTS — SWING MOTION TRUCK

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-04

ROCKER SEAT TRUNNION THICKNESS
ROCKER SEAT BEARING THICKNESS
BOLSTER LATERAL STOP THICKNESS
TRANSOM LATERAL STOP THICKNESS

TDOP CAR # ______
RECORDED BY ______
CHECKED BY ______
PAGE ___ OF ___ DATE ______
PROJ/ACT # ______

PART NUMBER					TRUNNION THK (INCHES)	BEARING THK (INCHES)
CODE	NUMBER	LOC	CAR	REPL		
ZC	ØØØØ	BR1	ØØ1		1T	1B
ZC	↑↑↑↑	BR2	↑↑↑		↑↑	↑↑
ZC		BL1				
ZC		BL2				
ZC		AR3				
ZC		AR4				
ZC		AL3				
ZC	↓↓↓↓	AL4	↓↓↓		↓↓	↓↓

CODE	NUMBER	LOC	CAR	REPL	BOLSTER STOP THICKNESS (INCHES)
FF	4ØØØ	BRØ	ØØ1		1T
FF	↑↑↑↑	BLØ	↑↑↑		↑↑
FF		ARØ			
FF	↓↓↓↓	ALØ	↓↓↓		↓↓

CODE	NUMBER	LOC	CAR	REPL	TRANSOM STOP THICKNESS (INCHES)
FD	ØØØØ	BRØ	ØØ1		1T
FD	↑↑↑↑	BLØ	↑↑↑		↑↑
FD		ARØ			
FD	↓↓↓↓	ALØ	↓↓↓		↓↓

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ADDITIONAL MEASUREMENTS — DR-1 TRUCK

STEERING ARM SHAFT DIAMETERS
STEERING ARM BUSHING DIAMETERS
ELASTOMERIC PAD FREE HEIGHTS

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-05

TDOP CAR # ______
RECORDED BY ______
CHECKED BY ______
PAGE ___ OF ___ DATE ______
PROJ/ACT # ______

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	SHAFT HORIZ. DIAMETER (INCHES)	SHAFT VERT. DIAMETER (INCHES)	BUSHING HORIZ DIAMETER (INCHES)	BUSHING VERT. DIAMETER (INCHES)
ZC	1ØØØ	BØØ	ØØ3		1H	1V	1H	1V
ZC	1ØØØ	AØØ	ØØ3		2H	2V	1H	1V

PART NUMBER: CODE	NUMBER	LOC	CAR	REPL	PAD HT LEFT (INCHES)	PAD HT RIGHT (INCHES)
ZC	2ØØØ	BR1	ØØ3		1A	1B
ZC		BR2				
ZC		BL1				
ZC		BL2				
ZC		AR3				
ZC		AR4				
ZC		AL3				
ZC		AL4				

WYLE LABORATORIES

ADDITIONAL MEASUREMENTS
BARBER-SCHEFFEL TRUCK

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD - A-06

ELASTOMERIC SHEAR PAD FREE HEIGHTS

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					OUTER PAD HT AXLE SIDE	OUTER PAD HT STRAP SIDE	INNER PAD HT AXLE SIDE	INNER PAD HT STRAP SIDE	
CODE (1)	NUMBER (6)	LOC (7, 8)	CAR	REPL (15)	(INCHES) (16, 20)	(INCHES) (30)	(INCHES) (35)	(INCHES) (40, 45)	(50, 55, 60, 65, 70, 73, 80)
ZC	3ØØØ	BR1	006		1A	1S	2A	2S	
ZC		BR2							
ZC		BL1							
ZC		BL2							
ZC		AR3							
ZC		AR4							
ZC		AL3							
ZC		AL4							

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

WYLE LABORATORIES

TDOP PHASE II
WEAR DATA COLLECTION PROGRAM
FORM WD -A-07

ADDITIONAL MEASUREMENTS
S-2 HD/C-PEP TRUCK
C-PEP FREE AND COMPRESSED HEIGHTS

TDOP CAR # ____________
RECORDED BY ____________
CHECKED BY ____________
PAGE ___ OF ___ DATE ______
PROJ/ACT # ____________

PART NUMBER					FREE HEIGHT	COMPRESSED HT.
CODE	NUMBER	LOC	CAR	REPL	(INCHES)	(INCHES)
FZ	ØØØØ	BRØ	ØØ4		1F	1C
FZ		BLØ				
FZ		ARØ				
FZ		ALØ				

SEE REVERSE SIDE OF SHEET FOR PAD ORIENTATION

C-901-0006-A

APPENDIX C

WEAR DATA BASE DESCRIPTIONS

TRUCK DESIGN OPTIMIZATION PROJECT (TDOP) PHASE II

TDOP WEAR DATA BASE DESCRIPTION

January 4, 1979

(Revised October 25, 1979)

CONTRACT NO. DOT-FR-742-4277		WYLE LABORATORIES SCIENTIFIC SERVICES AND SYSTEMS GROUP COLORADO SPRINGS, COLORADO
PREPARED Joseph Walther JGW	1-13-79	
APPROVED Ed Gadden ECG	1-9-79	
APPROVED David Gibson DWG	1/12/79	
APPROVED Gordon Bakken GBB	2/23/79	
PROGRAM MANAGER Dean de Benedet	2/23/79	Size A · Code Ident No. 2B360 · C-901-0003-A
NEXT ASSY	USED ON	Scale · Rev A · Sheet Title Page

ACTIVE SHEET RECORD

REV LTR

SHEET NO.	REV LTR	ADDED SHEETS SHEET NO.	REV LTR	ADDED SHEETS SHEET NO.	REV LTR	SHEET NO.	REV LTR	ADDED SHEETS SHEET NO.	REV LTR	ADDED SHEETS SHEET NO.	REV LTR
Title Page											
i	A										
ii	A										
iii	A										
1											
2											
3	A										
4	A										
5	A										
6	A										
7	A										
8											
9											
10	A										
11	A										
12	A										
13	A										
14	A										
15											
A-1											
B-1	A										
C-1	A										
D-1	A										
D-2	A										
D-3											

Size	Code Ident No.	
A	2B360	C-901-0003-A
Scale	Rev A	Sheet i

REVISION

LETTER	DESCRIPTION	DATE	APPROVAL
A	Updates the computer program documentation to incorporate a new master file, Car Number/Component Code, as well as other enhancements.	10/25/79	[illegible] 10/29/79

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SECTION 1 - INTRODUCTION

One of the tasks of the Truck Design Optimization Project (TDOP) Phase II is the collection and storage of pertinent data from railroad and government sources in order to perform various economic and engineering analyses of freight car truck performance. Inherent in this task is the development of the TDOP Phase II Wear Data Base for data collection, storage, and analysis.

This Wear Data Base Description is included as part of TDOP's Wear Data Collection Plan. The document describes the methodology used in establishing an analytical wear data base. Specifically, it a) identifies the data base design and its limitations; b) identifies data base files and wear data relationships; c) identifies part number methodology and definition; and d) introduces and describes the use of TOTAL as a data base manager.

The primary users of this data base will be the TDOP Wear Data Collection staff of field engineers and analysts for the purpose of summarizing and reporting test findings made of the various truck types tested in the Wear Data Collection Program.

The scope of this Wear Data Base subtask includes accepting the recorded field measurement forms; verifying, validating, and storing the data; interpreting and summarizing the data through hardcopy reporting; and plotting.

Wyle Laboratories is using the Interdata 8/32 Computer System together with the TOTAL data base management system to establish the TDOP Wear Data Base. This combination of the Interdata 8/32 central processing unit (CPU) and the automatic file management capabilities of TOTAL provide a more than adequate capacity for data base development and growth.

SECTION 2 - DATA BASE ORGANIZATION

The TDOP Wear Data Base will control large amounts of wear data collected over a specified period of time. It will also include several levels of accessibility and be flexible in design for growth and development. In addition, it has been designed to include data from multiple data sources (e.g. Union Pacific Railroad, AAR, FAST program) (see Appendix A for others). Initially, the TDOP Wear Data Base will consist of a collection of interrelated wear data records stored together so as to provide a controlled approach in the accumulation, maintenance and retrieval of wear data. To achieve this, TOTAL, the data base manager, provides two languages: the first to define the data base and the other for use in accessing and manipulating the data base. It also provides for master and variable file relationships through the use of keys and linkages. Master files contain fixed, static data identified by unique control keys (i.e., car number); variable files contain variable, dependent data (i.e., wear data) which may be linked to the control keys of one or more master files. It is this association of master and variable files through the use of keys and linkages that provide the logical foundation for the TDOP Wear Data Base. See Section 4.0 for a more detailed discussion of TOTAL.

SECTION 3 - DATA BASE FILES

The data base contains at present six master files and one variable data file (see Appendix B). The variable file is the Wear Measurement Data File. The master files are the Car Number Specification File, the Truck Inventory File, the Component Code File, the Part Location Code File, the Wear Measurement Cycle Date File, and Car Number/Component Code File. All seven files are discussed below.

3.1 WEAR MEASUREMENT DATA FILE

This variable file, the central file with the data base, stores the records of the actual measurements of truck part components recorded in the field. The raw wear measurement data, recorded on data forms at the test repair site, will be forwarded to Wyle Laboratories' Colorado Springs facility after each monthly measurement cycle. The data will then be keypunched, validated and entered into the data base and stored permanently on disk. Any errors noted will be hardcopy reported and entered into the data base upon correction.

This file will contain the largest number of physical records with a 12-character part number as the control key. Each wear record will be chained to each of the six master files based on this part number and the components within it. The part number was selected because the construction of an analytical data base necessitates combining information from various sources and systems onto a common basis. The part number, thus, will serve as a framework for relating and comparing wear data of components from six separate and distinct trucks which are not readily defined within the railroad or railroad manufacturing industry for computer data processing. For analytical reasons then, the part numbers will be assigned according to the following scheme.

Part Number Specification

```
XXX XXX
XX  XXX XXX XXX
 1   2   3   4
```

1. XXX - AAR component code description (i.e., FN0, EN1, EN2)
2. XXX - Alpha/numberic component measurement number (unused at present)

3. XXX - AAR part location code (i.e., AR3, BL2)

4. XXX - TDOP car number (i.e., 003, 006)

The Component Measurement Numbers are used to further define part number uniqueness if needed. The 12-character part number scheme contains all of the control keys of the associated master data files (for chaining purposes) while still retaining part number uniqueness and a method for inventory control. Each part number, therefore, has component and car location identity which should aid in the measurement and manual recording of components. Also, each data form used in the measurement process will be designed so that the part number is identified as the first entry for each measurement. Since the part number is the basis for each measurement, it becomes "required" data and validated before being added to the data base.

An individual part may require one or two measurements to be taken while another part may require four or five measurements. Also, each measurement may require a particular unit of expression (i.e., inches, ounces, degrees). Recognizing the uniqueness of each part number with respect to the type of measurement(s) and the number of measurement points, the following system design limit was established. Each individual part may contain up to a maximum of eight separate measurement types to be made against it. Each measurement type can consist of several measurements up to an accumulative maximum of 45 for all eight measurements. These design limits easily accomodate the existing measurement requirements identified in the TDOP wear program proposal and also provide for reasonable growth and flexibility for any additional requirements. (See Appendix D for a more detailed discussion of part number assignment and measurement relationships.)

The location of wear measurement points will be standardized for the various measurement types for each part. It will always be a two character position with the first character alpha/numberic and second alphabetic (i.e., 1A, 1R, 2F). There are over 35 groups of codes identifying each of the measurement types. Many of the codes are common to several groupings but differ in range due to the differing number of wear measurement points or to the various measurement instruments used (i.e., templates) that were designed with common location wear point codes. Other location codes were arbitrarily assigned and based on the multiple entry design of the field data forms.

This location code will always be associated with the actual recording measurement value from its input source (data form) to internal storage (disk) to the final interpretation (reporting). Therefore, the measurement type (one through eight), the actual measurement value and the location wear point all become the basic unit of information for each wear point stored in the wear measurement record. The measurement value is a six-character position of three significant positions with three decimal places stored in a six-byte packed decimal format.

Other fields of information stored on each wear record are control dates such as dates processed and dates measured, accrued mileage, and also comment fields for recording unusual conditions such as instrument malfunctions, abnormal maintenance or repair practices, weather conditions, etc.

3.2 CAR NUMBER SPECIFICATION FILE

A TDOP car number (001 through 006) will be assigned arbitrarily to each car for purposes of data control and analysis. This master file's control key is: TDOP Car Number. It contains:

a. Car specifications data such as age, capacity, carbody dimensions, owner car number

b. Truck data such as type, description

c. Baseline carbody static measurements (one-time measurements taken by Wyle personnel)

d. Initial spring inventory squareness measurements

e. Miscellaneous data as needed.

3.3 TRUCK INVENTORY FILE

This master file's control key is: Part Number. It contains:

a. Part number, noun description, date inventoried

b. Definition for up to eight measurement types to include description, tolerance, instrument used, whether assembled or dissassembled and number of wear points.

3.4 TRUCK COMPONENT CODE FILE

This master file's control key is: (AAR) Component Code (i.e., FN, EY). It contains:

a. Component code, name description

b. Miscellaneous data as needed.

3.5 PART LOCATION CODE FILE

This master file's control key is: (AAR) Part Location Code (i.e., AL3, BR1). It contains:

a. Location codes

b. Miscellaneous data as needed.

3.6 WEAR MEASUREMENT CYCLE DATE FILE

This master file's control key is: Wear Measurement Date - MMYY (i.e., 0779, 0380). It contains:

a. Date

b. Measurement location

c. Comment information regarding overall cycle measurement conditions

d. Miscellaneous data as needed.

SECTION 4 - TOTAL

TOTAL is a data base management system. It provides two languages: the first is Data Base Definition Language (DBDL) to define a data base for TOTAL's organization and management, and the other is Data Manipulation Language (DML) for use in accessing and manipulating the data base. DML commands are issued via CALL statements in application programs using a host language. FORTRAN is the host language in this TDOP data base application. It readily supports the functions of DML commands which include the opening and closing of data sets, the accessing and manipulation of master and variable data sets and other special functions.

TOTAL was purchased from CINCOM Systems, Inc. CINCOM specializes in data base and data communication software systems. CINCOM Systems provided Wyle with the document, "TOTAL Interdata Reference Manual," a publication number P12-0001-00.

4.1 DATA SET RELATIONSHIPS

The direct relationships among different groups of data is the foundation of a TOTAL data base. Within the TDOP data base framework and using three data base files previously identified (i.e., wear, car, component) as examples, an examination of one group of data related to another group of data provide relationships such as:

a. freight car and component wear

b. freight car and component maintenance

c. freight car and inventory

d. component wear and mileage

e. component maintenance and mileage

Acknowledging these relationships, it is desirable to access information about any freight car or component type for selective processing and analysis. Information regarding freight car or freight car component can be stored in a record which is accessible directly by freight car number and freight car component type respectively. These records are grouped together to form two master data sets: Car File and the Truck Component Code File. These files are independent in nature and contain identifying and control information and also reference data. Transactions corresponding to a freight car or a freight car component will be linked together in a chain which, in turn, will be linked to the associated freight car number record or freight car component type record in the master data sets. Wear, maintenance and inventory data are examples of transactions belonging to a variable data set. A variable data set is dependent and must be attached to a master data set (See Appendix C).

Transaction records (variable) corresponding to a particular car number or component type or both are chained together because of their association with that car or component type (master) (See Appendix C).

A car number file or a component type file is chained together with a group of transaction (i.e., wear) records because of its association with those transactions (i.e., wear) records (See Appendix C).

A car number record can be accessed directly by a car number. A component type file can be accessed directly by a component type code.

When a number of master data sets and variable data sets are meaningfully associated in a group, a data base is formed. A data base may contain stand-alone master data sets, one variable data set associated with multiple master data sets, one master data set associated with multiple variable data sets (up to 2500) or single variable file linkages (up to 2500) in a chain.

4.2 TOTAL DATA BASE FEATURES

The principal features of a TOTAL data base include:

a. Ability to expand data base and add new data sources.

b. Establish automatically master and variable information through file relationships using keys and linkages internal to TOTAL.

c. Ability to change data base without changing application programs (data independence)

d. Allows simple access to data due to file management techniques within the data management system.

e. Provides common control and standardization in file maintenance.

SECTION 5 - MULTIPLE ACCESS PATHS

Through TOTAL, each variable wear data record is linked to each of the six master files. This creates multiple access paths within the data base and allows wear data to be analyzed in a variety of ways. For example, first line analysis can readily be made of wear data along these major access paths:

a. by car number/truck type

b. by individual part number

c. by component code grouping (i.e., wheels)

d. by part location on car (i.e., BL1, AR4)

e. by measurement cycle date/mileage (i.e., 0779).

Measurement wear data may also be selected at an even more detailed level such as:

a. wheel wear on car number 001

b. wheel wear with part location AR4

c. brake shoe wear with part location BL2

Inventory component changeout analysis can also be performed, such as:

a. brake shoe replacement between dates 0179 to 0979

b. wheel changeout on car number 003

c. spring replacement on car number 002 between 0179 to 0680.

It is through the linkages of master to variable files that this record selectibility can be made efficiently.

SECTION 6 - SOFTWARE PROCESSING MODULES

The TDOP Wear Data Base will be divided into six software processing modules. Each module is separate and independent of each other and serves a unique function. The five Data Base modules are: Create, Load, Maintenance, Backup and Recovery, Report Writer, and Selective Retrieval.

6.1 CREATE

Each data base file must be identified and created by TOTAL. Each file must be designed to include file name and type, data field (length, type and name), space allocation (sector size, blocking factor, record size, number of physical files, maximum number of records-volume, disk volume assignments) and the use of various available options such as shared file buffering.

6.2 LOAD

Five of the six master files will be loaded by one computer program storing data initially through the use of "table indexing". This load program will be executed only once and data stored in these tables will be transferred to disk in the form of five separate master files. The sixth master file (truck inventory) will be loaded also by using an indexing table; however, it is much more complex and utilizes two programs and a sort to load the file.

The wear variable data file will be loaded upon receipt of the first set of measurements (baseline, cyclic, inventory). An ongoing loading program will be used to add this data and subsequent months wear data to the data base.

The load software programs may contain certain data validation, record selection bypass, code conversion, record statistics and file building routines to ensure data integrity for each file generated.

6.3 MAINTENANCE

This module will consist of at least one edit and one update software program for the manipulation of stored data for the purpose of addition, modification, correction an deletion of wear data and master files. Inherent in this module is the creation of an error processing and reporting system for maintaining accurate data quality assurance levels. Both the edit and update software programs will check for valid control keys (i.e., part numbers, car numbers, cycle dates, component codes, part location codes), valid reference data, missing data, and also numeric and range checking.

TOTAL also produces "status codes" for errors such as duplicate records, unmatched control keys, invalid record changes, deletions, and additions. Some of these checks may be of a "warning" nature while others are "fatal" and not entered into the data base. In any event, both the warning and fatal errors will be hardcopy printed for research and corrective submission at a later date. After all input records are edited, validated and otherwise checked for accuracy, those remaining edited records will be processed for update and placement into the data base.

6.4 BACKUP AND RECOVERY

The data base files will be duplicated on magnetic tape on a periodic basis dependent on the volume and activity of the files. This is to ensure that all files can be reconstructed with a minimum of effort in the event of computer malfunction or severe disk crash problems.

6.5 REPORT WRITER

This module consists of a series of extract, sort, and print software programs for hardcopy reporting. This reporting feature involves one set of reports for listings of all files in the data base while the second set, through the use of various sorting sequences, produces more selective reporting. Selective reporting can be used for analyzing variable wear data based on component mileage, dates, inventory with respect to car number and truck type. The selective reporting can also be used as a preliminary effort in the selection and preparation of Interdata 8/32 computer plotting software routines.

6.6 DATA BASE SELECTIVE RETRIEVAL

Retrieval of data base file information for analysis and plotting will be generated from a selective retrieval program using parameters with select criteria. Examples of select criteria are data type (e.g., inventory, wear, etc.), truck type, component type along with a finer selection such as dates, mileage, ascending and descending sequences. The selection output files can then serve as input to several analytical programs for calculation, plotting and reporting test findings.

6.7 DATA BASE USE

The TDOP wear data base will primarily be used in two ways: first, to provide quality assurance during the measurement program, and second to provide data for detailed engineering analysis of rates of deterioration. To fullfill the objective of providing quality assurance support for the measurement program, several summary reports will be generated for use both at Wyle and in the field. A variance report will be generated each month listing previous measurements and the changes in these measurements. This report will be available to the field team for comparison with the measurement results as they are obtianed. Additionally, previous measurements will be extrapolated and compared to the data obtained in each measurement cycle. A report will be generated based on these results flagging possible errors and providing early identification of any findings. Part number listings, car number listings, car maintenance listings, and the like will be provided from the data base to provide timely information on exactly what is being tested. Finally, inventory change out reports will be generated indicating recent part change outs to simplify keeping track of the current state of the program.

To fulfill the objective of providing data for engineering and economic analysis, several forms of graphical displays will be plotted. Changes in wear rates can be quantified through the use of standard statistical analysis methods and plotting the results in various ways. Examples of plots to be generated are comparative trend wear analysis plots and curve-fitting plots.

Under comparative trend wear analysis, single-curve plots can be used to compare wear measurements of selected components (i.e., bolster wear plates) between various truck types, and multi-curve plots (up to four curves per plot) can chart the wear on individual components (i.e., brake shoes) as a function(s) of time and mileage. Curve-fitting routines can be generated for smoothing of plotted curves, and expressing curves using selected mathematical formulas. In addition, various other data point statistical analysis techniques such as root mean square (RMS) and averaging can be generated.

SECTION 7 - DATA BASE STATISTICS

The TDOP wear data base will consist of one variable fixed-length file and six master fixed-length files using TOTAL as the file management system. All TOTAL files are Interdata OS 8/32 Multi-Tasking (MT) contiguous disk files (ASCII 7-bit) which are defined by sector length. Each section occupies 256 character positions of data. The entire data base (all seven files) have a total allocated space of approximately 100,000 sectors or just under 25 million characters. The expected accumulation of measurement data is 60 to 70% of the total thereby allowing sufficient space for additional data as requirements are added or revised over the life of the TDOP wear program.

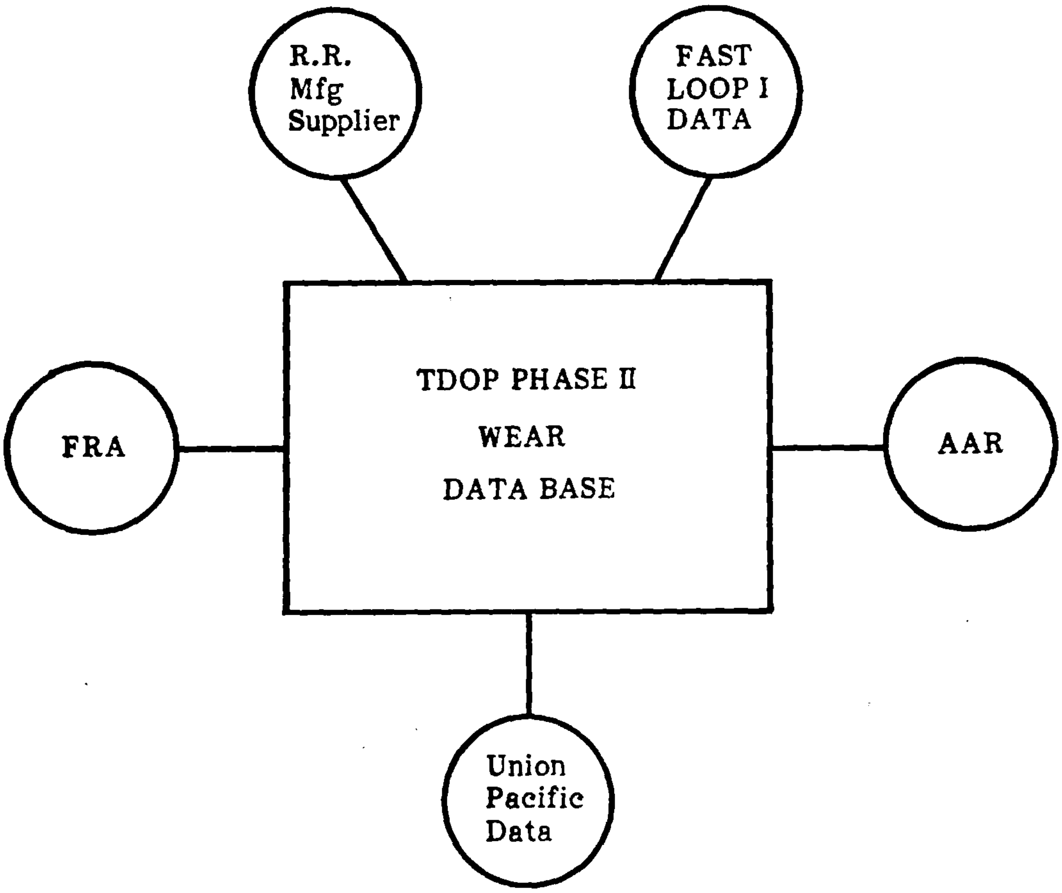
Two disk volumes reside in the Interdata OS 8/32 system: a 67 megabyte system volume and a 256-megabyte volume for use in the storage of large data files. Each of the six master files are allocated to the small disk (67 MB) while the wear variable data is allocated to the larger disk. This allocation of data files between the two disk volumes improves read-access time while reducing overall execution time for file loading, maintenance and data retrieval. The data base files are shown in Table 1.

The maximum record volume and record size characteristics represent the data base design limit and allows for reasonable growth on an ongoing basis. However, any additional requirements to increase record volume or size beyond this limit may necessitate a redesign and a regeneration of new data base requirements.

Table 1. File Descriptions

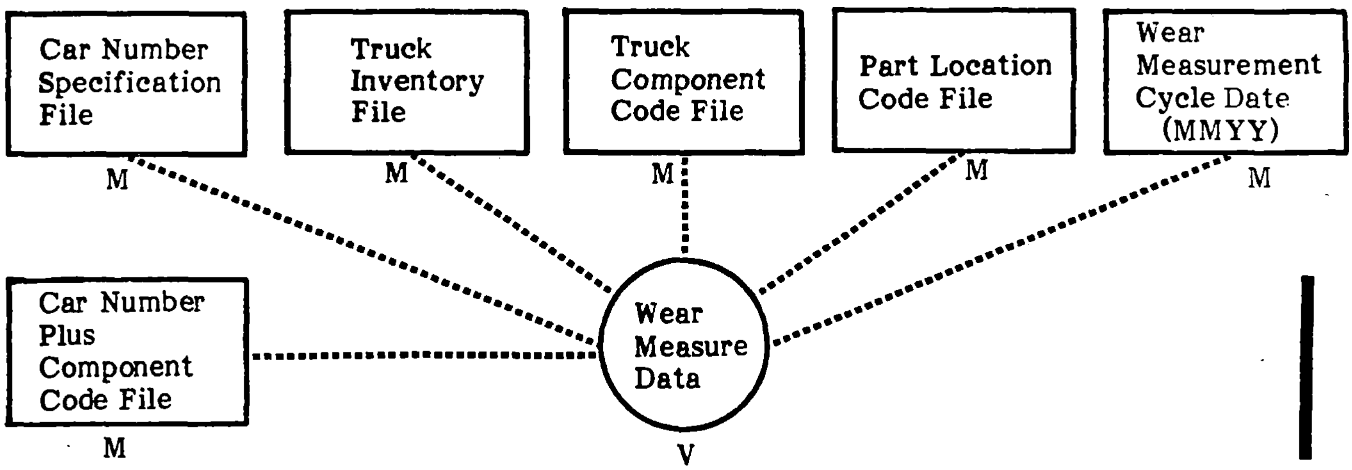
FILE NAME	WEAR.TOO	WINV.TOO	WNUM.TOO	WCØM.TOO	WLØC.TOO	WDAT.TOO	WCPC.TOO
FILE DESCRIPTION	Measurement Data	Truck Inventory	Car Number	Component	Location	Cycle Data	Car Number Plus Component
FILE TYPE	Variable	Master	Master	Master	Master	Master	Master
LINKAGE KEY	All Master Linkages	Part Number	Car Number	Component Code	Part Location	Date MMYY	CarNumber Plus Component
RECORD SIZE (CHARACTERS)	512	512	512	64	64	128	64
EXPECTED RECORD VOLUME	32,640	1,360	6	40	18	38	240
MAXIMUM RECORD VOLUME	48,000	2,000	12	80	32	64	360
TOTAL SECTORS	96,000	4,000	24	20	8	32	90

APPENDIX A - DATA SOURCES



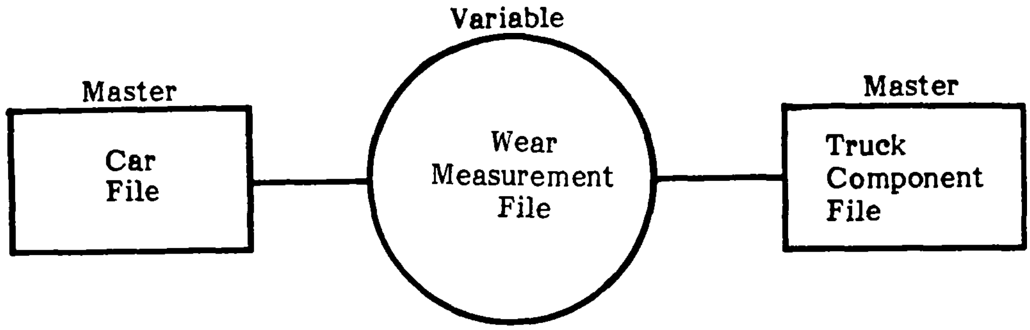
DATA COLLECTION FROM MULTIPLE DATA SOURCES

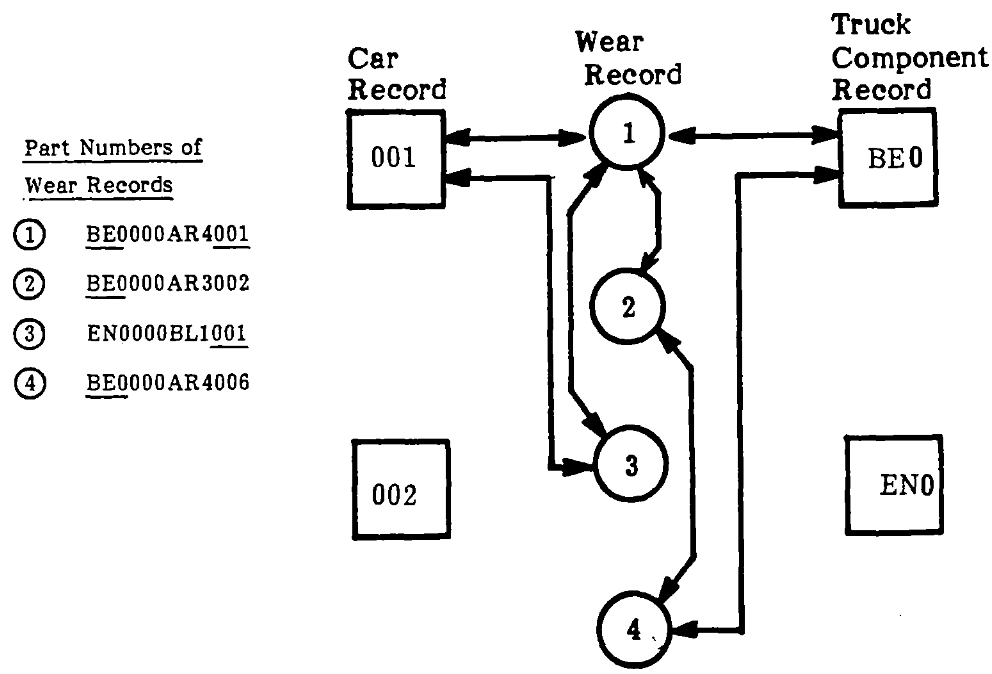
APPENDIX B - TDOP WEAR DATA BASE FILE RELATIONSHIPS



- Wear Variable File Linked to Six Master Files
  - Six Major Access Paths
  - Wide Range of Record Selectibility
- Part Number Contain
  - Control Key Linkages
  - Truck Component Code Identity
  - Part Location Code Identity
  - Car Number Identity
- Data Base Growth and Expansion Allowances For
  - New Files and Linkages
  - More Volume
  - Additional Data on Trucks, Components and Car Type
  - Expanded Record Files, Keys

APPENDIX C - TOTAL FILE RELATIONSHIPS





This example shows wear records 1 and 3 chained to CAR Record (001). It also shows wear records 1, 2, and 4 chained to Truck Component Record (BE). In addition, each wear record is chained similarly to three more master files of part location, date and truck inventory (part number). This demonstrates the chaining mechanism of TOTAL and the importance of the part number and the control keys within it for data retrieval. Thus, a wear measurement, to be valid and not reported as an error, must contain all five control keys of information such as component, car, date, location, and part number identification to properly link it to the data base file.

APPENDIX D - PART NUMBER AND MEASUREMENT DEFINITION

There are over 1000 truck component parts identified in the TDOP test cars used in the Wear Data Collection Program. The assignment of those part numbers is based on the standard AAR Field Manual of Interchange Rules, Rule 83 component code list. In the first level of part number assignments, all components to be measured are assigned a component code in accordance with Rule 83. This is the determinant in deciding the level of component to be measured. In general, if a requirement exists for a measurement of a component (i.e., brake shoes) and that component was readily defined in Rule 83 (i.e., BE), then that code is assigned accordingly. However, if not AAR component code exists (i.e., gibs), then the next relatable level of component (i.e., truck bolster) is assigned (FF).

In the second level of part number assignments, each component is identified as to the total number of identical parts per car and its part location in accordance with the AAR Standard for Component Location. For example, there are two carbody center plates (FV), four bolster wear plates (EA) and eight wheels (FN) with respective car locations of two end locations of A and B, four locations of AR, AL, BR, BL and eight locations of AR3, AR4, AL3, AL4, BR1, BR2, BL1, BL2. The A and B locations are padded with two numeric zeros (i.e., A00, B00) and the four locations of AR, AL, BL, BR are padded with one numeric zero (i.e., AR0, AL0) to fill the fixed three character position.

The third level of part number assignment is the added identification of the TDOP car number (001 through 006) which also provides truck type identification. This creates part number uniqueness of identical parts located in each of the freight cars.

In summary, the part number assignments were necessary to readily identify truck components, and also provide a method of inventory control. The part number, in effect, <u>becomes</u> the standard identification or basis by which all measurements are made. To further illustrate, a part number having two sets of measurements is shown in the following example:

Part Number:	BE000AR4002-000	Brake Shoe						
Measurement #1:	1 Shoe Wear		1	12	000.002	12	D	M
Measurement #2:	4 Weight at In-install/remove to oz		1	01	000.000	01	D	S

	1	2
<u>Part Number:</u>	BE0000AR4002-000	Brake Shoe
	3 4 5 6 7	

1 - Denotes 15-character part number

2 - Part number description

3 - BE - AAR component code for brake shoe

4 - 0000 - An expansion field to be used in the future (not used at present)

5 - AR4 - Identified as one of 8 parts located in the A end, right side and axle 4.

6 - 002 - TDOP car number which links it to the truck type.

7 - 000 - Component part that was in initial inventory at start of wear measurement cycle.

	1	2	3	4	5	6	7	8
<u>Measurement #1:</u>	1	SHOE WEAR	1	12	000.001	12	D	M

1 - Denotes measurement type number (one through eight) where one (1) is allocated a maximum of 45 wear points - this example having 12 wear points.

2 - Measurement description.

3 - Identifies number of measurements taken.

4 - Identifies number of wear points.

5 - Denotes measurement tolerance (6 character position of three significant positions with three decimal places).

6 - Identifies number of location wear point codes.

7 - Identifies whether part number is assembled (A) or disassembled (D) at measurement time.

8 - Instrument used - (M - Micrometer)

Measurement #2: 1 2

4 Weight at Install/Remove to nearest ounce 1 01 000.000 01 D S

1 - Denotes second measurement type and description

2 - Instrument used - (S - scale)

As shown, the above illustrated part number contains reference data in support of the description of part number and measurements. This information is stored in the truck inventory file. The actual wear measurement values (recorded in the field) of a given measurement are stored in the variable wear data file and chained to the truck inventory by its key-part number. Although these two files are physically separated within the data base, both are logically associated with each other and can readily be accessed together for data maintenance or data presentation (reporting).