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US Department
of Transportation
**Federal Railroad
Administration**

TRUCK DESIGN OPTIMIZATION PROJECT (TDOP)

WEAR DATA COLLECTION PROGRAM

Office of Research and
Development
Washington, DC 20590

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an Exodyne Company

Washington Operations
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16. Abstract

The Wear Data Collection Program was a field testing study associated with the Truck Design Optimization Project in which test trucks in unit coal train service were monitored for wear in an effort to develop comparative wear performance data. Seven truck types (one car set of each type) including both standard three-piece trucks in common use in the industry and premium trucks which incorporate design features such as steering in curves were monitored and periodically disassembled at which time a large number of mechanical measurements were made at points which were considered to be potential wear points.

This report reviews and evaluates the measurements which were taken and describes the forms in which this data is now available. In addition, recommendations are made both for reducing the number of measurements and for simplifying the problem of storage and retrieval of the data by reducing the number of data points.

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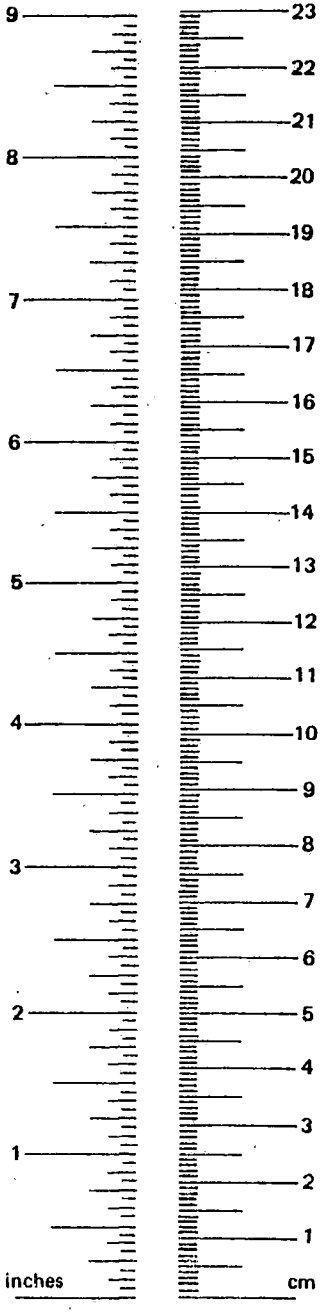
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

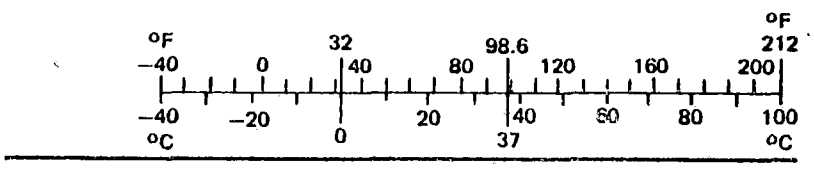
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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



ACKNOWLEDGEMENTS

Many persons cooperated in this effort. N. Thomas Tsai and later Donald E. Gray of the Federal Railroad Administration served as Technical Directors and provided overall direction and support for the program; and the technical staff of Wyle Laboratories designed the program and performed most of the measurements. In addition, the suppliers of the trucks provided their time and support throughout the effort.

The work could not have been completed without the excellent cooperation of the Union Pacific Railroad in providing facilities in their Las Vegas Yard for storing instruments and for taking the periodic measurements. In particular, Frank Bruner, Assistant Chief Mechanical Officer, who provided continued support and advice throughout the project; and Donald Joy of the Las Vegas Yard, without whose cooperation and, at times, patience the program could not have functioned.

EXECUTIVE SUMMARY

The Truck Design Optimization Project (TDOP) involves a series of studies designed to characterize the performance of various designs of freight car trucks. These trucks are generally characterized as type I and type II trucks. Type I trucks are premium trucks in common use in industry. Type II trucks are premium trucks which incorporate design features such as steering in curves.

One of these studies, the wear data program, was designed to establish the wear performance of several test trucks in unit coal train service. All but one of the test trucks were put into service in April of 1979 and have been in service since then except when they have been removed for dynamic testing or for wear measurements. The program was started by Wyle Laboratories. Dynamic Science, Inc. assumed control of the program in November of 1981, when the wear data program was the only remaining program, with the goal of allowing at least 2 truck types to travel 250,000 miles. The test trucks and their mileages as of January 8, 1983 are shown below.

Truck	Mileage as of Jan. 8, 1983
National Swing Motion	256,102
Barber S-2-C	326,018
Dresser DR1	172,529
Barber S-2-HD with C-PEP	273,571
ASF Ride Control	178,747
Barber-Scheffel	234,216
M.T.S. Maxiride	49,857

At intervals of approximately 75,000 to 100,000 miles, the trucks were disassembled and over 400 individual measurements were taken on each truck. Dynamic Science transferred these measurements to a computer data base for accessibility and analysis. In addition, except for brake pad replacements, records were kept on any maintenance or parts failures which occurred during the life of the trucks. These maintenance records are given in Section II.

The measurements, which were intended to cover probable locations of truck wear, were successful to varying degrees. In some cases, no wear occurred and in other cases the measurements suffered from inaccuracies due to difficulties in providing stable reference points. This report discusses these measurements and gives an evaluation of them in light of the experience in this test. Recommendations are also given on measurements to be continued in any additional efforts; and on ways to simplify the data storage and retrieval by averaging appropriate raw measurements.

The data base was discontinued in February, 1983, and the data was transferred to both hard copy printout and magnetic tape. A discussion of the format of this data is also provided.

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TABLES AND ILLUSTRATIONS

Section I - INTRODUCTION AND BACKGROUND

The Truck Design Optimization Project (TDOP) involves a series of studies designed to characterize the performance of various designs of freight car trucks. These trucks are generally characterized as type I and type II trucks. Type I trucks are the standard 3 piece trucks in common use in the industry. Type II trucks are premium trucks which incorporate design features such as steering in curves.

This project was conducted by Wyle Laboratories under contract to the Federal Railroad Administration between 1978 and 1981 and included field testing along with computer modeling, economic analysis, and engineering analysis. One of the field testing studies in the project was the wear data program which was designed to establish the wear performance of several test trucks in unit coal train service. When the dynamic measurements portion of the program was completed in 1981, Dynamic Science assumed responsibility for the wear data collection program from Wyle. This report discusses the measurements taken during the program and the data collected. Recommendations are also made on ways to reduce the number of measurements in any future program.

The measurements were designed by Wyle Laboratories and most of the measurements were taken by Wyle personnel. Since assuming the program in 1981, Dynamic Science Inc. (DSI) has taken periodic measurements to continue the program. Several trucks in the program have now reached 250,000 miles of service.

The measurements and measurement procedures have been discussed in detail by Wyle and are documented in two reports (1) which are available through the National Technical Information Service (NTIS). This report will not duplicate these discussions but will refer to them. Seven truck designs were under test. These were the National Castings Swing Motion Truck, Barber S-2 Truck, Dresser DR-1 Truck, Barber S-2 Heavy Duty Truck with Center Plate Extension Pad, ASF Ride Control Truck,Barber-Scheffel Truck, and the MTS Maxiride Truck. Two trucks of each design were installed on 100- ton coal cars in unit train service on the Union Pacific Railroad between California and Utah. During this trip they also traveled on track owned by the Santa Fe Railroad and the Denver and Rio Grande Railroad. The trucks were periodically disassembled in Las Vegas, Nevada with the help of the Union Pacific Railroad and a series of wear measurements taken. Resulting data were transferred to a data base for reference and data analysis.

Section II of this report discusses the test truck mileages and maintenance histories; Section III lists the measurements taken; Section IV discusses the data collection procedures and the formats in which the data are presently available; and Section V discusses the measurements in more detail including an evaluation of each measurement and recommendations for reducing both the number of measurements and the number of data points to be stored in a data file for wear analysis.

1. Truck Design Optimization Project (TDOP) Phase II, Wear Data Collection Program Reports; FRA/ORD-81/37-I(Vol I, PB 82-168196) and FRA/ORD-81/37-II (Vol II, PB 82-168204).

Section II - CAR HISTORIES

With the exception of the MTS Maxiride truck, all of the trucks were first put into service in April of 1979 and have been in service since then except when they were removed for dynamic testing. The Maxiride truck was put into service in April of 1981. The car mileages accumulated as of January 8, 1983 are listed below.

Car	Mileage as of 8-Jan-83
National Swing Motion	256,102
Barber S-2-C	326,018
Dresser DR1	172,529
Barber S-2-HD with C-PEP	273,571
ASF Ride Control	178,747
Barber-Scheffel	234,216
M.T.S. Maxiride	49,857

The maintenance history of these trucks is given in the following pages. The cars are referred to by number. The car numbers are:

1 National Swing Motion (NSM)
2 Barber S-2-C (S2C)
3 Dresser DR1 (DR1)
4 Barber S-2-HD with C-PEP (S2HD)
5 ASF Ride Control (ASF)
6 Barber-Scheffel (BS)
7 *
8 M.T.S. Maxiride

* Car number 7 was originally equipped with an additional set of test trucks; however, it was removed from the test program prior to the time that DSI took over the measurements.

Truck Number 1 - National Swing Motion

Mileage	Component	Location	Maintenance Action and Reason
177,000	Wheelset FN0000	1,3	Replaced for shelling
187,631	Rocker Bearing FJ4000	AL3,AR3 AL4,AR4 BL1,BR2	Replaced due to cracked welds
187,631	Center Plate Wear Liner EJ0000	B	Liner jammed under wear ring so that it could not be moved

Truck Number 2 - Barber S-2-C

Mileage	Component	Location	Maintenance Action and Reason
11,000	Wheelset FN0000	1,2,3,4	Replaced - The reason was not recorded
25,000	Friction Casting EN0000	AR3	Replaced - The reason was not recorded
117,000	Wheelset FN0000	2,3,4	Replaced - The reason was not recorded
159,000	Wheelset FN0000	1	Replaced - The reason was not recorded
159,000	Friction Casting EN0000	AL4	Replaced due to wear
220,000	Wheelset FN0000	2	Replaced due to shelling of wheel R2

Truck Number 3 - Dresser DR1

Mileage	Component	Location	Maintenance Action and Reason
22,000	Steering Arm ZC1000	A00 B00	Replaced - reason was not recorded
147,836	Wheelset FN0000	1	Replaced due to chip out of wheel L1, shelling on R1
147,836	Wheelset FN0000	3	Replaced for shelling and flat spot, not yet condemnable
147,836	Steering Arm Bushing ZC1000	A,B	Sleeve separating due to improper vulcanizaton during manufacture
147,836	Steering Arm Clearance Hole	R2	Crack at hole - weld repaired
147,836	Side Wear Plate Mounting Bolts	B	Bolts on side wear plate were loose causing side frame wear

Truck Number 4 - Barber S-2-HD with C-PEP

Mileage	Component	Location	Maintenance Action and Reason
119,200	Wheelset FN0000	1	Replaced - reason was not recorded
203,329	Wheelset FN0000	3	Replaced for shelling - not yet condemnable

Truck Number 5 - ASF Ride Control

There was no maintenance recorded for truck number 5.

Truck Number 6 - Barber-Scheffel

Mileage	Component	Location	Maintenance Action and Reason
15,000	Wheelset FN0000	1,2,3,4	Replaced - reason was not recorded
126,097	Cross Strut	Number 1	Broken weld on one end
126,097	Cross Strut Lock Washers	L2,L3	Washers Broken
168,987	Shear Pad Housing	All	Replaced for cracks
168,987	Shear Pads ZC3000	All	Replaced due to wear
168,987	Cross Strut	All	Replaced along with shear pad housings
231,895	Shear Pad Housings	All	Housings cracked at lateral Strut attachment

Truck Number 8 - M.T.S. Maxiride

Mileage	Component	Location	Maintenance Action and Reason
9,754	Piston Wear Plate EN4000	BL2	Plate broken at welds between piston and plate
29,851	Side Bearing Springs	AL3,AL4 BL1	Springs broken
40,000	Side Bearing Spring	n.a.	Spring broken

Section III - MEASUREMENTS TAKEN

At each measurement cycle, over 400 individual measurements were taken on each truck. Since the truck designs varied, the number of measurements would also vary. An attempt was made to take wear measurements on every part which was expected to wear during the life of the test so that a full picture of the wear patterns could be developed. The dataincluded measurements on all of the wear plates, wheels, friction castings, etc.. The measurements met with varying degrees of success. For instance, it was quickly apparent that some measurements such as spring heights, brake shoe thickness and weights could not be taken or monitored practically in this program and were therefore dropped. In other cases the measurement worked but the truck exhibited very little wear. An evaluation of the measurements is given in Section V. The following pages contain a full list of these measurements, listed alphabetically by their measurement numbers. In addition, the sections in the Wyle reports which discuss these measurements are referenced and the applicable trucks are listed.

A typical example of a measurement listing follows.

1. EN0000 2. 4A-6C 3. Friction casting sloping face relative height
4. Report Sections - 3.4.8
5. Report Figures - 2.1,2.2,3.9-12
6. Applicable Trucks - NSM BS S2C S2HD DR1

Item 1 is the major part number.

Item 2 is the range of specific 2 digit identifiers which identify specific measurements on that series of measurements. In this case, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 6C all of which are taken at different locations on the sloping face of the friction casting.

Item 3 is the name given to the series of measurement points.

Item 4 is the number of the section or sections in the reference report which discusses this set of measurements. The sections are in Appendix B of Volume I of the report. In the case of Maxiride measurements, the references, preceded by an A. (i.e. A-3.3), are in Appendix A of Appendix B.

Item 5 is the number of the figure or figures, if any, in the reference report which illustrate the set of measurements. The figures are also in Appendix B of volume I of the report.

Item 6 is a list of the abreviations for the trucks on which this measurement set is taken.

TDOP Wear Measurements List

BE0000 1A-4C Brake shoe thickness
Report Sections - 2.4.3
Report Figures - 2.6
Applicable Trucks - NSM BS S2C S2HD ASF DR1 MTS

BE0000 1W Brake shoe weight
Report Sections - 2.4.3
Report Figures - 2.6
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

EJ0000 1T-8T Bolster center plate wear ring thickness
Report Sections - 3.3.1
Report Figures - 2.13, 2.14
Applicable Trucks - NSM BS S2C S2HD ASF DR1

EJ0000 1A-4F Bolster center plate horizontal wear liner thickness
Report Sections - 3.3.1
Report Figures - 2.13, 2.14
Applicable Trucks - NSM S2C ASF

EN0000 1A-3C Friction casting vertical face relative height
Report Sections - 3.4.8
Report Figures - 2.1,2.2,3.9-12
Applicable Trucks - NSM BS S2C S2HD DR1

EN0000 4A-6C Friction casting sloping face relative height
Report Sections - 3.4.8
Report Figures - 2.1,2.2,3.9-12
Applicable Trucks - NSM BS S2C S2HD DR1

EN0000 1W Friction casting weight
Report Sections - 3.4.8
Report Figures -
Applicable Trucks - NSM BS S2C S2HD DR1

EN1000 1A-3C Friction casting vertical face relative thickness
Report Sections - 3.4.8.3
Report Figures - 3.13
Applicable Trucks - ASF

TDOP Wear Measurements List

EN1000 4A-6B Friction casting sloping face thickness
Report Sections - 3.4.8.3
Report Figures - 3.13
Applicable Trucks - ASF

EN1000 1W Friction casting weight
Report Sections - 3.4.8.3
Report Figures -
Applicable Trucks - ASF

EN4000 1T-5T Friction snubber piston face thickness
Report Sections - A-3.6
Report Figures - A-15, A-16
Applicable Trucks - MTS

EN4000 1L Friction snubber piston length
Report Sections - A-3.6
Report Figures - A-15, A-16
Applicable Trucks - MTS

EN4000 1D Friction snubber piston shaft minimum diameter
Report Sections - A-3.6
Report Figures - A-15, A-16
Applicable Trucks - MTS

EY0000 1A-3B Bearing adapter crown relative height
Report Sections - 3.4.7
Report Figures - 2.5, 3.8
Applicable Trucks - NSM BS S2C S2HD ASF DR1

EY0000 4A-5B Bearing adapter lug lateral face relative thickness
Report Sections - 3.4.7
Report Figures - 2.5, 3.8
Applicable Trucks - NSM BS S2C S2HD ASF DR1

EY0000 6A-6B Bearing adapter longitudinal stop relative thickness
Report Sections - 3.4.7
Report Figures - 2.5,3.8
Applicable Trucks - NSM BS S2C S2HD ASF DR1

TDOP Wear Measurements List

EY0000 1W Bearing adapter weight
Report Sections - 3.4.7
Report Figures -
Applicable Trucks - NSM BS S2C S2HD ASF DR1

EY2000 1A-3C Bearing adapter outer main wear plate thickness
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

EY2000 1D-3F Bearing adapter inner main wear plate thickness
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

EY3000 10-3I Bearing adapter outboard side plate thickness
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

EY3000 40-6I Inboard bearing adapter side plate thickness
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

EY3000 1S-3S Bearing adapter outboard side plate spacing
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

EY3000 4S-6S Bearing adapter inboard side plate spacing
Report Sections - A-3.2
Report Figures - A-10
Applicable Trucks - MTS

FA0000 1T Side bearing cage base thickness
Report Sections - 2.4.9
Report Figures - 2.3
Applicable Trucks - NSM BS S2C S2HD ASF DR1

TDOP Wear Measurements List

FB0000 1D Side bearing roller minimum diameter
Report Sections - 2.4.9
Report Figures - 2.3
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FD0000 1T Transom stop thickness
Report Sections - 3.3.4.1
Report Figures - 3.3
Applicable Trucks - NSM

FF0000 1T-3T Bolster inboard gib thickness
Report Sections - 3.3.4
Report Figures - 2.12
Applicable Trucks - BS S2C S2HD ASF DR1

FF0000 4T-6T Bolster outboard gib thickness
Report Sections - 3.3.4
Report Figures - 2.12
Applicable Trucks - BS S2C S2HD ASF DR1

FF0000 1W-3W Bolster column width
Report Sections - 3.3.4
Report Figures - 2.12
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FF3000 1S-2S Bolster outboard column spacing
Report Sections - 3.3.3
Report Figures - 3.1
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FF3000 3S-4S Bolster inboard column spacing
Report Sections - 3.3.3
Report Figures - 3.1
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FF3000 5S-6S Bolster inboard gib spacing
Report Sections - 3.3.3
Report Figures - 3.1
Applicable Trucks - BS S2C S2HD ASF DR1

TDOP Wear Measurements List

FF4000 1T Bolster stop thickness
Report Sections - 3.3.4.1
Report Figures - 3.3
Applicable Trucks - NSM

FG0000 1D Bolster center plate longitudinal diameter
Report Sections - 2.4.8, 3.3.1
Report Figures - 2.13
Applicable Trucks - BS NSM S2C S2HD ASF DR1

FG0000 2D Bolster center plate lateral diameter
Report Sections - 2.4.8, 3.3.1
Report Figures - 2.13
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FG1000 1A-4F Bolster center plate horizontal surface relative height
Report Sections - 2.4.8, 3.3.1
Report Figures -
Applicable Trucks - NSM BS S2C S2HD ASF

FJ0000 10-1I Side frame outer lug relative thickness
Report Sections - 3.4.1
Report Figures - 3.5
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ0000 20-2I Side frame inner lug relative thickness
Report Sections - 3.4.1
Report Figures - 3.5
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ0000 1A-3B Side frame pedestal roof relative height
Report Sections - 3.4.1
Report Figures - 3.5
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ0000 1T-3T Side frame antirotation lug thickness
Report Sections - 3.4.2
Report Figures - 2.10
Applicable Trucks - NSM BS S2C S2HD ASF DR1

TDOP Wear Measurements List

FJ0000 1W-3W side frame column width
Report Sections - 3.4.2
Report Figures -
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ1000 4T Side frame outer lug lateral width
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ1000 5T Side frame inner lug lateral width
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM BS ASF S2C S2HD DR1

FJ1000 1S Side frame jaw spacing
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ2000 1S-3S Side frame antirotation lug spacing
Report Sections - 3.4.2
Report Figures - 3.6
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ3000 1S-3S Side frame outboard column spacing
Report Sections -
Report Figures -
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ3000 4S-6S Side frame inboard column spacing
Report Sections -
Report Figures -
Applicable Trucks - NSM BS S2C S2HD ASF DR1

FJ4000 10-1I Side frame outer lug relative thickness
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

TDOP Wear Measurements List

FJ4000 20-2I Side frame inner lug relative thickness
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ4000 2A-2B Side frame pedestal roof relative height
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ4000 4T Side frame outer lug lateral width
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ4000 5T Side frame inner lug lateral width
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ4000 1L Side frame lug to lug spacing
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ4000 1S Side frame jaw spacing at bearing center
Report Sections - 3.4.3
Report Figures - 3.5
Applicable Trucks - NSM

FJ5000 1W-3W Pedestal outer jaw width
Report Sections - A-3.3
Report Figures - A-14
Applicable Trucks - MTS

FJ5000 4W-6W Pedestal inner jaw width
Report Sections - A-3.3
Report Figures - A-14
Applicable Trucks - MTS

TDOP Wear Measurements List

FJ5000 20 Outboard link pin minimum diameter
Report Sections - A-3.3
Report Figures - A-14
Applicable Trucks - MTS

FJ5000 2I Inboard link pin minimum diameter
Report Sections - A-3.3
Report Figures - A-14
Applicable Trucks - MTS

FK0000 1A-3C Side frame wear plate thickness
Report Sections - 3.4.4
Report Figures - 3.6
Applicable Trucks - NSM ASF BS S2C S2HD DR1

FK1000 1A-3C Side wear plate thickness
Report Sections - 3.4.4
Report Figures - 3.6
Applicable Trucks - NSM

FK1000 10-30 Outboard side wear plate thickness
Report Sections - 3.4.4
Report Figures - 3.6
Applicable Trucks - NSM

FK1000 1I-3I Inboard side wear plate thickness
Report Sections - 3.4.4
Report Figures - 3.6
Applicable Trucks - NSM

FK2000 1A-3C Pedestal jaw outer wear plate thickness
Report Sections - A-3.3
Report Figures - A-14, A-11
Applicable Trucks - MTS

FK2000 10-3I Pedestal jaw outboard side plate thickness
Report Sections - A-3.3
Report Figures - A-11, A-14
Applicable Trucks - MTS

TDOP Wear Measurements List

FK2000 40-6I Pedestal jaw inboard side wear plate
Report Sections - A-3.3
Report Figures - A-11, A-14
Applicable Trucks - MTS

FN0000 1T-2T Wheel rim thickness
Report Sections - 3.4.9
Report Figures - 3.14
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FN0000 1H-2H Wheel flange height
Report Sections - 3.4.9
Report Figures - 3.14
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FN0000 1W-2W Wheel flange width
Report Sections - 3.4.9
Report Figures - 3.14
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FN0000 1C Wheel circumference
Report Sections - 3.4.9
Report Figures - 3.14
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FN0000 1Z-2Z Wheel tread thickness
Report Sections - 3.4.9
Report Figures - 3.14
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FN1000 1G-2G Wheel outside to outside distance
Report Sections -
Report Figures -
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

FV1000 1D-1K Body center plate
Report Sections - 2.6.3, 3.4.10
Report Figures - 2.17
Applicable Trucks - NSM BS MTS S2C S2HD ASF DR1

TDOP Wear Measurements List

FW0000 1T Body side bearing thickness
Report Sections - 3.4.10
Report Figures - 3.15
Applicable Trucks - NSM BS S2C S2HD MTS ASF DR1

FZ0000 1F C-PEP free height
Report Sections - 3.3.4.3
Report Figures - 3.4
Applicable Trucks - S2HD

FZ0000 1C C-PEP compressed height
Report Sections - 3.3.4.3
Report Figures - 3.4
Applicable Trucks - S2HD

XXXXXX Wheel profile
Report Sections -
Report Figures -
Applicable Trucks - MTS NSM BS S2C S2HD ASF DR1

ZC0000 1T Rocker seat trunion thickness
Report Sections - 3.3.4.1
Report Figures - 3.2
Applicable Trucks - NSM

ZC0000 1B Bearing thickness
Report Sections - 3.3.4.1
Report Figures - 3.2
Applicable Trucks - NSM

ZC1000 1H Steering arm shaft horizontal diameter
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

ZC1000 1V-2V Steering arm shaft vertical diameter
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

TDOP Wear Measurements List

ZC1000 1H Steering arm bushing horizontal diameter
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

ZC1000 1V Steering arm bushing vertical diameter
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

ZC2000 1B Right elastomeric pad free height
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

ZC2000 1A Left elastomeric pad free height
Report Sections - 3.3.4.2
Report Figures -
Applicable Trucks - DR1

ZC3000 1A Outer elastomeric shear pad height - axle side
Report Sections - 3.3.4.4
Report Figures -
Applicable Trucks - BS

ZC3000 1S Outer elastomeric shear pad height strap side
Report Sections - 3.3.4.4
Report Figures -
Applicable Trucks - BS

ZC3000 2A Inner elastomeric pad height - axle side
Report Sections - 3.3.4.4
Report Figures -
Applicable Trucks - BS

ZC3000 2S Inner elastomeric shear pad height - strap side
Report Sections - 3.3.4.4
Report Figures -
Applicable Trucks - BS

TDOP Wear Measurements List

ZC4000 1T Spring cap wear button thickness
Report Sections - A-3.5
Report Figures - A-14
Applicable Trucks - MTS

ZC4000 10 Outboard cap pin diameter
Report Sections - A-3.5
Report Figures - A-14
Applicable Trucks - MTS

ZC4000 1I Inboard cap pin diameter
Report Sections - A-3.5
Report Figures - A-14
Applicable Trucks - MTS

ZC4000 20 Outside load link inside length
Report Sections - A-3.5
Report Figures - A-14
Applicable Trucks - MTS

ZC4000 2I Inboard load link inside length
Report Sections - A-3.5
Report Figures - A-14
Applicable Trucks - MTS

Section IV - DATA COLLECTION AND FORMAT

A detailed discussion of the data collection procedures is provided in Section 2 of Appendix B of the Wyle report referenced in Section I of this report.

Briefly, the data collected during the field measurement cycles were recorded on data sheets, an example of which is provided on the next page. Recorded on this sheet are: the AAR part designation for the component appended with 3 zeroes; the standard car location codes; a three digit number representing the car number; a three digit number representing the replacement number; and the individual measurements for that part referenced by a unique two digit number.

These data were transferred by Dynamic Science into a wear data base on a time sharing computer. The data base system was a commercial system called RAMIS. This data base was used by Dynamic Science for reviewing and organizing the data.

The data are presently available in two forms, hard copy printout and magnetic tape files.

The hard copy printout is organized by car and part number. The part number, location and code are provided down the left hand columns of the printout and the measurement values for each individual measurement location are given along the horizontal beneath the mileage at which that measurement was taken. A measurement of 0 indicates that no measurement was taken at that time. The table provided in Section II of this report provides the key to associate part numbers with truck components and individual measurements.

After a component was replaced, any measurements taken on the new part were put into a separate data base of measurements for replaced parts. These measurements are provided in the rear of the printout stack organized in the same way as the major data file.

The data from the data base were also written to a magnetic tape for storage and later retrieval. The tape is a standard 9 track, 1600 bits per inch, standard labeled tape with EPSIDIC format. The data for each car is in a separate file and the data for the replaced parts for all of the cars is in an eighth file. Each data file is separated by a short header file and a short trailer file. The file designations are provided in Table IV-1.

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 # _____

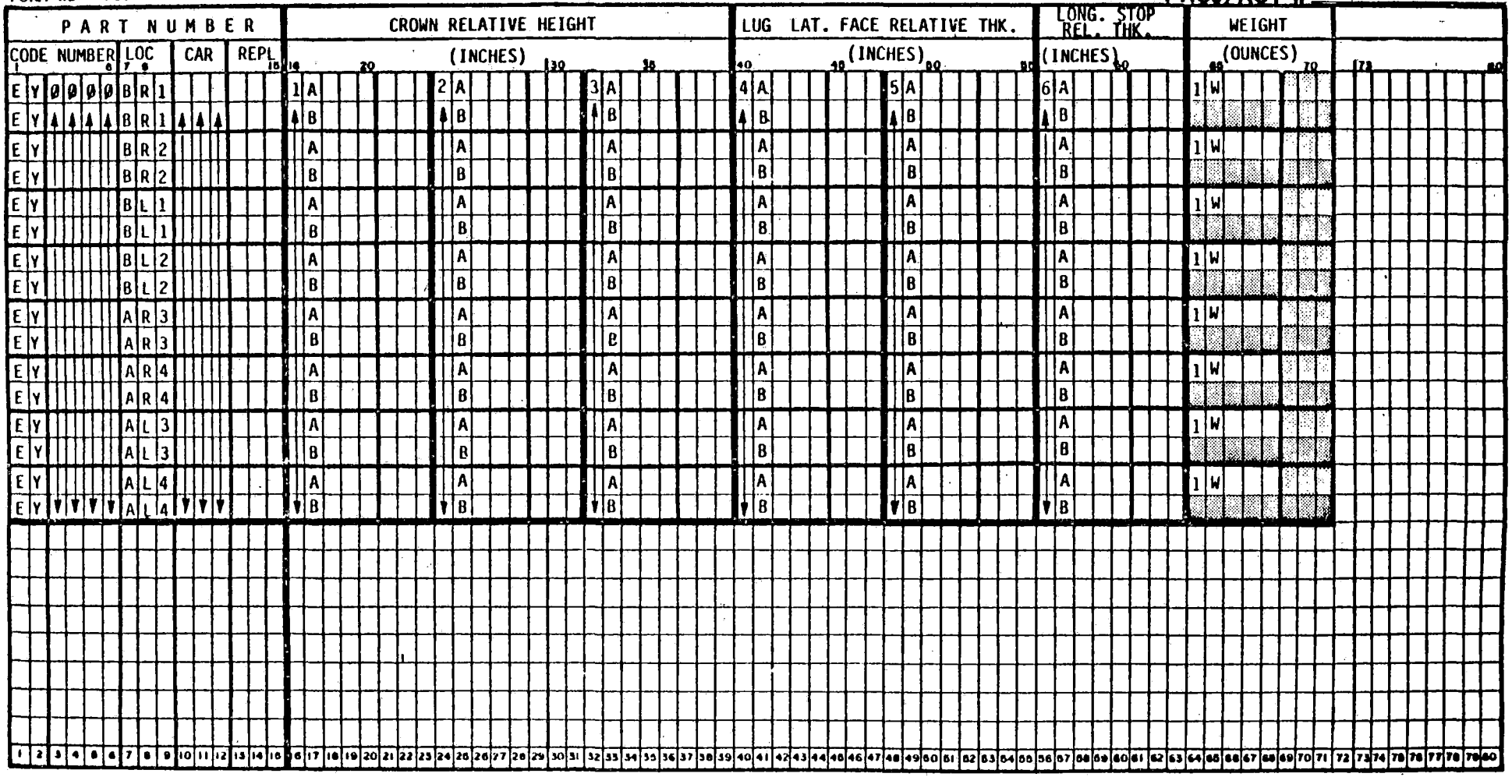

Figure IV-1 Example Meaurement Form

Table IV-1 Magnetic Tape File Listing

car #:	car type	number of records	file name
1	National Swing Motion	3934	mesfile.car1
2	Barber S-2-C	4667	mesfile.car2
3	Dresser DR-1	4190	mesfile.car3
4	Barber S-2-HD with C-PEP	3251	mesfile.car4
5	ASF Ride Control	2863	mesfile.car5
6	Barber-Scheffel	3074	mesfile.car6
8	M.T.S. Maxiride	1940	mesfile.car8
	Replaced parts all cars	416	mesfile.carrp

In the above files, each measurement is contained in a 56 byte record which contains all of the necessary designation information. The EBSIDIC record format is given below.

Table IV-2 EBSIDIC Record Format

Field Name	Format	Length
Carnumber	A3	3
Cartype	A20	20
Mileage	16	6
Inspdate	14	4
Partnumber	A6	6
Locmeas	A5	5
Meascode	A2	2
Measurement	F7.3	7
Slack	X3	3
TOTAL		56

A printout of a few records from the replaced parts file is given on the following page as an example.

```
003|DRESSER DR-1      |  90116|8101|ZC1000|B001V|1V|  1.991
003|DRESSER DR-1      |  90116|8101|ZC1000|B001W|1W|  1.996
003|DRESSER DR-1      | 147836|8201|ZC1000|B001H|1H|  1.989
003|DRESSER DR-1      | 147836|8201|ZC1000|B001J|1J|  1.998
003|DRESSER DR-1      | 147836|8201|ZC1000|B001V|1V|  1.990
003|DRESSER DR-1      | 147836|8201|ZC1000|B001W|1W|  2.006
004|BARBER S2-HD      | 203329|8201|FN0000|BL11C|1C|14.130
004|BARBER S2-HD      | 203329|8201|FN0000|BL11H|1H|  1.140
004|BARBER S2-HD      | 203329|8201|FN0000|BL11T|1T|  2.100
004|BARBER S2-HD      | 203329|8201|FN0000|BL11W|1W|  1.270
004|BARBER S2-HD      | 203329|8201|FN0000|BL11Z|1Z|  5.684
004|BARBER S2-HD      | 203329|8201|FN0000|BL12H|2H|  1.160
004|BARBER S2-HD      | 203329|8201|FN0000|BL12T|2T|  2.100
004|BARBER S2-HD      | 203329|8201|FN0000|BL12W|2W|  1.300
004|BARBER S2-HD      | 203329|8201|FN0000|BL12Z|2Z|  5.693
004|BARBER S2-HD      | 203329|8201|FN0000|BR11C|1C|14.090
004|BARBER S2-HD      | 203329|8201|FN0000|BR11H|1H|  1.110
004|BARBER S2-HD      | 203329|8201|FN0000|BR11T|1T|  2.070
004|BARBER S2-HD      | 203329|8201|FN0000|BR11W|1W|  1.340
004|BARBER S2-HD      | 203329|8201|FN0000|BR11Z|1Z|  5.683
004|BARBER S2-HD      | 203329|8201|FN0000|BR12H|2H|  1.110
004|BARBER S2-HD      | 203329|8201|FN0000|BR12T|2T|  2.100
004|BARBER S2-HD      | 203329|8201|FN0000|BR12W|2W|  1.360
004|BARBER S2-HD      | 203329|8201|FN0000|BR12Z|2Z|  5.678
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL21H|1H|  1.090
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL21T|1T|  2.090
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL21W|1W|  1.430
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL22H|2H|  1.140
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL22T|2T|  2.120
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BL22W|2W|  1.430
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR11H|1H|  1.170
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR11T|1T|  2.100
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR11W|1W|  1.450
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR12H|2H|  1.170
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR12T|2T|  2.100
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR12W|2W|  1.440
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR21H|1H|  1.160
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR21T|1T|  2.110
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR21W|1W|  1.410
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR22H|2H|  1.160
006|BARBER SCHEFFEL   |  42682|7910|FN0000|BR22T|2T|  2.100
```

Figure IV-2 Typical TDOP Wear Data Records

Note: Lines have been added to separate the fields for clarity.

The first column contains the car number, in this case either 003, 004, or 006. The next 20 columns contain the truck name. This is followed in the next 6 columns by the mileage at which the measurement was taken, in this case 90116, 147836, 203329, and 42682. This is followed by the measurement date. The measurement date is a 4 digit number representing the year followed by the month. In this case 8101-January 81; 8201-January 82; 7910-October 79. The next 6 columns are the major part number, in this case ZC1000 and FN0000. The next 5 columns are the measurement code consisting of the AAR location designation followed by the unique measurement code, in this case B001V, B001W, etc.. This is followed by two columns repeating the unique measurement code, in this case 1V, 1W, etc.. Finally, the measurement is given. It is always a 7 column number consisting of 3 digits followed by a decimal and then 3 significant digits following the decimal.

Section V - Measurement Descriptions, Evaluation, and Recommendations

The wear measurements taken during the program were developed by Wyle in consultation with the FRA consultant committee consisting of representatives from the railroads and the truck suppliers. They identified those areas of the trucks which were subject to wear and then attempted to develop repeatable and accurate ways of measuring the wear. These measurements are discussed below.

Each measurement is identified with a unique set of numbers. The first identifying number is referred to as the part number and consists of two characters followed by 4 numbers (i.e. FN0000, FF3000). The first 3 characters are the AAR component code description and the last 3 characters were reserved for a measurement number or other identifier which was not used in this effort. The next 3 identifiers are the 3 digit AAR part location code (i.e. AR3, BL1) representing the end of the car, the side of the car and the number of the axle associated with the measurement. Finally each measurement is given a two digit measurement code. Thus the flange height measurement on the A end of the car, right side, axle 3 is identified as FN0000 AR3 1H or FN0000 AR3 2H depending on which of the two flange height measurements per wheel is being referenced.

These measurements are discussed fully in the report prepared by Wyle Laboratories for the FRA entitled Truck Design Optimization Project (TDOP) Phase II, Wear Data Collection Program Reports, which is referenced in the Introduction to this report. For cross referencing, the chapters and figure numbers in the Wyle report where each measurement is discussed is provided after each major category in the discussion which follows. All of the references are in Appendix B of the report. Descriptions of the measurements for the Maxiride Truck are contained in Appendix A of Appendix B and these are referenced with an A in front of the chapter and figure numbers.

The following discussion covers many aspects of the measurement. A typical example is provided below:

1. EJ0000 Truck Bolster Center Plate

2. Section 3.3.1; figures 2.13,2.14

3. Wear Ring Thickness - 1T-8T

4. Measured with the ultrasonic thickness gage at several points around the perimeter of the center plate.

3. Horizontal Wear Liner Thickness - 1A-4C; 1D-4F

4. Measured with an ultrasonic thickness gage at 3 points along 8 axes of the plate.

5. Evaluation

These measurements are easy to take and relatively accurate but there are reference problems because the liner has a tendency to turn. This component has shown wear on the order of .001 inches per 10,000 miles during the test and thus is not likely to be useful for comparing trucks. However, it has been pointed out that deformation or excessive wear in the center plate area can occur if hunting action is present.

6. Recommendation

Take only final measurements.

7. Recommended Data Reduction

8. Wear ring thickness - Average 8 measurements per ring.

9. Original data points - 16
10. Reduced data points - 2

Wear liner thickness - Average 12 measurements per liner.

Original data points - 48
Reduced data points - 2

Item 1 is the major part number followed by the name of the major component.

Item 2 is the section and figures if any in the Wyle report in which the series of measurements that follows is discussed.

Item 3 is the description and range of specific measurement numbers which identify the individual measurements. For instance, the individual measurements for the wear ring thickness are 1T, 2T, 3T, 4T, 5T, 6T, 7T, 8T and the individual measurements for horizontal wear liner thickness are 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4B, 4C, 1D, 1E, 1F, 2D, 2E, 2F, 3D, 3E, 3F, 4D, 4E, 4F.

Item 4 is a brief description of the measurement.

Item 5 is an evaluation of the measurement based on the measurement history to date and on the field experience.

Item 6 is a recommendation of how to use this measurement in any follow-on to this effort or in other truck wear measurement programs.

Item 7 is the start of the section containing recommendations on ways to reduce the number of measurements which must be stored for future data analysis. The present data file contains over 24,000 measurements and thereby requires the use of a large computer data base to store and access the data. If the number of measurements to be stored can be reduced the

job of storing and analyzing data may become manageable either manually or on a microcomputer, thereby eliminating the expense of the large computer data base for storing measurements which are accessed infrequently.

The most likely method of analysis for many measurements will be to average the multiple measurements taken on a given part or surface and then compare the averaged numbers. By averaging these numbers before storage, the number of measurements to be stored in a readily accessible form will be greatly reduced. If another form of comparison is required the original measurements would still be accessible by going back to the original data collection forms.

Item 8 is the specific recommendation for that part or that group of measurements. In this case the recommendation is that the 8 measurements taken on the wear ring be averaged.

Item 9 is the number of data points measured per car (2 test trucks) per measurement cycle.

Item 10 is the number of reduced data points which would be stored in the readily accessible form.

The measurements and discussions are presented below in alphabetical order by major part number.

BE0000 Brake Shoes

Section 2.4.3; figure 2.6

Brake Shoe Thickness - 1A-4C

Measured with dial calipers at 12 points (6 on each end) from the metal backing surface to the wearing surface.

Brake Shoe Weight - 1W

The weight of the shoe.

Evaluation

The brake shoes were being replaced in between measurement cycles at locations other than Las Vegas, making it unfeasible to accurately monitor the brake shoes. The brake shoe measurement was dropped when DSI took over from Wyle and no brake shoe measurements have been entered into the data base.

Recommendation

Measurement was dropped.

Recommended Data Reduction

Brake shoe thickness - Measurement dropped

Original data points - 96
Reduced data points - 0

Brake shoe weight - Measurement dropped

Original data points - 8
Reduced data points - 0

EJ0000 Truck Bolster Center Plate

Section 3.3.1; Figures 2.13,2.14

Wear Ring Thickness - 1T-8T

Measured with the ultrasonic thickness gage at several points around the perimeter of the center plate.

Horizontal Wear Liner Thickness - 1A-4C; 1D-4F

Measured with an ultrasonic thickness gage at 3 points along 8 axes of the plate.

Evaluation

These measurements are easy to take and relatively accurate but there are reference problem because the liner has a tendency to turn. This component has shown wear on the order of .001 inches per 10,000 miles during the test and thus is not likely to be useful for comparing trucks. However, it has been pointed out that deformation or excessive wear in the center plate area can occur if hunting action is present.

Recommendation

Take final measurements only.

Suggested Data Reduction

Wear ring thickness - Average 8 measurements per ring.

Original data points - 16

Reduced data points - 2

Wear Liner thickness - Average 12 measurements per liner

Original data points - 48
Reduced data points - 2

EN0000 Friction Casting

Section 3.4.8; Figures 2.1,2.2,3.9,3.10,3.11,3.12

Vertical Face Relative Height - 1A-3C

Measurement taken at 9 points spaced on the vertical face of the casting using templates and either a dial depth gage or an ultrasonic thickness gage.

Sloping Face Relative Height - 4A-6C

Measurement taken at 9 points spaced on the sloping face of the casting using a template and either a dial depthe gage or an ultrasonic thickness gage.

Weight - 1W

Measurement dropped

Evaluation

The measurements are simple and accurate.

Recommendation

Take measurements at each cycle. Drop weight.

Recommended Data Reduction

Vertical face relative height - average 9 measurements

Original data points - 72
Reduced data points - 8

Sloping face relative height - average 9 measurements

Original data points - 72
Reduced data points - 8

Friction casting weight - Measurement dropped.

Orignial data points - 8
Reduced data points - 0

EN1000 - ASF Friction Casting Vertical Face Relative Height

Section 3.4.8.3; Figure 3.13

Vertical Face Relative Height - 1A-3C

Measurement taken at 9 points spaced on the vertical face of the casting using templates and either a dial depth gage or an ultrasonic thickness gage.

Sloping Face Relative Height - 4A-6B

Measurement taken at 6 points spaced on the sloping face of the casting using a template and either a dial depth gage or an ultrasonic thickness gage.

Weight - 1W

Measurement dropped.

Evaluation

The measurements are simple and accurate.

Recommendation

Take measurement at each cycle. Drop weight.

Recommended Data Reduction

Vertical face relative height - average 9 measurements per face.

Original data points - 72
Reduced data points - 8

Sloping face relative height - Average 6 measurements per face.

Original data points - 48
Reduced data points - 8

Weight - Measurement dropped.

Original data points - 8
Reduced data points - 0

EN4000 - Maxiride Friction Snubber

Section A-3.6; Figures A-15,A-16

Piston Face Thickness - 1T-5T

Measured at 5 points around the face of the plate using a template and an ultrasonic thickness gage.

Piston Length - 1L

Measured from the face of the plate to the end of the shaft using dial calipers.

Evaluation

The measurements are straightforward and accurate.

Recommendation

Take measurement at each cycle.

Piston Shaft Minimum Diameter - 1D

Minimum diameter of the shaft measured with a dial caliper.

Evaluation

Measurement is easy to take although the use of a minimum diameter rather than a fixed point reference makes referencing difficult.

Recommendation

Take final measurement only.

Recommended Data Reduction

Piston face thickness - Average 5 measurements per face.

Original data points - 40
Reduced data points - 8

Piston length - No data reduction.

Original data points - 8
Reduced data points - 8

Piston shaft minimum diameter - No data reduction.

Original data points - 8
Reduced data points - 8

EY0000 - Bearing Adapters

Section 3.4.7; Figures 2.5,3.8

Crown Relative Height - 1A-3B

Measured in 6 places with a dial depth gage inserted in holes in a template placed over the top of the bearing adapter.

Lug Lateral Face Relative Thickness - 4A-5B

Distance between a tab on the bearing adapter template and inside edge of the lateral face measured with a telescoping gage.

Longitudinal Stop Relative Thickness - 6A-6B

Distance between a tab on the adapter template and the center of the lateral stop measured using a telescoping gage.

Weight - 1W

Measurement was dropped

Evaluation

Measurements are of good quality and are useful because they relate to the free play in the bearing adapter area.

Recommendation

Take final measurement only. Weight dropped.

Recommended Data Reduction

Crown relative height - Average 6 measurements per adapter crown.

Original data points - 48
Reduced data points - 8

Lug lateral face relative height - No data reduction.

Original data points - 32
Reduced data points - 32

Longitudinal stop relative thickness - No data reduction.

Original data points - 16
Reduced data points - 16

Weight - Measurement dropped

Original data points - 8
Reduced data points - 0

EY2000 - Maxiride Bearing Adapter Main Wear Plates

Section A3.2; Figure A-10

Outer Main Wear Plate Thickness - 1A-3C

Thickness of the outer wear plate measured at 8 points along the face using a template and an ultrasonic thickness gage.

Inner Main Wear Plate Thickness - 1D-3F

Thickness of the inner wear plate measured at 8 points along the face using a template and an ultrasonic thickness gage.

Evaluation

The measurements are straightforward and accurate.

Recommendation

Take measurements at each cycle.

Recommended Data Reduction

Outer main wear plate thickness - Average 8 measurements per plate

Original data points - 64
Reduced data points - 8

Inner main wear plate thickness - Average 8 measurements per plate

Original data points - 64
Reduced data points - 8

EY3000 - Maxiride Bearing Adapter Side Wear Plates

Section A-3.2; Figure A-10

Outboard Side Plate Thickness - 10-3I

Wear plate thickness measured at 3 points on each side plate using a template and an ultrasonic thickness gage.

Inboard Side Wear Plate Thickness - 40-6I

Wear plate thickness measured at 3 points on each side plate using a template and an ultrasonic thickness gage.

Evaluation

Measurements are accurate and straightforward and relate to free play in the bearing adapter area.

Recommendation

Take measurements at each cycle.

Outboard Side Plate Spacing - 1S-3S

Inboard Side Plate Spacing - 4S-6S

Distance between side plates measured at 3 points using templates and a tubular micrometer.

Evaluation

Measurements are accurate and straightforward but are also a duplication of the information provided by the side wear plate thickness measurements. They can serve to verify these thickness measurements.

Recommendation

Take final measurements only.

Recommended Data Reduction

Outboard side plate thickness - Average 3 measurements per plate.

Original data points - 48
Reduced data points - 16

Inboard side plate thickness - Average 3 measurements per plate.

Original data points - 48
Reduced data points - 16

Outboard side plate spacing - Average 3 measurements per location.

Original data points - 24
Reduced data points - 8

Inboard side plate spacing - average 3 measurements per plate.

Original data points - 24
Reduced data points - 8

FA0000 - Side Cage Base Thickness

Section 2.4.9; Figure 2.3

Cage Base Thickness - 1T

Thickness of the base of the cage measured with an ultrasonic thickness gage at the point of maximum wear.

Evaluation

The measurement has no clear reference point. Also, the cage base does not seem to be a wear area.

Recommendation

Drop measurement.

Recommended Data Reduction

Cage base thickness - Drop measurement.

Original data points - 8
Reduced data points - 0

FB0000 - Side Bearing

Section 2.4.9; Figure 2.3

Side Bearing Roller Mininmum Diameter - 1D

Minimum diameter of the roller bearing measured with dial calipers at the center of the roller.

Evaluation

Easy to take but seems to be of limited usefulness.

Recommendation

Drop the measurement. An inspection at the end of the test to see if the roller is out of round would be useful.

Recommended Data Reduction

Roller minimum diameter - Drop measurement.

Original data points - 8
Reduced data points - 0

FD0000 - National Swing Motion Transom Stop Thickness

Section 3.3.4.1; Figure 3.3
Transom Stop Thickness - 1T

Thickness of the stop measured with dial calipers at center of stop.

Evaluation

Simple measurement but not a wearing surface. There is little rubbing, only contact.

Recommendation

Drop measurement.

Recommended Data Reduction

Transom stop thickness - Drop measurement.

Original data points - 4
Reduced data points - 0

FF0000 - Bolster Gib Thickness and Column Width

Section 3.3.4; Figure 2.12

Inboard Gib Thickness - 1T-3T

Outboard Gib Thickness - 4T-6T

Distance from the flat inside face of the gib to a button placed on the non wearing side of the gib measured with a dial caliper at 3 places on the gib.

Evaluation

The flat wearing faces tend to wear in a sloping manner from inside to outside so that it becomes progressively harder to reference the dial caliper. Thus, the accuracy of this measurement decreases over time. However, gib wear is related to truck free play and truck squareness which are important to truck performance.

Recommendation

Take measurements at each cycle

Column Width - 1W-3W

Section 3.3.4, Figure 2.12

Distance from flat wearing face of inboard gib to flat wearing face of outboard gib measured in 3 places with dial calipers.

Evaluation

The change in the column with is equal to the sum of the changes in the inboard and outboard gib thicknesses. However in this case the redundancy is worth retaining.

Recommendation

Take measurement at each cycle.

Recommended Data Reduction

Inboard gib thickness - Average 3 measurements per gib.

Original data points - 24
Reduced data points - 8

Outboard gib thickness - Average 3 measurements per gib.

Original data points - 24
Reduced data points - 8

Column width - Average 3 measurements per location.

Original data points - 24
Reduced data points - 8

FF3000 - Truck Bolster

Section 3.3.3; Figure 3.1

Outboard Column Spacing - 1S-2S

Inboard Column Spacing - 3S-4S

Distance across bolster body measured with a dial caliper 1 inch from the top of the bolster and one about 1 inch from the bottom of the bolster on the inboard side of the friction casting pocket area.

Evaluation

The column spacing is important because it relates directly to the truck squareness and free play between the bolster and the side frame.

Recommendation

Take measurement at each cycle.

Inboard Gib Spacing - 5S-6S

The distance across the bolster from outside edge of the gibs taken across each gib about 1 inch from the top and one inch from the bottom of the gib.

Evaluation

The edges of the gib are not wearing surfaces.

Recommendation

Drop measurement.

Recommended Data Reduction

Outboard column spacing - Average 2 measurements per location.

Original data points - 8
Reduced data points - 4

Inboard column spacing - Average 2 measurements per location.

Original data points - 8
Reduced data points - 4

Inboard gib spacing - Drop measurement.

Original data points - 8
Reduced data points - 0

FF4000 - National Swing Motion Bolster Stop Thickness

Section 3.3.4.1; Figure 3.3

Bolster Stop Thickness - 1T

Thickness of the stop taken with a dial calipers at the center of the stop.

Evaluation

Simple measurement to take but the surface has minimal friction contact.

Recommendation

Take final measurement only.

Recommended Data Reduction

Bolster stop thickness - No data reduction

Original data points - 4
Reduced data points - 4

FG0000 - Truck bolster Center Plate

Section 2.4.8, 3.3.1; Figure 2.13

Longitudinal Diameter - 1D

Measurement taken with dial calipers in the longitudinal direction.

Lateral Diameter - 2D

Measurement taken with dial calipers in the lateral direction.

Evaluation

These measurements are initial measurements only.

Recommendation

Inventory only - drop.

Recommended Data Reduction

Bolster center plate longitudinal diameter - Inventory only - drop.

Original data points - 2
Reduced data points - 0

Bolster center plate lateral diameter - Inventory only - drop.

Original data points - 2
Reduced data points - 0

FG1000 - Center Plate Horizontal Surface Relative Height

Section 2.4.8, 3.3.1

Horizontal Surface Relative Height - 1A-1F

A template is put on top of the center plate ring and a dial depth gage is used to measure the depth relative to this fixed plate. Only performed on those trucks with no center plate liner (Barber S-2-C HD, Barber Scheffel) or those trucks with removable center plate liner (National Swing Motion, Barber S-2-C, ASF Ride Control).

Evaluation

This measurement is easy to take but wear is slight. Some unusual wear could occur if the truck was hunting.

Recommendation

Take final measurements only.

Recommended Data Reduction

Horizontal surface relative height - No reduction.

Original data points - 48
Reduced data points - 48

FJ0000 - Side Frame

Section 3.4.1; Figure 3.5

Outer Lug Relative Thickness - 10-1I

Inner Lug Relative Thickness - 20-2I

Distance between tabs on the pedestal roof relative height fixture and the ends of the side frame lugs which mate with the bearing adapters.

Evaluation

Straightforward measurement with solid reference point. However, a preliminary look at the data indicates that there is a great deal of

variation in measurements.

Recommendation

Take final measurements only.

Pedestal Roof Relative Height - 1A-3B

Distance from the surface of the pedestal roof relative height fixture and the top of the side frame pedestal jaw area measured in six places with a dial depth caliper.

Evaluation

Measurements seem to have a great deal of variation.

Recommendation

Take final measurement only.

Antirotation Lug Thickness - 1T-3T

Section 3.4.2; Figure 2.10

Distance between the flat face of the antirotation lugs and button head screws located on the sloping side of the lug.

Evaluation

The flat side of the lug wears to a taper thus eliminating the reference point.

Recommendation

Take final measurement only.

Column Width - 1W-3W

Section 3.4.2

The distance between the antirotation lugs oposite the thickness buttons.

Evaluation

The uneven wear of the lug faces makes the referencing of the measurement difficult.

Recommendation

Take final measurement only.

Recommended Data Reduction

Outer lug relative thickness - Average 3 measurements per location.

Original data points - 24
Reduced data points - 8

Inner lug relative thickness - Average 3 measurements per location.

Original data points - 24
Reduced data points - 8

Pedestal roof relative height - Average 6 measurements per location.

Original data points - 48
Reduced data points - 8

Antirotation lug thickness - Average 3 measurements per location.

Original data points - 24
Reduced data points - 8

Column width - Average 3 measurements per location

Original data points - 24
Reduced data points - 8

FJ1000 - Truck Side Frame

Section 3.4.3; Figure 3.5

Outer Lug Lateral Width - 4T

Inner Lug Lateral Width - 5T

The width of the jaw lug taken with a dial micrometer at one point where the wear appears to be greatest.

Evaluation

The measurement suffers from lack of a fixed reference point. The measurement relates to the free play in the bearing adapter.

Recommendation

Take final measurement only.

Lug to Lug Spacing - 1L

The distance across the bearing adapter jaw from one lug to the other in the center of the lug.

Evaluation

The measured wear is equal to the sum of the wear indicated by the corresponding bearing adapter lug lateral face relative thickness.

Recommendation

Take final measurement only.

Jaw Spacing - 1S

Distance across the side frame jaws at the center of the bearing adapter measured with dial calipers.

Evaluation

The surfaces are not normally wearing surfaces.

Recommendations

Take final measurement only.

Recommended Data Reduction

Outer lug lateral width - No reduction

Original data points - 8
Reduced data points - 8

Inner lug lateral width - No reduction

Original data points - 8
Reduced data points - 8

Lug to lug spacing -

Original data points - 8
Reduced data points - 8

Jaw spacing - No reduction

Original data points - 8
Reduced data points - 8

FJ2000 - Truck Side Frame Antirotation Lug Spacing

Section 3.4.2; Figure 3.6

Antirotation Lug Spacing - 1S-3S

The spacing between the ends of the lugs measured with a dial caliper at 3 points oposite the thickness reference buttons for each set of antirotation lugs.

Evaluation

Unless there is deformation of the casting, this measurement is a duplication of the antirotation lug thickness measurement. Since it is taken over a distance of about 19 inches it would be expected to be less accurate. It can serve as a check on the truck squareness.

Recommendations

Take final measurement only.

Recommended Data Reduction

Antirotation lug spacing - Average 3 points per location.

Original data points - 12
Reduced data points - 4

FJ3000 Side Frame Column Spacing

Section 3.3.3, Figure 3.1
Distance across the column opening from wear plate to wear plate.

Evaluation

Straightforward measurement - Inventory only.

Recommendation

Inventory only - drop measurement.

FJ4000 - National Swing Motion Side Frame Thickness and Spacing

Section 3.4.3; Figure 3.5

Outer Lug Relative Thickness - 10-1I

Inner Lug Relative Thickness - 20-2I

Pedestal Roof Relative Height - 2A-2B

Outer Lug Lateral Width - 4T

Inner Lug Lateral Width - 5T

Lug to Lug Spacing - 1L

Jaw Spacing at Bearing Center - 1S

See FJ0000 for discussion of measurements

FJ5000 - Maxiride Side Frame

Section A-3.3; Figure A-14
Pedestal Outer Jaw Width - 1W-3W

Pedestal Inner Jaw Width - 4W-6W

Distance across the bearing adapter jaw measured in three places with dial calipers.

Evaluation

Straightforward and accurate they relate to free play in the bearing adapter.

Recommendation

Take the measurements at each cycle.

Outboard Link Pin Minimum Diameter - 20

Inboard Link Pin Minimum Diameter - 2I

Minimum diameter of the spring cap link pin measured with a dial micrometer.

Evaluation

There is no clear reference point for this measurement

Recommendation

Take final measurement only.

Recommended Data Reduction

Pedestal outer jaw width - Average 3 measurements per jaw.

Original data points - 24

Reduced data points - 8

Pedestal inner jaw width - Average 3 measurements per jaw.

Original data points - 24
Reduced data points - 8

Outboard link pin minimum diameter - No reduction.

Original data points - 8
Reduced data points - 8

Inboard Link pin minimum diameter - No reduction

Original data points - 8
Reduced data points - 8

FK0000 Truck Side Frame Wear Plate Thickness

Section 3.4.4; Figure 3.6

Wear Plate Thickness - 1A-3C

The thickness measured at 9 places on the column wear plate with an ultrasonic thickness gage.

Evaluation

The measurements are quick and are relatively accurate. The measurements relate to free play and truck squareness. If the plate loosens, some wear can occur on the back side of the plate.

Recommendations

Take measurement at each cycle.

Recommended Data Reduction

Wear plate thickness - Average 9 measurements per plate.

Original data points - 72
Reduced data points - 8

FK1000 National Swing Motion Side Wear Plate

Section 3.4.4; Figure 3.6

Wear Plate Thickness - 1A-3C

Wear Plate Thickness Outboard - 10-30

Wear Plate Thickness Inboard - 1I-3I

See FK0000 for discussion of measurements

Recommended Data Reduction

Wear plate thickness - Average 9 measurements per plate.

Original data points - 72
Reduced data points - 8

Outboard wear plate thickness - Average 3 measurements per plate.

Original data points - 24
Reduced data points - 8

Inboard wear plate thickness - Average 3 measurements per plate.

Original data points - 24
Reduced data points - 8

FK2000 Maxiride Side Frame

Section A-3.3; Figures A-11-14

Outer Wear Plate Thickness - 1A-3C

Thickness measured at 9 places with an ultrasonic thickness gage.

Evaluation

Measurement is straightforward and relates to bearing adapter free play.

Recommendation

Take measurement at each cycle.

Outboard Side Plate Thickness - 10-3I

Inboard Side Plate Thickness - 40-6I

Thickness measured with an ultrasonic thickness gage.

Evaluation

Measurement is straightforward and relates to bearing adapter free play

Recommendation

Take measurement at each cycle.

Recommended Data Reduction

Outer wear plate thickness - Average 9 measurements per plate.

Original data points - 72
Reduced data points - 8

Outboard side plate thickness - Average 6 measurements per plate.

Original data points - 48
Reduced data points - 8

Inboard side plate thickness - Average 6 measurements per plate.

Original data points - 48
Reduced data points - 8

FM.... Springs

Spring measurements were droppd by Wyle because of difficulties in producing meaningful and repeatable numbers.

FN0000 Wheels

Section 3.4.9; Figure 3.14

Rim Thickness - 1T-2T

Thickness of the wheel rim measured with a standard AAR finger gage.

Evaluation

Measurements are standard and are important indicators of truck performance.

Recommendation

Take every 50,000 - 75,000 miles.

Flange Height - 1H-2H

Height of the wheel flange measured with a standard AAR finger gage.

Evaluation

Measurements are standard and are important indicators of truck performance.

Recommendation

Take every 50,000 - 75,000 miles.

Flange Width - 1W-2W

Width of the wheel flange measured with a standard AAR finger gage.

Evaluation

Measurements are standard and are important indicators of truck performance.

Recommendation

Take every 50,000 - 75,000 miles.

Wheel Circumference - 1C

Circumference of the wheel measured with an AAR standard wheel tape.

Evaluation

Measurements are standard and are important indicators of truck performance.

Recommendation

Take every 50,000 to 75,000 miles.

Tread Thickness - 1Z-2Z

Thickness across the tread measured with a dial calipers.

Evaluation

Wear in this measurement would be caused by external elements such as switch points and would not be directly related to truck performance.

Recommendation

Drop measurement.

Profile - No numerical designation

Profile of wheel taken with a Pullman-Standard wheel profilometer.

Evaluation

Profilometer provides a clear representation of the shape of the tread and flange but does not have a clear reference for quantitative comparison. Profiles thus are good mainly for illustration purposes.

Recommendation

Drop measurement.

Recommended Data Reduction

Rim thickness - Average 2 measurements per wheel.

Original data points - 16
Reduced data points - 8

Flange height - Average 2 measurements per wheel.

Original data points - 16
Reduced data points - 8

Flange width - Average 2 measurements per wheel.

Original data points - 16
Reduced data points - 8

Circumference - No reduction

Original data points - 8
Reduced data points - 8

Tread thickness - Drop measurement.

Original data points - 16
Reduced data points - 8

Profiles - Not saved in data file.

FN1000 Wheel Outside to Outside Distance

Initial inventory only

FV1000 - Body Center Plate

Sections 2.6.3,3.4.10; Figure 2.17
Lower Diameter - 1D-2D

Upper Diameter - 1D-2D

Upper Minimum Diameter - 1U

Upper Wear Axis Angle - 1K

Lower Minimum Diameter - 1L

Lower Wear Axis Angle - 1K

Body center plate measurements proved to be difficult to make and were dropped early in the program.

FW0000 Body Side Bearing

Section 3.4.10; Figure 3.15

Body Side Bearing Thickness - 1T

Measurement taken with an ultrasonic thickness gage and a location template.

Evaluation

Simple measurement but it is not clear how valuable it is.

Recommendation

Drop measurement.

Recommended Data Reduction

Body side bearing thickness - Discontinue measurement.

Original data points - 8
Reduced data points - 0

FZ0000 - S-2 HD/C-PEP Free and Compressed Height

Section 3.3.4.3; Figure 3.4

Free Height - 1F

Distance between the bottom surface of the bolster center plate and the top of the pads when the truck is out from under the car.

Compressed Height - 1C

Free height minus the distance beween the car body center plate and the car side bearing surface.

Evaluation

It is a measurement on an elastic media which is by nature innacurate.

Recommendation

Drop measurement.

Recommended Data Reduction

Free height - Discontinue measurement.

Original data points - 4
Reduced data points - 0

Compressed height - Discontinue measurement.

Original data points - 4
Reduced data points - 0

ZC0000 - National Swing Motion Rocker Seat

Section 3.3.4.1; Figure 3.2

Trunion Thickness - 1T

Thickness measured at the point of maximum wear across the central vertical axis using dial calipers.

Evaluation

The measurement is straightforward but the exact location is a judgement.

Recommendation

Take final measurement only.

Bearing Thickness - 1B

Thickness measured at the point of maximum wear across the central vertical axis using dial calipers.

Evaluation

The measurement is straightforward but the exact location is a judgement.

Recommendation

Take final measurement only.

Recommended Data Reduction

Trunion thickness - No reduction.

Original data points - 8
Reduced data points - 8

Bearing thickness - No reduction.

Original data points - 8
Reduced data points - 8

ZC1000 - Dresser DR-1 Steering Arms

Section 3.3.4.2

Shaft Horizontal Diameter - 1H-2H

Shaft Vertical Diameter - 1V-2V

The minimum diameter is measured with dial caliper.

Evaluation

Measurements seem of limited usefulness

Recommendation

Drop measurements.

Bushing Horizontal Diameter - 1H-2H

Bushing Vertical Diameter - 1V-2V

Minimum diameters are measured with a dial calipers.

Evaluation

Measurements seem of limited usefulness.

Recommendation

Discontinue measurement.

Recommended Data Reduction

Shaft horizontal diameter - Discontinue measurement.

Original data points - 2
Reduced data points - 0

Shaft vertical diameter - Discontinue measurement.

Original data points - 2
Reduced data points - 0

Bushing horizontal diameter - Discontinue measurement.

Original data points - 2
Reduced data points - 0

Bushing vertical diameter - Discontinue measurement.

Original data points - 2
Reduced data points - 0

ZC20000 - DR1 Elastomeric Pad Free Heights

Section 3.3.4.2

Pad Height Left - 1A

Pad Height Right - 1B

Height measured with a dial caliper.

Evaluation

Measurement on a non-rigid surface and thus inherently weak.

Recommendation

Drop measurements.

Recommended Data Reduction

Pad height left - Discontinue measurement.

Original data points - 8
Reduced data points - 0

Pad height right - Discontinue measurement.

Original data points - 8
Reduced data points - 0

ZC3000 - Barber Scheffel Elastomeric Shear Pad Free Heights

Section 3.3.4.4

Outer Pad Height Axle Side - 1A

Outer Pad Height Strap Side - 1S

Inner Pad Height Axle Side - 2A

Inner Pad Height Strap Side - 2S

Thickness of pad measured after disassembly.

Evaluation

It is a measurement on a non-rigid surface and not clearly referenced.

Recommendation

Drop measurements.

Recommended Data Reduction

Outer pad height axle side - Discontinue measurement.

Original data points - 8
Reduced data points - 0

Outer pad height strap side - Discontinue measurement.

Original data points - 8
Reduced data points - 0

Inner pad height axle side - Discontinue measurement.

Original data points - 8
Reduced data points - 0

Inner pad height strap side - Discontinue measurement.

Original data points - 8
Reduced data points - 0

ZC4000 - Maxiride Spring Cap

Section A-3.5; Figure A-14

Outboard Cap Pin Diameter - 10

Inboard Cap Pin Diameter - 1I

Minimum diameter of pin measured with a dial caliper.

Evaluation

There is no clear reference.

Recommendation

Take final measurement only.

Outboard Load Link Inside Length - 20

Inboard Load Link Inside Length - 2I

Inside length measured with a dial calipers.

Evaluation

Straightforward measurement.

Recommendation

Take final measurements only.

Recommended Data Reduction

Outboard cap pin diameter - No reduction.

Original data points - 8
Reduced data points - 8

Inboard cap pin diameter - No reduction.

Original data points - 8
Reduced data points - 8

Outboard load link inside length - No reduction.

Original data points - 8
Reduced data points - 8

Inboard load link inside length - No reduction.

Original data points - 8
Reduced data points - 8

The recommended data reductions listed above would result in a significant decrease in the number of data points which would have to be stored in a data file of the wear measurements. If all of the recommendations were followed, the number of data points to be stored in a readily accessible form would be roughly one quarter of the number to be stored if all of the raw measurements were maintained for analysis. These reductions are summarized below in table V-1. The recommendations for the most part are based on averaging individual data points over a wear surface. It is conceivable that someone might wish to look at individual wear points on that surface, however, the cost of keeping this data in a readily accessible form is high. If individual points are desired, the data would still be available by going to the raw data sheets and extracting only that information which is desired.

Table V-1. Summary of Recommended Data Storage Reduction

Truck Type	Number of Original Data Points	Number of Reduced Data Points
National Swing Motion	1194	350
Barber S-2-C	978	266
Dresser DR-1	906	216
Barber S-2-HD with C-PEP	938	264
ASF Ride Control	954	266
Barber Scheffel	962	264
MTS Maxiride	818	218

Truck Design Optimization Project: Wear Data Collection Program, 1983
US DOT, FRA, Kenneth W Larsen, David Clark