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TRACK/TRAIN DYNAMICS TEST PROCEDURE TRANSFER FUNCTION TEST

Contract NAS8-29882

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FOREWORD

This document is submitted in accordance with the requirements of NASA Contract NAS8-29882.

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1.0 SCOPE

This procedure provides the necessary information and detailed operations required to conduct the transfer function vibration test on an 80 ton open hopper freight car.

1.1 Objective - The objective of the transfer function test is to obtain data for the validation of the freight car nonlinear elastic model.

1.2 Summary - The test configuration, handling, test facilities, test operations, and data acquisition/reduction activities necessary to meet the conditions of the test requirements document (TS-005-TF) are delineated herein.

2.0 TEST CONFIGURATION

The test article will be setup as illustrated in Figure 7.1.

3.0 SUPPORT REQUIREMENTS

3.1 Handling Equipment - The support equipment necessary to move the freight car, shakers, and coal is listed in Table 8.1.

3.2 Test Equipment - The support equipment necessary to conduct the test is listed in Table 8.2.

3.3 Reference Documents -

3.3.1 P74-48338-1, "Track-Train Dynamics Analysis and Test Program," Update

3.3.2 TS-005-TF, "Track/Train Dynamics Test Requirements Document, Transfer Function Test"

3.3.3 LAB 1007302, "Track-Dynamic Analysis GVS and Transfer Function Test"

3.3.4 LAB 0212205, Sinewave Vibration Control Standard Operating Procedure

3.3.5 1923-5017, Time/Data Sinusoidal Vibration Control Manual

3.4 Facility Requirements -

3.4.1 115 VAC, 60 Hz, 1 Ø

3.4.2 440 VAC, 60 Hz, 3 Ø

3.4.3 Hydraulic Power Supply

4.0 SPECIAL CONSIDERATIONS

4.1 Cautions and Warnings - The description appearing within a CAUTION or WARNING precedes the information that it is intended to emphasize. A CAUTION is used to prevent personnel from damaging equipment. A WARNING is used to prevent test personnel from endangering their safety or that of others. Each step of this procedure shall be read completely before proceeding with the action.

4.2 Test Discrepancies - A test discrepancy shall be logged and reported when test performance and/or results are affected.

4.3 Safety - MMC supervision are directly responsible for the safety of all personnel, safe working conditions and the implementation of all safety requirements applicable to this procedure.

4.3.1 All test team members are responsible for adhering to normal safety standards and procedures. They are also responsible for advising of any unsafe acts or conditions observed during preparation for or during conduct of this procedure.

4.3.2 Personnel safety will be notified 24 hours prior to the official test start date. This test is classified as having non-destructive potential.

4.4 Procedure Changes - All changes to this procedure will be documented and added to a post-test procedure update.

4.5 Test Personnel

Code	Description	Quantity
TD	Technical Director	1
TE	Test Engineer	1
MT	Mechanical Technician	1
ET	Electronic Technician	1
SF	Safety	1

4.6 Test Log - A test log shall be maintained during the test and shall contain information for a complete historical chronological description of test activities.

4.6.1 Instrumentation setup sheets shall be maintained and form part of the test log.

4.7 Test Data - Provision shall be made to retain all test data for a period of 18 months after the test completion.

4.8 Test Control Board - A test control board (TCB) shall periodically monitor test activities and shall consist of the following personnel:

Name	Title	Function
G. Morosow	Project Manager (MMC)	Chairman
P. Abbott	Technical Director (MMC)	Member
J. Macpherson	Technical Representative (NASA/MSFC)	Member

STEP NO.	RESPONS-IBILITY	CK	ACTION	REMARKS
5.0			OPERATIONS	
5.1			Preparations	
5.1.1	MT	___	Position the freight car in the facility per drawing LAB 1007302.	
5.1.2	MT	___	Install hydraulic power supply near actuator test positions.	
5.1.3	MT,ET	___	Install aft truck support, forward slide plates and load cell/spacer assemblies per LAB 1007302. Locate load cells under wheel 1 and 2 per Figure 7.3 and measure static load.	
5.1.4	MT	___	Install actuator support fixture per LAB 1007302.	
5.1.5	MT	___	Install actuators for (Y) direction tests per Figure 7.1.	
5.1.6	ET	___	Install instrumentation in the locations identified by Figures 7.2, 7.3 and Table 8.3. Record data in Table 8.4.	
5.1.7	ET/MT	___	Setup actuator system and data acquisition/reduction equipment as shown in Figure 7.1.	
5.1.8	ET/MT	___	Connect and route all interconnecting cables and plumbing per Figure 7.4.	
5.1.9	ET	___	Verify data acquisition equipment operation, tap check transducers, record full scale calibrations and log information in Table 8.4.	
5.1.10	ET	___	Load sine control program in computer and verify operation per Time/Data manual.	
5.2			Detailed Operations	
5.2.1	TE/et al	___	Perform a 2000 lb-pk sinewave sweep from 0.5 to 50 Hz controlling FL1 per LAB 0212205 and record all data channels.	Control Abort Tol. ± 3dB

STEP NO.	RESPONS-IBILITY	CK	ACTION	REMARKS
5.2.2	ET	___	Load transfer function program and plot selected data per TD.	
5.2.3	TE/et al	___	Load sine control program, perform a 5000 lb-pk sine sweep from 0.5 to 50 Hz controlling FL1 per LAB 0212205 and record data.	Limit Actuator Displ. to ±2" D.A.
5.2.4	ET	___	Load transfer function program and plot selected data per TD.	
5.2.5	TE/et al	___	Load sine control program, perform a 10,000 lb-pk sine sweep from 0.5 to 50 Hz controlling FL1 per LAB 0212205 and record data. Also, take movies of car/truck motion.	Limit Actuator Displ. to ±2" D.A. & 5000 lb-pk above 10 Hz
5.2.6	TE	___	Load transfer function program and plot selected data per TD.	
5.2.7	TE/et al	___	Load sine program and repeat steps 5.2.1 through 5.2.6 with the actuators 180° out of phase.	
5.2.8	MT	___	Photograph test setup and actuator/ transducer locations.	
5.2.9	MT	___	Install actuators for (X) direction tests and vertical load cells per Figures 7.1 and 7.3.	
5.2.10	TE/et al	___	Repeat step 5.2.7, except control measurement FL3.	
5.2.11	MT	___	Photograph new actuator locations	
5.2.12	MT	___	Install a single actuator for (Z) direction tests per Figure 7.1.	
5.2.13	TE/et al	___	Load sine program and perform steps 5.2.1 through 5.2.6, except control measurement FV1.	
5.2.14	MT	___	Photograph actuator location.	
5.2.15	ET	___	Complete data reduction per TD.	
5.3			Post-Test Review	
5.3.1	TCB	___	Perform post-test review to verify test objectives & terminate test.	

STEP NO.	RESPONS-IBILITY	CK	ACTION	REMARKS
5.4			Post-Test Disassembly	
5.4.1	MT/ET	___	Remove all instrumentation, actuators and fixturing.	
5.4.2	MT	___	Unload coal	
5.4.3	TE	___	Prepare data package containing logs, setup sheets, photographs and data.	

6.0 ABBREVIATION AND ACRONYMS

Calib.	Calibration
Cap.	Capacity
CDC	Control Data Corporation
Ch.	Channel
Ck.	Check
CO	Coincidence Component
ET	Electronic Technician
FS	Full Scale
Meas.	Measurement
Mfg.	Manufacturer
MMC	Martin Marietta Corporation
MSFC	Marshall Space Flight Center
MT	Mechanical Technician
NASA	National Aeronautics and Space Administration
No.	Number
O-Graph	Oscillograph
Osc.	Oscillator
Qty.	Quantity
QUAD	Quadrature Component
Sens.	Sensitivity
SF	Safety
SW	Switch
TCB	Test Control Board
TD	Technical Director

TE	Test Engineer
TTY	Teletype Terminal
Typ.	Typical
U-D	Unholtz-Dickie Corporation
XDCR	Transducer

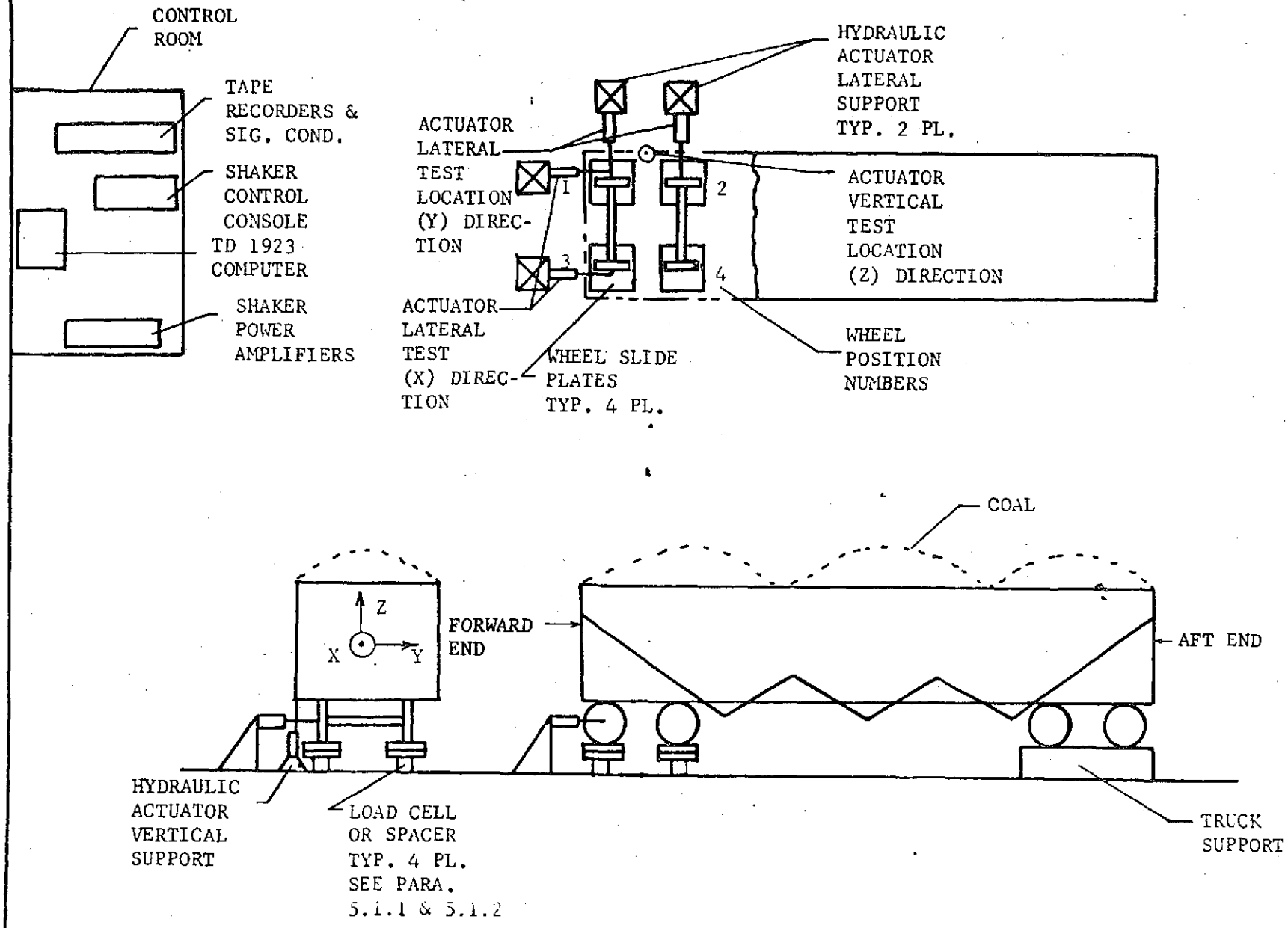


FIGURE 7.1 TEST SETUP AND CONFIGURATION

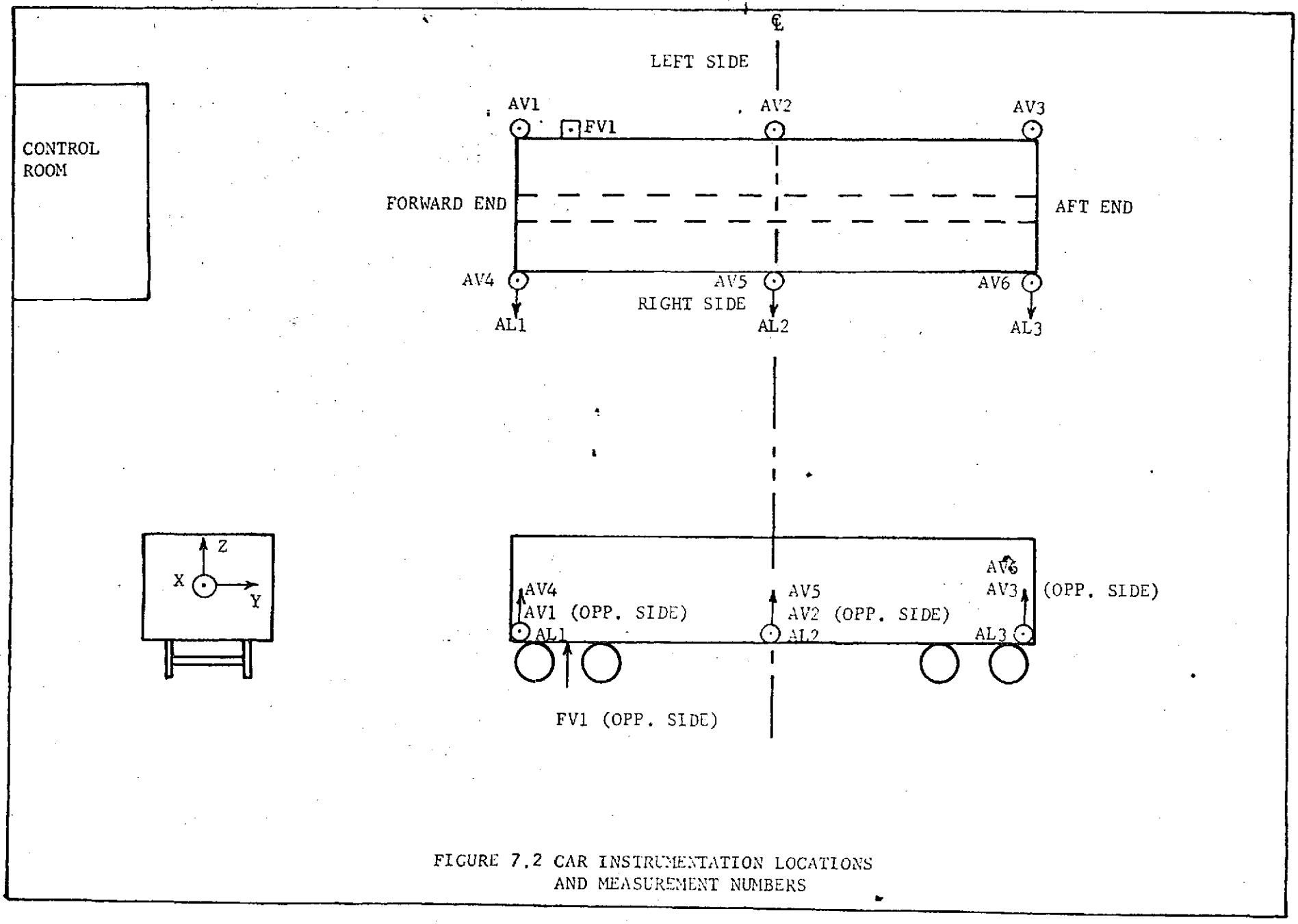
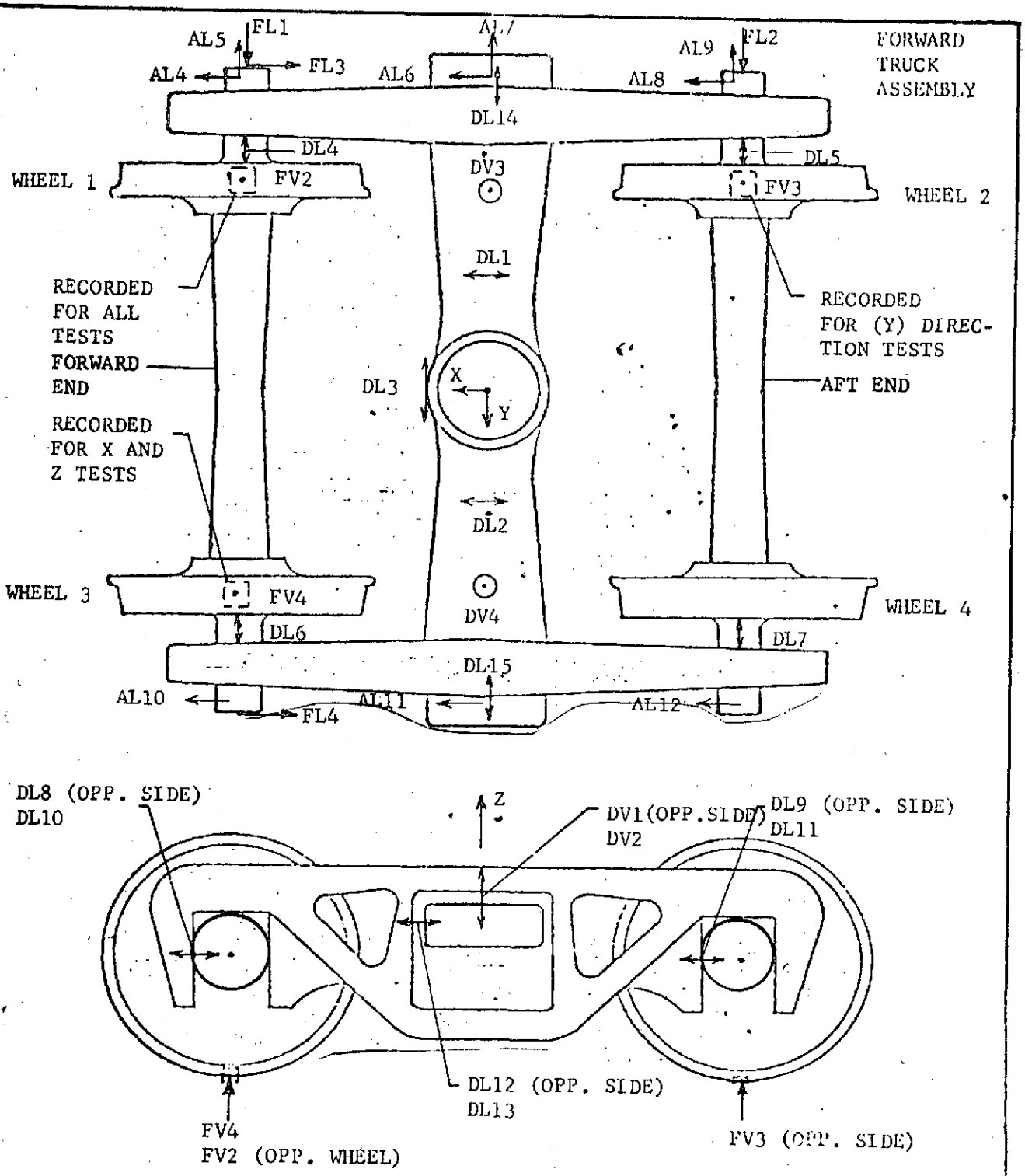


FIGURE 7.2 CAR INSTRUMENTATION LOCATIONS AND MEASUREMENT NUMBERS



NOTES: DL1,2&3 ARE RELATIVE DISPL. OF BOLSTER WRT CAR, ALSO DV3 & DV4
DL4 THROUGH DL11 ARE RELATIVE DISPL. OF SIDE FRAMES WRT AXLE
DV1, DV2, DL12 & DL13 ARE RELATIVE DISPL. OF BOLSTER WRT SIDE FRAMES, ALSO DL14 & DL15

FIGURE 7.3 TRUCK INSTRUMENTATION LOCATIONS AND MEASUREMENT NUMBERS

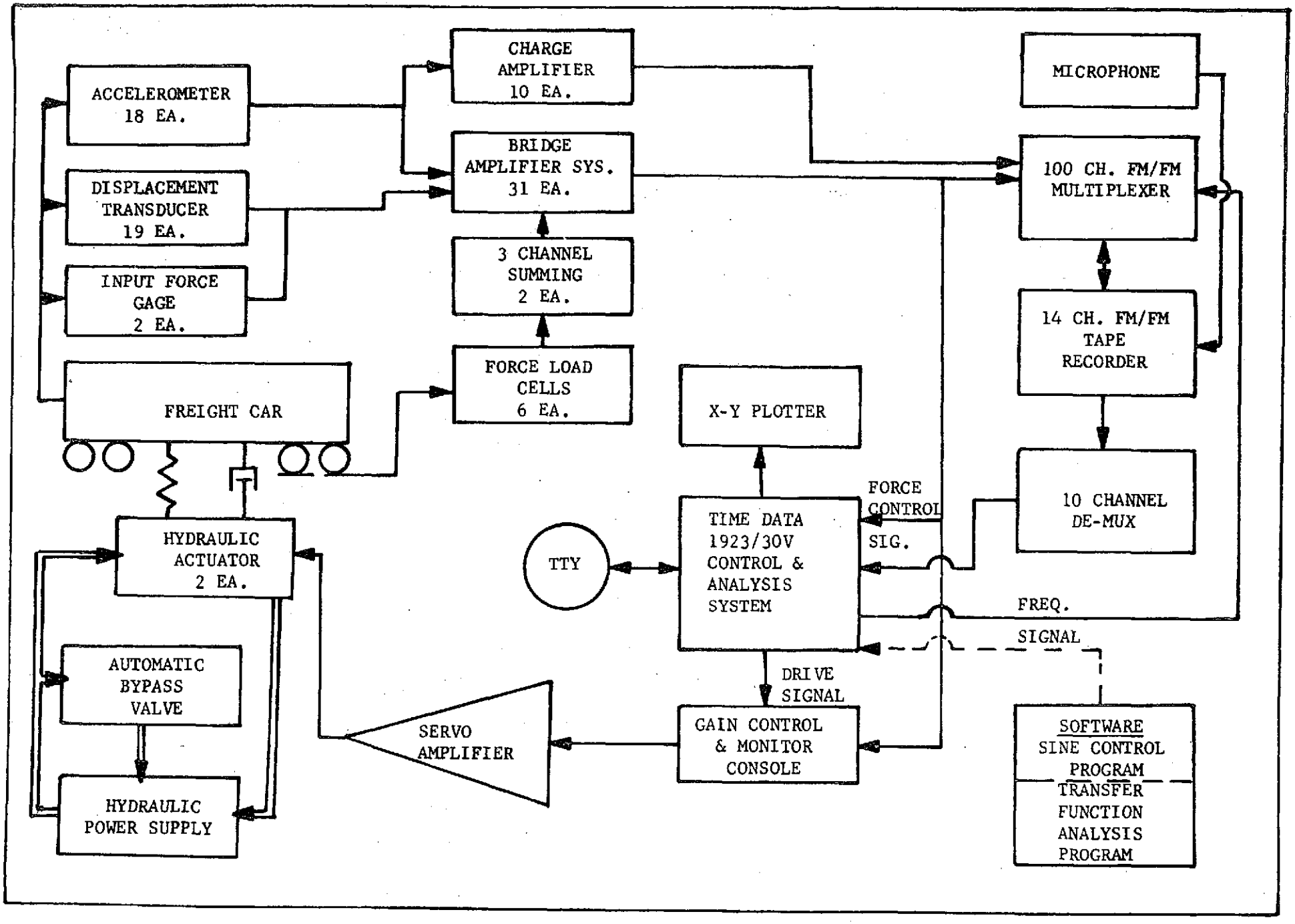


FIGURE 7.4 TEST INSTRUMENTATION & CONTROL SYSTEM
BLOCK DIAGRAM

Table 8.1 HANDLING EQUIPMENT

ITEM NO.	DESCRIPTION	MFG/MODEL NO.	QTY.
1	Facility Crane (20,000 lb. Cap.)		1
2	Facility Handling Slings and Harnesses	MMC	As Req'd
3	Hydraulic Jacks		2
4	Coal Conveyor System		1

Table 8.2 TEST EQUIPMENT

ITEM NO.	DESCRIPTION	MFG./MODEL NO.	QTY.
1	Computer (Shaker Control & Data Analysis)	Time Data/1923 30V	1
2	Shaker Gain Control & Monitor Console	MMC	1
3	Servo Amplifier	MMC	1
4	Hydraulic Actuator	Moog	2
5	Hydraulic Power Supply		1
6	Actuator Support, Slide Plates & Truck Support Assemblies	MMC/LAB 1007302	1
7	Automatic Bypass Valve		1
8	Accelerometer	U-D/75 D 21	2
9	Accelerometer	Columbia/302-2	8
10	Accelerometer	Statham/A5a-2.0, 5.0,10.0-350	8
11	Displacement Transducers		19
12	Load Cell		6
13	Force Gage	MMC	2
14	Charge Amplifier	Kistler/505M111	10
15	Bridge Amplifier	Dana	31
16	Summing Amplifier		2
17	Tape Recorder (FM/FM)	Honeywell	1
18	Multiplexer		1
19	De-Mux		1
20	Cable (100 foot mini-noise)	Microdot	10
21	Equipment Interconnecting & Power Cables		As Req'd
22	Hydraulic Plumbing		As Req'd

TABLE 8.3 TEST MEASUREMENT SUMMARY

MEAS. NO.	TRANSDUCER LOCATION	PURPOSE OF MEASUREMENT	SENS. AXIS
AV1	Car Left Side, Fwd. End	To Meas. Car Vert. (Z) &	Z
AV2	, Middle	Roll (TX) Acceleration	
AV3	, Aft End		
AV4	Car Right Side, Fwd. End		
AV5	, Middle		
AV6	, Aft End		
AL1	, Fwd. End	To Meas. Car Lateral (Y)	Y
AL2	, Middle	Accelerations	
AL3	, Aft End		
AL4	Axle, Opposite Wheel 1	To Meas., Axle, (X) & (TZ) Accel.	X
AL5		, (Y) Accel.	-Y
AL6	Bolster, Left Side	To Meas., Bol., (X) & (TZ) Accel.	X
AL7		, (Y) Accel.	-Y
AL8	Axle, Opposite Wheel 2	To Meas. Axle, (X) & (TZ) Accel.	X
AL9		, (Y) Accel.	-Y
AL10	Axle, Opposite Wheel 3	, (X) & (TZ) Accel.	X
AL11	Bolster, Right Side	To Meas. Bol., (X) & (TZ) Accel.	
AL12	Axle, Opposite Wheel 4	To Meas. Axle, (X) & (TZ) Accel.	
DV1	Btwn. Bol. & Side Frame L. Side	To Meas. Rel. Displ. (Z)&(TX) of	Z
DV2	Rt. Side	Bolster WRT Side Frame	
DV3	Btwn. Bol. & Car Left Side	To Meas. Rel. Displ. (Z) &	
DV4	Rt. Side	(TX) of Bol. WRT Car	
DL1	Btwn. Bol. & Car Left Side	To Meas. Rel. Displ. (X) & (TZ)	X
DL2	Rt. Side	of Bol. WRT Car	
DL3	Center	To Meas. Rel. Displ. (Y) of Bol. WRT Car	Y
DL4	Btwn. S. Fr. & Axle, Wheel 1	To Meas. Rel. Displ. (Y) of	
DL5	2	Side Frame WRT Axle.	
DL6	3		
DL7	4		
DL8	1	To Meas. Rel. Displ. (X) of	X
DL9	2	Side Frame WRT Axle	
DL10	3		
DL11	4		
DL12	Btwn. Bol. & Side Fr. L. Side	To Meas. Rel. Displ. (X) & (TZ)	
DL13	Rt. Side	of Bol. WRT Side Frame	
DL14	L. Side	To Meas. Rel. Displ. (Y) of	Y
DL15	Rt. Side	Bol. WRT Side Frame	
FV1	Btwn. Actuator & Car L. Side	To Meas. Vert. (Z) Input Force	Z
FV2	Btwn. Wheel 1 & Facility Floor	To Meas. Vert. Force @ Wh. 1	
FV3	2	2	
FV4	3	3	
FL1	Btwn. Actuator & Axle, Opp. Wh. 1	To Meas. Lat. (Y) Input Force	Y
FL2	2		
FL3	1	(X)	X
FL4	3		

Table 8.4 INSTRUMENTATION SETUP SHEET

MEAS. NO.	XDUCR MODEL NO.	XDUCR SENS.	SIG. COND. CH. NO.	TAPE CH. NO.	TAPE FS CALIB.	XDUCR S/N	CABLE NO.				
AV1											
AV2											
AV3											
AV4											
AV5											
AV6											
AL1											
AL2											
AL3											
AL4											
AL5											
AL6											
AL7											
AL8											
AL9											
AL10											
AL11											
AL12											

Table 8.4 INSTRUMENTATION SETUP SHEET

MEAS.	XDUCR. MODEL NO.	XDUCR. SENS.	SIG. COND. CH. NO.	TAPE CH. NO.	TAPE FS CALIB.	XDUCR. S/N	CABLE NO.				
DV1											
DV2											
DV3											
DV4											
DL1											
DL2											
DL3											
DL4											
DL5											
DL6											
DL7											
DL8											
DL9											
DL10											
DL11											
DL12											
DL13											
DL14											
DL15											

Table 8.4 INSTRUMENTATION SETUP SHEET

MEAS. NO.	XDUCR. MODEL NO.	XDUCR. SENS.	SIG. COND. CH. NO.	TAPE CH. NO.	TAPE FS CALIB.	XDUCR. S/N	CABLE NO.				
FV1											
FV2											
FV3											
FV4											
FL1											
FL2											
FL3											
FL4											
OSC.	Rockland										
VOICE											

Table 8.5 TEST HISTORICAL LOG

TIME	DATE	RUN NO.	TEST DESCRIPTION	REMARKS